BOOK REVIEW: The Alien Communication Handbook

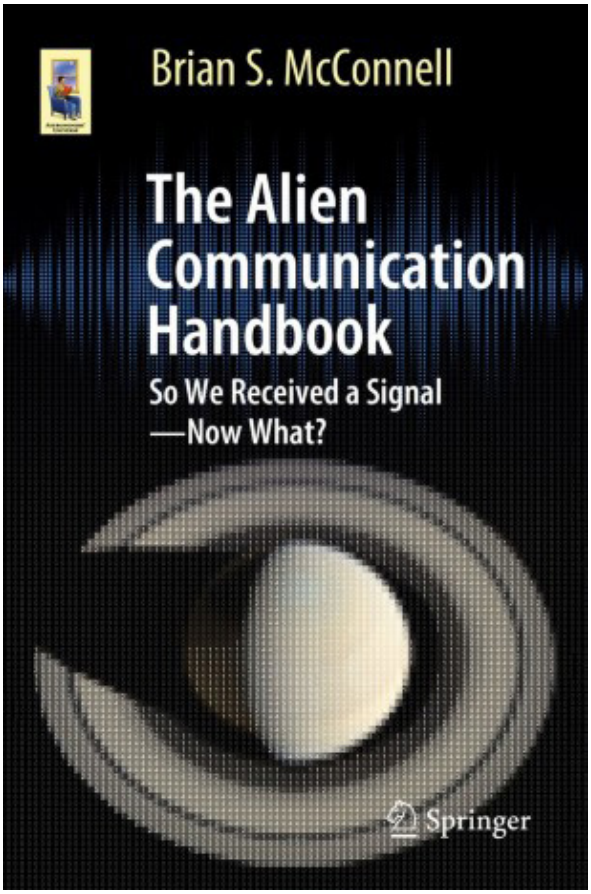
So We Received a Signal – Now What?

Patrick J Mahon

Most books about communications with extraterrestrial intelligences (CETI), the thing we might do after SETI has succeeded, are written from a scientific or linguistic point of view so when we spotted Brian McConnell's book [1], written by a communication systems engineer, we thought it deserved a review. Here Principium Deputy Editor Patrick Mahon gives us his thoughts.

If you are interested in the Search for Extra-Terrestrial Intelligence (SETI), you will probably be familiar with books that focus on the mechanics of search strategies, covering such issues as the pros and cons of radio versus optical SETI, the choice of wavelengths to search (eg the 21-centimetre line emitted from neutral hydrogen atoms), how to distinguish artificial signals from natural phenomena, and so on. Although these topics are briefly covered here, The Alien Communication Handbook [1] spends most of its time in rather different territory.

Author Brian S McConnell is an American computer engineer who has been writing about SETI for over two decades. He has discussed the issues I've just mentioned in earlier works. In this new book, as its subtitle makes clear, he poses an interesting thought experiment: if we were to receive a SETI signal that appeared to be genuine, what should our next steps be?



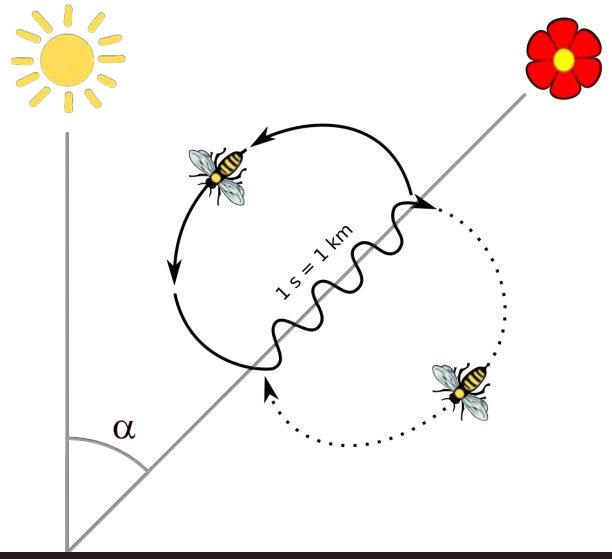
[1] The Alien Communication Handbook: So We Received a Signal – Now What?, by Brian S McConnell (Springer, October 2021) link.springer.com/book/10.1007/978-3-030-74845-6

This book has been published as part of Springer's "Astronomers' Universe" series of popular science books aimed at those who want to go beyond basic explanations of astronomical phenomena to gain a greater level of understanding and insight. From the very first pages, McConnell stresses the role citizen scientists will have in decoding a confirmed SETI signal. So this book is not just for armchair enthusiasts. If you'd like to get actively involved in SETI, it's full of information that will enable you to do just that, should the fateful day arrive when we find out 'we are not alone'.

