polifonia
eISSN 22376844

Heptapod B and the Metaphysics of Time – Hybrid Interfaces of Literature, Cinema and Science

Israel A. C. Noletto[1]
Instituto Federal do Piauí (IFPI)
Sebastião Alves Lopes Teixeira[2]
Universidade Federal do Piauí (UFPI)

Abstract

In this paper, we intend to promote an analysis of the use of the artificial language Heptapod B in *Story of Your Life* (1998) written by Ted Chiang and in its filmic adaptation, *Arrival* (2016), written by Eric Heisserer and directed by Denis Villeneuve in relation to the authors' views on the metaphysics of time. In both literary and filmic texts, the glossopoeia is used as a plot device upon which the alien race's time perception is constructed and explicated in connexion with the strong metaphor provided by Fermat's principle of least time. Throughout the article, we discuss these hybrid interfaces of literature, cinema and science, researching the stories' specific diegeses, the writers' own elicitations as well as various texts on the Philosophy of time. The result consists of a comprehensive exegesis of the problematics generated by the narratives and an extensive philosophical debate on the subject.

Keywords: metaphysics of time. Fermat's principle. Heptapod B.

Heptapod B e a metafísica do tempo – Interfaces híbridas de literatura, cinema e ciência

Resumo

Neste artigo, pretendemos promover uma análise sobre uso da língua artificial Heptapod B em *História da sua vida* (1998) de Ted Chiang e sua adaptação fílmica, *A chegada* (2016), escrita por Eric Heisserer e dirigida por Denis Villeneuve em relação à visão dos autores quanto à metafísica do tempo. Tanto no texto literário como no fílmico, a glossopeia é explorada como instrumento narrativo sobre a qual a percepção de tempo da raça alienígena é construída e explicada em conexão com a poderosa metáfora proporcionada pelo princípio do menor tempo de Fermat. Em todo o artigo, discutimos estas interfaces híbridas de literatura, cinema e ciência, pesquisando a diegese específica dos enredos, as elucidações dos próprios autores, bem como vários textos que tratam da filosofia do tempo. O resultado inclui uma exegese abrangente das problemáticas geradas pelas narrativas e um extenso debate sobre o tema.

Palavras-chave: metafísica do tempo. princípio de Fermat. Heptapod B.

[1] Graduado em Letras/Inglês pela UESPI e mestre em Letras pela UFPI. Professor efetivo de Inglês e literatura correspondente no IFPI, campus São Raimundo Nonato. E-mail para contato: israelnoletto@ifpi.edu.br.
[2] Doutor em Letras, Área de concentração: Língua Inglesa e Literaturas Inglesa e Norte-Americana, pela Universidade de São Paulo (2002); Pós-Doutorado na Universidade de Winnipeg, Canadá (2007); Pós-Doutorado na Universidade de Londres/School of Oriental and African Studies, Inglaterra (2014). Atualmente é professor Associado da Universidade Federal do Piauí. E-mail para contato: slopes10@uol.com.br.

polifonia
eISSN 22376844

Heptapod B y la metafísica del tiempo – interfaces híbridas de literature, cine y ciencia

Resumen

En este artículo, pretendemos promover un análisis acerca del uso que se hace de la lengua artificial Heptapod B en *La historia de tu vida* (1998) de Ted Chiang y en su adaptación fílmica, *La llegada* (2016), escribido por Eric Heisserer y dirigido por Denis Villeneuve relacionado con la visión que tienen los autores sobre la metafísica del tiempo. Tanto en el texto literario, así como en el fílmico, se explora la glosopeya como instrumento de la trama con lo cual se construye y explica la percepción de tiempo que tienen los alienígenas en conexión con la poderosa metáfora proporcionada por el principio del tiempo más corto de Fermat. Por todo el artículo, discutimos estas interfaces híbridas de literatura, cinema y ciencia, pesquisándose la diégesis específica de los enredos, las elucidaciones de los escritores mismos, así como varios textos conexos con la filosofía del tiempo. El resultado final incluye un exégesis exhaustiva de las problemáticas que emanan de la narrativa y un extenso debate acerca de la cuestión.

Palabras-clave: metafísica del tiempo. principio de Fermat. Heptapod B.

