

Anaerobiosis of fluid mud

OBSERVATIONS in estuaries have reported the existence of ephemeral deposits of semi-fluid mud^{1,2} extending several metres from the bottom. These muds differ from 'mud' as normally understood in that although they form definite boundaries with the overlaying water mass they have a lower solid content and settle, if at all, only very slowly. They are also reported to have only 4–400 mg ml⁻¹ suspended solids compared with an average of 1,300 mg ml⁻¹ for bottom muds³. Fluid muds can be detected only by high frequency (30 kHz) echo sounding techniques and have been found to vanish at certain periods of the tide cycle.

To obtain samples of fluid muds a special open-ended sampler⁴ was used, in conjunction with precautions to minimise microbial contamination. Samples were taken from masses located in the Bristol Channel by echo sounding with a Kelvin Hughes type MS26A echo sounder. The samples were returned to the laboratory for microscopic examination, estimation of bacterial numbers and measurement of the oxygen uptake.

Both wet and stained samples were examined by phase contrast and direct microscopy. Unlike ordinary mud from the Bristol Channel the samples contained little or no crystalline or unstainable material, and resembled a light floccular biological sludge. Organic carbon estimations showed between 2.5% and 7% organic carbon compared with 5% for Thames mud⁵ and ~15% for digested sewage sludge. Bacteriological counts were performed by the pour-plate method⁶ and duplicates incubated at 22 °C in the air, for 48 h and also anaerobically in a McIntosh and Fildes' jar. Aerobic bacterial counts were 10⁷ per 100 ml and anaerobic counts 10⁵ per 100 ml.

Measurements on freshly collected liquid mud using a modified Clarke oxygen electrode⁷ showed the mud to be anaerobic immediately after collection and the rate of oxygen consumption to be 20 nmol ml⁻¹ min⁻¹. No samples of water from above the mud layer have shown dissolved oxygen values of <7 p.p.m. and most are close to saturation. It is reasonable to deduce, therefore, that the mud masses are anaerobic. That they have not been previously recognised as such probably arises from their characteristically 'aerobic' brown colour. It has been shown that proliferation of strictly anaerobic bacteria and the production of H₂S and black colours associated with metallic sulphides usually takes upwards of 5 d to develop subsequent to the onset of anaerobiosis⁸.

The high aerobic, and lower anaerobic counts suggest that these ephemeral muds may not persist long enough to become appreciably reduced before being dispersed in oxygenated waters at spring tides.

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To define true meaning

As any lexicographer knows, the meanings of words are not immediately open to introspection. Their covert nature underlies at least one current controversy: some theorists propose that meanings are composed of semantic primitives¹, whereas others deny the existence of such entities^{2,3}. We have investigated the matter in an evaluation of the responses of naive speakers as a source of lexicographical information.

According to a recent theory, there are two sorts of semantic primitive⁴. The first sort includes such notions as motion, vision, and possession, which are each the basis of a corresponding semantic "field". The second sort occurs across different semantic fields in a variety of semantic formulae; it includes such notions as action, causation, and intention. For example, the meaning of "x propels y" can be roughly analysed as "x does something that causes y to move", where "move" is the primitive that defines the field of motion, and "does something" and "causes" are ubiquitous primitives which occur in such similar formulae as "x does something that causes z to possess y", that is "x gives y to z", and "x does something that causes y to be visible to z", that is "x shows y to z."

The most elementary constituents of meaning are presumably various ineffable mental operations and states: these are the fundamental "particles" that make up the "atomic" primitives which seldom need to be analysed in the everyday use of language. It should consequently be relatively easy to produce a label for a semantic primitive but relatively difficult to define it. Therefore, the simpler a verb's semantic formula, the harder it should be to define the meaning of the verb: "atoms" should be harder to take apart than "molecules". For example, "move" should be difficult to define because it labels something that is virtually a primitive; "come" should be less difficult to define because its formula at least involves an adverbial modification, "move towards the location of speaker or some other specified location"; "bring" should be still easier to define because it involves the ubiquitous primitive of causation, "cause to come with"; and "chase" should be the easiest of these verbs to define because it introduces the further ubiquitous primitive of intention, "move rapidly after as a result of an intention to catch". We predicted that the order of difficulty from easiest to hardest for the four corresponding generic classes of verbs would be: intentional verbs, causative verbs, adverbially modified verbs, and primitive verbs.

In a preliminary study to test this prediction, eight undergraduate students each attempted to define sixteen words (verbs of the four classes drawn from each of the semantic fields of motion, vision, possession and communication). We tried to choose words with the same frequency of usage, but there was a slight tendency for the intentional verbs to be less commonly used. Half the subjects received one set of sixteen words, and the other half received another set of sixteen words. Each word was presented separately with a sentence exemplifying the particular sense to be defined. The subjects, who were tested individually, were told to imagine that they were defining the words for the benefit of a child or a foreigner with an imperfect grasp of the language. They wrote down their definitions in their own words and in their own time. After they had finished this task, they put the verbs into a rank order corresponding to their subjective impression of the difficulty of defining them.

