Proposal for an evolutionary approach to self-consciousness (Feb 8th 2014)

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Abstract

It is pretty obvious to most of us that self-consciousness is a product of evolution. But its nature is unknown. We propose here a scenario addressing a possible evolutionary nature of self-consciousness covering the segment linking pre-human primates to humans. The scenario is based on evolutions of representations and of inter-subjectivity that could have taken place within the minds of our pre-human ancestors[1]. We begin by situating self-consciousness relatively to other aspects of human consciousness. With the help of anthropology, we date a possible starting point of our scenario at a time when our non self-conscious pre-human ancestors were able to build meaningful representations and were capable of inter-subjectivity, like are our today modern apes. As the proposed scenario is based on an evolution of representations, we recall an existing model for meaningful representations based on the generation of meaningful information by systems submitted to internal constraints. This model allows us to define representations of conspecifics and auto-representations that we assume as having been present in the minds of our pre-human ancestors.

The next step of the scenario is to consider an evolution of inter-subjectivity towards identification with conspecifics that could have led to a merger of the auto-representation with the representations of conspecifics in the minds of our ancestors. Such a merger brought the auto-representation to become about an entity existing in the environment, as were the representations of conspecifics. We consider that such identification with conspecifics has introduced in the mind of our ancestors an elementary and embryonic sense of being an existing entity that we name 'ancestral self-consciousness'. The same process has also imposed to our ancestors an identification with suffering or endangered conspecifics which has produced an important anxiety increase that could have blocked the evolutionary process. We propose that the performances developed by our ancestors to manage that anxiety increase have also generated significant evolutionary advantages that have helped the development of ancestral self-consciousness and favored its evolution toward our full-fledged self-consciousness. It is also proposed that some pre-human primates have avoided the anxiety increase by finding a niche where evolutionary advantages were not necessary. This may have led to our today apes.

The contribution of anxiety to the proposed scenario brings to position anxiety management as having guided the evolution of self-consciousness and as still being a key player in our today human minds.

Regarding philosophy of mind, possible links between phenomenal consciousness and the proposed nature of self-consciousness are introduced.

The conclusion presents a summary of the points addressed here. Possible continuations are highlighted as related to human mind, to anxiety management and to artificial intelligence.

Keywords: self-consciousness, pre-human, meaningful representation, auto-representation, inter-subjectivity, evolution, anxiety, evolutionary engine, ancestral self-consciousness, primitive self-consciousness, pre-reflective self-consciousness, phenomenal consciousness.

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1 The current paper is an enriched summary of presentations made at TSC and ASSC conferences, and elsewhere (Menant, 2005, 2006, 2010 a & b).

1) Consciousness and self-consciousness. Humans, apes and pre-human primates

Human consciousness is a product of evolution. Few people would today disagree with an evolutionary history of human mind. But human consciousness is a complex and still mysterious performance. Different perspectives have been developed to try to understand it. Among the key ones: as concepts of consciousness like phenomenal consciousness, access consciousness, monitoring consciousness and self-consciousness (Block, 1995); as functions of consciousness like adaptation and learning (Baars, 1993); as levels of consciousness like core consciousness and extended consciousness (Damasio, 1999); as self-representational theory of consciousness where a mental state is phenomenally conscious iff it represents itself in the right way (Kriegel, 2012).

The choice made here is to focus on self-consciousness following an evolutionary approach. We define self-consciousness as being 'the representation of oneself as an existing entity like others humans are represented as existing' (representations are here understood as being meaningful representations[2]). Such a definition of self-consciousness refers to the representations of conspecifics and does not use the concept of self. It is different from defining self-consciousness as 'the possession of the concept of the self and the ability to use this concept in thinking about oneself.' (Block, 1995). In the proposed evolutionary approach self-consciousness is the consciousness of oneself as an existing entity rather than the consciousness of a self[3].

Regarding self-consciousness in philosophy of mind it is worth noticing that at the end of the 20th century self-consciousness 'has fallen on hard times. Though once regarded as the very essence of mind, most philosophers and psychologists today treat it as a marginal and derivative phenomenon' (Van Gulick, 1988). But the beginning of our 21st century is presenting a new perspective where self-consciousness is becoming a subject of interest under various thematics (Crone & al., 2012). Some address human self-representations (Vosgerau, 2009). Others take evolution into account without expliciting a possible scenario (Carruthers & al., 2012).

