

# We Do Have Memories of the Future; We Just Cannot Make Sense of Them.

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## Abstract

From time to time, in the scientific literature or in science popularization articles, appears the question: Why do we remember the past but we can't remember the future? This question, of course, finds its legitimacy in the time symmetry of the equations of physics. However, it is not always answered clearly, and there are still debates about the best way to explain this paradox. In the present article, I analyze the remembering process in the perspective of the entropic arrow of time to grasp the possibility of memories of the future, and to understand what that would actually mean.

## Remembering Process and Arrow of Time

Laws of physics, for all practical purpose here, can be assumed as time-symmetric. It may not strictly be the case, but we will see that no potential asymmetry is necessary to explain the current paradox. In this context, every state of a system that we view as a consequence of the past could be seen as a consequence of the future in exactly the same way. We view memory as a record of events in the form of stored information in the brain; but depending on what events we are considering, this type of information could be a "memory" of the future as well as a memory of the past. However, it seems that it is not the case. How can we explain that?

What does remembering actually mean? We can describe remembering as the combination of three different processes: recording an event (as a result of a sensitive path, some atoms in the brain –to make it simple– switch to a particular position and state, resulting in a storage of information), accessing the information, and making sense of that information. The fact is, those three processes, as we understand them, happen in the macro world that is subject to the entropic arrow of time. Storing information globally increases entropy, as well as accessing that information and making sense of it. That means we make sense of a memory after we access it, we access it after we record it, and we record it after the associated event occurs. The existence of those processes, and the apparent absence of a similar combination of processes regarding future events, basically explain why we only can remember events from the past.

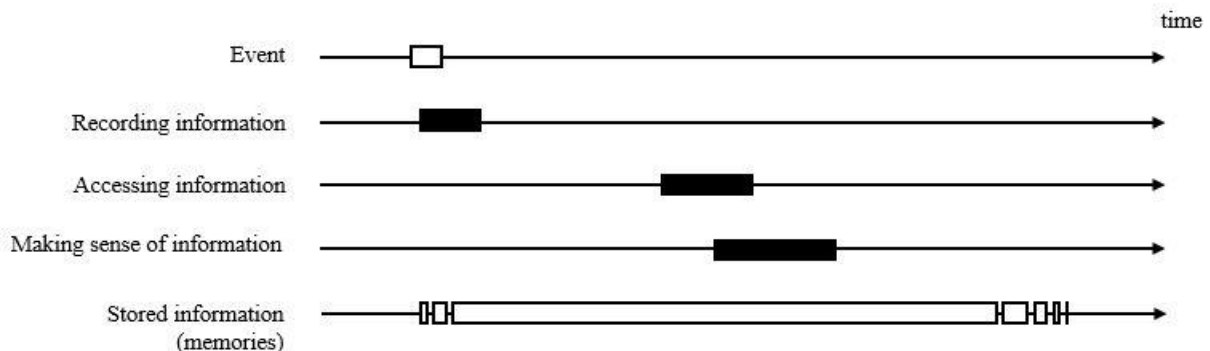


Figure 1: The remembering process

## Remembering the Future?

Let's go a bit further. The fact that accessing the information and making sense of it are processes that need to follow the entropic arrow of time is not enough, from a purely logical perspective, to conclude that we

cannot remember the future. We could still imagine that some recorded information in our brain is a “consequence” of future events, as much as a consequence of past events, if we consider the symmetry of the laws of physics. We somehow understand the rationale behind the later approach (the first process I was referring to, consisting in a complex entropy-creating chain of phenomena including the usage of sensors such as eyes or ears, and resulting in stored information – a local decrease of entropy). However, we cannot ignore the former. In that case, what appears to be information destruction, following the entropic arrow of time, would be a time-reversed process of information storage. If the stored information can be seen as a “consequence” of future events, the fact we have to access that information and make sense of it following the usual arrow of time does not prevent us from “remembering the future”. For this, we would only need to apply those two processes before the future event associated with the stored information occurs (assuming here that accessing memories does not alter such information).