1 Introduction

"We are so bound by time; by its order." (HEISSERER, 2016, p. 2) That is a part of the opening words in *Arrival* (2016). We are really very bound by time and its order, as Dr Banks remarks; everything around us, in our perspective is connected to our view of it. Conceptualizing time, thus, is a problematic task, for its notion cannot be physically grasped. We tend to perceive it as a sequence attached to movement – "a day is the movement of the Earth around itself, while a year is the movement of the Earth around the Sun" (KAWAMOTO, 2016, p. 17). In that context, although it may give this impression, *Story of Your Life* and *Arrival* are not about "time travel", at least not the traditional type of it, since the characters of both stories do not move physically in time, but only their consciousness, their cognition; instead they are about the metaphysics of time and how perceptions thereof can be different. In other science fiction stories related to time, characters travel to the past, for example, and modify it. That is not the case here. Although characters' consciousness moves cyclically in time, they cannot change the past, and perhaps, not even the future, as we seek to establish in the discussion that follows. So as to proceed with that, we promote a deep discussion on the philosophical issues exhumed from the texts while also provoking thought experiments on them, pointing out their key differences, thus producing a comprehensive exegesis of both literary and filmic texts..

polifonia
eISSN 22376844

The way time is noted and how memories are represented in both literary and filmic texts make things even a little odder. There is an intentional confusion in the tenses used to narrate the stories: "I *remember* the scenario of your origin *you'll suggest* when you're twelve" (CHIANG, 1998, p. 91). The word "remember" and the future tense are put together in the same sentence. Is it a plot incongruity? Not really! Reading on in the text or watching the film onwards reveals a series of what appears to be flashbacks of Dr Banks, her husband and daughter, but they are in reality "flash forwards"[3], as shown through the citation below (all italics are ours):

> The request for that meeting was perhaps the second most momentous phone call in my life. The first, of course, *will be* the one from Mountain Rescue. At that point your dad and I *will be* speaking to each other maybe once a year, tops. After I get that phone call, though, the first thing I *'ll* do *will be* to call your father. (CHIANG, 1998, p. 95)

The short story follows two lines of narration that intertwine each other all the time. Sometimes, the text that relays the past, arguably in the case of the short story, and/or the present, in the case of the film, is interrupted, and there comes up a flash forward regarding Louise's daughter. In fact, Ted Chiang's first paragraphs are about the protagonist's memories of her yet unconceived daughter. Only then, the foreground story really comes forth – the aliens arrive in the vicinity of the earth in the short story, and enter the planet's atmosphere in the film. With that, concerned with the reasons surrounding such a visit, the military hire scientists to study the visitors and their language, and they come to the conclusion that Heptapod B, their written language is organized in a nonlinear fashion, which in turn, also grants them the ability to perceive time in the same manner.

Indeed, the same nonlinearity noticed in the heptapods' time perception and writing system is denoted in the narration, and that is intended to have the audiences also experience a little bit of what Louise is going through. The excerpt that follows shows this sort of nonlinear narration, as it presents a linguistic explanation Dr Banks was giving Dr Donnelly, which is interrupted all of a sudden to show one of the professor's flash forwards on her daughter. In the film, a number of cutaway transitions are used in a series of scenes in which Hannah appears with

[3] It could be argued that foreshadowing would be a better term to refer to the plot device Chiang, Heisserer and Villeneuve use so often in their texts. Nonetheless, flash forward is an interjected scene in a narrative, which takes the narrative forward in time. The events presented in a flash forward are bound to happen in the story, whereas foreshadowing predicts the future events, but the events do not necessarily take place in the future. Besides the term flash forward works perfectly as a precise opposition to flashbacks, which is the meaning we intend here.

polifonia
eISSN 22376844

different ages, right at the beginning in a sort of Kuleshov effect[4] that gives the impression that Hannah is a daughter from a broken marriage whom Louise has lost and therefore she now mourns, and then, finally, a fading out leads the audience to the present of Dr Banks (ARRIVAL, 2016). Contrariwise, in the short story, only a single spaced line between the two paragraphs is used to indicate the change in the context:

> […] the third, and most interesting to me, was that the heptapods were using a nonlinear system of orthography that qualified as true writing.
> I remember a conversation we'll have when you're in your junior year of high school. It'll be Sunday morning and I'll be scrambling some eggs while you set the table for brunch […] (CHIANG, 1998, p. 107)

The way the story is reported, sometimes in the past simple tense, sometimes in the future tense, indicates that Louise is telling it to her daughter, even before she is conceived, while she is still a memory from the future. It is possible to deduce that because of the moment in the story at which Louise falls in love with Dr Donnelly, right to the end of it, more precisely in the last paragraph, when he comes to her and asks: "Do you want to make a baby?" (CHIANG, 1998, p. 145) It is, by the way, her daughter that the title *Story of Your Life* is about.

