Guided Verbalization for Conceptual Understanding: A scaffold for making sense of multiple traces of cognition

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Learning Case in Focus

- A 6th grade classroom in a remote branch school
- Six students (Girls:Child K,N; Boys:Child Y,N,O,F)
  - They had learned fractional calculation and were of similar performance on math.
- One teacher-experimenter (The first author)
- The first lesson (about 50 min.) at Oct. 1998
  - to think of the meaning of fractional multiplication

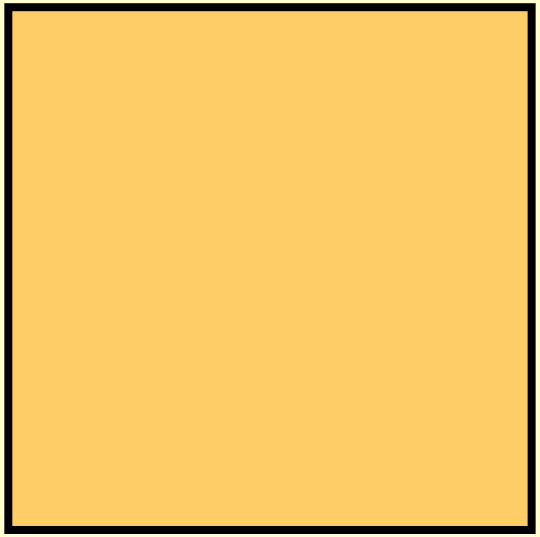
Six months later

- A follow up inquiry at Mar. 1999
  - to ultimately introduce cognitive science

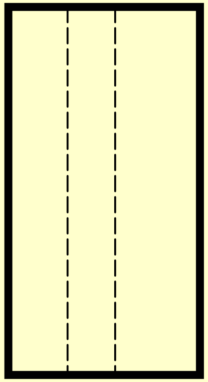

一人一人を
大切にする
クラスに!!
T
G
K
F
N
O
Y

Task in the Lesson

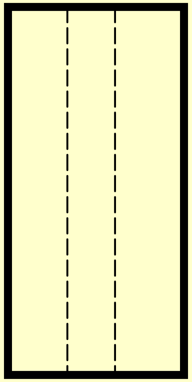
"Please CUT OUT the 3/4 of 2/3 of the origami paper's area"