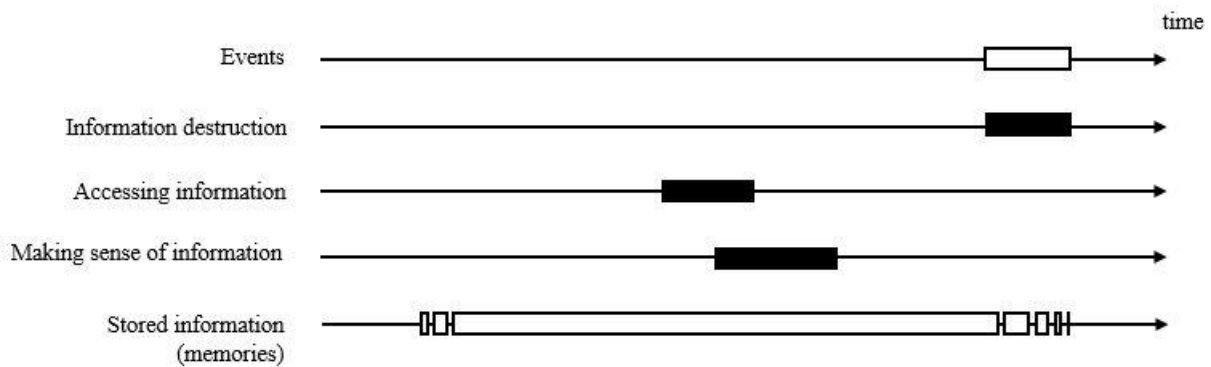


Figure 2: Memories related to future events

Of course, the process combinations depicted in Figure 1 and Figure 2 may be completely independent. In other words, they may not be associated with the same information: memories of the future do not have to be memories of the past as well. Therefore, accessing information linked to future events and making sense of it may be completely different processes from the ones at work with memories of past events. They would have to exist anyway, if we still want to talk about something like “remembering”.

### Macro-Events vs. Micro-Events

However, there is a fundamental asymmetry, related to the different types of events we may record. Information storage in our memory is a very effective (though entropy-creating) process, fruit of evolution, to record macro events. When I walk into a new apartment, my brain does not have to record every single detail of the scene: it stores information in a way that will allow me to somehow visualize it when I remember it. There are many ways the scene I witness could be different without changing the sense I make of it when I remember it (billions of molecules could, for example, change place without consequence in the outcome of the process). It is in that sense that the standard memorizing process is about macro-events: it is a **consistent** process whose outcome is largely unchanged by small variations of its inputs. Incidentally, it is also event-independent or, said differently, **replicable**: it would work basically the same way if I were visiting a different place. This is a necessary condition for making sense of recorded information: without replicability, the information access process and/or the making-sense process would need to be event-dependent as well, probably preventing the remembering process from being reliable or even useful at all.

On the other hand, what would it mean to say that some stored information in my brain is the consequence of future events? Actually, no consistent and replicable time-reversed process that one can think of could store information from future macro-events. Indeed, such a complex process would require global time-reversed entropy creation, or, in other words, global entropy reduction following the entropic arrow of time,

which cannot happen in a consistent and replicable way. In this scenario, atom states forming a memory of the future have to be the time-reversed result of very precise micro-events happening in my brain after (potentially long after) the information is stored. I am talking about very precise events in the sense that any small change in those micro-events would end-up in a completely different atom configuration before them (which is basically the statistical characteristic of the entropic arrow of time).

Figure 3 below illustrates the two potential information-recording processes. Once again, they may or may not be exclusive: stored information may be linked to past events only, to future events only, or to both.