Louise Banks has acquired the skill to perceive time in somewhat a similar way to the heptapods, after learning and thinking in their language; now, indeed she is *remembering* and *recounting* the "future", if put in the audience's perspective. This is an allusion to the strong view of the Sapir-Whorf hypothesis, which basically states that the language one speaks shapes and determines their thoughts (BORODITSKY, 2001).

As already stated, the text and the film are related in a sort of temporal disorder or confusion, in which future is sometimes told as though it were past. Chiang and Villeneuve intended the audience to find out by themselves what this aesthetics is about, for there is no introduction about it or any previous explanation anticipating it. In its place, the authors prefer to draw his narration towards the scientific issues of the short story. As Dr Donnelly makes it clear, the heptapods simplistic view and understanding of the variational principles of Physics is what

[4] Lev Kuleshov (1899-1970), a Soviet filmmaker, came up with the theory that the meaning of a shot was determined not only by the material content of it, but also by its association with the preceding and succeeding shots. In plain words, viewers of a film should derive more meaning from the interaction of sequential shots than from a single isolated one. This general principle of film editing is known as the Kuleshov effect (PRAMAGGIORE; WALLIS, 2005, p. 162).

polifonia
eISSN 22376844

enables them to move their consciousness through time simultaneously in the past, present and future. This feature of the stories allows for some excellent speculations.

Physics is indeed a fantastic subject both for scientists and science fiction writers, and the way Chiang concatenates science fiction with Linguistics and Physics is quite astonishing. It is unnecessary to state that an elementary comprehension of such concepts is essential to properly understand the target texts of our research. Because of that we proceed with a brief explanation on both the basics of what is currently assumed by the principles of time relativity and Fermat's principle.

2 Fermat's Principle and the Metaphysics of Time – An Outline

In plain and short terms, time relativity is a theory proposed by Albert Einstein in 1905, according to which time can be perceived in different ways and distinct durations depending on various factors, in other words, not everybody realizes time in the same way and length. Isenberg (2016, p. 2) makes some very curious and pertinent comments on this matter: "General relativity predicts the possibility of […] strange effects related to time. Specifically, there are models of the cosmos consistent with the principles of general relativity in which observers can move *cyclically* (our italics) in time." An everyday life illustration of that is how time feels quicker to pass when spent on enjoyable things than while feeling pain. As we said, time perception is subjective.

One way in which time relativity is put into practice is in the behaviour of light. This is the point in which the understanding of Fermat's principle of least time (named after French mathematician Pierre de Fermat in 1662) comes handiest. In line with it, light travelling between two points traverses its path within the shortest possible time. In a homogeneous environment, light will always propagate in a rectilinear fashion, but that may change in denser mediums (NUSSENZVEIG, 1998, p. 11). The notion of the refraction of light is a good example of that. In this sense, a fascinating feature of *Story of Your Life* and *Arrival*, which has led many critics of the genre to classify them as "hard science fiction", is that the texts provide readers and viewers with a realistic scientific background.

After discussing some of the notorious characteristics Heptapod B presents, Dr Donnelly deduces the aliens' views and starts to explain Fermat's principle to Louise using just the example

polifonia
eISSN 22376844

of the refraction of light. He says, "[…] here's the path a ray of light takes when crossing from air to water. The light travels in a straight line until it hits the water; the water has a different index of refraction, so the light changes direction." (CHIANG, 1998, p. 116) He then draws a diagram (see Figure 1) to represent what he is saying, and goes on, "Now here's an interesting property about the path the light takes. The path is the fastest possible route between these two points (CHIANG, 1998, p. 116)." He next draws another diagram (see Figure 2) adding a dotted line to represent what would be a linear route from point "A" to point "B" in a trajectory. He remarks that the hypothetical path is shorter than the path light actually takes, but light travels more slowly in water than it does in air, and a greater percentage of that path is underwater. Therefore, it would take more time for light to travel along that trajectory than along the real path. After drawing a third diagram, he continues: "[…] imagine if light were to travel along this other path" (CHIANG, 1998, pp. 116-117).

