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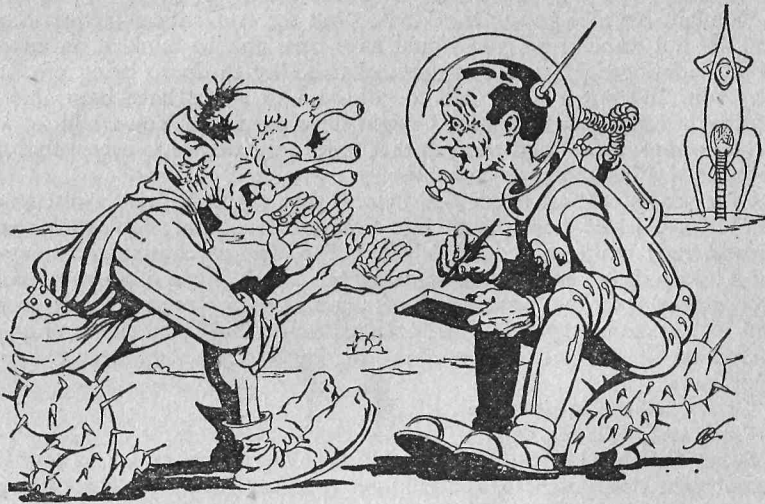
# Astounding SCIENCE FICTION

OCTOBER



How to Learn Martian by Charles F. Hockett





# HOW TO LEARN MARTIAN

By CHARLES F. HOCKETT

*Once upon a time, people thought that a vocabulary and the grammar rules were the whole story on learning a language. But modern linguistics finds it's both more complicated, and also somewhat simpler than that . . .*

Illustrated by Freas

AN agent of the Galactic Federation, sent to Earth to case the joint secretly for either friendly or inimical purposes, could do a good deal worse than to make a survey of the scientific terms that appear, quite casually, in contemporary science fiction. True enough, there would be some discrepancy between the state of scientific development suggested by such a survey and the actual state of development in laboratory and industry—atomic energy

was spoken of quite freely in our type of fiction for decades before technology caught up with imagination, and, in reverse, real recent developments in some fields are only now beginning to find their way into science fiction. If the agent's sole aim were to measure our technological potential, science fiction would be of no great help. But if he also wanted to determine the *degree of general technological readiness* of the whole population—at least in so-called "civilized" parts of the world—then the suggested survey would be of considerable value.

One score on which, as a measure of real technological development, our agent's study of science fiction might badly mislead him, is in the matter of communication, particularly basic form of human communication, *language*. An occasional term of modern linguistics turns up from time to time in science fiction: "phoneme," in particular, is a word to conjure with just as much as is "transistor" or "cybernetics." The effect sought by the use of such a word is spoiled if the story-writer pauses to explain: the use must be casual, implying that the reader knows all about such things. And, because many of our magazines regularly run factual articles or departments, and we addicts regularly read them, this assumption of the story-writer is very often true.

If we can pride ourselves on the number of modern developments which were anticipated by the lively imaginations of an earlier generation of authors, I think perhaps we should temper this pride with a bit of shame that we have been such Johnny-come-latelies about phonemes, morphemes, intonations, constructions, immediate constituents, the impact of language on culture, and the like. Do you know when the fundamental principle of phonemics was first expounded?

It was explained rather clearly—though of course without the word "phoneme"—by a twelfth-century Icelander who was annoyed by the inaccuracy with which his compatriots put down written marks to represent Icelandic speech. We can probably forgive ourselves for not having known about this particular early episode, especially since modern linguists had forgotten all about it and had to rediscover the principle for themselves. But even in modern times the phonemic principle was stated, in one way or another, as early as about 1910: the earliest mention I have been able to track down in science fiction postdates World War II.

Maybe we should catch up. If our authors would like to follow their usual custom of being ahead of the times instead of lagging behind, they must at least know what the times have to offer. If we readers insist that they should do this, they will.