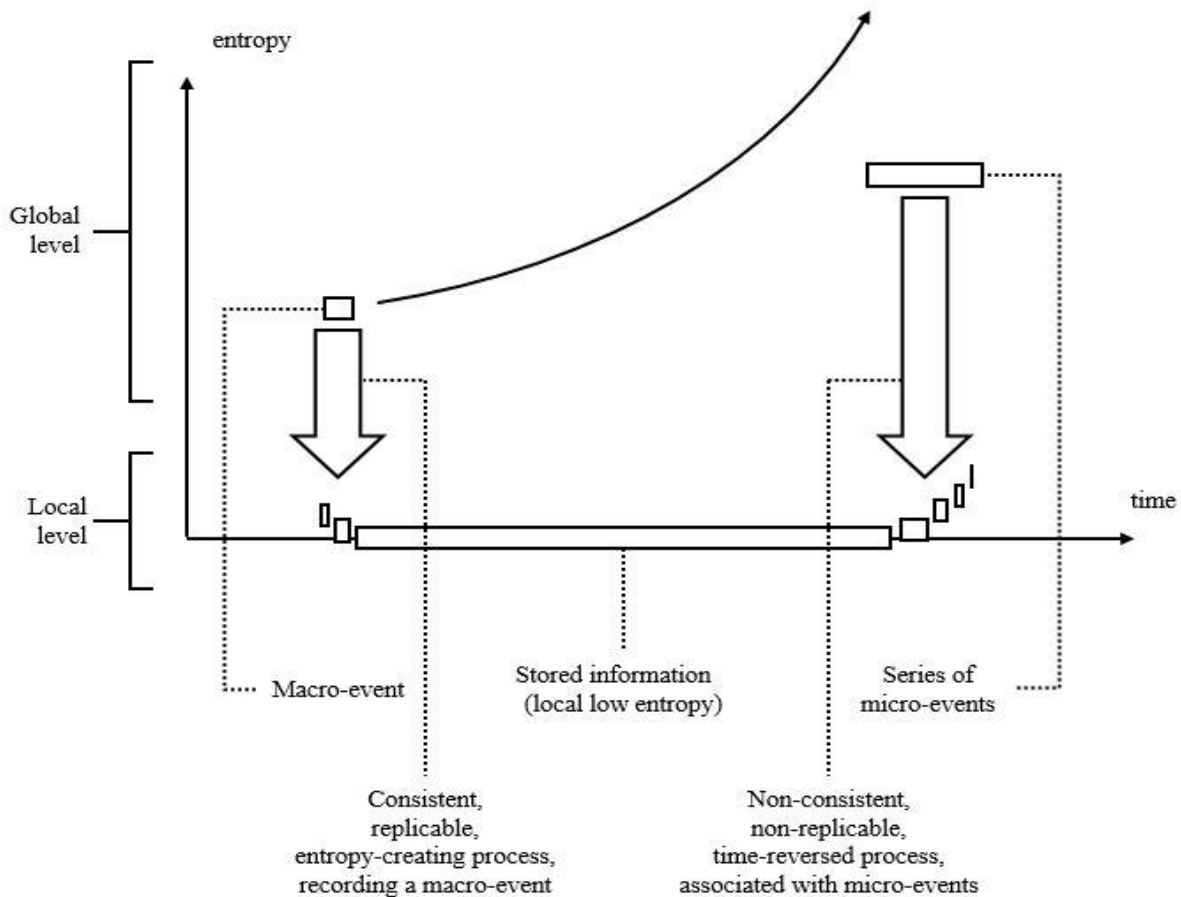


Figure 3: Two theoretical ways to record memories

To use a classical analogy, let's consider two ways to build an egg, a particularly low-entropy object when considering all the constituents it requires. One way consists in using a complex system called a chicken. The process for building an egg is here consistent (small changes in the environment should not change much the outcome), and replicable (if I take a different chicken, chances that the outcome will be a slice of bacon instead of an egg are slim). Another way is to use a broken egg that fell on the floor, and wait for nature to rebuild it spontaneously. It would require ridiculously precise tuning, a unique combination of micro-events, for a process to rebuild a broken egg; and no particular macro-event can be associated with that configuration. Said differently, the same macro-state around the broken egg will never lead to an unbroken egg unless this precise configuration occurs: therefore, if an unbroken egg can be seen as the time-reversed record of very precise future micro-events, it can never be seen as a time-reversed record of any future macro-event.