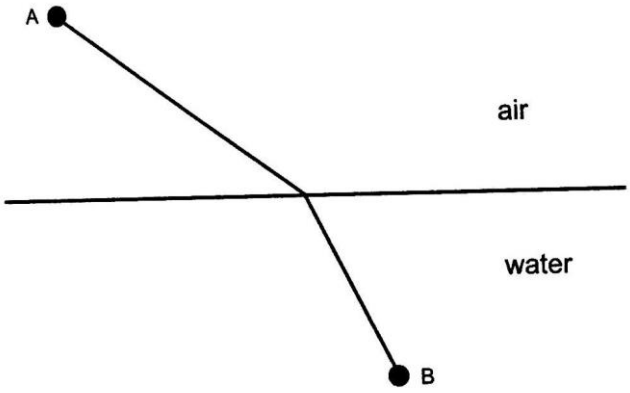

Figure 1. First of Dr Donnelly's diagrams. Source: Chiang (1998, p. 116)

Dr Donnelly reasons that any other hypothetical and plausible trajectory that anyone could come up with will always be longer than the path light actually takes from one point to another (see figure 3). So light is capable of bending its route in order to shorten the trajectory it is to take, that is, light will always arrive at the fastest speed and shortest path possible. He finishes, "That's Fermat's principle of least time." (CHIANG, 1998, p. 118) It is attention-grabbing that understanding the behaviour of a ray of light at the boundary between air and water appears to involve awareness of both its starting and ending points; a perception that is by no means instinctive for humans.

polifonia
eISSN 22376844

By noting the second diagram Dr Donnelly drew, it is easy to see that if the ray of light did not refract while travelling through water, half of its path would occur before entering water and the other half would be travelling through it (cf. dotted line), but because the ray of light refracts or bends, the path it takes inside water is reduced drastically, since light moves more slowly through water, the time needed for the ray to go from point "A" in the diagram to point "B" is also reduced drastically. But then again, you can only know how much time light spent in its trajectory once you know both the starting and the ending point of the emission of light.

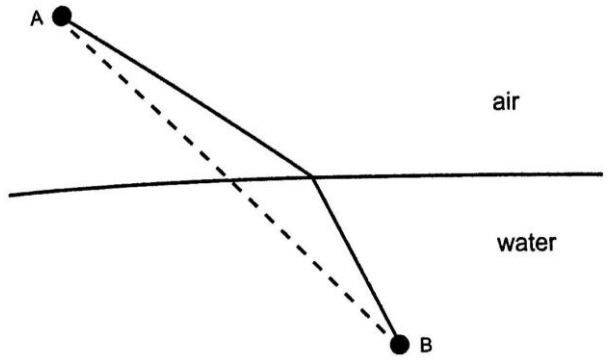

Figure 2. Second of Dr Donnelly's diagrams. Source: Chiang (1998, p. 117)

Laid in a practical standpoint, if one knows both the starting point of the emission of the ray of light and the point of its destination, it is very elementary to predict the amount of time that path will take. Fermat's principle defines "demeanour" in the physical world in terms of in what way the system works universally. Unlike, the author's views on language underlying the unorthodox and controversial premises of the Sapir-Whorf hypothesis, Chiang's outlook on this Physics matter tends to be a little more factual and scientifically accurate, showing off impeccable knowledge. There is surely some amount of poetic license, as well, as it is proper of a great science fiction story.

polifonia
eISSN 22376844

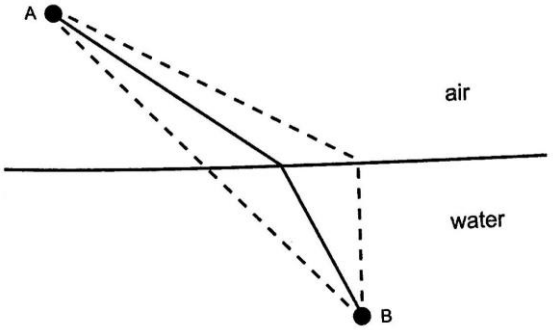

Figure 3. Third of Dr Donnelly's diagrams. Source: Chiang (1998, p. 117)

