Mathematics and Memory

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An all too common scene in the home during the evening: a child sits at the kitchen table, staring at math pages with her head held in her hands. Time ticks by. Sometimes tears are involved in the scene, sometimes anger or rage, but the scene does not change. As parents, we long to help our children, yet we often feel inept or too far removed from mathematics or teaching.

Students who struggle often understand math problems while at school, or while sitting with a tutor, but, given time alone with the subject, they draw a blank. By taking a closer look at the relationship between memory and mathematics, we can begin to unravel the mystery of why the learning of mathematics does not always stick in the minds of those who study it.

The development of memory is of great importance to the advancement of the ability to think. In turn, this maturity of thinking, in conjunction with development of other capacities, is of great significance to the ability to perform math. In any study of memory, it is helpful to begin with the first three years of life, when memory forms in three distinct ways: localized memory (movement memory), rhythmical memory, and picture memory.[1]

Localized memory (movement memory), which begins in the first year of life, is created out of our limbs. Infants use their arms, hands, legs, feet, and tongue to feel and to remember during this early stage of life. Out of the bodily experiences of moving themselves and the objects in their environment up and down, left and right, backwards and forwards, they develop a sense of movement, of balance, and of the space around them. These bodily experiences lead to the ability to move inwardly, through thought, and to remember. During the first three years of life, if the young child's movement is overly restricted or confined, this faculty of memory may need some additional strengthening work during the later school age years. Long periods of time strapped in car seats, baby carriers, and strollers may further hamper the natural development of this fundamental form of memory.

When it comes to mathematics, this underdevelopment of movement memory may first show up in kindergarten or first grade. The pupil may experience difficulties with place value and the meaning of a number, called "number sense." This is because the child may not have had sufficient bodily experiences of moving around various numbers of objects, or of counting and sorting, during earlier stages of development. It may also become apparent in second grade when borrowing and carrying begin. Around the third grade, weakness in localized memory may become apparent when long division is attempted. Without the ability to move their own bodies and the objects around them, children cannot move around comfortably within the context of all the operations (multiplication, addition, subtraction) and locations (left, right, above, below, forward, backward) in a long division math problem.

When these challenges present themselves, it is helpful to take the child back into movement in order to strengthen the memory before proceeding with the mathematical problem. Activities may consist of large bodily gross motor movements (such as zoo exercise movements, jump rope, skipping, and bean bag tossing) and fine motor movements (such as exercises using blocks, counting sticks, beads, beans, and proper pencil grip). Children with weak localized memory may be helped in their math lessons by moving every mathematical problem in a concrete form first, using their limbs and handling objects that can represent the thoughts.

In addition, a child exhibiting these weaknesses needs permission to stay at that stage of learning in order to explore the objects that make the math true before moving to the next stage. Fortunately, in Waldorf schools, many teachers recognize the importance of movement in learning and memory formation and thus support additional movement classes such as the zoo exercises

1. König, Karl. *The First Three Years of the Child*, Edinburgh: Floris Books, 2004.

in the second grade, "extra lesson" classes or exercises, and curative eurythmy.

The second step in the development of memory involves rhythmical memory formation. This aspect of memory is related to the use of speech and song during the second year of life. We see this clearly in a child's first words, "Mama" for mother or "Dada" for father or "baba" for bottle. Sometimes this rhythm is stretched out further, making the pattern more apparent: "Mamamama…." Every new word is repeated and repeated. In these speech patterns the small child is forming rhythmical memory. The person or object, in this case mother, is remembered through the rhythm of the sounds. Later in school, this faculty of memory is called upon when the child sings a song to help remember the names for the days of the week or the states of a country, or when it creates a rhythm to memorize the multiplication tables.

The risk of moving to rhythmical memory too early in school is that if children have not sufficiently touched and moved with their limbs what is now being taught in rhythm, they have little or nothing of inner experience to connect to the rhythm. Thus the rhythm, while it may be fun, will not necessarily lead to independent thought formation if presented too early. Although many children may get caught up in the songs and rhythms of the classroom, when asked later to reproduce them independently, they may struggle and perhaps even fail in their attempts. Teachers often see this in the children who find it challenging to say their multiplication tables forward and backward on their own. With the help of classmates, they participate fully in the reciting and chanting of the tables, seeming to grasp the math facts, but without the group to carry them externally, they struggle to reproduce these tables independently. In such cases a parent or teacher can take the children back to the localized memory stage with work involving their limbs and objects able to be touched and manipulated, then work with verses, poetry, story, and speech.

Picture memory, the third step in the formation of memory, develops in small children through their use of imagination and storytelling or fantasy play in the third year of life. Here the inner "movie screen" comes into being; the ability to see in the "mind's eye" develops. This faculty is of paramount importance in the study of higher mathematics, specifically the work with abstract ideas. Conditions that contribute to deficiencies in the creation of the picture memory include environments with screens such as television and computer, since these screens provide completely formed images. They obviate the need for inner picturing. Reading and pretending with children consequently support the growth of picture memory. Beginning with pre-algebra in the middle school years, this faculty of inner picturing can be enhanced through the use of stories, images, and color-coding of the work.

Children who struggle with mathematics are trying to tell us something. Often it is not so simple as a dislike of the subject matter itself. There is an underlying reason. When we use a student's struggle as information in a critical but judgment-free way, we can support and heal the child.

I am a willow of the wilderness,
Loving the wind that bent me. All my hurts
My garden spade can heal. A woodland walk,
A quest of river-grapes, a mocking thrush,
A wild-rose, or rock-loving columbine,
Salve my worst wounds.

– Ralph Waldo Emerson