We can say the same about memory: it would require a similar kind of precision to put those brain atoms in their current memory state through a time-reversed process. In both ways regarding the arrow of time, we decrease entropy locally to store information. In one way, through a complex but consistent and replicable process that requires global increase of entropy to record a macro-event. In the other way, through the natural

entropy decrease of an event-specific time-reversed process. However, in this last case, the recorded information is linked to a unique combination of future micro-events, not to any future macro-event.

As a result, if I consider recording processes in a symmetric way, there is no macro-event in the future that I can make sense of from the information I am accessing in my brain. In other words, I cannot remember future macro-events, the only kind of events that can make sense to me.

### **Memories of the future and time symmetry**

I based my line of reasoning on the idea that we should consider the symmetry of the laws of physics, and therefore the symmetry between past and future when we access our memory. The result is that I cannot record any future macro-event the same way I record past macro-events. This result, as relevant as it may be, is not enough to answer the initial question. Because of the symmetric approach, I am talking here about future macro-events that might lead to the recorded information following a time-reversed process. However, at the time I access that information, it does not matter whether the information will be stored in a time-reversed process involving series of fine-tuned micro-events or destroyed by a more conventional process, potentially associated with a macro-event. There are two ways to describe the same reality, as we can show using again the previous example: the egg can be seen as recorded information of series of future and time-reversed converging waves in the floor, launching in the air all the constituents of the broken egg, and precise electro-magnetic interactions putting everything together. Or it can be seen as recorded information of the fact the egg “un-fell” from the floor. Seen from the present moment, “un-falling from the floor” and “falling on the floor” are just two different ways to describe the same macro-event. And here, conditions on fine-tuning are somehow relaxed: there is an infinite number of ways an egg can “un-fall” from the floor, and result in the same egg. Said differently, when memories disappear as a result of a macro-event (and not as a result of a long process involving only punctual micro-events – i.e. the egg decaying slowly, in our example), we come back to a more parallel situation regarding events to make sense of: whether we are considering the past or the future, our recorded memories may actually be associated with macro-events. In both cases, the remembered macro-event will precede the time of “recording”.

Then, we may argue that there are many different possible ways my memories can be destroyed as a result of a macro-event. There are, for example, many ways to pass away from violent death. So how could the same recorded information potentially be a memory of two very different future macro-events?

Well, it can, but once again, there is no way to make sense of it. This is contrary to the standard memory recording process, because of one of its fundamental characteristics: its **segregating** capacity. This quality is what forbids (at least in most cases) two different macro-events to result in the same recorded information. This is obviously not the case for a hypothetical process recording information from future events. If I die in a car accident or in a plane crash next year (two very different macro-events), the time-reversed outcome will be the same regarding most of my present “memories”<sup>1</sup>. Being consistent and replicable is not enough for a remembering process to be effective: it also needs to be segregating, a capacity that cannot be found in the type of mechanism we are considering here.

To sum-up: if we look at micro-events creating information in a time-reversed process, we lack consistency and replicability; if we look at cases of macro-events causing the destruction of information, we lack segregation.

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<sup>1</sup> In a perfectly deterministic world, one could argue that there is no time when my destiny can take one direction or another, coming from the same past. I would be in a trajectory (a “world line”) leading to a unique sequence of events. Segregation would be pointless, due to the unicity of this trajectory that would embed all recorded information in my brain. The “memories” of my death in a car accident or in a plane crash would be as different as the two separate potential trajectories leading to those events. However, there are always ways to imagine a macro-event caused in a far future by a phenomenon that is not in my current light cone. In that case, all “memories” until the moment this phenomenon’s consequences reach my light cone will be independent from the future event in question. I then come back to my initial point, even in such a world: from the present, I cannot benefit from any segregation from the future recording process.