It interests us genuinely the fact that the heptapods' time perception or experience is remarkably similar to the theories of the "block universe", which is known in Philosophy as Eternalism. This ontological view of the nature of time was first proposed by British idealist metaphysician John McTaggart Ellis (best known as McTaggart) in the paper entitled *The Unreality of Time* (1908), in which he argues that time is unreal. This entangles the notion that past, present and future things all exist simultaneously, being just as real as each other. In fundamental Physics, this concept has been described as follows:

> […] Space and time are best described as a four-dimensional spacetime [*sic*] that represents all the places and all the times that ever exist as a single unchanging entity. There is no essential difference between the past and the future, because there is no present time defined to separate them; they cannot be distinguished from each other, so there is no meaningful present. Without an objective present, time does not flow in any real sense: the passage of time is an illusion. (ELLIS, 1908, p. 26)

This argument is interesting because it takes into account that distinguishing time into the classical categories of past, present and future is so dynamic that it is nearly impossible. With that we mean that the present only lasts for a tiny fraction of time as perceived by an observer and as such is merely a subjective view. Put differently, present can quickly become past and future constantly becomes present depending on our own assessment of an event, and thus the passage of time is an illusion produced by an observer's mind in order only to organize things and happenings in his/her memory with no factual ties to reality.

Nowadays, comparable to what chanced to the Sapir-Whorf hypothesis, McTaggart's conclusion that time is unreal has fallen into disregard in the theoretical realm of modern Physics,

polifonia
eISSN 22376844

although, his statement in relation to that conclusion is generally taken to be important (CURTIS; ROBSON, 2016). Anyhow, what really matters for our discussion here are the philosophical implications of such observations, and that allows for many extrapolations in the genre of science fiction as well as it constitutes just what Chiang needed to convey non-linear time experience to his heptapods.

Therefore, the topic that follows addresses the philosophical and metaphysical implications of the least time principle and the confabulations on the nature of time in the short story and its filmic adaptation.

3 Heptapod B Time Perception in Relation to the Nature of Time and Fermat's Principle

There are a lot of repercussions that we can derive from the heptapods' way of perceiving time. None of them may be very accurate in terms of the mechanics of Physics, but Philosophical implications are more important than facts and precise theories for a science fiction story. As a consequence, those repercussions will still be substantially valid here, since much more than a minimal plausibility criterion is met. The most important resulting matter of all, therefore, is what the nature of time and Fermat's principle have to do with the heptapods.

Well, we must begin by simply stating that according to the short story's and the film's "metaphysics", time, as we consider it, only exists in our heads, which is tacitly what McTaggart asserted, as we have just stated; it is an illusion, just according to what is defended by those who advocate the "block universe/Eternalism" theory. As it is, in both plots, not only light, but also the whole universe is depicted as being susceptible to explanation from two distinct perspectives. The succeeding quotation confers a philosophical starting point to our debate:

> You're used to thinking of refraction in terms of cause and effect: reaching the water's surface is the cause, and the change in direction is the effect. But Fermat's principle sounds weird because it describes light's behavior in goal-oriented terms. It sounds like a commandment to light beam: 'Thou shalt minimize […] the time taken to reach thy destination.' (CHIANG, 2016, p. 124)

Consider a driver trying to decide on which routes to take among many possibilities in order to get to his destination in the least time possible. He would have to know first what his

polifonia
eISSN 22376844

destination was and which route choices there were, logically. The same happens to the beam of light. Before being emitted, it is as if light had to know exactly where its path would lead in order to then calculate which path would be the fastest one. Unlike the driver who chooses a route based on distance and traffic predictions, and may end up having to make corrections to his route along the way, light cannot make any changes in its path because something changed after it was emitted, otherwise that would not be the fastest path possible. In simpler terms, light is capable of predicting the future, once it is emitted, it already "knows" precisely where it will end or reflect, and thus it serves the stories as a perfect metaphor to represent how the heptapods viewed time and events, or the cosmos. Ponder how Dr Donnelly explains that:

