PRIMARY CHILDREN'S IMAGERY IN ARITHMETIC

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This paper discusses four ideas about imagery drawn from the domain of psychology and illustrates these ideas using examples from pilot study interviews with primary children.

Introduction

Gray and Tall describe strategies used by primary children to do simple addition and subtraction (Gray and Tall 1994). Low attainers were found to use predominantly counting strategies and, when compared with high attainers, are described as *'doing a different kind of mathematics that is intolerably hard'*, My own experience as a teacher of low attainers in years 5 and 6 agrees with this statement. I have observed the struggle these children have in maintaining a counting strategy. To help the children move to more flexible strategies, I devised a programme based on the manipulation of images of numbers. This programme had some success but the reasons for this were not clear.

My current research follows on from this and is centred on gaining an understanding of the nature and use of imagery by primary children and how use differs according to level of attainment. My research is in a very early stage. I will consider four ideas drawn from my literature survey of psychological research. Examples from early pilot work will be used to examine the connections between the psychological research and primary children's arithmetic.

What is an image?

Kosslyn (1994) defines images as *'internal representations that "stand in for" (re-present) the corresponding objects'* and Horowitz (1978) as *'any thought representation that has a sensory quality'.* The two points to emerge from these definitions are that images are mental representations of actual perceptions and that they involve sensory experiences.

7.

With these criteria in mind are the following examples of imagery?

- A drawing of dots to represent a million
- A description of subtraction using a decomposition algorithm
- A description of addition using a 'flying arrow' (fig. 1)
- Silent table chanting

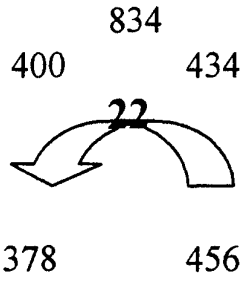

Figure 1: flying numbers

Of the four, the drawing of dots seems to be the most likely image. However, it is not based on an actual perception because the child had never seen a million dots. The drawing is based on a mental picture of a million as a large number. The taught algorithm and flying numbers were descriptions of mental 'pictures' of how the tasks were carried out and so could be classed as images. Both were produced by high attainers and rely heavily on symbols. The interviews showed that high attainers were able to manipulate 'mental symbols'. Others required pencil and paper to produce a result, so moving the task from a mental to an actual manipulation. The final example is given as a possible use of an auditory image. This adult, when asked 7 x 8, backtracked to 3 x 8 and then silently chanted to 7 x 8. In these examples, images are used when a mental

manipulation takes place based on original visual or auditory sensory inputs.

Imagery in action

The idea of mental manipulation of images is supported by Kosslyn's (ibid.) theory of image generation (fig. 2).

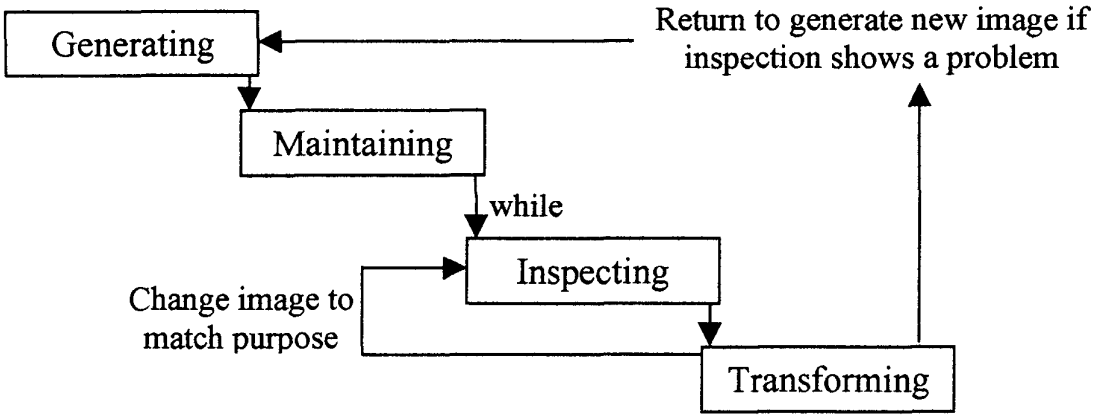

Figure 2: Kosslyn's theory

One adult described *'scanning the sum to see whether it would be difficult* '. William described getting a picture of a sum without noticing individual numbers, then slowly focusing on the numbers. In both cases the image was maintained during inspection. Transformation of an image can be seen in Lily's description of 8 + 5 (fig. 3).

