Became, Become, Becoming

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Arrival
Directed by Denis Villeneuve
Paramount Pictures, 116 minutes, 2016

TWELVE ALIEN SPACESHIPS have mysteriously appeared around the world. The purpose of their visit is unknown. Governments and armies become nervous. Teams of linguists are assembled. *Arrival* follows one of them, Dr. Louise Banks, as she attempts to learn the aliens' language. The experience has a profound impact on Banks. The language changes her. She comes to perceive her life as a single, integrated whole, her actions as both freely chosen and inevitable. Interspersed throughout the film are what, at first glance, appear to be a series of flashbacks. These include scenes depicting the hospitalization and death of her young daughter. The viewer gradually becomes aware that these scenes merge the past, present, and future. By the end of the film, Banks is aware that her as-yet-unborn daughter will die. She still makes the choices that lead to the birth of her daughter.

Arrival is based on a short story by the science fiction writer Ted Chiang, entitled "Story of Your Life." Chiang has described the piece as "a story about a person's response to the inevitable."[1] Despite knowing the story of her life, Banks still wants to live it.

IN THE ORIGINAL short story, ideas from physics and mathematics are crucial to the plot. Among them is Fermat's principle of least time. This states that light traveling between two points traverses the shortest possible path. The refraction of light can be understood in terms of this principle. Upon coming into contact with water, a beam of light changes direction because the index of refraction of water is different from that of air. Because light travels more slowly through water than air, the amount of time light spends travelling through water is minimized. The overall length of the path is also minimized. Understanding the behavior of a beam of light at the interface between air and water seems to require knowledge of both its starting and end points—a notion that is counterintuitive.

Fermat's principle describes behavior in the physical world in terms of how the system works globally. The difference between the immediate agent of change and some final result that the system aims to achieve has been the subject of study for centuries, going back as far as the time of Aristotle and the distinction he made between effective (efficient) cause and final cause. In 1744, Leonhard Euler wrote that "there is absolutely no doubt that every effect in the universe can be explained as satisfactorily from final causes ... as it can from the effective causes."[2]

In the original short story, not just light, but the whole universe is depicted as being susceptible to explanation from two distinct standpoints. Human language and physics are shaped by an inclination to see the world in terms of cause and effect. It is for this reason that Fermat's principle seems unintuitive. The aliens in *Arrival* understand the universe as involving final, not efficient, causes. Humans think of refraction as being caused by the differing densities of air and water—in effect, a succession of causal chains. The aliens would see it as a point of equilibrium of the system, and the system as an atemporal whole.

Chiang's short story interweaves ideas from both linguistics and physics, but the latter are largely absent from the film. Fermat's principle featured in early versions of the script, but did not make the final cut. This is a shame because the notion that the world can be perceived and understood from two distinct perspectives, local and causal versus global and atemporal, helps to explain the effects that learning the alien language has on Banks. In the original story, the physics and linguistics reinforce one another. In the film, more has to be taken on trust.

IN ONE OF the film's opening scenes, a delegation from the U.S. military visit Banks in her office.[3] A colonel remarks to Banks, "You're at the top of everyone's list when it comes to translation." Linguists in the audience will likely cringe. What the military really want from Banks is an analysis of the alien language. One could be forgiven for assuming at this point, as I did, that the film's portrayal of linguistics would be perfunctory at best. But as the film unfolds, the opposite proves to be true. *Arrival's*

depiction of linguists working to discover the structure of a new language is both realistic and captivating.

Jessica Coon, a linguist at McGill University, acted as a consultant for the film. The filmmakers sought to understand the work of linguists, what they look like, what kinds of offices they work in, and so on. They rented books from Coon and her colleagues for use on set and spent time with the speech analysis program Praat, a favorite among practitioners in the field. The effort invested in learning about the work of linguists from Coon and her colleagues at McGill is evident in the film.

Some of the scenes in *Arrival* will resonate with any linguist who has ever done fieldwork. The joy of discovery, the moment of realization that a hypothesis is, in fact, correct, and the unexpected twists and turns along the way, are all beautifully captured in the film. When beginning with a new language, most field linguists already have one in common with their consultants. But the idea of working with a monolingual speaker is familiar. As Banks notes, we know how it works in theory, even if we have not done it ourselves.

Banks is shown using recording equipment, playback, and pointing in her initial attempts at communicating with the aliens. Nonetheless, making progress with their spoken language proves difficult. She has no idea of the aliens' physiology, or how they might produce and perceive sounds. To make matters more complicated, the aliens in *Arrival* remain mostly out of sight. They are depicted as gigantic, tentacular, Lovecraftian creatures, emerging from swirls of thick mist. Because of their seven limbs, the scientists call them *Heptapods*.