> "That's right; the notion of a 'fastest path' is meaningless unless there's a destination specified. And computing how long a given path takes also requires information about what lies along that path, like where the water's surface is."
> I kept staring at the diagram on the napkin. "And the light ray has to know all that ahead of time, before it starts moving, right?"
> "So to speak", said Gary. "The light can't start traveling in any old direction and make course corrections later on, because the path resulting from such behavior wouldn't be the fastest possible one. The light has to do all its computations at the very beginning." (CHIANG, 1998, p. 125)

Without a doubt, in the plots, the whole universe is beheld as being susceptible to explanation from two distinct angles. Whereas humans tend to shape language and Physics so as to regard the cosmos in terms of cause and effect, the heptapods, on the other hand, understood the universe as involving final, not efficient, causes. Aristotle's doctrine differentiates four sorts of "*cosmic* causes". If we take, for instance, a sculptor at work on a statue; the marble block is the material cause; the action of sculpting, the efficient cause, the shape of the statue is the formal cause (formal in relation to form, shape), and the final cause is the purpose for which the statue is intended (TODD, 1976). The heptapods viewed the world in terms of purpose, goal, destination, just like a ray of light according to Fermat's principle. So, instead of thinking on the causes and effects of actions or happenings, that is, sequence, they always looked at their purpose, in a teleological manner. So, the purpose had to be already known in order for one to start working on it, or to take action. Putting it very simply, that was why they necessitated observing time in a cyclic way. Illustrating that difference, Dr Donnelly says:

polifonia
eISSN 22376844

> Consider the phenomenon of light hitting water at one angle, and traveling through it at a different angle. Explain it by saying that a difference in the index of refraction caused the light to change direction, and one saw the world as humans saw it. Explain it by saying that light minimized the time needed to travel to its destination, and one saw the world as the heptapods saw it. Two very different interpretations. (CHIANG, 1998, p. 133)

"The physical universe is a language with a perfectly ambiguous grammar." (CHIANG, 1998, p. 133). Reality as we see it is a linguistic construction. The Sapir-Whorf hypothesis and the Heptapod glossopoeia are here again also underlying the metaphysics of *Story of Your Life* and *Arrival's* plots:

> When the ancestors of humans and heptapods first acquired the spark of consciousness, they both perceived the same physical world, but they parsed their perceptions differently; the worldviews that ultimately arose were the end result of that divergence. Humans had developed a sequential mode of awareness, while heptapods had developed a simultaneous mode of awareness. We experienced events in an order, and perceived their relationship as cause and effect. They experienced all events at once, and perceived a purpose underlying them all. A minimizing, maximizing purpose. (CHIANG, 1998, p. 134)

In conformity with that, however, one thing, intrigued us from the start regarding the heptapods' time perception: They could move their consciousness through time, but how far could they go? In the case of humans, our memories of the past can only go as far as our own existence starts, and even the first moments of our lives are buried in our subconscious. Louise explains that by pointing:

> After I learned Heptapod B, new memories fell into place like gigantic blocks, each one measuring years in duration, and though they didn't arrive in order or land contiguously, they soon composed a period of five decades. It is the period during which I know Heptapod B well enough to think in it, starting during my interviews with Flapper and Raspberry and ending with my death. (CHIANG, 1998, p. 140)

We assume that just like Louise, any heptapod could only stretch its consciousness into the future within its own life span; which leads to the question of how long they were capable of living. That is not answered, regrettably, but the filmic heptapods are said to expect humans' help in 3,000 years, and therefore, it is possible that they could live even longer than that. Here comes the whole "minimizing-maximizing" mechanism that Chiang keeps giving attention to, which was alluded as well in the citation of the page 134 of *Story of Your Life*. Precisely as light can minimise or maximise its path in order to go faster from one point to another, the heptapods had

polifonia
eISSN 22376844

the ability to cognitively minimise or warp the time needed to arrive at a certain point in the future in order to look at it. It does sound too fantastical, but the relativistic character of time, which depends on its *observer's* perspective, does allow, theoretically, for something like that to happen. With such view, thinking of how long one can live ceases to be of any importance.