What we propose here is to formalize an evolutionary scenario that starts at a time when our non self-conscious pre-human ancestors were managing meaningful representations and were capable of inter-subjectivity. The former performance exists in primates as most animals manage meaningful representations of elements of their environment (like predators or preys) in order to satisfy survival constraints. Regarding the performance of inter-subjectivity, anthropology has shown that 'around six million years ago, our pre-human ancestors might have had such capacities that broadly resembled those of some modern apes' (Bednarik, 2003). As modern apes are non self-conscious primates capable of inter-subjectivity, we can compare them to our pre-human ancestors and position the starting point of our evolutionary scenario at around six millions years ago. This comparison from primatology positions the behaviour of modern apes as close to the ones of these pre-human ancestors. It allows us to refer to what we know about the behaviour and characteristics of the former to address the ones of the later. A first point coming from this comparison is that our pre-human ancestors were far from having our mental capacities as modern apes lack several human performances and have a brain much smaller than ours. Like today apes, our ancestors had a limited access

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[2] *Meaningful representations have been defined as networks of meaningful information [Menant, 2011]. Their characteristics and usages in the current paper are presented in the next paragraph*

[3] *The concept of self is not needed in the proposed scenario. We will however look at introducing it as based on the evolutionary nature of self-consciousness presented here (see 5).*

to concepts and causality (Woodward, 2007) and had no access to human type language.
As our scenario uses the notion of meaningful representation managed by pre-human primates, we need to provide clear enough a background about such representations that we position as meaningful for the agent that carries them[4]. The next paragraph will recall the definitions of meaningful information and representations with applications to representations of conspecifics and to auto-representation that we use in our scenario.

2) Evolutions of representations and of inter-subjectivity. The possibility for self-consciousness in evolution

2.1 Meaningful representations. Representations of conspecifics and auto-representation

As introduced above, the proposed scenario about an evolutionary nature of self-consciousness began 6 million years ago. It uses an evolution of the meaningful representations that our pre-human ancestors were carrying. Meaningful representations are made of meaningful information understood as information generated by systems submitted to internal constraints. Such approach can be summarized as follows:
When a system submitted to an internal constraint receives information from its environment, it can generate meaningful information (a meaning) that will be used to implement an action in order to satisfy the constraint.
The generated meaning is the connection existing between the received information and the constraint. A meaning generation process has been formalized in terms of a Meaning Generator System (MGS) (Menant, 2003). The MGS is represented in Fig 1.

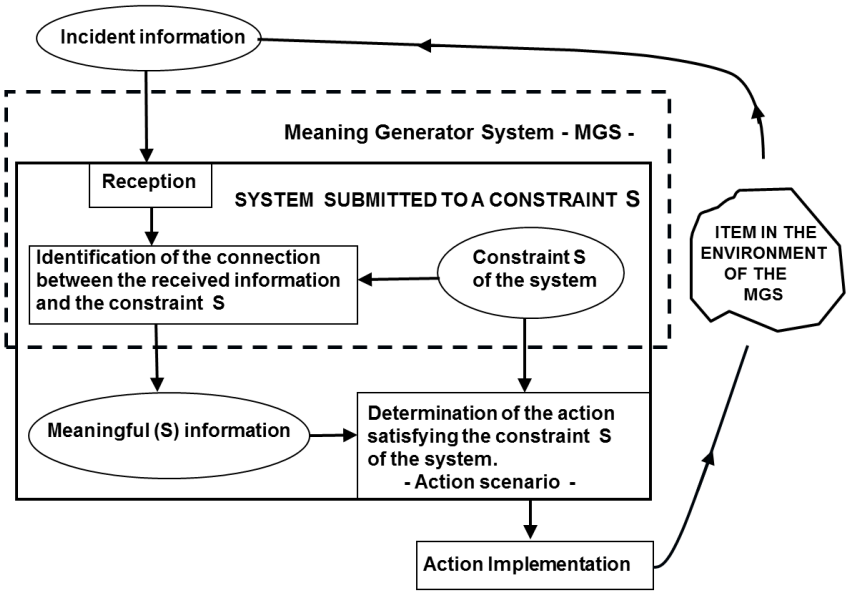

Fig. 1.The Meaning Generator System.

