

accommodation. Logical operations are means of organizing experience (schemata) that are superior to prior organization.

According to Piaget, an operation always has four characteristics: (1) It is an action that can be internalized or carried out in thought as well as materially; (2) it is reversible; (3) it always supposes some conservation, some invariance; and (4) it never exists alone but is always related to a system of operations (Piaget 1970a, pp. 21–22). Operations become truly logical during the concrete operational stage. Previous operations (at the preoperational stage) were prelogical, never meeting all the above criteria. One logical operation, already discussed, is reversibility. Two other structures central to concrete operations are *seriation* and *classification* (Piaget 1977a). These two logical operations are basic to the child's understanding of number concepts (Wadsworth 1978; Gallagher and Reid 1981).

### **Seriation: Ordering Objects According to Differences**

Seriation is the ability to mentally arrange a set of elements accurately according to increasing or decreasing size, weight, or volume. The ability to seriate *length* develops throughout the preoperational and concrete operational stages. The task usually used by Piagetians to assess knowledge of seriation of length is a simple one. A child is presented with a set of approximately 10 sticks varying in length by small but perceptible differences (1/4 inch). The child is asked to order the sticks from the smallest to the largest. The examiner may show a properly arranged construction prior to asking the child to make his or her construction. Piaget's research discerns five levels in development of seriation of length knowledge.

At the first level, age 4 or earlier, children typically place some of the sticks in a construction, with no order discernible. At Level 2, children construct pairs comprised of a small stick and a large stick, but their constructions show no relationship between pairs. Any stick can be placed