Frustrated by her inability to progress with their spoken language, Banks suggests showing the Heptapods human writing.[4] This proves to be a breakthrough. The Heptapod visual language is produced when one of the aliens emits a stream of dark, squid-like ink. The ink resolves mid-air into a circular shape, or whorl, with multiple curlicues, or tendrils, that interweave and twist away from the circumference. Each circular shape conveys an idea. These are termed *logograms* by Banks, and her team sets about analyzing them. They find that the orientation, shape, modulation, and direction of the tendrils convey the meaningful connections between the parts of a logogram and the idea that is being expressed. It is a purely visual grammar.

The Heptapod visual language is one of the most striking and artfully designed aspects of the film. The logograms were created by the artist Martine Bertrand and systematized by a production team led by Patrice Vermette. As a proof of concept, the filmmakers sent the logograms to the developer Christopher Wolfram.[5] He analyzed them using the Mathematica suite of programs to tease out the significance in their structure. The logograms were also sent to Coon. She applied linguistic analysis techniques, annotating the logograms as though they were an unde-

ciphered writing system. Coon's annotated versions can be seen scattered around on tables and pinned up on the walls of the field laboratory depicted in the film. The programs Wolfram developed to analyze the logograms are running in real time on computers dotted around the lab. The two approaches converge in an iPad-like device that Banks uses to construct her own logograms in order to communicate with the Heptapods.

WHEN CONFRONTED WITH an alien species possessing an unknown language, formulating a question as simple as "Why did you come here?" is a challenge fraught with linguistic complexities. Consider the word *why*. Several very particular concepts are packaged into this small word. Some of these are particularly relevant to the plot of *Arrival*. The first is the concept of a reason. In English, when we ask *why*, we do not distinguish between different kinds of reason. This is not true for all human languages. In Pitjantjatjara, an Australian aboriginal language, one asks: *nyaaku* (for what purpose?), *nyaanguru* (from what cause?) or *nyaangkatawara* (to avoid what?). Would the Heptapods grasp *why*? The notion of a reason is particularly human. It may not travel all that well. For the Heptapods, the universe is governed by atemporal principles; the future consequences of any action are known as soon as the action is undertaken.

There is also the grammatical function of *why*. Words such as *who*, *what*, *where*, *when* and *why* have something in common. In *I know why you came*, no question is being asked. These words open up a set of alternative individuals, things, places, times, and reasons.[6] The grammar of English works with these alternatives. The question *Why did you come*? presupposes a range of alternative reasons, and asks the hearer to identify which of these constitutes a true answer. In the sentence *I know why you came*, the word *know* signals that one among the range of alternative reasons is known to the speaker.

For the Heptapods, alternatives collapse to a single outcome. The interaction of time, space, and matter is completely determined. Why did you come? *We came*. What more could they say? Other grammatical concepts also enter into the meaning of *Why did you come here*? Linguists analyze verbs of becoming or arriving as if they were switches that changed the subject or object of a sentence from one state to another. Under the linguist's eye, *she came* really means that she was there, and now she is here. Getting her from there to here requires a local and efficient cause.

The Heptapods understand the universe only in terms of final causes. The universal weave connecting human grammar and human thought involves the very notions to which the Heptapods are indifferent. Using normal linguistic methods, could Banks figure out Heptapod grammar? It seems unlikely. The grammar of human languages is

built from certain recurrent conceptual categories. Causes produce effects. Reasons govern action. Things change by changing states. In some languages, verbal elements capture the complicated relationship between the time of an event and the time of an utterance.

When linguists examine a new language, they work from the common conceptual heritage of the human race. Time and again we see familiar distinctions and similarities at play. In 1957, the year that Noam Chomsky published *Syntactic Structures,* Martin Joos described the prevailing view as "languages could differ from each other without limit and in unpredictable ways."[7] Chomsky has spent his career showing that this view is false. Languages no more differ from each other without limit than human bodies differ from each other without end.