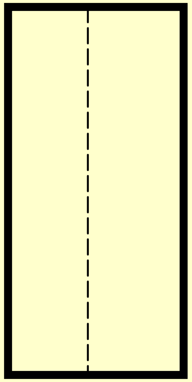
Multiple Traces of Cognition



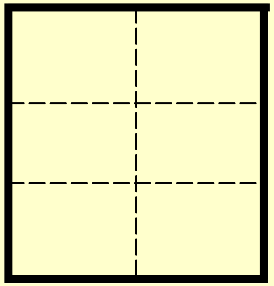
N1, G1, O, F



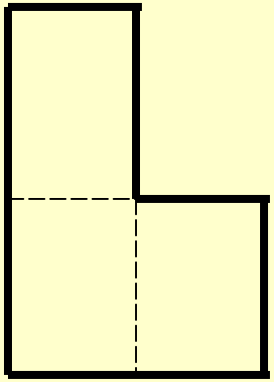
G2



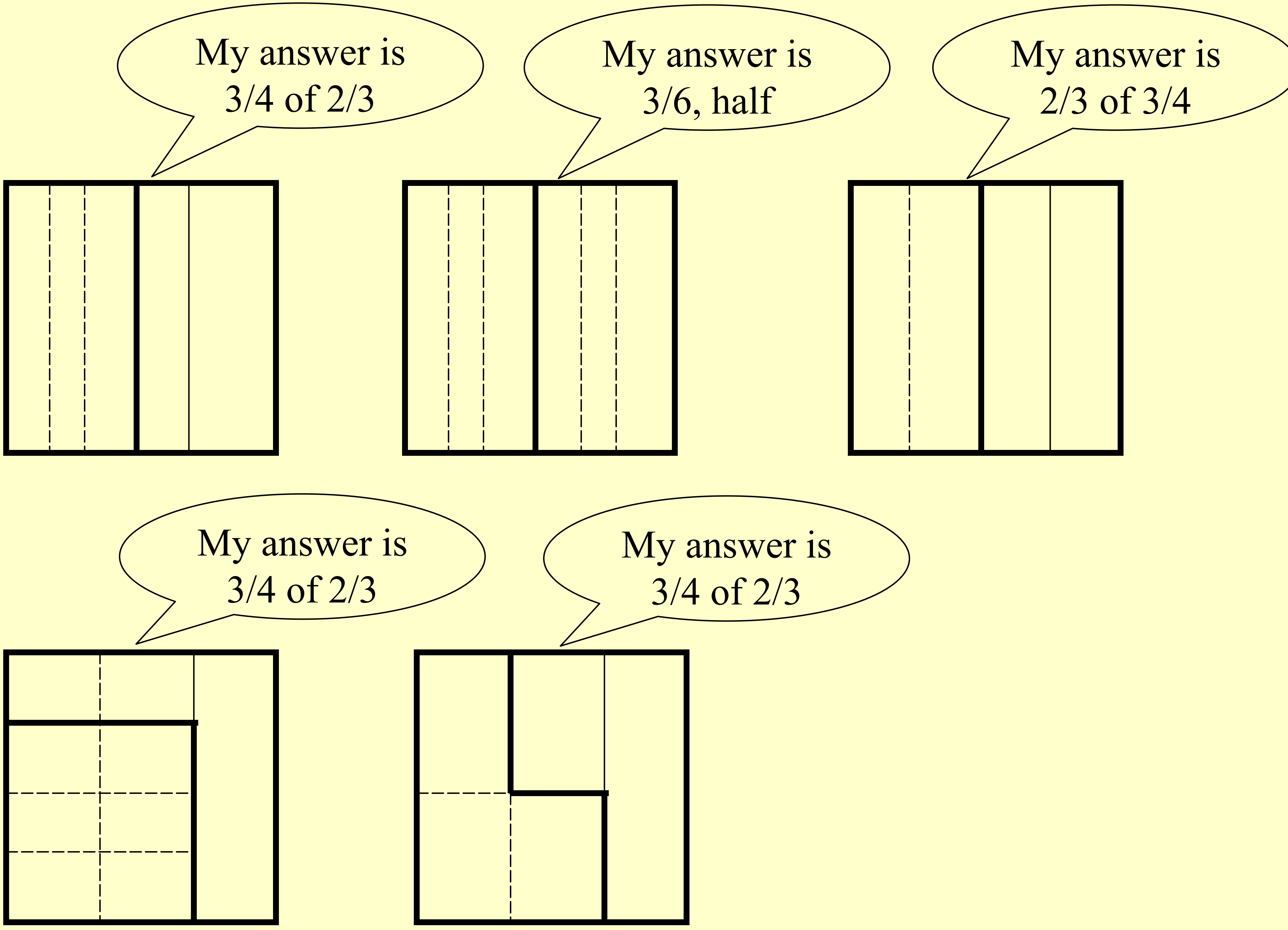
K

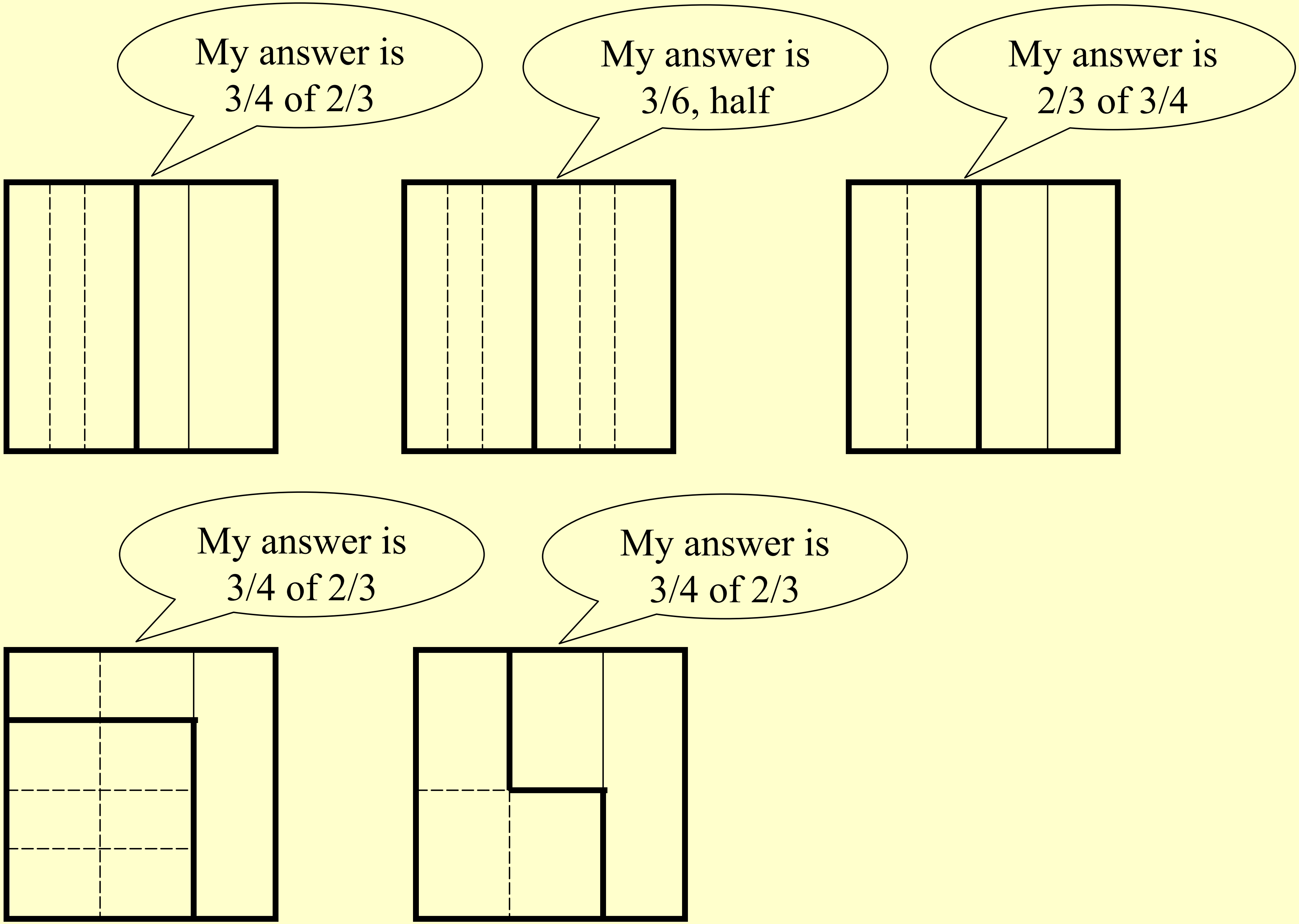


N2



Y