As an example a monkey has a 'stay alive' constraint to satisfy (like all animals have). If the monkey sees a hyena, the connection of the sensed information with the constraint will

[4] *Our starting point is meaningful representations for non self-conscious animals, not for human minds. The proposed approach is not to be considered as part of the 'Representational Theories of Consciousness' (Lycan, 2006) which are about representations in human minds.*

produce meaningful information like ‘danger’. And that meaning will trigger an action like hiding or getting away in order to satisfy the constraint.
On a general standpoint, agents contain several different MGSs (different sensors delivering different information, different constraints, different connections between received information and constraints). As a consequence, the perception of an item generates several different meanings within an agent. These meanings are networked and include the existing action scenarios related to the satisfaction of the constraint. All these elements participate to the build up of a meaningful representation of the item for the agent. Our monkeys represent hyenas under different components (shape, sound, odor, environmental changes, ...) including the action scenarios that are permanently enriched. As another example, meaningful representations of stones and sticks carried by our pre-human ancestors included their usage to crack nuts and to collect termites.
Meaningful representations are constraint satisfaction driven. The constraint satisfaction processes dynamically embed the agent in its environment.
For an agent, a meaningful representation of an item of the environment is made of:
- Meanings generated by information relative to the item that the agent receives from its environment.
- Meanings generated by information related to the item and coming from inside the agent. (for an organism: interoception, proprioception, action scenarios with history of outcomes and emotions).
These elements of the representation are interdependent and characterize the represented entity[5]. Representations do not exist alone, by themselves. They are generated by and for the agent carrying the MGSs for the satisfaction of the agent’s constraints. These representations are dynamic as connected to past and future actions related to the represented entity. They are updated through new experiences[6].
The above applies to our evolutionary approach where animals are agents that have to satisfy stay alive and group life constraints. Animals have intense relations with the items of their environments in terms of constraints satisfactions. They generate and use meaningful representations of these items, and these representations contain the characteristic ‘belongs to the environment’ which is an implicit part of the meanings.
Among the many items of the environment that are represented within animals sharing a group life, there is one that deserves a specific attention for our scenario. It is the representation of conspecifics. As our pre-human ancestors were quite similar to modern apes, we can look at the behavior of the latter to address the relations with conspecifics of the former. Group life of modern apes goes with interdependencies and hierarchies among elements of the group, with dominances and conflicts. Such a relational context implies the need for detailed representations of conspecifics as global entities existing in the environment and interacting with it. The same was true for our pre-human ancestors where the components of these representations were the ones of items of the environment as presented above. Such meaningful representations were mandatory for the satisfaction of vital constraints and group life constraints.
There is another type of representation carried by our pre-human ancestors that is important

[5] *The term ‘representation’ is to be understood as addressing meaningful representations.*

[6] *Such meaningful representations contain only the meanings related to the represented item for the agent. They do not include all possible aspects of the represented item which would lead to a combinational explosion. The MGS approach avoids the problems of GOFAI type representations (Menant, 2011).*

for our scenario. Our pre-human ancestors also received information from their own bodies and from the actions they implemented on the environment. Different parts of the body could be seen like hands and feet, or felt by tactile sensation. Vocalisations could be heard also. Actions implemented on the environment were perceived with their results modifying that environment. All these information made available meanings about the body with the associated emotions. This brings to consider that our pre-human ancestors were carrying an 'auto-representation'[7] made of representations of different parts of the body with the action scenarios relative to the interactions with the environment, including past experiences and emotions. But that auto-representation carried by our ancestors was very limited as compared to the representations that we humans have of ourselves. This because our pre-human ancestors had small brain sizes as compared to ours and were not conscious of themselves as overall entities existing in the environment. They were not self-conscious.