## Memories in motion

We just looked at cases of memory destruction as a result of future macro-events, cases that one might consider restrictive, and not reflecting the usual way memories disappear. However, even if we consider a very general case of information destruction/recording, another characteristic of the memorizing process is at work, which only allows us to make sense of past events. The memorizing process requires some kind of **ordering** mechanism with regard to the time of recording. This is not only necessary to access memories, but also to make sense of them. As I record events, information is not stored in an anarchic way: the process respects some complex (and largely not understood) rules to reflect a certain level of sequencing. When I remember someone who entered the room, I can't mistake that with a supernatural apparition or with a realistic statue, nor will I think this person has always been there: I put this event in the context of other memories to make sense of the information I'm accessing (the fact that the door opened just before, or the fact we talked just after). It is because I can put a specific memory into perspective, in relation with other memories, that I can make sense of it.

An ordering mechanism supposes a correlation between the time of information recording and the nature of the information (potentially including where it is stored). Yet, there is a fundamental asymmetry here. Recording information following the entropic arrow of time is done more or less continuously during our life through our senses, which enables this ordering mechanism. However, there are reasons to think that the destruction of memories happens in a much more erratic way, which does not allow such a correlation between the nature of the information and the time of its disappearance. For instance, we can assume that the mechanism at work to ensure the correspondence between a stored information and the moment of its storage is a complex and entropy-creating process, which brings us back to our first arguments regarding consistency and replicability. And if we consider the many ways information may be destroyed as a direct result of a macro-event like an accident or death, then all erased memories would have the same "time-stamp" (they would not be time-wise segregated), and would therefore be useless.

To conclude: whatever phenomenon we consider as potentially responsible for information destruction/recording in the future, because no ordering mechanism can happen as it happens in the recording process of past events, we have now way to make sense of future events.

## Using our senses to record the future

We have left behind a hypothesis that may look obvious when one thinks about the question of remembering the future, but that does not fit easily the scientific approach of time symmetry. We can imagine that the recording process for future events may use the same path as the recording process for past events: our senses. We are then in the case of macro-events preceding the recording process, as seen before. Basically, we would be able to remember what we will see or hear in the future. However, this would imply a very special way to associate micro-events, working in a time-reversed process to build our memories of the future, with a macro-event preceding the recording. When we talked, above, about macro-events destroying our memories, this destruction was, *a priori*, a direct effect of this macro-event (the trivial case being violent death). However, in this new perspective, destruction of stored information would be the result of micro-events triggered in the consistent, replicable and potentially ordered way of a usual memorizing process. Therefore, we are neither in the case of time-reversed micro-events that cannot be associated with any macro-event we can make sense of, nor in the case of a macro-event, direct cause of information disappearance, that we should consider backwards. Here, the usual sensitive path would be at work, resulting in the disappearance of recorded information... while recording new information, building memories of the past. The recording of new information may simply erase and replace some existing memories (in the case the same information storing system is used for both memories of the past and the future), or at least result in their destruction (in the case memories from the past and from the future use distinct storing systems).