We are going along on the first voyage to Mars, and very conveniently we shall find intelligent oxygen-breathing beings with respiratory and digestive tracts shaped very much like our own. (Later on we can point out why this last assumption is so convenient.) Our ship lands; we make the first hesitant contact with the Martians; and before long our xenologist, Ferdinand Edward Leonard, B.A., M.A., Ph.D., M.D., X.D.—who is about as chock full of modern anthropological, linguistic, communicative, engineering, psychiatric, and biological training as one skin can be stuffed with—sits

down with a Martian to try to find out something about the latter's language.\* (Hidden assumption: Martians can sit down.) For short, we shall call these two "Ferdie" and "Marty"—the latter because even Ferdie won't be able to learn, or to pronounce, Marty's real name for quite a while. (Query: Do Martians have personal names?)

Ferdie points to the Martian's foot and says, of course in English, "What do you call that in your language?" Marty certainly does not understand, but at this moment he makes a bit of vocal sound, something like *GAHdjik*. Ferdie puts this down in his little notebook, and writes the English word "foot" by it. What Ferdie puts down to represent the Martian "word"—if it really is a word, and not just Marty clearing his throat in the typical Martian manner—doesn't look quite like what we have written above, because Ferdie has a special set of written marks which he can use more efficiently and accurately for the purpose (a "phonetic alphabet"); but we needn't bother with this, because it is merely a convenience, not an essential. Now Ferdie is not being a fool and jumping to conclusions when he makes his notebook entry. He knows perfectly well that the sound Marty has made may not only not mean "foot," but may not even be a word at all. Ferdie makes his entry only as a memory aid: it will be easy enough to scratch it out when and if necessary.

Ferdie also says *GAHdjik* himself—or tries to—and observes Marty's reaction. Just for fun, we shall pretend that Marty does not react, so that this time Ferdie has gained nothing.

Next Ferdie points to something else, gets another reaction from Marty which may be a "word," writes it down, and tries to imitate it. Then he points to a third thing. After a while, having elicited a number of such bits of what may be speech, Ferdie returns to Marty's foot. This time what Marty says doesn't sound like *GAHdjik*, but more like *KAHchuk*.

Right at this point, Ferdie comes face to face with the most ticklish and crucial problem which can be encountered by a xenologist or by an Earth linguist. (We except, of course, the task of working with the dragonlike inhabitants of Antares II, whose languages make use not of sound but of heat-waves.) Has friend Marty given two different "words" for two different meanings? Has he given two distinct "words" for a single meaning? Or has he simply said the same "word" twice, with slight differences in pronunciation which are clear to Ferdie but which would be entirely overlooked by Marty's fellows?

Since this problem lies at the very heart of phonemics, we had better return to Earth momentarily and look at some more homely examples of what is involved.

Suppose that your name is Paul Revere and that you want to arrange

\*Roger Williams, of Rhode Island and Providence Plantations fame, wrote a little book called *Key Into the Language of America*—a grammar of a language spoken by a few hundred Indians in his vicinity, which was but one of several hundred distinct languages spoken in aboriginal North America. Some of our exploring science-fiction heroes fall into this same error. If there are millions of intelligent beings on Mars, there may be thousands of Martian languages.

for me, over in Boston, to send you some sort of a signal across the Charles River so that you can know whether the British are coming by land or by sea. This is all you want to know—it is already clear that they are going to be coming one way or the other, but you need to know which way. What we have to do is to establish a code containing just two signals. One of the signals will mean "they're coming by land," and the other will mean "they're coming by sea." The physical circumstances have something to do with what kinds of signals we can choose. They must both be something that you, over on the Cambridge side of the river, can easily detect, so that a shout or halloo wouldn't do very well. Since it will be night, some sort of arrangement of lights—up in a high place—would be a good idea.

Another consideration is that there must be no possible danger of my sending one signal and you receiving what is apparently the other. That is, we want to keep the two signals physically distinct, so that there will be no danger of misunderstanding. Shall we use a red lantern for "by sea" and a green one for "by land"? No—green might not show up too well, and what's more, we haven't got a green lantern. But I know there are two lanterns over in the basement of the Old North Church: suppose I put just one of them up in the tower for one of the signals, but both of them, at opposite sides, for the other. "One, if by land, and two, if by sea?" Agreed! Good luck on your ride! Hope a fog doesn't come up.