Something of the flavour of the subjects' definitions is conveyed by the following examples: chase: (1) to follow closely—indication of speed and urgency; (2) he

followed the dog and tried to catch it; (3) to chase is sometimes to follow it with the intention of catching up with it; (4) to pursue in order to catch or overtake. Example (2) is one of the few cases where a subject has ignored the instructions and couched the definition of a word in terms of the sentence illustrating its meaning. Despite the superficial variety of the definitions, an amalgam of them captures the essential meaning of the word. In fact, example (4), which is presented for purposes of comparison, was culled from a recent dictionary compiled with considerable linguistic sophistication³. As anthropologists have known for some time, naive informants can on occasion yield accurate and relevant lexicographical information.

Some of the definitions consisted of synonyms or words with more specific or recondite senses than the *definiendum*. They could hardly be helpful to children or foreigners. Such definitions were particularly prevalent for primitive verbs, accounting for just under 70% of the responses to them. The prevalence of synonyms in the definition of this class of verb attests to the difficulty experienced in attempting to explain their meaning. In addition, it makes it difficult to include this class when rank ordering the accuracy of each subject's definitions. In contrast, it was a relatively straightforward matter to rank order the accuracy of each subject's definitions for the three remaining classes of verb within a given semantic field. Thus, granted our earlier analyses of "come," "bring" and "chase," the following definitions from one subject are ranked in order of increasing accuracy: (1) "come": "to come to a place or situation means to change the place or situation from a different place or situation to the first mentioned place or situation"; (2) "bring": "when something moves from some place to another and takes something with it"; (3) "chase": "to chase is sometimes to follow it with the intention of catching up with it". The first definition fails to mention either movement or the crucial role of the speaker's location; the second definition mentions movement but is not as helpful as it could be about the causal relation since it resorts to a near synonym, "take"; the third definition is very nearly complete. The mean ranks of the accuracy scores were as follows: adverbially modified verbs, 2.4; causative verbs, 2.8; intentional verbs, 3.1; and the ranks conformed in a highly reliable manner to the predicted trend (Page's $L=106$, $P=0.01$). The subjects' own impressions of the difficulty of the task, as revealed by their rank orders of the verbs, also conformed reliably to the predicted trend. Their mean ranks were as follows: intentional verbs, 5.3; causative verbs, 8.4; adverbially modified verbs, 9.5; and primitive verbs, 10.7 (Page's $L=225.5$, $P < 0.01$). The numbers of words and clauses in a definition were not related to its accuracy or subjective difficulty. However, subjective difficulty was negatively correlated with the accuracy score in a highly reliable way (Page's $L=4375.5$, $P < 0.005$).

The predicted order of difficulty was confirmed in two further studies both of which used the measure of accuracy employed in the original experiment. The first study examined 5 subjects' spontaneously spoken, rather than written, definitions: their accuracy was in accord with the predictions. The second study, carried out by Marla Petal, again replicated the trend using the written definitions of both Japanese and English words. Three English-Japanese bilinguals and four English-speaking mono-linguals served as subjects in this experiment.

Of the twenty subjects so far tested, 11 have an overall trend that conforms exactly to the prediction, 7 have an overall trend more in accord with the prediction than against it, and only two subjects have produced results definitely incompatible with the prediction ($P=0.0003$, Sign

test). We conclude that some common words are, indeed, easier to define than others.

Words that can be adequately captured in a definition ought accordingly to have formalised senses, that is, they should be less likely to take on new meanings than words that are less adequately defined. Consequently, the number of different meanings of the 32 words used in our original study would be expected to increase as their semantic formulae became more simple. We tested this prediction by recourse to the dictionary³. The mean frequencies of separate numbered meanings in the dictionary³ of the 32 words used in our first study were as follows: intentional verbs, 5.4; causal verbs, 8.8; adverbially modified verbs, 10.3; and primitive verbs, 14.8 (a trend that just fails to reach significance, Page's $L=212.5$, $P>0.05$). This phenomenon and the results of the experimental studies can be explained by postulating the existence of semantic primitives that are easy to label but hard to define. We do not wish to imply that primitives are necessarily retrieved in every linguistic task—a listener may well understand a sentence without having to break it down into atoms. However, it seems that primitives are verbalised in a task that requires naive informants to act as lexicographers and to define the true meaning of words.

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Tidal rhythm in a seabird

GUILLEMOTS (*Uria aalge*) breed on cliff ledges in densely packed colonies often numbering many thousands of pairs. About 25% of the British population of these birds nests in Orkney¹, where their proximity to North Sea oil developments makes it important that the numbers breeding are continuously monitored to check for any adverse effects. One of the difficulties in estimating the breeding population is that the numbers present on cliff ledges show considerable variation, particularly before egg-laying². The data presented here were collected on the island of Copinsay, Orkney, between April 20 and May 13, 1976 with a view to determining the reasons for these fluctuations. They demonstrate the clear effect of a tidal rhythm, a phenomenon previously described for birds which feed close inshore^{3,4}, but not apparently for any species which feeds in deeper water, though Tuck⁵ makes passing reference to the possibility of such an effect at some of the guillemot colonies which he studied in Canada.

Data were collected at a study colony of roughly 80 pairs. The number of birds present on the cliff was counted at 0800, 1200, 1600 and 2000 BST on each day. Figure 1 shows the results of these counts over a 16-d period and indicates substantial variance both within days and between counts at the same time on different days. There was, however, no significant tendency for the counts on some days to be higher than those on others ($0.10 > P > 0.05$, Friedman two-way analysis of variance). As shown in Table