My answer is 3/4 of 2/3
My answer is 3/6, half
My answer is 2/3 of 3/4
My answer is 3/4 of 2/3
My answer is 3/4 of 2/3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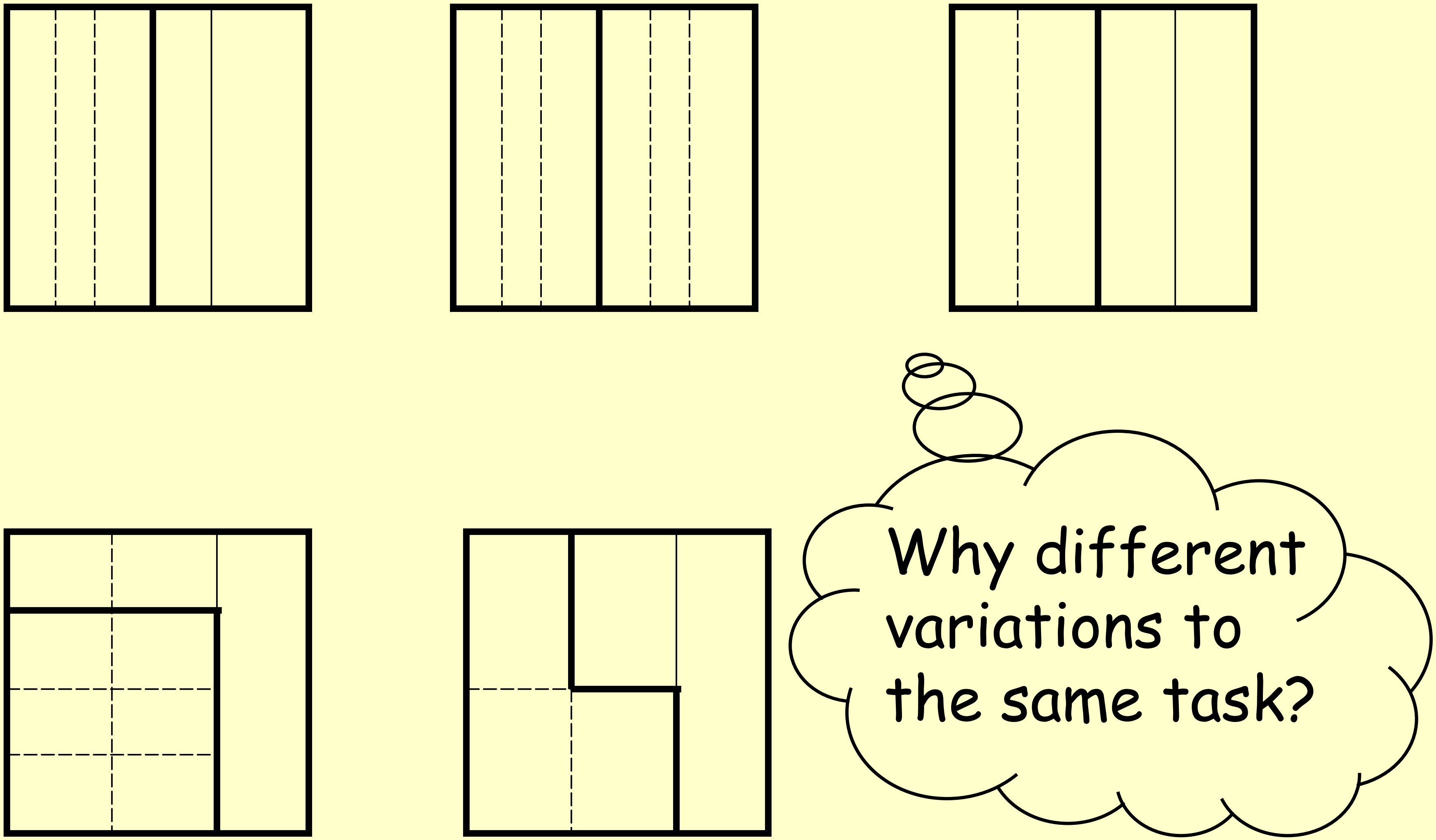
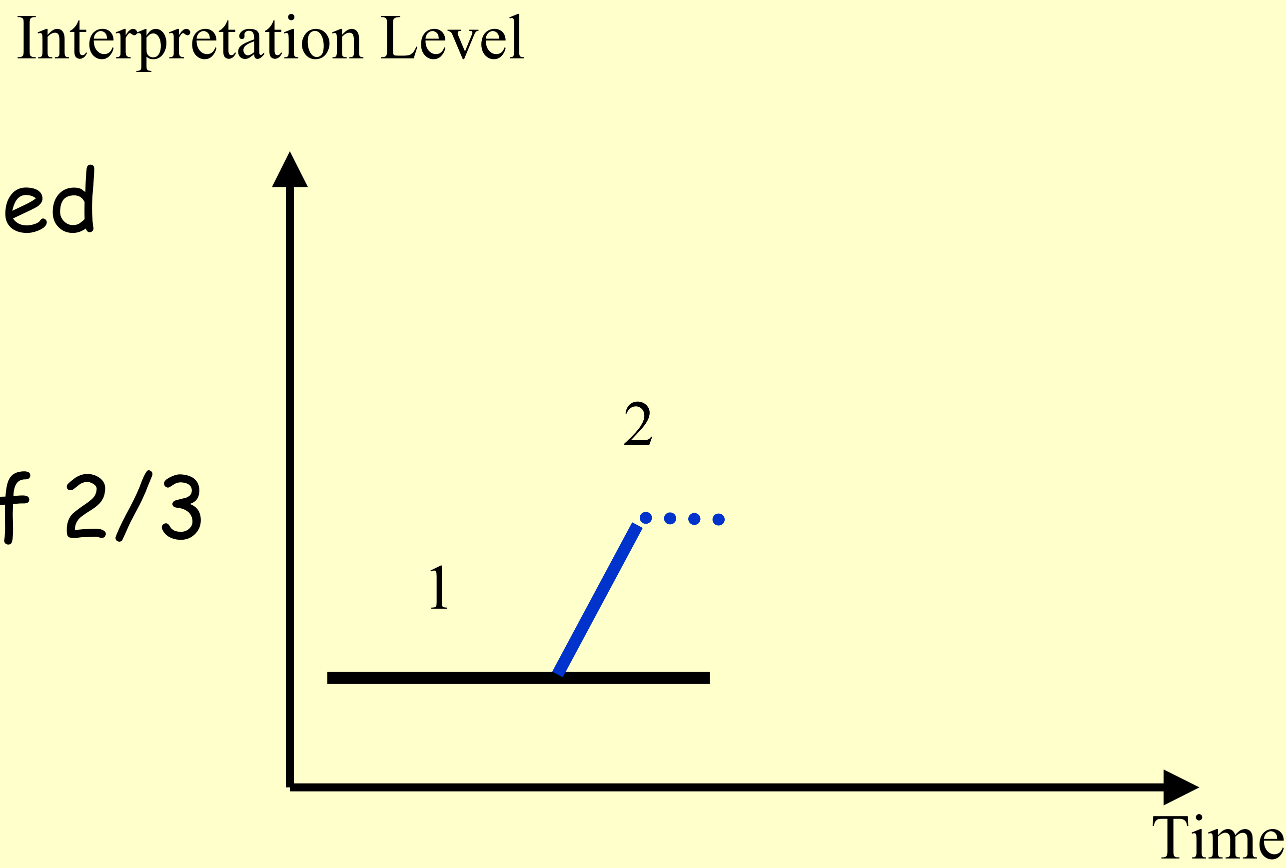
Integration of Multiple Traces