A big issue, though, which begins here as an underlying point in this whole Philosophy of time is this: does future already exist, so that someone can really look at it? We demonstrated that for a ray of light, yes, future sort of already exists, since light can compute it and measure it in order to calculate trajectory with perfection; light "must know" in advance both the starting and the ending point; something similar to how the Heptapod writing system had to be laid out. As previously discussed, this is just what the Philosophy of Eternalism advocates; past, present and future are mental and linguistic constructions invented so that humans can organize memories and knowledge, but those three classifications do not occur independently, but rather coexist, making it possible for precise foreknowledge to come about; just like past may be accurately described, so may the future as well.

In this regard, there are some great comments that we should like to borrow from the novel *The Time Machine* (1895) by H. G. Wells. With the intention of keeping focus and succinctness, we do not leave the philosophical field. Before anything else, however, it is indispensable to note here that both *Story of Your Life* and *Arrival* have been dealing with the improbable all the way, and obviously our paper as well, so we have to extrapolate science and Philosophy during this discussion.

For Wells and his Time-Traveller, there was no difference between time and any of the three dimensions of space except that "*our consciousness moves along it*" (WELLS, 1995, p. 4). Men can move around with relative freedom through space. With natural capability, however, we can only move in two dimensions: right or left and forwards or backwards, and all those dimensions coexist, they do not simply come to be whenever we want to move into them, they are always there. With time, something similar takes place. We are always moving in time, from the moment of our conception until the day of our demise. "Our mental existences, which are immaterial and have no dimensions, are passing along the Time-Dimension with a uniform velocity from the cradle to the grave." (WELLS, 1995, p. 5) As it happens, we not only can, but also do move about in time, or our consciousness does. For example, when someone recalls an incident very vividly, they go back to the instant of its occurrence: they become "absent-minded".

polifonia
eISSN 22376844

They jump back for a moment. Of course they have no means of staying back for any length of time, any more than "an animal has of staying six feet above the ground" (WELLS, 1995, p. 6).

Another science fiction story that comes to mind on the subject of simultaneous time experience is Kurt Vonnegut's *Slaughterhouse Five* (1969). This satirical novel recounts the time travels of Billy Pilgrim who is abducted by a race of time-unbound aliens called the Tralfamadorians. According to the narrative, extra-terrestrial species existed out of time, and thus could move either backwards or forwards in what humans perceive as time. As a result of that encounter, the protagonist of the story also acquired the ability to move about through time. Coincidentally, the novel is also narrated in the same manner as *Story of Your Life* and *Arrival*, that is, non-linearly, though Chiang claims he had no knowledge thereof prior to writing his story (CHIANG, 1998, p. 277). The time travel that takes place in *Slaughterhouse Five* is poles apart from what the heptapods are able to do, in that instead of moving themselves in time, or really travelling in time, it is their cognition that can stretch itself either in the past, in the present or in the future. Still, the point is that the coexistence of past, present and future, or in fact the inexistence of time is always what allows for escaping the prison of time to which humans are condemned.

It is now important to remember the main premise of Fermat's principle; if a ray of light can "anticipate the future", "knowing" no obstacle will suddenly show up to prevent it from reaching its initial destination; another big question regarding this comes up out of these considerations as Louise utters the following:

> Was it actually possible to know the future? Not simply to guess at it; was it possible *to know* what was going to happen, with absolute certainty and in specific detail? Gary once told me that the fundamental laws of physics were time-symmetric, that there was no physical difference between past and future. Given that, some might say, "yes, theoretically." But speaking more concretely, most would answer "no," because of free will. (CHIANG, 1998, p. 131)

Louise sees, nonetheless, a great paradox here. If someone can peek at their own future like Louise was doing, free will should be able to confer them a chance to change that future, and subsequently that future prediction would suddenly become wrong and outdated, because of this, would that really be predicting the future, or would it just be guessing at it? What is more, since it is not possible to change the past, is it possible to change the future? If not, is there really such a

polifonia
eISSN 22376844

thing as free will? Again, if not, what is it like to live knowing exactly what is going to happen, but at the same time being helplessly incapable of doing anything differently? At the end of the film, Louise starts to ponder that by meditating: "Despite knowing the journey, and where it leads, I embrace it, and I welcome every moment of it" (Arrival, 2016, cap. 4).