In *Arrival,* Banks has no idea how the Heptapods think, or what the categories of their language might be. There is nothing to provide the analytical traction linguists usually have when tackling an unfamiliar language.[8]

T HE SECOND ASPECT of linguistics addressed in *Arrival* concerns the Sapir–Whorf hypothesis. In a brief technical note, Benjamin Lee Whorf remarked that

the background linguistic system (in other words, the grammar) of each language is not merely a reproducing instrument for voicing ideas but rather is itself the shaper of ideas, the program and guide for the individual's mental activity, for his analysis of impressions, for his synthesis of his mental stock in trade. Formulation of ideas is not an independent process, strictly rational in the old sense, but is part of a particular grammar, and differs, from slightly to greatly, between different grammars. We dissect nature along lines laid down by our native languages. The categories and types that we isolate from the world of phenomena we do not find there because they stare every observer in the face; on the contrary, the world is presented in a kaleidoscopic flux of impressions which has to be organized by our minds—and this means largely by the linguistic systems in our minds. We cut nature up, organize it into concepts, and ascribe significances as we do, largely because we are parties to an agreement to organize it in this way—an agreement that holds throughout our speech community and is codified in the patterns of our language.[9]

The idea that the grammar of a language is a shaper of thought is fundamental to the film. *Arrival* embraces the strong version of the Sapir–Whorf Hypothesis. Every language determines a world. As Banks becomes more competent with the Heptapod language, its way of organizing reality becomes hers. Learning the language rewrites her cognitive processes. Logograms emerge holistically, each inky tendril settling into a position that is related to all the other tendrils simultaneously.

The linguist and polyglot Kenneth Hale once wrote that it is possible to have a complete command of the grammar and phonology of a language without knowing the smallest thing about the worldview of its speakers.[10] If grammar and culture are profoundly separated, as Hale suggested, then what scope for the Sapir–Whorf hypothesis? Grammar does not affect our perception of the world, nor is our perception of the world reflected in our grammar. The worldviews of a culture are often reflected in the *vocabulary* of its language, but we do not need to appeal to them to explain the grammar of languages.

From his research with the Warlpiri aboriginal people of Australia's Northern Territory, Hale identified a theme in their philosophy that he described as the logic of eternity. The Warlpiri see time in cyclical terms. The act of making something is merely altering the stuff of the world to form a manifestation of an eternal object. Hale argues that this worldview can be seen in the Warlpiri's ritual and totemic practices, kinship system, and the words in their vocabulary that loosely correspond to our own *make*: *ngurrju-ma-ni* (to perfect or fix); *yirra-rni* (to put something in place); and various verbs of impact, such as *paka-rni* (to chop), *panti-rni* (to pierce or gouge), and *jarnti-rni* (to trim or sculpt). In the Warlpiri's vocabulary, the act of making is coded not as creation, but as change. These aspects of Warlpiri culture do not arise at the level of grammar. Hale contrasts this with the kinds of concepts that *do* often appear in the grammar of the world's languages. These include cause, alternatives, volition, spatial and temporal orientation, and evidence. Color is a fundamental category of human visual systems, but is never found as a mode of grammatical organization.

Grammar and overall cognitive perspective connect, but in limited and highly constrained ways. When linguists and psychologists have attempted to test the Sapir–Whorf hypothesis, they have found that humans do not in fact "dissect nature along the lines laid down by our native languages." Our languages reflect how we antecedently dissect reality.

Some languages, such as Korean, make an obligatory distinction in their grammar between information that is obtained first hand and information that is inferred. If Korean speakers want to convey that Toli ate dumplings, they have no choice but to say either *Tolika mantwulul mekess-e,* (literally, Toli dumplings ate), or *Tolika mantwulul mekess-tay*. Note the change at the end of the sentence: either *-e* or *-tay*. The first indicates that the speaker has direct perceptual evidence, perhaps having seen Toli eat dumplings, while the second indicates that the speaker has inferred that Toli ate the dumplings, but did not directly perceive it. If the Sapir–Whorf hypothesis were correct, Korean speakers would be tuned to this aspect of reality in a way that English speakers are not. A research team led by Anna Papafragou found that this is simply not the case.[11] They studied the ability of young Korean and English chil-

dren to think and reason about how one knows what one knows. Even though Korean children encode this in a huge number of the sentences they utter, they are no better than English-speaking children at this task. Where studies have found a Sapir–Whorf type effect, it appears to be very weak and a side effect of the processing of language. There is no evidence of a deep and permanent impact on cognition.

The Sapir–Whorf hypothesis has long been a trope of speculative fiction: Big Brother in George Orwell's *1984* developed Newspeak as a means of totalitarian control; the Láadan language in Suzette Haden Elgin's *Native Tongue* trilogy sought to de-masculinize language; and Ursula K. Le Guin's Pravic, the language of the anarchist community in *The Dispossessed*, lacks the grammar of ownership and possession. *Arrival* takes a giant step further.