2.2 Pre-human primates inter-subjectivity and identification with conspecifics. Ancestral self-consciousness

Inter-subjectivity is the sharing of perceptual or affective experiences between two or more subjects. We humans possess a high degree of inter-subjectivity. Several animal studies have shown that some modern apes are capable of inter-subjectivity related to empathy (Preston & de Waal, 2002), to bodily mimesis (Zlatev, 2000), and to mirror neurons (Gallese, 2001). By similarity we can assume that our pre-human primate ancestors were capable of inter-subjectivity.

Identification with others is a higher level of performances. We humans are capable of identifying with others on physical and mental standpoints. We can easily put ourselves in the shoes of other humans and understand their desires, their intentions and their emotions. We use these performances, mostly unconsciously, for joint action, for imitation and for the understanding of others. Regarding modern apes, their capability to identify with conspecifics is subject of debates in the research community (Zlatev, 2000), (Decety & Chaminade, 2003), (Tomasello & all.2005). Whatever our progresses in the understanding of primate mental performances, we can agree that the performance of identifying with conspecifics came up in evolution sometime between our pre-human ancestors and us humans. Our position here is to assume that the evolutionary level of our pre-human ancestors was ready to implement an elementary and limited level of identification with conspecifics. And it is logical to consider that such performance has been favoured by evolution as it introduced some evolutionary advantages[8].

When our ancestors reached the capability to identify with their conspecifics, they were carrying the two types of meaningful representations presented in the previous paragraph: an auto-representation and representations of conspecifics. Identification with conspecifics brought the auto-representation and the representations of conspecifics to progressively become about a same entity. As a consequence, the two representations tended to merge their contents, and the meanings of the one became available to the other. By this process the auto-representation became able to access a characteristic of the representation of conspecifics: being about an entity existing in the environment. This brought our ancestors to slowly access the possibility to represent themselves as existing entities, like the conspecifics were

[7] *We choose for our non self-conscious ancestors the wording 'auto-representation' in order to avoid using 'self-representation' which could call for the concept of self that we do not need to use here.*

[8] *These evolutionary advantages were elementary and limited versions of the benefits that we human get from identification with conspecifics (like joint action and imitation).*

represented. This new performance began very slowly and progressively. The first elements of the auto-representation to participate to that process were probably the ones related to the body that were quite identical in the representations of conspecifics, like hands, feet and vocalizations.

We want to consider that such evolution of the auto-representation acquiring progressively the characteristics of the representation of an entity existing in the environment has generated the first elements of self-consciousness in the minds of our ancestors[9]. We take this event as having been the first step of primates into the world of self-consciousness.

Identification with conspecifics began by delivering only an elementary and embryonic sense of being an existing entity which was very far from the full-fledged self-consciousness that we humans carry nowdays. But it is clear that a primate accessing a representation of herself, even if very limited, as an entity existing in the environment is a new performance in evolution. Such a performance did not exist before and has to be characterized and named. Philosophers have developed concepts like primitive self-consciousness or pre-reflective self-consciousness that can be related to some aspects of our today self-consciousness. But these concepts are based on the performances of human minds existing in our today brains which are bigger and more performant than the brains of our pre-human ancestors. It looks difficult to relate these concepts to pre-human minds deprived of self-consciousness. In order to avoid the questions and problems that would be risen by using these concepts at this level of our approach, we prefer introducing an original naming. As that elementary and embryonic version of self-consciousness initially came up in the mind of our pre-human ancestors, we propose to call it 'ancestral self-consciousness' and define it as an elementary and embryonic representation of oneself as an existing entity, like conspecifics are represented as existing.