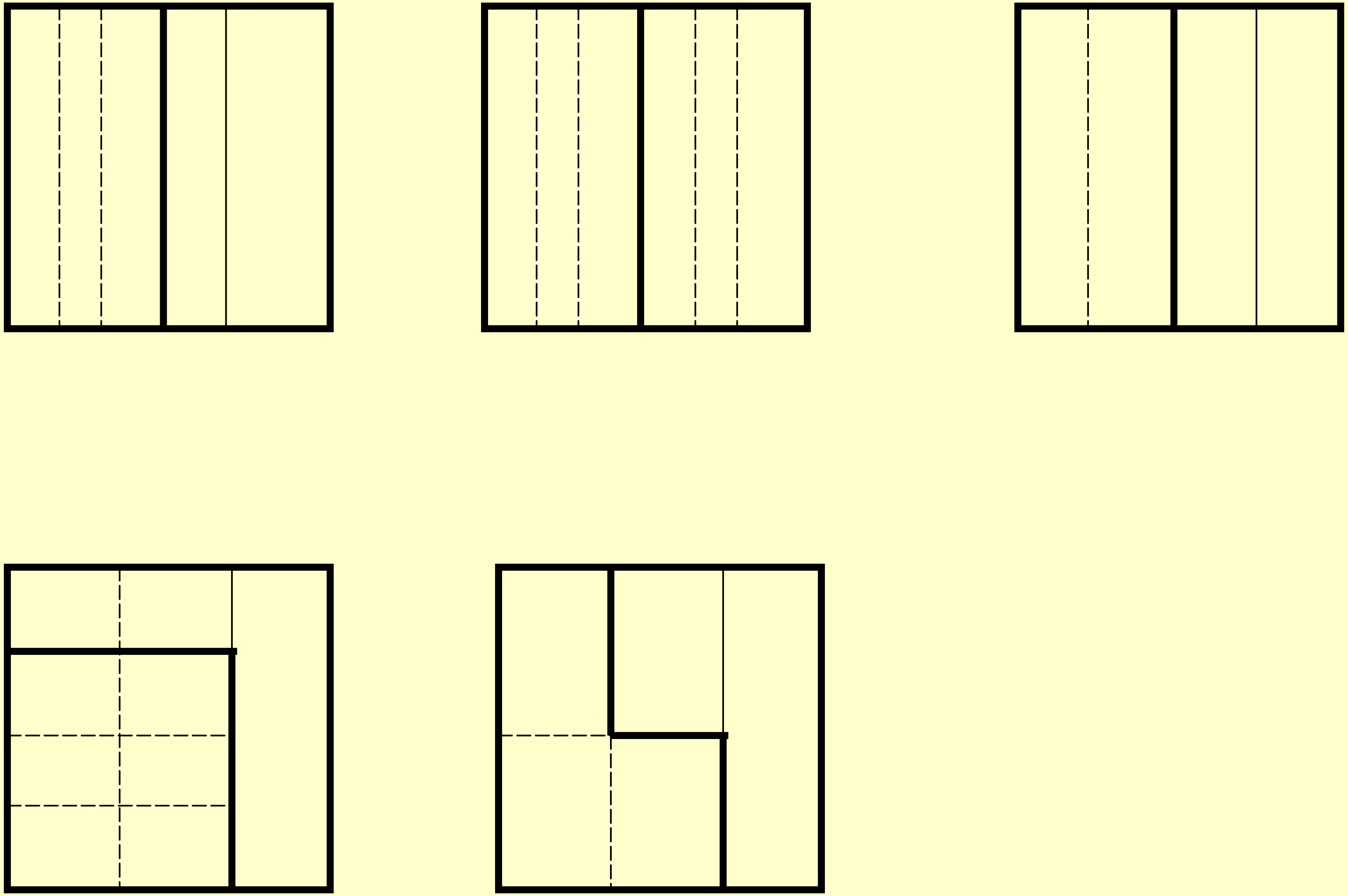


All but G stayed
At level 1

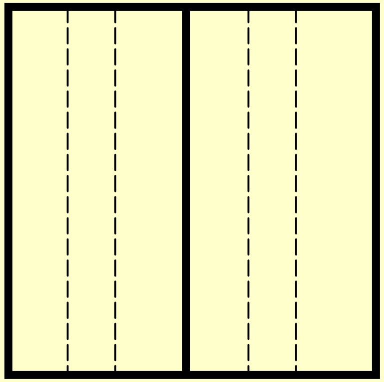
Level 1: 3/4 of 2/3
Level 2: Half



Multiple Traces of Cognition



One Trace   Multiple Interpretation



"3/4 of 2/3 "

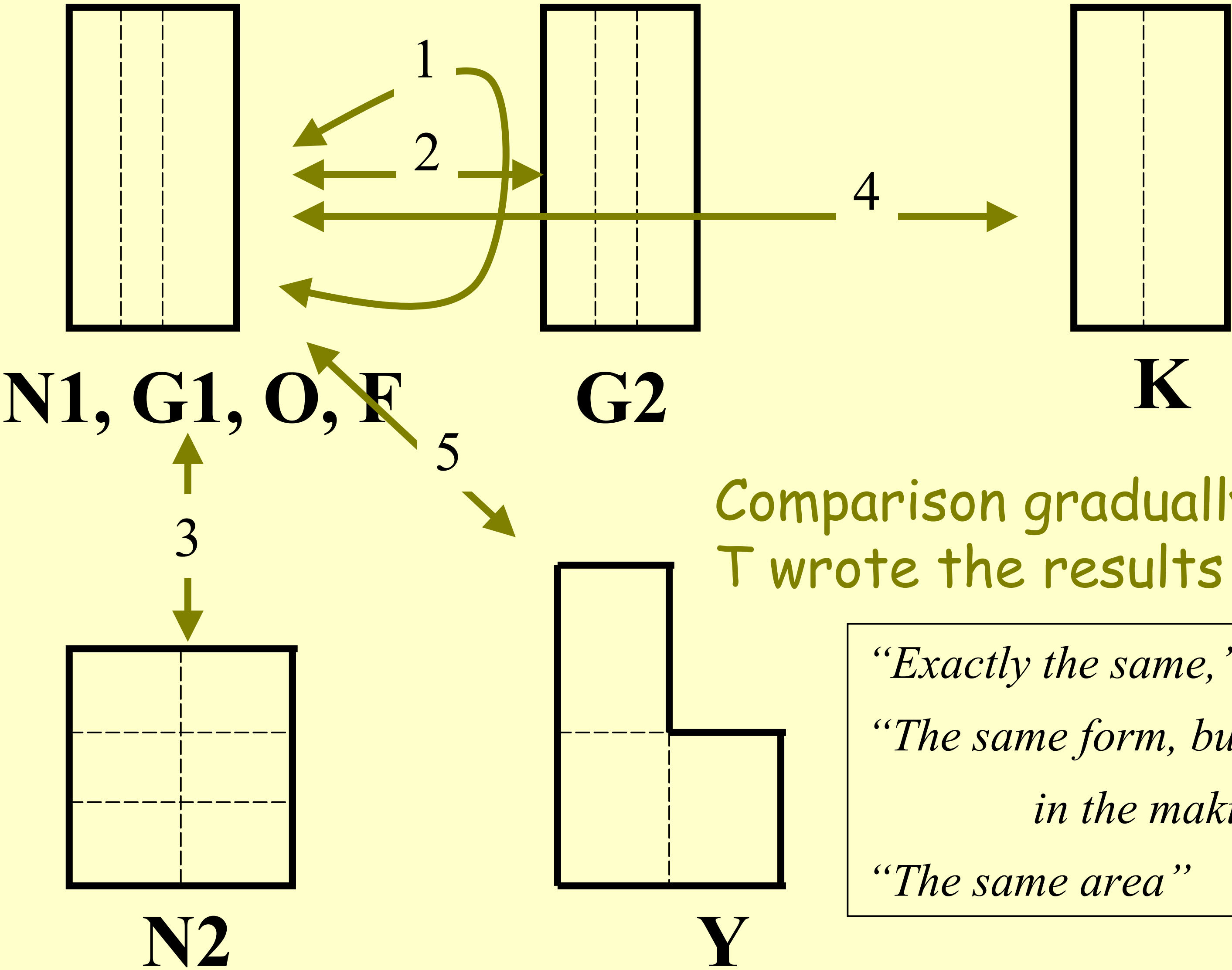
"Three out of six cells"