People can make signals out of anything they can *control* and can *observe*, and they can make the signals mean anything they wish. We constantly establish little short-term signaling systems, use them, and then discard them. A wave of the hand, a drop of a handkerchief, a wink of the eye, the raising of a window blind, the toot of an auto horn—such events are assigned special meaning over and over again. Some signaling systems are a little more elaborate and a bit more enduring—for example, the pattern of lights, stable or winking, shown at night by a plant for takeoff, for landing, or during flight. The really elaborate systems are hardly "invented," but merely passed down from generation to generation, with gradual changes; among these, of course, belongs language itself. Now, however varied these different systems may be, they all conform to certain fundamental principles. One of these—the one in which we are concerned here—is that the users of the signals must be able to tell them apart. This sounds simple and obvious enough, but it has some pretty complicated results.

Paul Revere and his side-kick had no trouble on this score, because they needed only two signals—all Paul had to have was one item of information of the either-this-or-that sort. But suppose you had to work out a signaling-system which will include hundreds or thousands of distinct signals. Keeping them physically apart and easily distinguished is in this case much more difficult.

One technique that anyone confronted with such a design-problem is bound to hit on is to set up some fairly small repertory of basic elements, each of them quite different physically from any of the others, and then arrange for the actual signals to consist of some sort of arrangement or combination of the fundamental elements. Suppose Paul and his henchman



had needed a couple of hundred different signals. They could have arranged, for example, for a row of five lights to be put up in the old North Church tower, each light either red or green or amber: this yields two hundred and forty-three distinct combinations, yet calls for only fifteen lanterns to be available—one of each color for each of the five positions.

It is pretty obvious that this set of two hundred and forty-three signals would be much easier for Paul to read from across the river than, say, the same number of signals consisting each of a lantern of a different shade. The human eye, true enough, can distinguish several thousand shades of color, but finer distinctions are not easy to detect, and for rapid and efficient use ought not to be involved. Even as it is, if Paul's assistant is only able to find four really red lamps and has to fill in with one which is rather orange, there will be the possibility that the orange lamp, intended as functionally "red," will be interpreted by Paul as "amber." This danger can be avoided if Paul knows in advance that the "red" lamps will in actual transmission vary somewhat in precise shade, without making any significant difference in the signal.

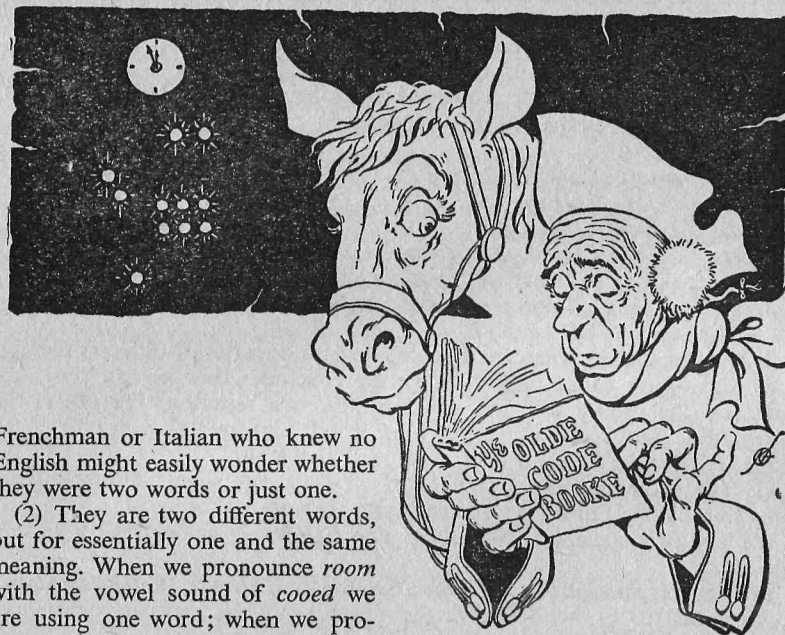
This sort of thing has actually happened in every known case of a really complicated signaling system, including language. When a linguist goes to work on a language he has never heard before, he can count on certain things along this line. The colored lanterns in this case are different motions of lips, tongue, throat, and lungs, which produce kinds of sound which can be heard, and told apart, by human ears.