At this level of our approach, a few points relative to the nature of that embryonic self-consciousness are to be highlighted:

- The representational nature of ancestral self-consciousness is to be underlined. Ancestral self-consciousness was carried by our ancestors as a representation of themselves as existing in the environment in a limited and embryonic form. It came from a merger of the auto-representation with the representations of conspecifics. Both were meaningful representations.
- Language was not mandatory for the coming up of that ancestral self-consciousness. If group life was needed for the first elements of self-consciousness to come through the process of identification with conspecifics, language was not a prerequisite. We will see in the next paragraph how language, on an evolutionary advantage basis, has been part of the evolution of self-consciousness in the proposed approach.
- The 'elementary and embryonic sense of being an existing entity' is taken globally. It does not look realistic for such a limited level of self-consciousness to introduce specificities about first or third person perspectives, or about self-consciousness as subject or as object. This position will be readdressed when looking at the evolution of ancestral self-consciousness towards our full-fledged self-consciousness (4.1).
-The coming up of ancestral self-consciousness and its evolution toward full-fledged self-consciousness look as natural events with the evolutionary advantages brought by the identification with conspecifics. But we will see in the next paragraph that the identification with conspecifics has also been the source of an anxiety increase that came as an obstacle to the coming up of ancestral self-consciousness. At this level of our approach, self-consciousness is only a possibility in evolution.

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[9] *This is consistent with the definition of self-consciousness given in the first paragraph:'the representation of oneself as an existing entity like others humans are represented as existing'*

3) Anxiety as an evolutionary engine. The high probability for self-consciousness

3.1 Identification with conspecifics and anxiety increase. Evolution toward self-consciousness or not

The performance of identification with conspecifics has been an important step in primate evolution: it has made ancestral self-consciousness a possibility. But identification with conspecifics also produced an important anxiety increase. Six million years ago the environment of pre-human primates was one of survival of the fittest with many dangers and risks. Representations of endangered or suffering relatives were also part of the representation of conspecifics. By identifying with these conspecifics, our ancestors were brought to feel the dangers, sufferings, pains and distresses encountered by the conspecifics, which came in addition to her own ones. These negative emotions about potentially dangerous situations were many and diverse. They were memorized and generated anticipations of threats. Overall, a dramatic upsurge in potential vulnerability was created, a traumatism leading to an important anxiety increase. Anxiety is a feeling of uneasiness, apprehension or fear related to threats that are perceived to be uncontrollable or unavoidable. Such multiple sources of fears encountered by our pre-human ancestors led to an important anxiety increase. Normal anxiety is a positive emotion as it allows early alerts against threats. It has been shaped by natural selection (Marks & Nesse, 1994). But too much anxiety has negative impacts perturbating mental and physical activities. It can lead to panic. Pathological anxiety triggers behavioural responses lacking adaptive value. This is true for humans and for some animals (Ohl & al., 2008). Such an increase in anxiety may have impacted the survival conditions of the pre-humans facing it and become unbearable. We correspondingly propose that the evolution of pre-human primates accessing the level of identification with conspecifics met a forking path with two options. The first one was to avoid the unbearable sufferings coming from the anxiety increase. That option implied for these primates to stop the identification with conspecifics and the associated evolutionary process. Such option has blocked the evolution of pre-human primates before they could access the performance of ancestral self-consciousness, and it has probably led to our today modern apes through ecological niches that allowed survival without significant performances increase. The second option was to cope at best with the level of anxiety, to maintain the identification with conspecifics with its evolutionary advantages and find ways to limit the anxiety increase. That option allowed an access to ancestral self-consciousness and a continuation of the evolutionary process toward full-fledged self-consciousness. We develop that option in the next paragraphs with the anxiety limitation processes.

Fig 2 represents the forking path in our evolutionary scenario where the limitation of anxiety had to be sufficient to allow our pre-human ancestors to build up the level of ancestral self-consciousness and open the way to an evolution toward full-fledged self-consciousness.

As shown in Fig 2, the scenario proposes that ancestral self-consciousness, besides participating to the evolution toward full-fledged self-consciousness, has continued to exist through evolution. Ancestral self-consciousness holds a generic position as being an elementary sense of being an existing entity. We want to consider that we still carry in the background of our human mind a diffuse sense of being, sourced in ancestral self-consciousness. The consequences of that position are highlighted here after (4.1 & 5).