The volume comprises nineteen chapters. Although not explicitly structured into different sections, the author's preface explains that they fall into five distinct parts:

- Part 1 (chapters 1 to 3) covers the basics of what SETI is looking for, what it might find and what we have learned about decoding non-human communications by studying how some other animals here on Earth share information with each other.
- Part 2 (chapters 4 to 7) discusses the early phases of work that would take place after a genuine alien signal was confirmed, covering a likely timeline of events, and the various ways in which useful information might be encoded into the signal.
- Part 3 (chapters 8 to 13) explores the various types of concrete information content that may be contained in a SETI signal and the ways that we might be able to differentiate between and decode them.
- Part 4 (chapters 14 to 17) considers how more abstract concepts might be encoded in a message in such a way that we might be able to build an understanding of these potentially very alien ideas over time.
- Part 5 (chapters 18 and 19) finishes things off by looking at the range of people and skills that will be needed to maximise the chances of success, and the sorts of information and knowledge that we could potentially gain from decoding the first SETI signal.

For me, the most fascinating material in Part 1 is found in chapter 3, which explores what SETI researchers can learn from academic studies of the ways in which animals communicate with others of their species. This chapter illustrates what McConnell does best, taking a complex subject, splitting it into bite-sized chunks and explaining each one clearly and simply. After summarising seven traits that any genuine language needs to contain, he explains how languages are typically structured and how that can aid the initial analysis of a new language. He then shows how such an analysis can be applied to the communications of several types of animals, from ants and bees through to prairie dogs (which have been extensively studied), dolphins and primates. Moving beyond animal research, McConnell then considers how a communications systems expert like himself might take a signal processing approach to the partial decoding of a new language of this kind. The chapter finishes with a discussion of how a similar approach might be of use in SETI and of the various ways in which this analogy between animal communication studies and SETI breaks down.



Bee waggle dance as cited by McConnell

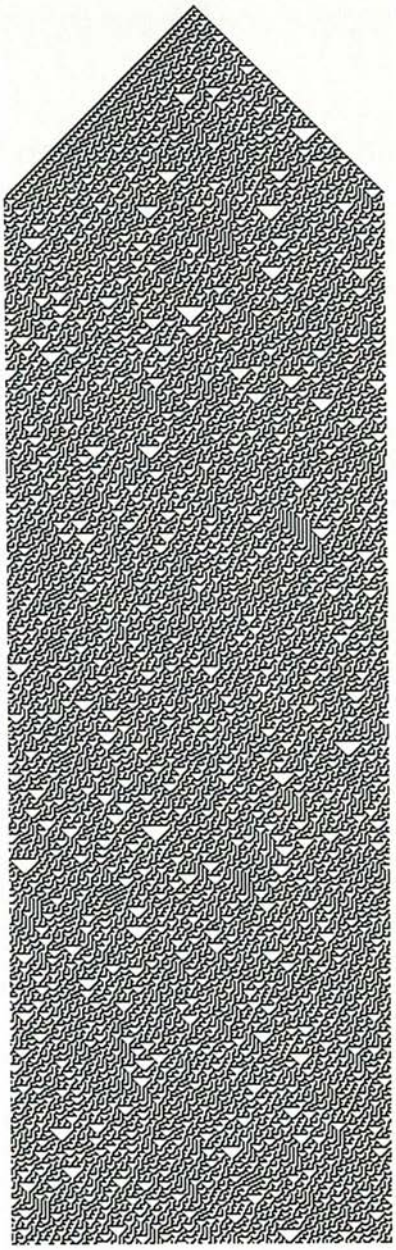
The bee waggles down a straight line pointing to the source it has found with the direction of the sun as reference and the duration of waggling indicating distance.