Degree of abstraction

"Half"

"2/3 X 3/4 = 1/2"

Paired comparison

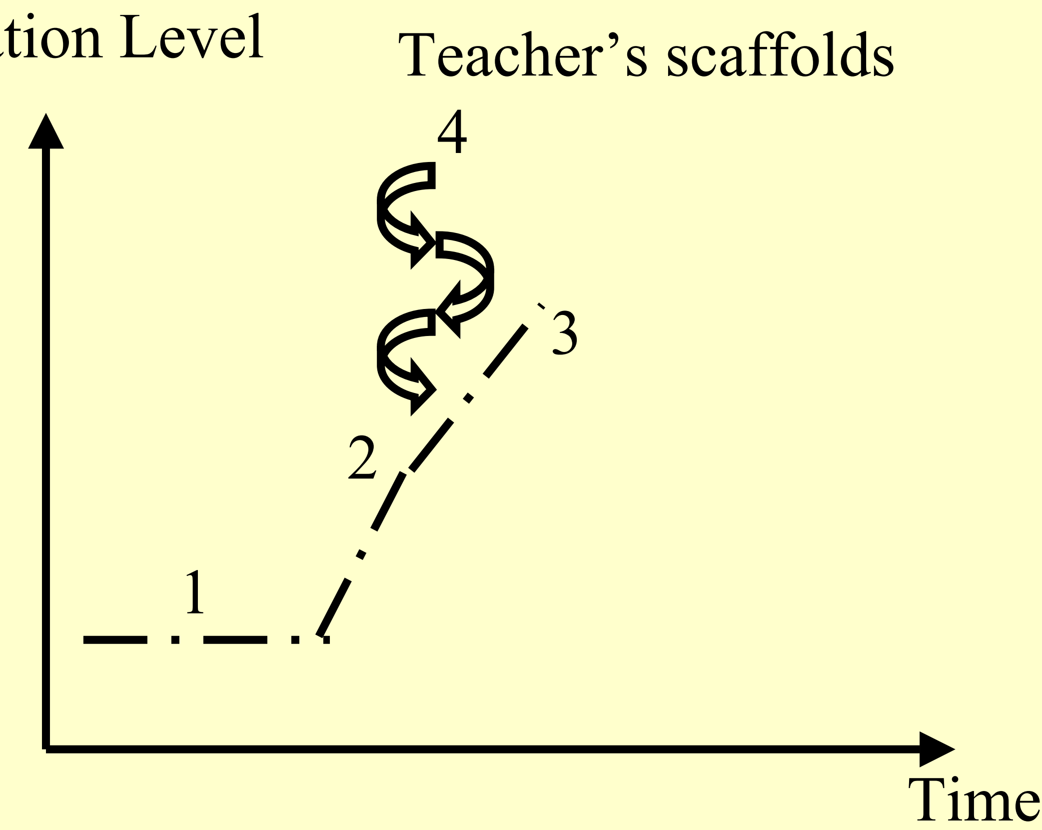


Comparison gradually works;
T wrote the results of comparison,

"Exactly the same,"
"The same form, but different in the making way,"
"The same area"

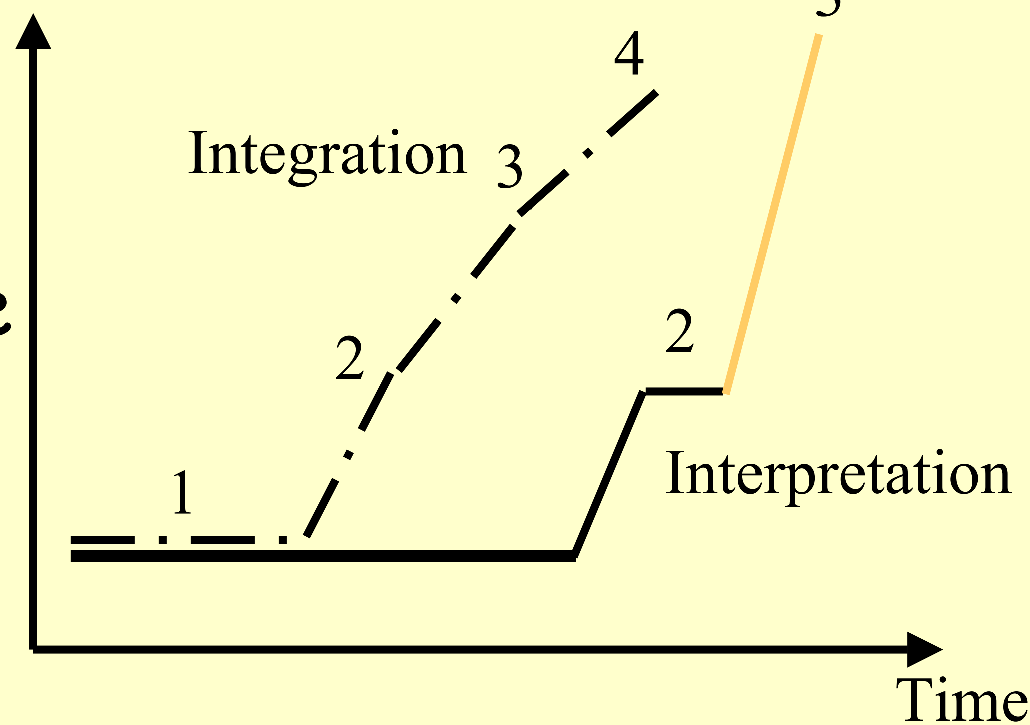
Teacher guided integration process

Level 1: No relation
Level 2: “Self-centered” linking
Level 3: “Among other’s”
Level 4: Integration



Guided integration preceded abstraction

Thinking why variations could be integrated led to the spontaneous verbalization of abstraction



Six months later

- Three out of the six students reported algorithmic point-of-view.