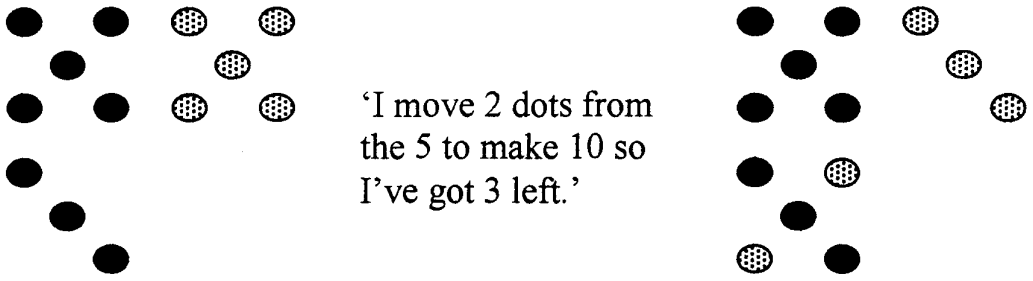

Figure 3: Lily's 8 + 5

Lily needed to generate the dot patterns for 8 and 5, maintain them while she considered what manipulation was needed and then transform the 8

into a 10. Transformation is a dynamic stage with the images flowing from one to the other rather than one disappearing and the next reappeanng.

Imagery as a knowledge-weighted process

Intons-Peterson and McDaniel (1991) discussed the role of knowledge in the use of imagery. They said that *'the more familiar we are with a task, the more likely we are able to create an elaborate "knowing image* '". They also stated the opposite *'the less familiar we are with a task, the closer the imagery is to the original perceptions'*. Looking at examples from the pilot study work, adults showed more creativity than children. F or example when working with subtraction, the children tended to follow each stage exactly as taught, whereas adults jumped or combined stages. High attainers were more creative in their arithmetic methods, for example using 'difference methods' for subtraction (fig. 4).

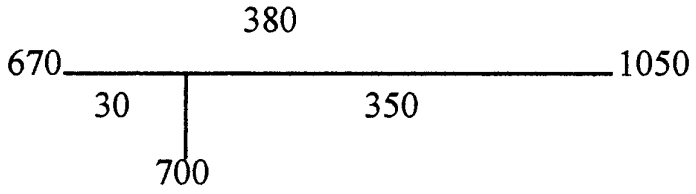

Figure 4: Claire's subtraction 1050 - 670

In this example Claire, generates an image of a line, partitioned at 700. She then focuses first on 700 to 1050, then on 670 to 700. Finally she regenerates the whole image to add the two sections. Kosslyn's stages can be clearly seen as she maintains, inspects and transforms the image but the whole process is based on a creative use of her knowledge of the number system and her understanding of the subtraction operation.

The interviews yielded examples of children using their everyday knowledge to assist them in forming images. Images for minus 4 included

a thermometer, throwing snowballs, sliding on ice and goose bumps. The latter was accompanied by shuddering, the only example I found of a kinaesthetic image.

Imagery as a mediator in learning

Paivio (1971) describes imagery and language as *'mediators in learning'*. Mediation could be thought of as scaffolding. Images are helpful in helping children to make sense of what they are learning and to remember what they need to know. Using the definitions given earlier, imagery is a mental activity and therefore would be a form of self scaffolding in the later stage of Vygotsky's Zone of Proximal Development (Tharp and Gallimore, 1988). Lily's dot images were being used as such a scaffold. These images had developed after specific image teaching (assisted learning in the earlier stage of the ZPD). Another example from the pilot study shows an image spontaneously created by a child and then used consistently in subsequent work. Daniel wrote 101 as 1001. During help to correct this problem, he suddenly pointed at the final zero of the hundred and said 'It's like a bomb exploding and becoming a stick!' The drawing in figure 5 followed. It was this visual image rather than the verbal description that was retained for further use.

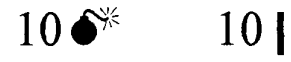

Figure 5: Daniel's image

Final thoughts

Images are internal thought processes and as such are hidden from view. The external expression of images, whether a verbal description or put on paper, does not necessarily match the internal processes. The pilot study has shown that there are many problems in validating images, particularly those of very young children. This is why the images presented in this

paper are those of older children (aged 9, 10 and 11) and adults. The technique associated with grounded theory has been used to check data, both by use of selected tasks and by direct checking of drawings and statements. At this moment in time, work with younger children is still being developed.

Even with this major qualification, I have found that the psychological research considered in this paper could be linked to examples in my pilot study.

References

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