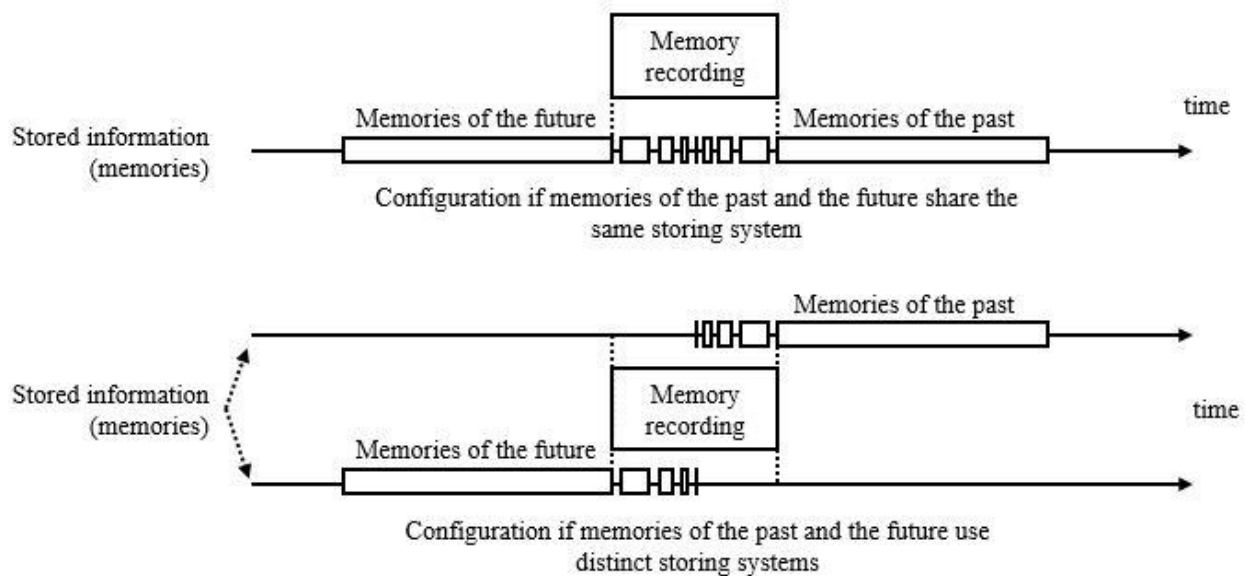


Figure 4: Past and future memory recording processes if they use the same sensitive path

Such a process could be consistent: by using the same sensitive path as the usual information recording process, it could also be insensible to micro-variations in the event to record. It could also be replicable, because it would be the result of an event-independent process. More surprisingly maybe, it could also be ordered with respect to time. If memories of the past and memories of the future do not share the same storing system, we can imagine that the information destruction part of the process targets specific zones depending on the time it operates. If they do, we can imagine the following mechanism: each recorded information of a past event stays in the brain during a period  $P$  that may be fixed, or at least whose length may follow a given rule. Then, a cycle of erasing/recording takes place in the brain. The destruction of information, result of a new recording through our senses, would therefore follow a certain temporal order (memories of the past could be copied in the brain though, to explain the long life of some of them). But there is no escape: because the memory recording process is still subject to the entropic arrow of time, its outcome occurs at  $t_1 > t_0$ , where  $t_0$  is the time before which the information is fixed. Therefore, there is no way the brain can embed information that is the result of a sensitive recording of a future event.

### What if?

Let's assume I could access memories of future events, considering memories as information in my brain, regardless of how it will get there. Let's assume I could also make sense of them. What exactly would I remember?

Considering memory from the future perspective, state of atoms in the brain may be seen, as we discussed above, as the result of a time-reversed process concomitant with the disappearance of the stored information. Yet, at the moment I am accessing a memory, two things may occur: either this information accessing process alters the stored information, or it does not. Therefore, remembering a memory would consist in making sense of events that are, in the first case, concomitant with the very fact I am currently accessing this memory, and in the second case, that are accompanying the loss of this very memory. If we were able to make sense of our "memories of the future", remembering would turn out to be a curious thing: memories would either directly reveal the very act of remembering, which would probably make them useless, or they would very often reflect the time of our own death.