  "Using the origami paper, we made its 3/4 of 2/3 area. Multiplying 2/3 by 3/4 was <u>1/2</u>, and we worked out <u>why it (the goal area) equaled 1/2</u>".

↑

Exposure to Collaborative Learning situation

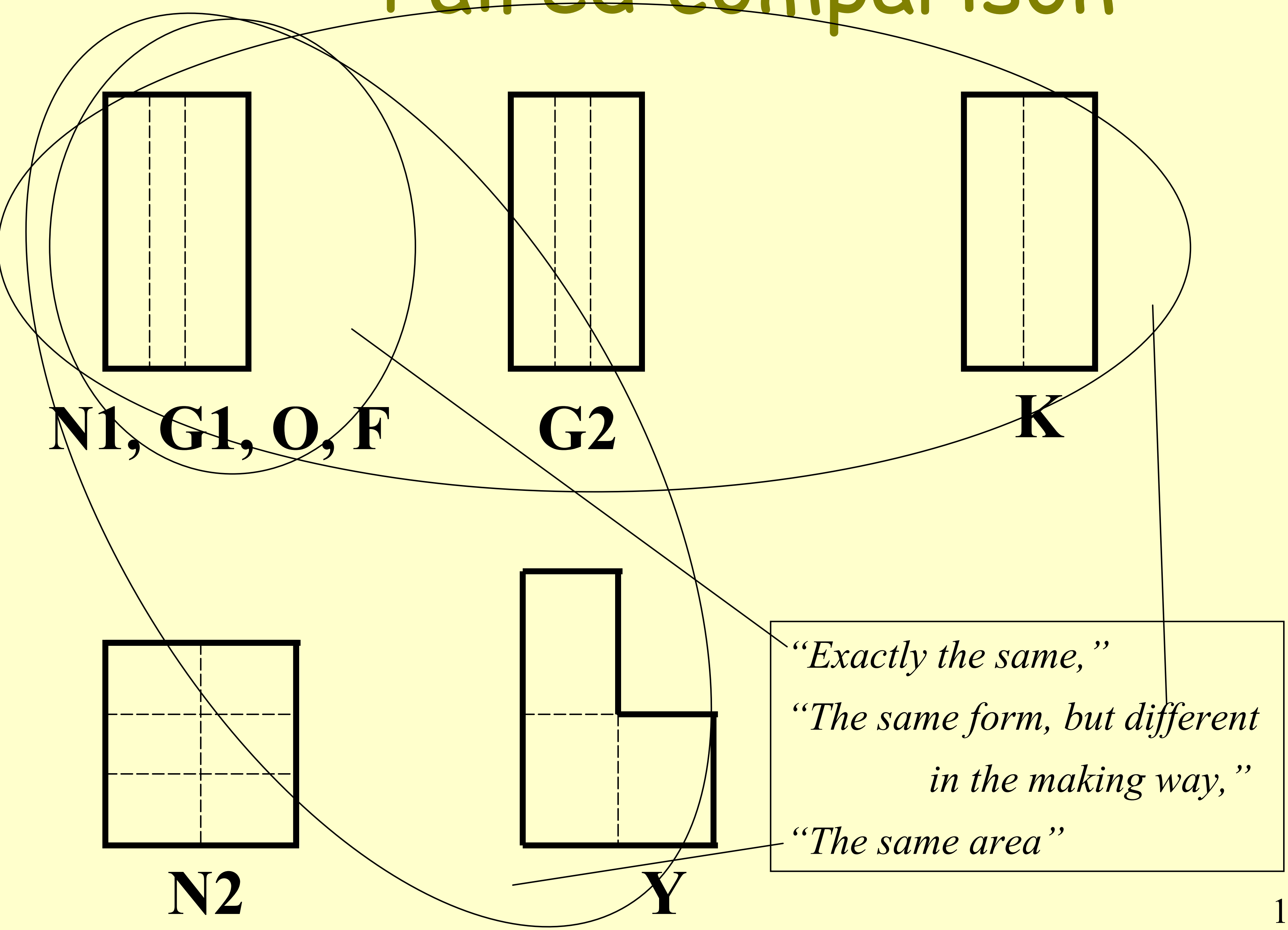
= Variations of verbalization differing in abstraction level

