**The Challenges in Learning about Volume**

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Size matters for young children as well as scientists. Children need to account for the size of things when picking them up (how far apart do you need to move your hands to catch the beach ball), or when putting things on shelves, in drawers, or in closets, or in selecting portions of peas. Further, some information about the relative size of objects is directly “given” in visual perception—such as when judging the relative sizes of the three bears (Papa, Mama, and Baby Bear) and their contrasting bowls, chairs, and beds.

Yet young children's concept of “object size” is quite different from scientist's concept of “volume.” Children judge how “big” something is holistically by looking—something that works reasonably well only when things are the same shape or when they are bigger in all dimensions. For most solid objects, whether something fits in a space depends more on its shape and particular dimensions than its abstract volume. Children's concept of size is quite undifferentiated; they pay attention to different features in different contexts. A big drink is different from a big dinner (probably lots of courses or different items), a big person (older, taller, heavier), or a big closet or room (how high the ceiling, how much it holds), or a big party (number of people). When children think and talk about size, they have some words to talk about size generally in a global, undifferentiated fashion (large, small, big), some words to talk about different spatial dimensions that typically focus on lengths (tall, long, wide, deep, thick, fat, skinny) and about shape (round, circle, square, heart-shape, cone-shape, star, etc.), but no words to specifically talk about volume. Although some words for specific volume measures are common in everyday life (a cup, a tablespoon, a gallon, a quart), different units are applied in different contexts and children most probably think of them as a measure of a certain amount of milk or flour, rather than a measure of its volume. In this sense, they haven't differentiated volume from amount of stuff.

Thus, the challenges in learning about volume are even more daunting than learning about weight. Whereas children enter the class with an intuitive concept of weight that they can not only name but also relate fairly easily to the balance scales, they do not have an intuitive concept of volume that is clearly differentiated from length, area, shape, or amount of stuff. Indeed, children have no way to accurately judge the volume of an object independent of its shape without having some system of formal measurement. For this reason, the very construction of a concept of volume goes hand in hand with learning to measure it. Further, there are several different senses of volume that need to be distinguished and inter-related to have a robust conception of volume. Take, for example, a can of soup; first there is the amount of space occupied by the can, second there is the amount of material (tin) the can is made of, and third, the space (volume) inside the can whether empty or full. For this reason, we choose to foreground weight and materials in our third-grade curriculum, leaving volume to be foregrounded in the fourth grade once children had a better sense of materials and how to measure weight. Nonetheless, in third grade, children begin to contrast weight and size and discuss different senses of taking up space. They also develop simple measures of the volume of objects made of solid materials (e.g. chunks of wood, clay) by building replicas with centimeter cubes, and explore how changing the shape of the object does not change its volume.

—Carol L. Smith