Credit: Emmanuel Boutet via Wikipedia
commons.wikimedia.org/wiki/File:Bee_dance.svg

Much of Part 2 will be familiar to SETI enthusiasts, covering as it does the numerous ways in which an electromagnetic signal can be modulated to carry information, and how error correction can be incorporated into the message to ensure that it can be accurately decoded at the other end, even if degraded on the way. The content that was new to me concerned the potential for SETI messages to be contained in 'inscribed matter' – that is, matter that has been altered in some way to encode information, with a CD and a DVD being two earthbound examples – rather than beamed through space via electromagnetic radiation. I was intrigued to learn that inscribed matter may in some cases be the better option, due to the extremely high density of information that can be encoded in this way.

Part 3 is the longest section of the book, covering six chapters and around one-third of the page count. This is where McConnell's expertise comes to the fore, as he explores how to decode an alien signal by looking for the data patterns that are typical of the different types of information content that an intelligent alien species might wish to share with others. His central contention here – and I imagine it may be contested by some in the SETI community – is that no matter how different the aliens who sent the signal may be, we can expect them to want to share some types of information we'll recognise, such as static and moving imagery. His basic argument is that if aliens send a signal through space at all, they will need to understand astronomy, electromagnetic radiation and some analogue of taking and sharing images. He explores the implications comprehensively, giving a clear idea of how such data might be encoded in, and decoded from, an alien signal.

An interesting departure from this discussion comprises a long chapter on the possibilities of aliens encoding algorithms or computer programmes of various kinds in their signals, since these might enable some limited level of real-time interaction between the recipients (us) and the signal, partially getting round the one-way nature of most electromagnetic communications over distances of light years. Such programmes could potentially be as simple as a Tic-Tac-Toe game (that's Noughts and Crosses to those of us in the UK), or as complex as a generalised artificial intelligence. Both would teach us something profound about the type of being that had programmed it.



Encoding of algorithms or computer programmes - McConnell's example above - and his explanation -

"Knowledge about digital computing is a de facto requirement for success in establishing a communications link, so it's not unreasonable to assume that the sender will know about computing and may incorporate algorithms into a transmission.

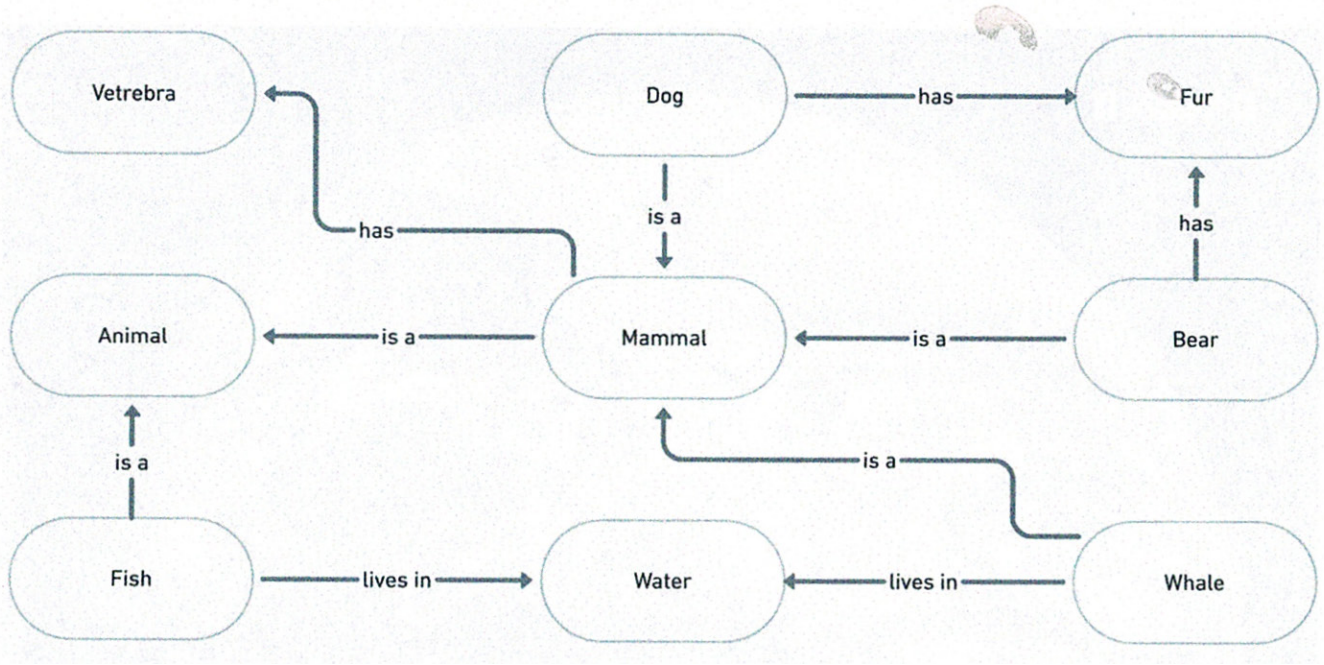
Algorithms, the procedures implemented in computer programs, are useful because they can implement arbitrarily complex instructions and math operations using a small and simple set of basic math and logic symbols. A program could represent something as simple as a tic-tac-toe game or something as complex as a climate model or machine learning system. The limits of communication are only constrained by the imagination of the sender.

