

A PARABLE OF TIME

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The following little parable about what counts as an accurate measure of time illustrates some of the complexities in the relation of language to the world.

When Gulliver visited the kingdom of Chronos (one of the incidents which Swift omitted to describe) he found that the king was regarded as a demigod, and that one aspect of this status was that features of his body were used as standards for the measurement of distance and time. His pulse rate was used as the measure of time, and the unit of time, the pulsec, was defined as the interval between one regal heart beat and the next. By ingenious devices which Gulliver never understood the King's pulse was continuously monitored and transferred to the kingdom's time pieces.

The people of Chronos were keen on athletics and very proud of their running. They held frequent races and kept careful records of their runners' times. Gulliver was puzzled by certain systematic variations in these records. Although their fastest runners always won their races, all the runners made their best times at night, and yet were slowest if they ran in the evenings. The pulsec people didn't seem concerned and when Gulliver remarked on it he was told, 'Yes, everything tends to happen more slowly in the evenings.'

Gulliver wondered if this might relate to their method of measuring time and asked after the king's daily round. He was told that the King kept regular habits: he would rise well after dawn, attend to affairs of state during the day and then visit his harem in the evening before going alone to his bedchamber to sleep for the night.

Now Gulliver immediately saw the source of the problem. Clearly the king's pulse rate was not regular: it was faster in the evenings when enjoying himself in the harem, and slower at night when he was asleep. But when he pointed this out the Chronosites were unimpressed, 'Of course the king's pulse rate is regular: one beat per pulsec.' Gulliver explained how his people measured time using a sundial, but the Chronosites immediately saw the problem with that! 'Everyone knows that the sun's motion is irregular – that it moves more quickly after rising in the morning and more slowly before setting in the evening.'

Gulliver's best efforts couldn't get them to see things his way and so he was relieved to find that the next people he visited sensibly used sundials to measure time.

These people were very interested in science and one of their astronomers was delegated to show Gulliver around. She mentioned that their units of time were trinchets and trincklets – twenty four trinchets to the day and twenty four trincklets to the trinchet – and explained that the names derived from a very old unit of time, the trinch – a period of about a month – which had been defined as time taken for a certain sacred tree to grow one inch, hence 'tree-inch' or 'trinch' for short.

'But', explained the astronomer, 'this measure gave rise to certain problems which were resolved by adopting sundial time. For instance in terms of trinch time the period between one sunrise and the next, was shorter in the winter than in the summer, and that implied that the earth rotated more quickly in the winter. The astronomers of the time had failed to find any explanation of this variation, and then one of them had suggested that the problem would just go away if we measured time in terms of the rotation of the earth itself. At first this was widely seen as an empty shift – just defining the problem away – but then people saw that this would also resolve certain other puzzles – for example the gradual shortening of the year could be seen as due to the growth rate of the tree slowing with maturity, and other motions, like that of the rotation of the Moon,

which had seemed to vary with the variation in the Earth's rotation, could be taken as actually regular. Our people came to see that taking the rotation of the earth as a measure of time would be a much more helpful convention to adopt'

'A more helpful convention!' remarked Gulliver, 'wasn't it simply a more accurate measure?'

'How do you mean, "More accurate"?' asked the astronomer.

'Well,' said Gulliver, rather puzzled by this question 'I suppose a truly accurate measure would show one time interval as equal to another if and only if they *really were* equal, and a *more* accurate measure would approximate more closely to that.'

'But,' replied the astronomer, 'what can you mean by "really are equal"? Intervals which are equal by one measure will not be equal by another. Talk of different time intervals being of the same length only makes sense relative to some specific measure of time.'

'Yes, but some measures of time are just wrong!' exclaimed Gulliver, 'A true measure of time must be based on something with a uniform motion or a regular cycle – like the rotation of the earth. If you choose something with an irregular motion as a measure of time then what are really equal intervals of time will be shown shorter when the measuring movement or rhythm is slower and longer when its faster.'

'I see what you're thinking,' said the astronomer, 'but to say that something moves with uniform motion is to say that in any given time interval it will cover the same distance as it does in any other equal time period. To say that a rhythm or cycle is regular is to say that it always has the same number of beats or cycles per unit of time. So you see, what will count as uniform or regular will vary with what you choose as your measure of time.'

Gulliver was exasperated. 'But the river of time, as they say, flows regularly!'

'A river of time flowing regularly.' mused the astronomer, 'That's a puzzling picture. If we say that a river flows

regularly we mean that similar quantities of water pass in similar times – and again we need a measure of time. I don't see what it would mean to say that time itself passes regularly. Would we mean that the same amounts of time pass in the same amounts of time? Well, that would be true no matter how we measured time! And so it can't give us any guidance as to how we *should* measure time.'

Gulliver felt more and more exasperated. 'But if you say that there is no sense to the idea that time flows regularly, or to the idea that one time interval really is longer or shorter than another, then we could measure time just any way we liked! I could say I took regular baths and then define a unit of time as the interval between my baths!'

The astronomer laughed, 'I think you could get pretty dirty with such regular baths! No, no, its not just an arbitrary matter: some measures of time are clearly better than others. For one thing, many significant motions and cycles are, at least roughly, "in step" with each other – the daily rotation of the earth, the periods of the orbits of the earth and the other planets, the rotation of the galaxies, the swinging of a pendulum – and to some extent, our own internal sense of time – the pendulum seems to us swing regularly – although over the longer run our sense of time varies depending on whether we are enjoying ourselves or not! Taking one of these "in step" cycles as a measure of time means that they all measure as regular, rather than as irregular but in step. And that allows for the development of a simpler mechanics, and easier explanation of the movement of things, in the heavens and on earth.'

Gulliver hesitated. 'But you're still saying that we can't measure which time intervals are *really* equal, or which of the motions which we *take* as regular *really are* regular – that its just convenient for us to *treat* them as regular.'

'Perhaps,' replied the astronomer, 'Perhaps you could say that it tells us nothing about reality, nothing about the world, that it can be described using sun-dial time, but that nonetheless it *does* tell us something about the world that it can thus be described more simply or more fruitfully

(Paraphrasing Wittgenstein, *Tractatus*, paragraph 6.342). Or perhaps I could ask, What more could you mean by saying that a motion is *really* regular than that taking it as such affords us the best explanation of how things are. Perhaps in the future it will turn out that the best explanation will require us to take something *other* than the rotation of the earth as regular.'

Gulliver found himself wondering if there were a measure of what was *really* the best explanation, but it made him feel a little giddy and so he asked after dinnertime!

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Postscript

In 1967, the 13th General Conference on Weights and Measures first defined the International System (SI) unit of time, the second, in terms of atomic time rather than the motion of the Earth. Specifically, a second was defined as *the duration of 9,192,631,770 cycles of microwave light absorbed or emitted by the hyperfine transition of cesium-133 atoms in their ground state undisturbed by external fields.* (US Navy Observatory website)