Number is Different from Quantity

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Number is different from quantity. This difference is basic for any sort of theorizing in behavioral science, any sort of imagining of what goes on between organisms or inside organisms as part of their processes of thought.

Numbers are the product of counting. Quantities are the product of measurement. This means that numbers can conceivably be accurate because there is a discontinuity between each integer and the next. Between two and three there is a jump. In the case of quantity there is no such jump, and because jump is missing in the world of quantity it is impossible for any quantity to be exact. You can have exactly three tomatoes. You can never have exactly three gallons of water. Always quantity is approximate.

In other words, number is of the world of pattern, of *gestalten* and digital computation, while quantity is of the world of analogic computation.

Even when number and quantity are clearly discriminated there is another concept which must be recognized and distinguished from both ‘number’ and ‘quantity’. For this other concept there is, I think, no English word and we have to be content with remembering that there is a sub-set of ‘patterns’ whose members are commonly called ‘numbers’. Not all ‘numbers’ are the product of counting. And indeed it is the smaller - and therefore commoner ‘numbers’ that are often not counted but recognised as patterns with a single glance. Card players do not stop to count the pips in the eight of spades and can even recognize the characteristic patterning of pips up to ‘ten’.

Crows can somehow distinguish number up to seven. But whether this is done by counting or by pattern recognition is not surely known. The story is as follows: A crow can be trained to the following routine. A number of small cups with lids are set out. In these cups small pieces of meat are placed. Some cups have one piece of meat, some two or three, and some cups no pieces of meat. Separate from the cups there is a plate on which there is a number of pieces of meat greater than the total number of cups. The crow learns to open each cup, taking off the lid and then eats any pieces of meat that are in the cup. Finally, when he has eaten all the meat in the cups, he may go to the plate and there eat the *same number* of pieces of meat that he got from the cups. He is punished if he eats more meat from the plate than was in the cups This routine he is able to accomplish.

Now the question is: Is he counting the pieces of meat or is he using some alternative method of identifying the number of pieces? The experiment has been carefully designed to push the bird towards counting. His actions are interrupted by his having to lift the lids, and the sequence has been further confused by some cups having more than one piece of meat and some having none and by separating the moment of reinforcement from the setting of the problem. By those devices the experimenter has tried to make it impossible for the crow to create for himself some sort of pattern or rhythm by which he might recognize the number of pieces of meat. He is thus forced, so far as the experimenter could force the matter, to count the pieces of meat.

It is still conceivable of course that the taking of the meat from the cups becomes some sort of rhythmic dance and this rhythm is in some way repeated when the crow takes the meat from the plate. The matter is still conceivably in doubt, but on the whole the experiment is rather convincing in favor of the hypothesis that the crow counts the pieces of meat rather than recognizing a pattern of pieces.

It's interesting to look at the biological world, with the question whether the various contexts in which number is exhibited should be regarded as instances of *gestalt* or number or mere quantity. There is a rather conspicuous difference between, for example, the statement 'this single rose has 5 petals and it has 5 sepals and indeed its symmetry is of a pentad pattern' and the statement 'this rose has 52 stamens and that other has 57 and this only 34'.

The process which controls the number of stamens is a good deal different from the process that controls the number of petals or sepals. And, interestingly, in the double rose what seems to have happened is that some of the stamens (in some double roses, all of them) have been converted into petals so that the process for determining how many petals has now become not the normal process delimiting petals to a pattern of 5 but has more become like the process which determines the quantity of stamens. We may say that petals are normally 'five' in the single rose but that stamens are 'many' where 'many' is a quantity having a median value which will vary from one kind of double rose to another.

With this difference in mind, we can look at the biological world and ask what is the largest number which the processes of growth can handle as a fixed pattern beyond which the matter is controlled by quantity. So far as I know the 'numbers' TWO, THREE, FOUR, and FIVE are common in the symmetry of plants and animals and particularly in the radial symmetry.

The reader may find a pleasure in collecting cases of rigidly controlled or patterned numbers in nature. For some reason the larger numbers seem to be confined to linear series of segments - the vertebrae of mammals, the abdominal segments of insects, and the anterior segmentation of earthworms. (At the front end the segmentation is rather rigidly controlled down to the segments bearing genital organs. The numbers vary with the species but may reach fifteen. After that the tail has 'many' segments.)