The data banner in this chapter [above] displays the output of a rule 30 cellular automaton, a simple algorithm that produces results that appear both orderly and chaotic.

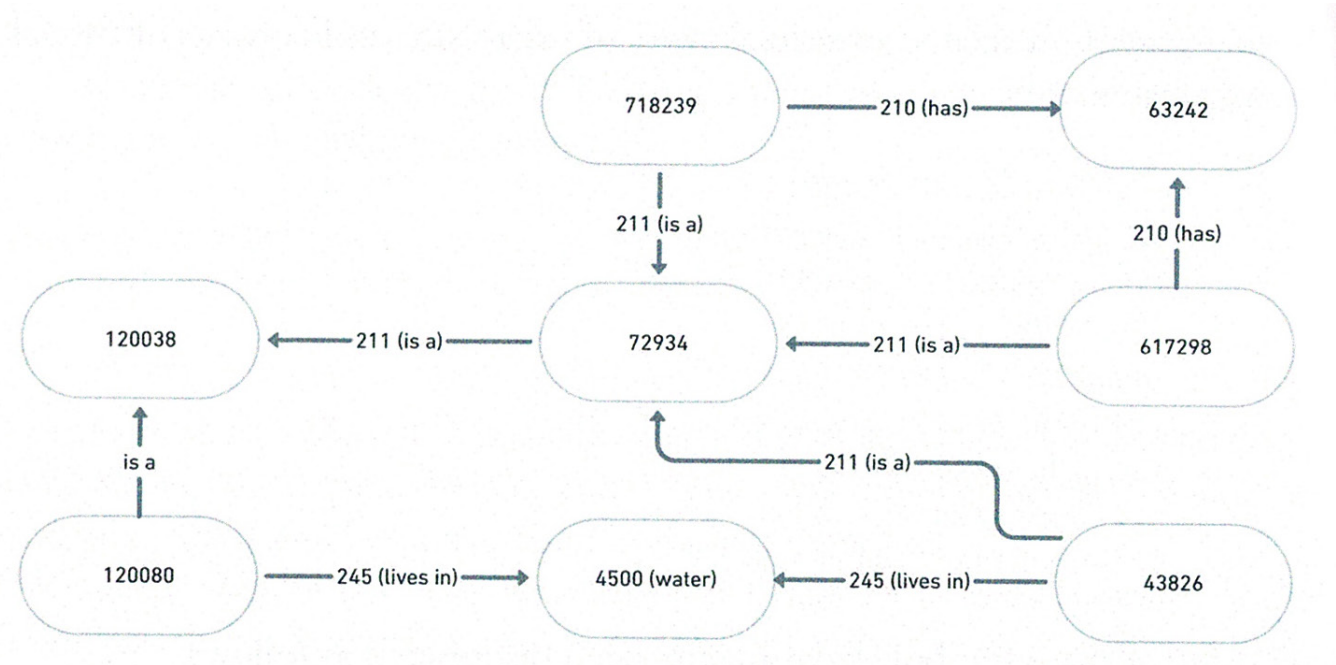
An algorithmic communication system is attractive because the amount of information that can be transmitted across an interstellar link is finite and possibly quite small relative to the amount of information the sender might want to share. If the sender can compress data using an algorithm and includes an algorithm that can be used to decompress it on the receiving end, the sender can increase the effective carrying capacity of the link manyfold."

Credit(image and caption); McConnell

In Part 4, the author considers whether and how it may be possible for aliens to encode more complex data and information into a signal. He starts with fundamental units of measurement of time, distance, mass, and so on, before moving on to the more complex question of how to communicate abstract ideas and concepts, through the development of a semantic network. Such a network links related ideas together, potentially allowing the recipient to move from descriptors of concrete objects to those for more abstract ideas.