- Individual differences depending on their verbalization

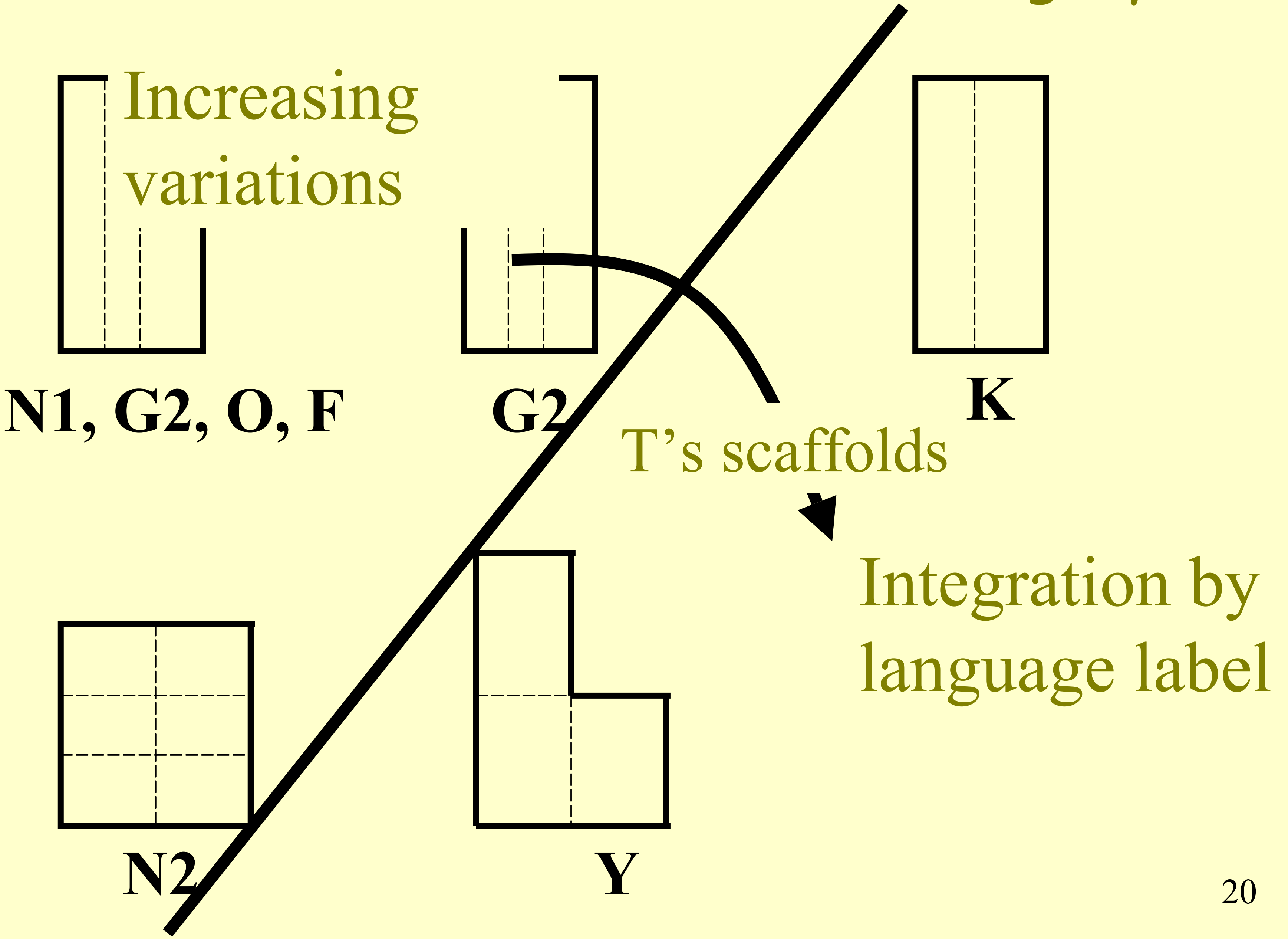
↑

Spontaneous language use (incl. Paraphrasing own thoughts) for abstraction

Paired comparison



Class as An Interactive Learning System



Learners:

Integration of Multiple Traces Of Cognition → Abstraction → Conceptual Understanding

Guide-able by the Teacher's Scaffolds

Learners:

Guided Verbalization

Integration of Multiple Traces Of Cognition → Abstraction → Conceptual Understanding

Seeking the zone

1. T:Next question is, are all of them the same? Oh, you shake your heads, hhh. Cs:…
2. T: Do you want any materials? They would help.
3. T: Do you want particular one? (Leaning over G) Don't hesitate. G:…
4. T: Didn't you say something?
5. T: Is there anybody who thinks the same? (T raising his hand) Cs:…
6. T: Can you say these are the same in this point, but different in that point? Cs:…
7. T: Do you want compare? Cs:…

…Teacher failed seven times.

Traces were integrated by "the area"

T: We have various kinds of the answer: the same in every point, in the form or only in the area. Now, what point is always the same?

Cs: (in a low voice) the area, (in unison) area

/Integration Level 4

T: How wide is it?"

Cs: over, over half (in very low voices)

Y: One-half of the whole

T: One-half of the whole. Why?

Yoshio stood up and came in front of the board. With pointing one of the results, he said:

Traces were interpreted more abstract

Y: If I combine this (the answer) with this (the rest), these equal the original. So I think it is the half. /Interpretation Level 2

Y: The another reason is that the task is to make 3/4 out of the 2/3, so, if I multiply these two fractions, I can see what the answer is in the frame of the whole. And 2/3 times 3/4 is 6/12, which equals one-half. So, all of these (answers) are equal to the one-half of original area. What do you all think about?

/Interpretation Level 3

All: "that's all right" in one voice.

Why four levels? : Analytical Framework

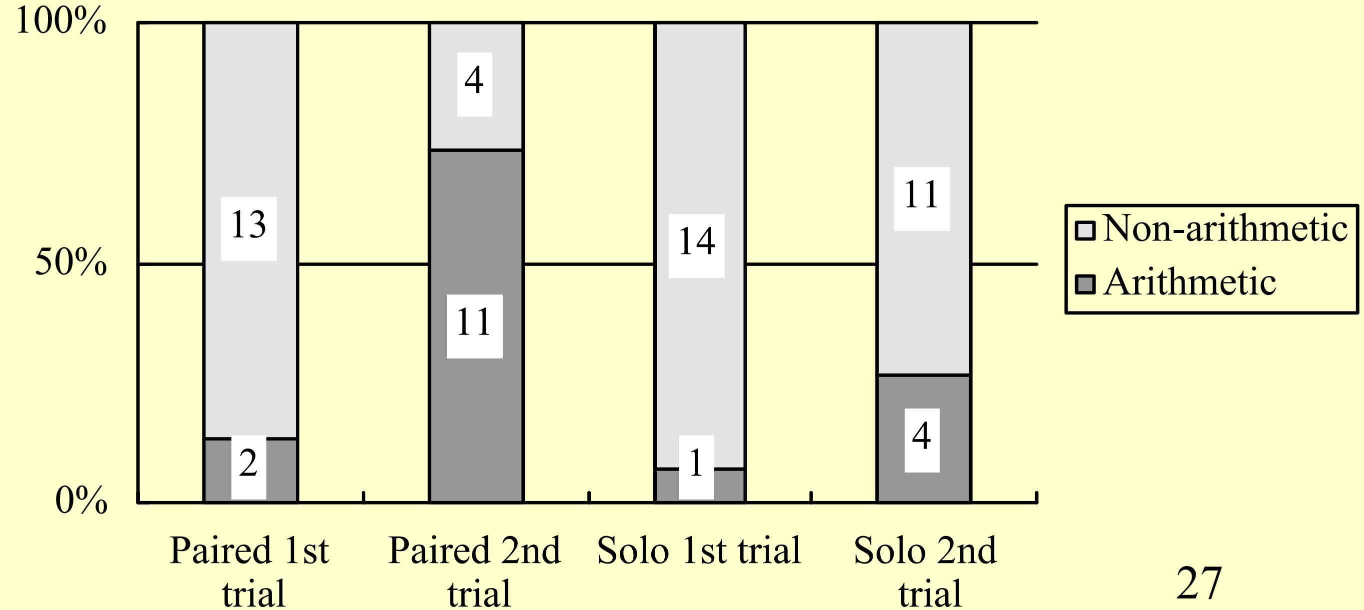
- Paired college students in laboratory experiments gained flexibility in solution through ***verbalization in collaborative reflection upon the externalized trace.***