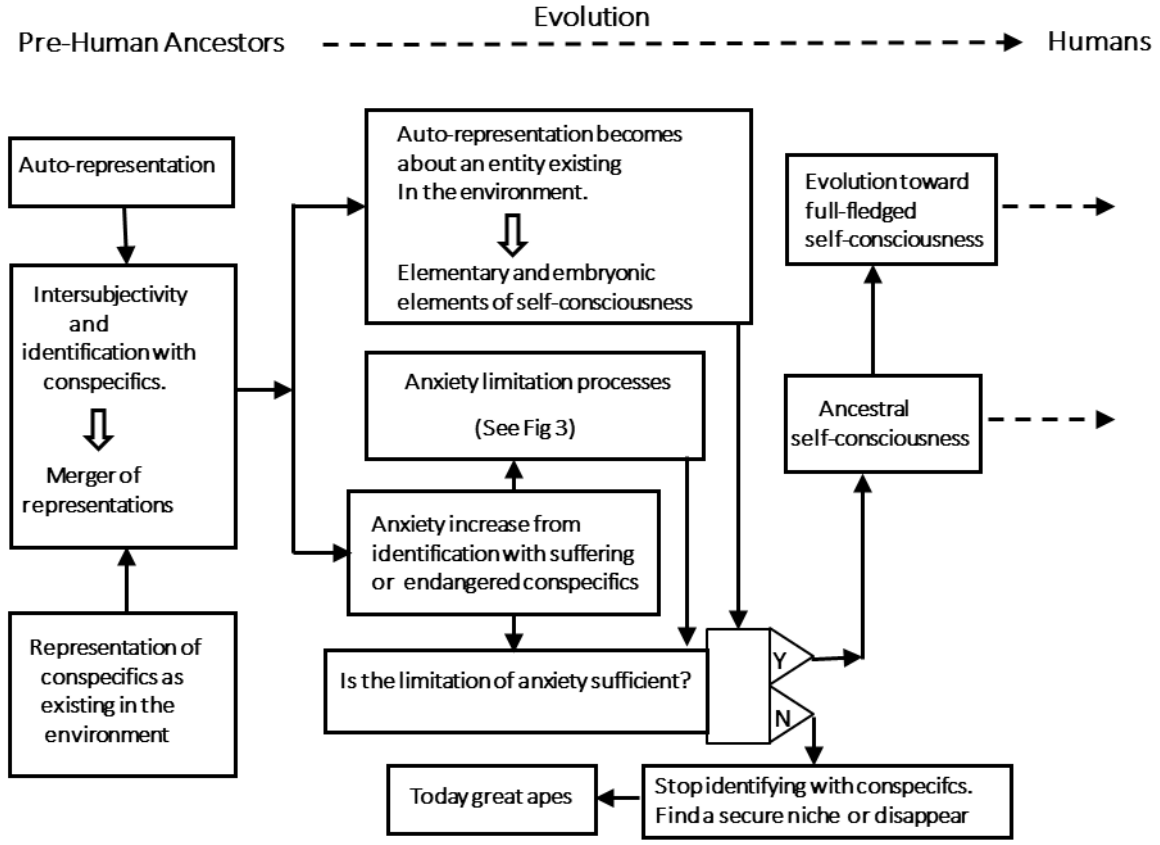

Fig.2- Forking path in the evolution of self-consciousness

3.2 Evolutionary advantages of anxiety limitation. An evolutionary engine toward self-consciousness

The previous paragraph has shown that the high anxiety increase encountered by our pre-human ancestors had to be limited in order to allow the coming up of ancestral self-consciousness and its evolution toward our today full-fledged self-consciousness. We need now to present the corresponding anxiety limitation processes that our ancestors may have gone through, and see how these processes have also introduced important evolutionary advantages that have significantly leveraged the overall evolutionary process toward self-consciousness.

We have seen that the anxiety increase came from the identification with suffering or endangered conspecifics which produced a feeling of increased vulnerability. Two sets of actions may have been implemented by our ancestors in order to limit that anxiety and the corresponding vulnerabilities: reduce the sufferings of conspecifics, and enhance the efficiencies of group and of individuals.