Another interpretation is that learning the alien language makes a preexisting aspect of human cognition accessible for the first time.[12] The new language provides Banks with a cognitive technology to access a part of her mind that had always been there, but had never been used. Ian Tattersall has suggested that our own language may have been such a cognitive technology.[13] Over the course of human history, the anatomy of our ancestors changed many, many times in ways that preceded, often by millennia, cultural behaviors dependent on that anatomy. Tattersall speculates that a subtle cognitive change occurred at some point. This could have been the appearance of a symbolic capacity, or, as suggested by Chomsky, the appearance of a recursive capacity to organize those symbols syntactically.[14]

In the context of *Arrival*, this is perhaps the only interpretation that makes sense with regard to Banks learning the alien language and its subsequent impact on her psychological and perceptual abilities. This interpretation also makes sense of the claim made by the Heptapods that they have brought with them a tool for humanity to use.

THE FILM'S ENDING is quite different from that of Chiang's original short story. At the end of "Story of Your Life," the Heptapods simply leave. The reasons for their arrival and departure are not at issue. The structure of the short story reflects its central idea: sequence is illusory, cause and effect unreal. In the film, things happen, which, in turn, cause other things to happen. A small group of soldiers attacks one of the Heptapods' ships; this in turn causes international tensions. China becomes restive, and prepares to act. Banks then uses her newfound perception to alter events. The sequential, causal, human worldview is very much at play in the conclusion to the film. In the short story, what makes freedom of choice impossible is knowing what the choices will be. The film, on the other hand, tries to have it both ways: Banks chooses to act and seemingly changes the future, thus subverting the philosophical point, and to some extent, the emotional one too.

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1. Ted Chiang, *Stories of Your Life and Others* (London: Pan Macmillan Tor, 2004), 328.
2. Leonhard Euler, "*Methodus Inveniendi Lineas Curvas,*" trans. William Abbott Oldfather et al., *Isis* 20, no. 1 (1933): 76–77.
3. The military and political characters in the film are portrayed, rather stereotypically, as short-sighted, cowardly, and scientifically ignorant.
4. In Chiang's short story, the Heptapod spoken language seems not too unfamiliar to Banks. Similar to the grammatical cases of Latin or German, nouns have special markers that signify meaning. There are distinguishable words, and although the order of the words is fairly free, this comes as no surprise. Many human languages express grammatical concepts through rich inflections, giving correspondingly greater latitude to order words as you will.
5. Christopher is the son of Stephen Wolfram, the computer scientist and physicist responsible for Mathematica and the Wolfram Alpha search engine.
6. Lauri Karttunen, "Syntax and Semantics of Questions," *Linguistics and Philosophy* 1 (1977): 3–44.
7. Martin Joos, *Readings in Linguistics* (Chicago: University of Chicago Press, 1957).
8. As a field linguist, Banks is faced with a dilemma described by W. V. O. Quine in *Word and Object* (Cambridge, MA: MIT Press, 1960). A linguist is sitting in a field with a native speaker. They watch a rabbit hop by. The native speaker remarks "Gavagai!" What then, Quine asks, should the linguist write in her field notebook? Rabbit? Hopping thing? Digestive system on the move? Undetached rabbit parts?
9. Benjamin Lee Whorf, "Science and Linguistics," *Technology Review* 42, no. 6 (1940): 229–31. Reprinted in Benjamin Lee Whorf, *Language, Thought, and Reality: Selected Writings of Benjamin Lee Whorf*, ed. John Carroll (Cambridge, MA: MIT Press, 1956).
10. Kenneth Hale, "Notes on World View and Semantic Categories: Some Warlpiri Examples," in *Features and Projections*, ed. Peter Muyskens and Henk van Riemsdijk (Dordrecht: Foris, 1986), 233–54.
11. Anna Papafragou et al., "Evidentiality in Language and Cognition," *Cognition* 103 (2007): 253–99.
12. This brings to mind attempts to teach human sign language to non-human primates, such as chimpanzees. Many animals use vocal signals or gestures for communication, and chimpanzees are both curious and extremely intelligent. Yet no animal test subject has ever managed to learn the grammar of sign languages. It has proven to be simply orthogonal to their biological capabilities. See David Premack, *Gavagai!*

or the Future History of the Animal Language Controversy (Cambridge: MIT Press, 1986).

13. Ian Tattersall, *Masters of the Planet: The Search for our Human Origins* (New York: Macmillan, 2012).

14. Noam Chomsky, *The Minimalist Program* (Cambridge: MIT Press, 1995).

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