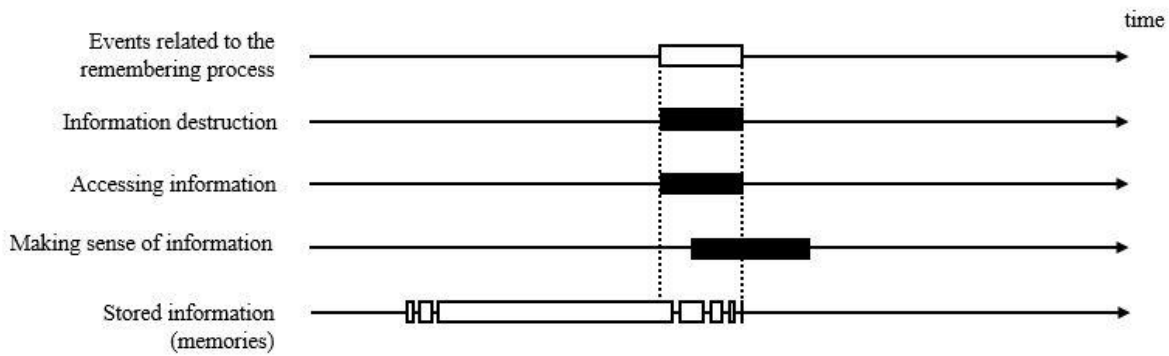


Figure 5: Memories related to the remembering process

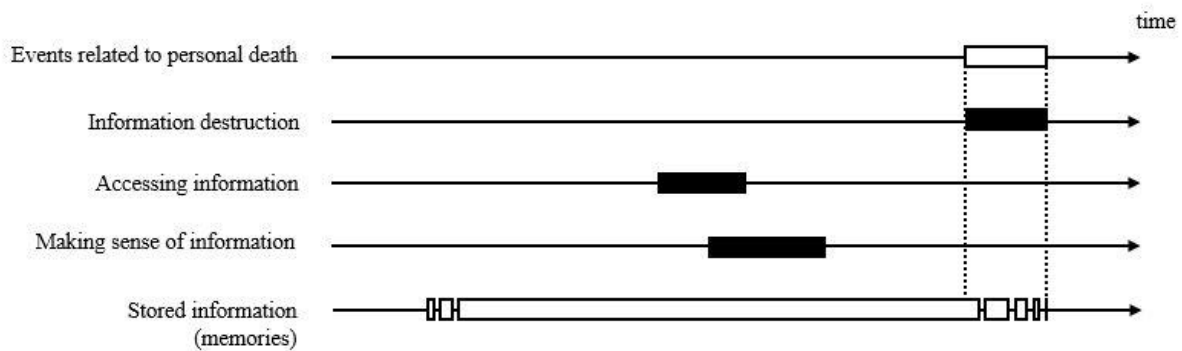


Figure 6: Memories related to personal death

Even if accessing memories does not alter them, a possible outcome of the remembering process could be even more troublesome. As we act mostly according to our memories and as our actions end-up having effects on our lives and ultimately on our death, there may be a complex causal chain between the fact we access our memories and the events leading to the loss of those memories. Remembering the future would therefore mean making sense of events that depend on the very fact we are remembering them. That would bring us in an infinite recursive loop that would have nothing to envy to the usual paradoxes of time travel.

## Conclusion

Time-symmetry of the laws of physics forces us to evaluate potential implications for what fundamentally contradicts this reality on a daily basis: our memories. We remember our past, we do not remember our future. However, analyzing the remembering process, and the potential ways to explain the presence of stored information in our brain with regard to the entropic arrow of time, I showed that potential memories have very different relationships, although equally real, with past and future events. This dissymmetry is linked to the memorizing process we have inherited through evolution. If we can remember macro-events from the past that have meaning for us, thanks to a consistent, replicable, segregating, and ordered mechanism, the only “memories” we may have of the future are associated with events that we can’t make sense of. Implications, if we could, would be either pointless, mystical or self-contradictory.

So, let’s conclude: *Is there a chance we may remember the future? ... Forget it!*

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