It appears that what seemed to be a quirk or peculiarity of human operation, *viz*. that we occidental humans get numbers by counting or pattern recognition, while we get quantities by measurement, turns out to be some sort of universal truth. Not only the crow but also the rose

are constrained to show that for them too, for the rose in its anatomy and for the crow in its behavior (and, of course, in its vertebral segmentation), there is this profound difference between numbers and quantity.

The question - What does this mean? - is very ancient, and goes back certainly to Pythagoras (500 B.C.) who is said to have encountered a similar regularity in the relation between harmonics. We go also back to the Eternal Verities of St. Augustine.

> Listen to the thunder of that saint, in about A.D. 500: '7 and 3 are 10; 7 and 3 have always been 10; 7 and 3 at no time and in no way have ever been anything but 10; 7 and 3 will always be 10,'
>
> -Warren McCulloch, **Embodiments of Mind**

No doubt, in asserting the difference between numbers and quantities I am close to asserting an Eternal Verity - and Pythagoras would surely agree.

But, we can reply to the saint: 'Yes very true. But is that really what you want and mean to say? It is also true, surely, that '3 and 7 are 10' and that '2 and 1 and 7 are 10' and '1 and 1 and 1 and 1 and 1 and 1 and 1 and 1 and 1 and 1 are 10'. In fact, the Eternal Verity which you are trying to assert is much more general and profound than the special case which you use to carry that profound message. And we can agree that that more abstract Eternal Verity will be difficult to state with unambiguous precision,'

The distinction between numbers and quantities is, I believe, non-trivial and is shown to be so by the anatomy of the rose with its '5' petals and its 'many' stamens; and I put those quotation marks into my description of the rose to suggest that the names of the number and of the quantities are the surfacing of formal ideas.

What happens with presuppositions such as 'Number is Different from Quantity'

I have taught various branches of behavioral biology and cultural anthropology to American students, ranging from college freshmen to psychiatric residents in various schools and teaching hospitals. At all levels I have encountered a very strange gap in their thinking which springs from a lack of certain sorts of tools of thought. This lack is rather equally distributed at all levels of education, among students of both sexes, and among humanists as well as scientists.

The lacuna is, strangely, less conspicuous in two groups of students who might have been expected to contrast strongly, one group with the other. These groups are Catholics and Marxists. Both of these have thought about or have been told about the last 2500 years of human thought, and both groups have some recognition of the importance of philosophic, scientific and epistemological presuppositions. Both groups are difficult to teach because

they attach such great importance to 'right' premises and presuppositions that heresy becomes for them a threat - of excommunication.

Naturally anybody who feels heresy to be a danger will devote some care to being conscious of his or her own presuppositions and will develop a sort of connoiseurship in these matters.

My subject matter is close to the core of religion and to the core of scientific orthodoxy. The presuppositions - and most readers need some instruction in what a presupposition looks like - are matters to be brought out into the open.

There is, however, another difficulty which is almost peculiar to the American scene. Americans are, no doubt, as rigid in their presuppositions as any other people (and as rigid in these matters as this writer) but they have a strange response to any articulate statement of presupposition. Such a statement is commonly assumed to be hostile or mocking or - and this is the most serious - is heard to be authoritarian.

It so happens in this land founded for the freedom of religion that the teaching of religion is outlawed in the state educational system. Members of weakly religious families, get, of course, no religious training from any source outside the family; i.e., what they get is from parents who went through the state system.

So, to make any statement or premise or presupposition in a formal and articulate way is to challenge the rather subtle counter-attack, not of contradiction because the hearers do not know the contradictory premises nor how to state them, but of the cultivated deafness which children use to keep out the pronouncements of their parents.

Be all that as it may, I personally believe in the importance of scientific presuppositions, in the notion that there are better and worse ways of constructing scientific theories, and in insisting on the articulate statement of presuppositions so that they may be improved. Their authority will always increase as the premises gather more and more verisimilitude.

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