-- Shirouzu, Miyake, & Masukawa (in print) *Cognitive Science*

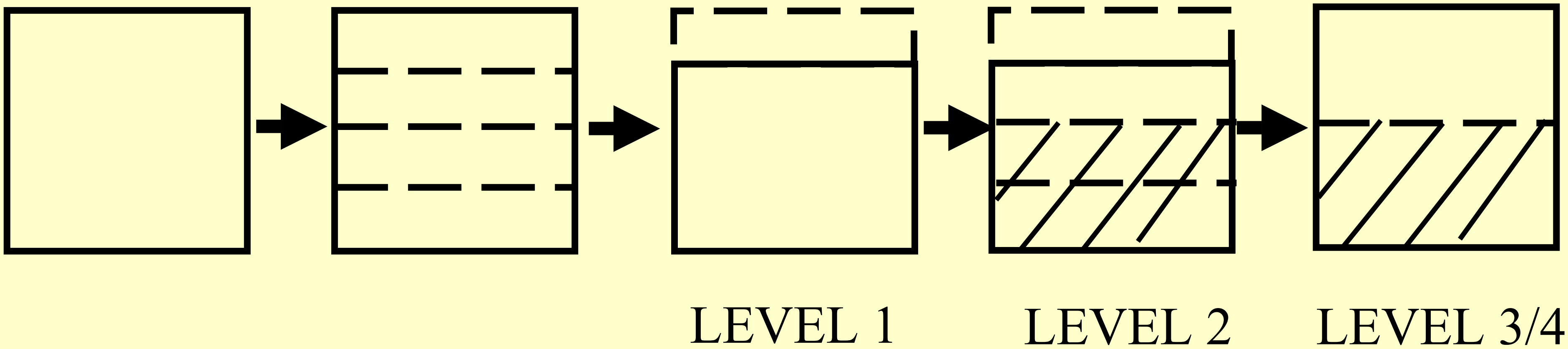
☞ Borrowing this analytical framework to re-analyze the case above.

Pairs' Flexibility versus Solos'

Task: Drawing oblique lines of
1st: 2/3 of 3/4 area
→2nd: 3/4 of 2/3 area



In solving 2/3 of 3/4 problem of the first task,



LEVEL 1: the “3/4” area requiring one more operation of folding
☞ describing the external-dependant solutions as it were

LEVEL 2: the “2/3 of 3/4” area that has already emerged as the answer
☞ foreseeing where the goal area is

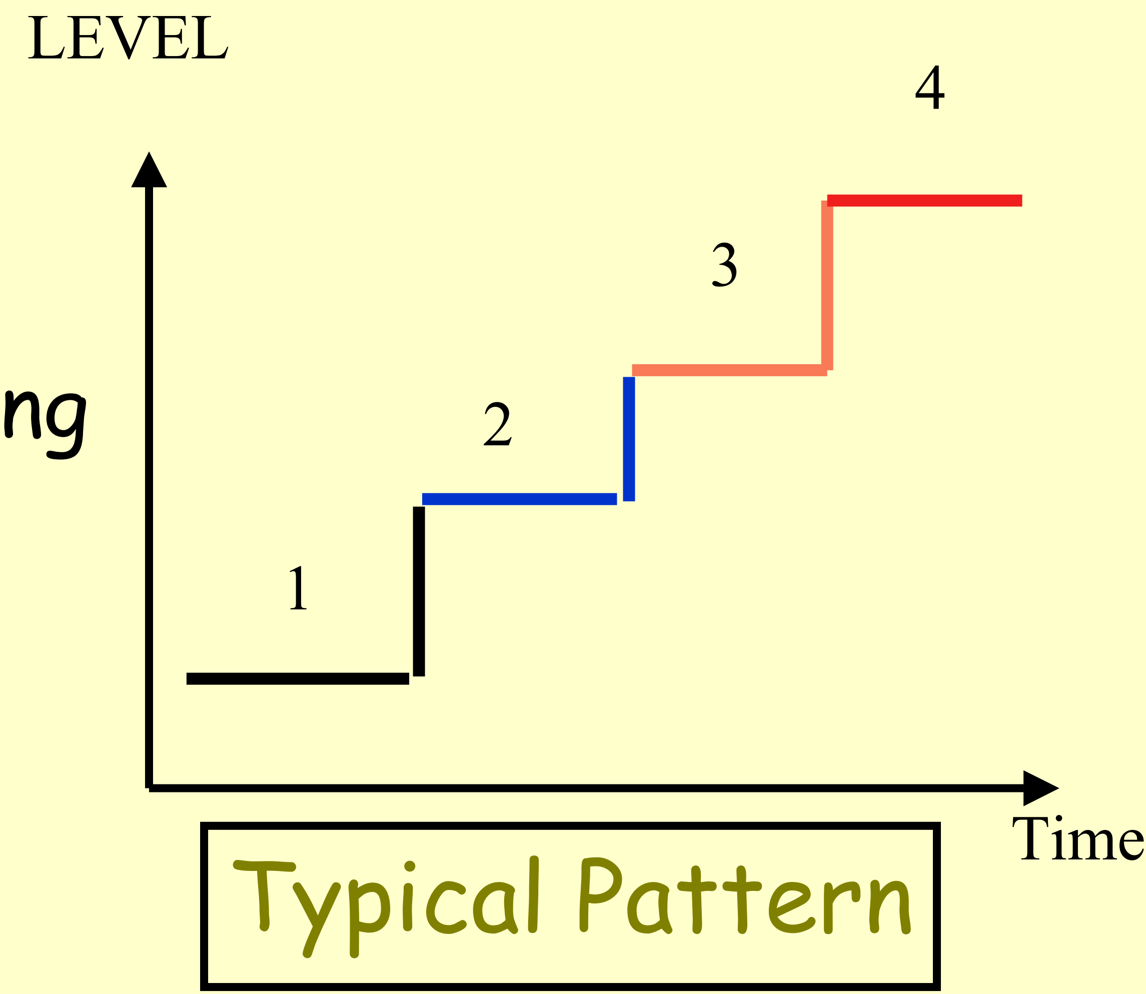
LEVEL 3: the “2/4” area, the “one-half” of the original
☞ seeing the goal area in the frame of the original size

LEVEL 4: the “1/2” area, the answer of the calculation
☞ seeing the goal area arithmetically

Seven out of the nine shifting pairs gradually revised their views on the trace

Triggered by

- Comparison among multiple views
- Think why for reinterpretation



Interests

- Collaborative learning: Shirouzu, Miyake, & Masukawa (in print) *Cognitive Science*
- Supporting Integration Process
- Meta-cognition