4 Conclusion

The laws of Physics are generally time-symmetric. Physical events can run backwards or forwards. Temporal and atemporal perspectives are equivalent; all the same predictions are made, once the starting and ending points are *determined*. A memory is when our brain departs from the present and extrapolates backwards. This is not always a perfect system, sometimes we have false memories, and we think we are remembering something, but we are actually inventing something that did not happen. The same can go forwards; we can predict or plan ahead of time. For instance, before crossing a road, a person may "predict" the near future by calculating with a great level of precision whether or not there will be enough time to cross safely. In the majority of times the calculations we make are correct. Perchance the heptapods possess such means of unconsciously computing algorithms of purposes to reach a fine view of the future, just like a ray of light does before being emitted. This is also similar to the idea behind weather forecasts – calculus of probability based on a great amount of observable variables that are taken into account before predicting that there will be rain or sun on the following day or days.

The Mathematics and Physics metaphors have been used to show the difference between choice-oriented views and purpose-guided perceptions. The inclusion of the variational principles of Physics in the context is one of the most significant things in the plot created by Chiang, and adapted by Heisserer. This strengthens measurably the artistic value of the texts for its innovative character. By the way, in case it has not been made sufficiently clear by now, Fermat's principle of least time is a metaphor used by the author to show that the epiphenomena in nature are deterministic and seek for accomplishing purposes, rather than being merely causal. We tend to think of events to enmesh a strict relation of cause and effect, and, therefore, for every cause there must be an effect and vice-versa. However, in the case of the ray of light, there is not such relation; instead, the ray of light has a purpose – taking the fastest path from one point to another, even if that path seems longer, like the phenomenon of the refraction of light in the water. It is

polifonia
eISSN 22376844

because of that that the heptapods need to see the world and time in a cyclic manner. Similar to light, which has a single purpose and thus has to "know" accurately where it "wants" to go and what path to take before initiating its journey, the aliens could not act in the way they do without foreknowledge. Although these deep physical considerations are poorly done in the filmic adaptation, they seem to import meaningfully in order to make sense of the heptapods' way of thinking.

References

ARRIVAL. Direção: Denis Villeneuve. [S.l.]: [s.n.]. 2016.

BORODITSKY, L. Does Language Shape Thought? Mandarin and English Speakers' Conceptions of Time. **Cognitive Psychology**, 2001. 1-22. Disponivel em: <http://lera.ucsd.edu/papers/mandarin.pdf>. Acesso em: 10 jul. 2017.

CHIANG, T. Story of Your Life. In: _____ **Stories of Your life and Others**. Northampton: Vintage books, 1998. p. 91-146.

CURTIS, B. L.; ROBSON, J. **A Critical Introduction to the Metaphysics of Time**. London: Bloomsbury Academic, 2016.

HEISSERER, E. **Arrival (Screenplay)**. Los Angeles: Paramount Pictures, 2016. Disponivel em: <http://www.paramountguilds.com/pdf/arrival.pdf>. Acesso em: 24 jan. 2016.

ISENBERG, J. General Relativity, Time and Determinism. In: GHIRARD, G.; IYENGAR, S. **Space time and the Limits of Human Understanding**. Salem: Univeristy of Oregon, 2016. p. 299-311.

KAWAMOTO, M. T. M. **The Question of Time in Science Fiction Films:** An Investigation on Modernism, Postmodernism and Post-Postmodernism (?). Florianópolis: Universidade Federal de Santa Catarina, 2016.

MCTAGGART, J. E. The Unreality of Time. **Mind**, 17, Oct. 1908. 457-474. Disponivel em: <https://philpapers.org/archive/MCTTUO.pdf>. Acesso em: 16 jan. 2017.

NUSSENZVEIG, M. H. **Curso de Física Básica 4:** Ótica, Relatividade, Física Quântica. São Paulo: Edgard Blücher Ltd, 1998.

PRAMAGGIORE, M.; WALLIS, T. **Film:** A Critical Introduction. London: Laurence King Publishing, Ltd., 2005.

polifonia
eISSN 22376844

TODD, R. B. The Four Causes: Aristotle's Exposition and the Ancients. **Journal of the History of Ideas**, 37, 1976. 319-322. Disponivel em: <http://www.jstor.org/stable/2708827>. Acesso em: 22 jul. 2017.

WELLS, H. G. **The Time Machine**. New York: Dover Publications, 1995.