The investigator knows that the people who speak the language will make *distinctive* use only of certain differences of articulatory motion—that is, maybe they will use relatively red, relatively green, and relatively amber lanterns, but not also orange or blue. He knows that if an articulatory motion of an ambiguous sort occurs, it will count as a "mistake" and will be allowed for by the speakers of the language—since orange is not functional, the actual appearance of an orange lantern must be a mistake for red or for amber. But he does not know in advance just what differences of articulatory motion will be thus used.

After all, a lantern-code could make use of any number of different ranges of spectral colors, providing that no two of the significantly different shades were so close together as to give rise to serious danger of confusion. In just the same way, there are any number of ways in which a selection can be made, from the "spectrum" of all possible speech-sound, of "shades" to be used distinctively. The only way to find out what selection is actually made by the speakers of a given language is—but let's watch Ferdie and Marty again and see if we can find out.

We left Ferdie confronting the problem of *GAHdjik* and *KAHchuk*. Assuming that each of these is really speech, not just Martian throat-clearing, then there are three possibilities:

(1) They are two different words with two different meanings. If we were in the position of Marty, the first time a xenologist pointed to our ear we might say *ear*, and at a subsequent time we might think he was asking what the organ is used for, and so say *hear*. *Ear* and *hear* are pretty similar: a



Frenchman or Italian who knew no English might easily wonder whether they were two words or just one.

(2) They are two different words, but for essentially one and the same meaning. When we pronounce *room* with the vowel sound of *cood* we are using one word; when we pronounce it with the vowel sound of *could* we are really using a different word. But it would be hard to find any difference in the meaning of the two.

(3) Marty has simply said the same word twice: the apparent variation in pronunciation would not be noticed by his fellow Martians. A speaker of Hindustani, hearing us say *pie* or *tie* or *cow* several times, might be convinced that we were pronouncing the initial *p-* (or *t-* or *k-*) now in one way, now in another, since Hindustani breaks up the "spectrum" of possible speech sound a little more finely in this particular region.

There are several things Ferdie can do to try to solve this problem. First, he points to Marty's foot again and says *KAHchuk*, to observe the response; a little while later, he makes the same gesture and says *GAHdjik*. For good measure, he also tries *GAHdjuk* and *KAHchik*, and even *gahDJIK* and *kahCHIK*, making the second syllable louder than the first. The hope is that he can manage to get something out of Marty's reactions which will indicate acceptance or rejection of the various pronunciations. If Marty accepts all the pronunciations except the last two, then Ferdie has fairly good indication that the answer is the second or third of the possibilities, rather than the first. Of course he can't yet be absolutely certain; perhaps Martians are too polite to criticize, or perhaps we simply haven't yet learned to read their gestures of acceptance and rejection.

Another procedure is available. Ferdie looks through his notebook and notices an entry *GOOpit*, apparently meaning "small tuft of green hair

sprouting from the back of a Martian's neck," and an entry *KOOsahng*, which seems to refer to a low-growing yellowish shrub that is plentiful in the vicinity. This is what Ferdie does and how Marty reacts:

Ferdie (pointing to the tuft of hair): "*GOOpit*."

Marty (closing his middle eye—apparently the gesture of assent): "*FUM*."

Ferdie (pointing to the bush): "*KOOsahng*."

Marty: "*FUM*."

Ferdie (the tuft of hair): "*KOOpit*."

Marty: "*FUM. NAHboo GOOpit*."

Ferdie (the bush): "*GOOsahng*."

Marty: "*FUM. NAHboo KOOsahng*."

Ferdie (pointing to the spaceship in which we arrived): "*GOOpit*."

Marty (popping all three eyes out on their stalks): "*HLA-HLA-HLA-HLA! EEkup SAHCH bahKEENDut!*"

This last response, whatever it actually means, is certainly different enough from the others to be indicative. Ferdie concludes that he can probably work on the theory that the last response was rejection, the others all acceptance. But what does this tell him? It tells him the following:

(1) *GOOpit* (or *KOOpit*) does *not* mean "spaceship."