To reduce the sufferings of conspecifics, our ancestors had to care more for them, in terms of protection and in terms of consolation. Regarding protection, our ancestors may have developed alert systems for warning of dangers, implemented defenses against the dangers like predators, and taken care of wounded conspecifics. Consolation was with empathy acting

close to the conspecifics. These improvements in conspecifics caring and consolation were reciprocal. They amplified inter-subjectivity and identifications with others. Regarding the enhancement of group and individual efficiencies, we assume that they began with the development of the modest performances brought in at the beginning of identification with conspecifics like joint action and imitation. More formal cooperations were then developed with coordinated actions, understanding of other's mental states, tasks simulations with action programs improvements and communications. These performances were interdependent and called for the development of other ones like social rules, social learning and teaching, and language. These performances, initially developed for anxiety limitation purposes, had obvious evolutionary advantages. Their implementation has accelerated the overall evolutionary process towards self-consciousness. The development of ancestral self-consciousness was not any more hampered by a high anxiety level and the evolution of ancestral self-consciousness toward our full-fledged self-consciousness was accelerated. Perhaps these evolutionary advantages could have occurred through a classic evolutionary process using selections after random mutations, without the proposed scenario. But our ancestors were not much used to cooperate with each other. They preferred living in a context of competitive social interactions as do today apes (Tomasello & al., 2005). Changing their behaviors into cooperation was not natural. We propose here that it is the specific need to limit the anxiety increase that has led our ancestors to changes their social behavior, with the resulting evolutionary advantages locking the process.

So the hypothesis presented here is that the performances initially implemented for anxiety limitation have dramatically accelerated the development of evolutionary advantages leading to self-consciousness. As part of the process, the amplification of inter-subjectivity and identification with conspecifics associated to these performances has introduced a positive feedback loop which has produced an acceleration in the evolutionary process.

Overall, we can say that the performances implemented by our ancestors in order to limit the anxiety increase have created an evolutionary engine, accelerating and strongly favoring the coming up of self-consciousness in evolution. This characteristic of our scenario highlights the importance of anxiety limitation as a human specificity attached to the nature of self-consciousness since its dawn in evolution.

Fig 3 summarizes the key points of the scenario about the evolutionary approach to ancestral self-consciousness and to full-fledged self-consciousness.

The overall evolutionary scenario brings to highlight the following points:

a) Anxiety limitation, as a new constraint for our ancestors, has participated to the generation of many new anxiety related meanings (see meaning generation in Fig 1). Many representations existing in the minds of our pre-human ancestors became populated with anxiety related meanings during the evolution toward ancestral self-consciousness and full-fledged self-consciousness. We will also see hereunder (4.1) how the anxiety limitation processes have by themselves generated new anxieties that had in turn to be limited. We regroup under the term 'anxiety management' the chaining and networking of anxiety limitations with generations of new anxieties to be limited.

b) The evolutionary advantages sometimes presented as associated to self-consciousness are not directly related to the performance of self-consciousness. These evolutionary advantages are related to the process that brought up self-consciousness[10].

[10] *Such a statement will need to be re-addressed when the relations between free will and self-consciousness will be better understood.*