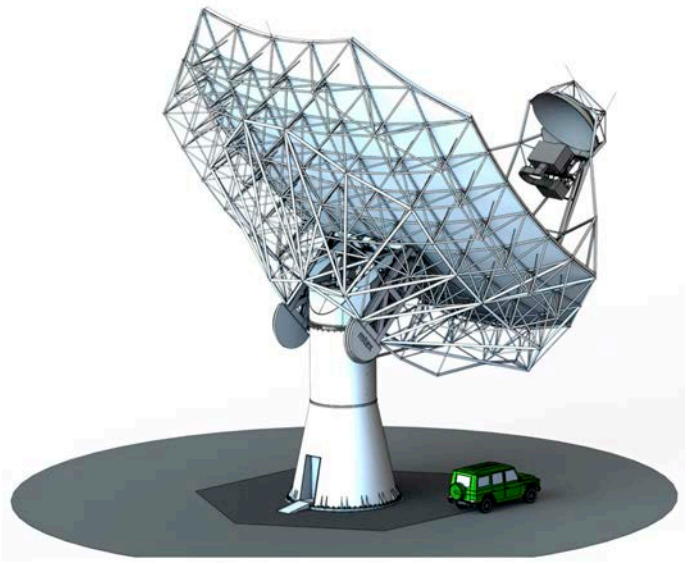
McConnell: Fig. 15.1 An English representation of a small semantic network that describes the relationships between several types of animals.
Credit (image and caption): Brian McConnell



McConnell: Fig. 18.2 A diagram of a partially understood semantic network. Notice that even though only a few of the concepts are mapped to human language terms, we can still understand how the concepts are connected to each other.
Credit (image and caption): Brian McConnell

The following chapter discusses why a message might include information on the alien genome. Were this included – and decoded – it could help answer some profound questions, including how life started and whether it is possible for intelligent life to evolve with different genetic coding systems.
This section concludes with a short chapter which considers whether the discovery of one alien species might lead us to find others, and the extent to which these aliens might communicate with each other via a galactic network of some kind.
The book concludes in Part 5 with two short chapters. The first identifies the different skills sets that could prove useful to the worldwide effort to decode an alien message, reinforcing the idea that citizen scientists and amateurs of many kinds could have a valuable role to play in this endeavour. The final chapter considers the central question, 'What could we learn from another civilisation?', exploring just a few of the categories of information that might expand our knowledge of the universe around us, and even of ourselves.
While this volume is, in my view, an excellent read, I do have a few minor criticisms to make. It seems odd that the five-part structure the author describes in the preface was not instituted in reality, as this would have split the material up logically and made it easier for the reader to navigate the book. Instead, we have nineteen chapters that follow one after the other, but they are somewhat uneven in both length and complexity. The longest chapter is 46 pages, while the shortest is just three. And whereas some – presumably those on subjects with which the author is most familiar – go into great detail, others rather skate over the topic, providing only the most basic information. In addition, the layout is not always as user-friendly as it might be, with the text sometimes referring to an important explanatory image that does not turn up until some pages later, while at other times the link between the text and a related image is not made clear.

My final criticism is of the author's mindset, rather than the book itself, and is one I would make of many SETI advocates. There seems little place in McConnell's worldview for the idea that there could be any dangers to be found in an alien message. For example, despite dedicating a long chapter to the potential communication of algorithms of varied complexity, the author assumes throughout that these algorithms will be harmless, and suggests that decoding them will be one of the activities open to anyone. Given the near ubiquity of computer viruses here on Earth, I would have expected a few lines at least to be dedicated to a discussion of the need for some basic precautions, just in case any alien algorithms, whether deliberately or accidentally, had the potential to infect and cause damage to the IT equipment of those investigating them. As an occasional writer of science fiction, I found the inspiration for several short story ideas in this chapter – but in none of them did humanity come out well.
Criticisms aside, though, I applaud Brian McConnell for the efforts he has taken to explore this fascinating SETI thought experiment. His enthusiasm and natural prose style makes the book a remarkably easy read, given the complexity of the subject matter. He explains difficult ideas simply and clearly, and tackles a wide range of topics in a way that threads them all together as a coherent whole. Having read The Alien Communication Handbook, I am now desperate for a SETI signal to arrive during my lifetime, so that I can volunteer to take part in what could potentially become one of the great citizen science activities of our or any age. If the idea of getting involved in such a project excites you too, I'd encourage you to get hold of the book.