(2) The pronunciations *GGOpit* and *KOOpit* may sound different to us English-speaking Earthlings, but to Marty they are all the same.

(3) The pronunciations *KOOsahng* and *GOOsahng* are also all the same for Marty.

(4) The pronunciations *GAHdjik*, *GAHdjuk*, *KAHchik*, *KAHchuk* sound quite varied to us, with our English-speaking habits, but the differences are irrelevant for Marty's language.

Or, in short, for the last three points, the difference between an initial *k*-sound and an initial *g*-sound, which is distinctive for us, is not functional in Marty's language. Ferdie has reached one conclusion about the phonemic system of Marty's language: in the region of the spectrum where English distinguishes between two phonemes, *k* and *g*, Marty's language has only one.

It is entertaining to follow the hard step-by-step field-work of a xenologist or a linguist this far, but after this it quickly becomes boring, at least for everyone but the investigator himself—and, often enough, for him, too. Because what he has to do is simply more of the same—over and over and over again, eliciting, recording, checking, correcting, reaching an occasional tentative conclusion, finding out he was wrong and revising. It is a routine sort of task, before long, but unfortunately it is not one which can be assigned to any sort of machine. (At least, a machine that could perform the task would have to have all the logic and illogic, all the strengths and weaknesses, of human beings.)

Ferdie's aim can be stated rather easily. He wants to reach the point where he can supply an accurate description of all the *differences in pronunciation* which are *distinctive* in the linguistic signaling of Marty and his fellows. He wants to be able to state what shades of lanterns are used, in what sequences the different colors are allowed to occur, and just what

range of spectral shades counts as an instance of each color. All of this constitutes the *phonemic system* of Marty's language.

Maybe you think it need not take Ferdie very long to achieve this aim. Well, if Earth languages are any guide, there is a good chance that our ship hasn't brought along enough food to supply Ferdie while he finishes the job; unless he can get along on Martian lizard-weed, the native staple, he is out of luck. In a day or so, a well-trained Earth linguist, working with a completely new language, can get the cultural wax out of his ears and begin to hear something that sounds like it might really be a language. Before that, everything is a mumbling buzz. In another ten or so days of hard work, the linguist can get perhaps ninety per cent of what counts in the sound-making and sound-recognizing habits of the language, though his own hearing may not yet be too well trained for the new system. In another hundred days he can get perhaps ninety per cent of *the remainder*. Sometimes it is years before he gets it all.

However, this rather long program shouldn't discourage us, since Ferdie can be making effective practical use of the local Martian dialect long before the full cycle is up. Ninety per cent is actually pretty good, though so long as, in his own attempts at speaking Martian, Ferdie uses only ninety per cent, he will impress Marty as having a pretty un-Martian accent. Let us see what "ninety per cent" means and why it is effective.

The phonemic system of Marty's language—or of any other—is a set of distinctive *differences* between pronunciations. The units which we call "phonemes" are in themselves of no importance: it is the differences between them that count. A given phoneme, in terms of its use in communication, is nothing except something which is different from all the other phonemes in the system. In Morse code, a "dot" is a "dot" and a "dash" is a "dash" whether the former is a short voltage pulse and the latter a long one, or the former is a wave of a flag in one direction and the latter a wave in the other direction. This is why we will irritate Ferdie no end if we ask him, after his first day's work, "Well, do they have a phoneme *K*?" or "Well, is *K* a phoneme in Martian?" If you want to compare languages with each other, the sort of question which must be asked—the sort that will be meaningful to Ferdie even if he can't yet answer it—is "Does Marty have a phonemic contrast between *K* and *G*?"

The difference between *K* and *G* is distinctive in English, so that we have two phonemes rather than just one in this general region of the spectrum, because a great many pairs of words are kept apart by the difference and by nothing else: *good*: *could*, *gap*: *cap*, *glue*: *clue*, *bag*: *back*, *bigger*: *bicker*, and so on. In Marty's language there are no pairs of words kept apart in just this way. On the other hand, the difference between *EE* and *AH* is distinctive in Marty's language—as in ours—because *KEEtah* means "eye-stalk" while *KAHtah* means "setting of Deimos."