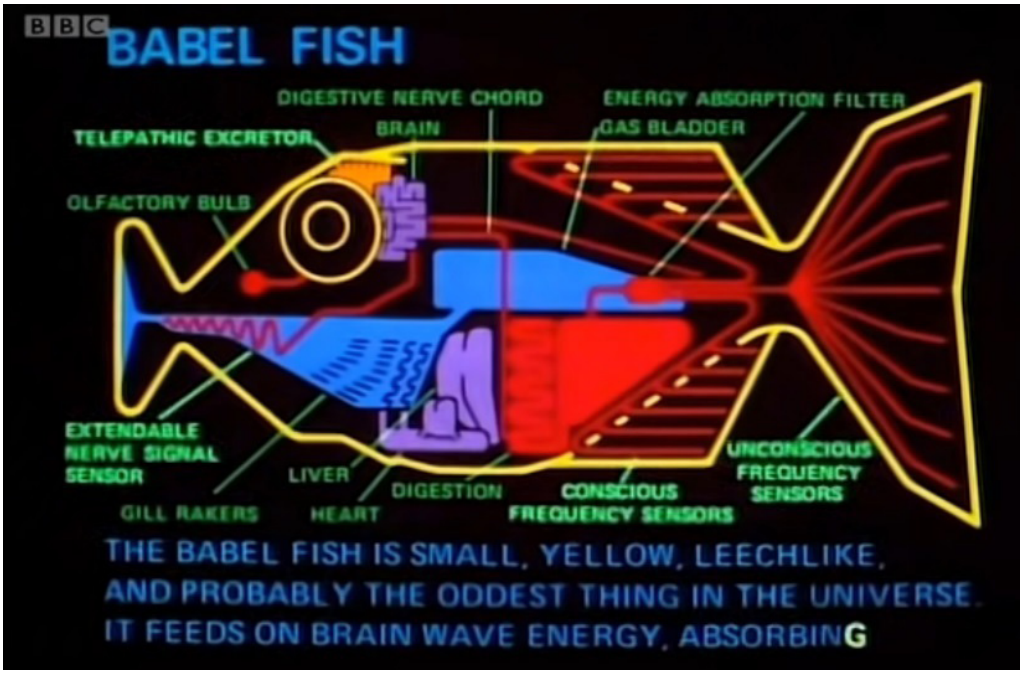
The next-generation Very Large Array (ngVLA)
One of the 244 mtex antennas, each measuring 18 m in diameter, of the Main and Long Baseline Array of the ngVLA.
"The unprecedented capabilities of next generation radio telescopes, including ngVLA, will allow us to probe hitherto unexplored regions of parameter space, thereby placing meaningful limits on the prevalence of technological civilizations in the Universe (or, if we are fortunate, making one of the most significant discoveries in the history of science)." *Science with an ngVLA: SETI Searches for Evidence of Intelligent Life in the Galaxy*, Croft et al, 2018 arxiv.org/abs/1810.06568

Image credit: National Radio Astronomy Observatory (NRAO)

A couple of fictional examples of communication with ETIs - hostile and (mostly) harmless - neither cited by McConnell

Scene from A For Andromeda by Fred Hoyle.
Credit: BBC Television

Julie Christie as Andromeda and Peter Halliday as John Fleming with the computer in the background. The computer is constructed according to a message received from an ETI. The computer kills its operator, Christine, and creates Andromeda as its agent.
Note the flashing lights - those were the days! Cited in *Book Review: Extraterrestrial Languages* Daniel Oberhaus (P31 November 2020)



The Babel fish - as conceived by the late Douglas Adams.
Credit (image and quote): Douglas Adams / BBC

"The Babel fish is small, yellow, leech-like, and probably the oddest thing in the Universe. It feeds on brainwave energy received not from its own carrier, but from those around it. It absorbs all unconscious mental frequencies from this brainwave energy to nourish itself with. It then excretes into the mind of its carrier a telepathic matrix formed by combining the conscious thought frequencies with nerve signals picked up from the speech centres of the brain which has supplied them. The practical upshot of all this is that if you stick a Babel fish in your ear you can instantly understand anything said to you in any form of language.

...

Meanwhile the poor Babel fish by effectively removing all barriers to communications between different cultures and races has caused more and bloodier wars than anything else in the history of creation"