The sole function of phonemes, then, is to be different from each other, and, in being so, to keep words and utterances—whole signals—apart. But some differences between phonemes do a lot more of this work than do



others. The difference between *K* and *G* in English carries, relatively speaking, a fairly large share of the total load, as you can easily see by looking for more pairs of words like those which we gave above—it is easy to list hundreds. The difference between the *sh*-sound of *she* or *hush* and the *zh*-sound in the middle of *pleasure* is also functional, but this distinction doesn't carry very much of the total load. If you look hard, you may be able to find three or four pairs of words in which this difference is the only one—one example is *measure* and *mesher*—but there are very few.

Actually, a technique deriving from information theory makes it theoretically possible to express the “functional load” of different phonemic contrasts in a language in quantitative terms, to any desired degree of accuracy. But the amount of counting and computing which is involved is enormous, and would hardly be undertaken without a properly designed computing machine—and then it costs lots of money instead of lots of time, which for linguists is even worse. But we don't need such figures here; the general principle is, we hope, clear enough.

It is because of this that Ferdie can begin making effective use of Martian long before he has ferreted out and pinned down every last vestige of distinctive difference in articulation of which the language makes some use. It is obvious on the face of it that the differences which he discovers first are bound to be, by and large, the differences of greatest functional importance. Working just with these in his own attempts to speak Martian, he will sometimes be misunderstood—but we misunderstand each other from time to time even under the best of circumstances. If you want further empirical evidence, you need only think of the German or the Frenchman who makes you understand him with imperfect English—or of you, yourself, managing to communicate in imperfect French or German.

If there *are* Martians, and they *are* intelligent and have a language, and if they *do* have upper respiratory and alimentary tracts shaped much like our own, and ears much like ours, and, finally, if they *do* make use of these organs in speech communication—given all these ifs, then the procedures of Ferdinand Edward Leonard will work, and he will be able to “break” the phonemic system of the language.

But suppose that the Martians fail on just one of the above ifs. Suppose that they have two tongues and no nose. How, then, is Ferdinand Edward Leonard to imitate and to learn to recognize their speech sounds?

Suppose something even more drastic. Suppose that the Martians communicate with a system just as complex as human language and with much the same essential structure, but that instead of modulating sound they modulate a carrier at frequencies above the reach of human ears—or radio waves, or a light beam, or odors, or electrical flows, or some kind of energy transmitted through the “sub-ether.” What kind of equipment and training shall we give our xenologists to handle situations of this sort? There are still certain fundamental design-features which any such language-like communications system is bound to include, but the problem of observation and analysis is tremendously harder.

## FURTHER BOOKS RECEIVED

*A Special Review (see also p. 119)*

SALAMANDER WAR by Charles Carr. Ward Lock & Co. London. 1955, 190pp. 9s. 6d.

Mr. Carr's book offers an unusually intriguing tale of a fictitious planet Bel—where conditions, comparable to those of Earth, provide a refuge for Earth's survivors. Once again, as in so many of to-day's S-F novels, Earth has been virtually destroyed by some unspecified catastrophe and at the outset it is described as “a dead cinder circling the sun” . . . rarely is our poor planet given a very rosy future!

Bel, colonised by Earth, proves to be a somewhat depressing land, with eternal twilight, little oxygen and two hemispheres—a cold side and a hot. Only the cold side is habitable as far as the colonists are concerned. Sleep is impossible on Bel and the children grow into adults in a matter of three years or so.

The story of “Salamander War” commences with the efforts of the colonists to maintain their production of oxygen by mining for fissionable material in the hot region of the planet. Here salamanders abound—menacing creatures which are never very clearly described at any point in the narrative. However, it is established that they can, by means of intense heat, airborne fire-balls and the like, threaten the existence of the colonists as they take counter-action when their own region is invaded.

In addition to the war waged against the salamanders, there is also an inner conflict among the colonists themselves. A group of extreme pacifists oppose the remainder who are prepared to battle for their existence. A slight love interest is also introduced—made the more titillating by the realisation that the young lady concerned is a rising four-year-old!

Mr. Carr's story develops soundly and the interest is well maintained throughout. The book is attractively produced, well bound, and carries a colourful and adventurous jacket.

P. F. I.