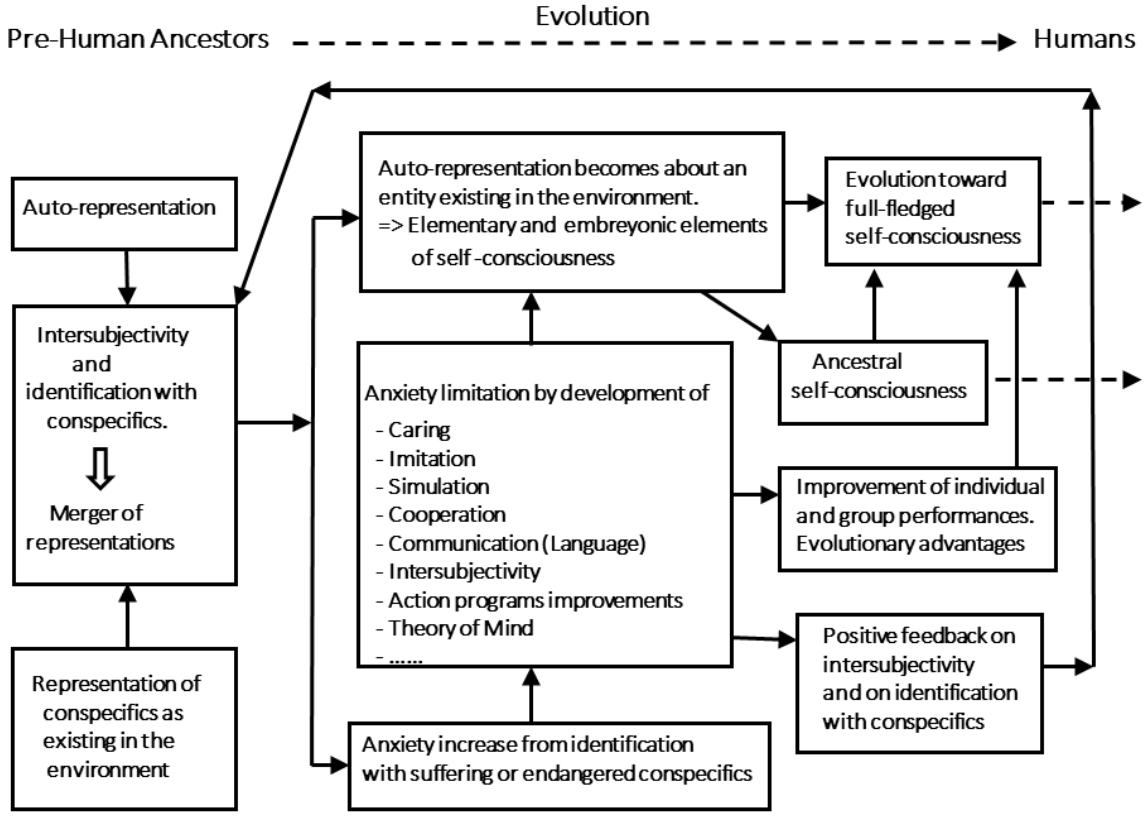

Fig. 3. Evolutionary approach to ancestral self-consciousness and to self-consciousness.

c) The explanation about the nature of self-consciousness as it is proposed here is based on an evolution of the performances carried by our pre-human ancestors: inter-subjectivity and management of meaningful representations. Inter-subjectivity cannot come up alone in the mind of an individual. Inter-subjectivity needs at least two persons. To come up in evolution, self-consciousness needed the others. Self-consciousness is a result of group life. Also, self-consciousness came up with the evolution of life and does not exist in the inanimate world. As the nature of life is unknown to today science and philosophy, the proposed evolutionary scenario is an explanation about the nature of self-consciousness if we do not question the nature of life. Such a status brings up questions regarding the possibility to create artificial intelligence without mastering artificial life (Menant, 2013).
d) In the previous paragraphs, the occurrence of human self-consciousness in evolution was a possibility resulting from a combination of representations with an evolution of inter-subjectivity. The evolutionary engine as introduced here has significantly increased that possibility of occurrence and raised it at a level of high probability.

4) Evolution from ancestral self-consciousness to full-fledged self-consciousness

4.1 From ancestral self-consciousness to full-fledged self-consciousness

The evolutionary scenario presented here above has proposed an explanation for the nature of an elementary and embryonic form of self-consciousness that we have named ‘ancestral self-consciousness’. Successful anxiety limitation with the resulting evolutionary engine opened

the road for an evolution of ancestral self-consciousness toward full-fledged self-consciousness. A formal analysis of that evolution is a subject deserving a specific work that is beyond the scope of the current paper [11]. We group under three headings the items that we feel should be taken into account in that work: evolutionary scenario, ancestral self-consciousness and anxiety management.

a) Evolutionary scenario:

Our ancestral self-consciousness has been built up through an evolution of meaningful representations based on constraint satisfaction. The evolution of ancestral self-consciousness toward full-fledged self-consciousness should contain and use a similar representational system with the coming up of new constraints.

Also, in addition to the assumed initial forking path based on anxiety management that led to humans and modern apes, others may have occurred during the evolution from ancestral self-consciousness toward full-fledged self-consciousness. Part of Neanderthal extinction could perhaps be looked at that way.

b) Ancestral self-consciousness:

We have proposed that ancestral self-consciousness, an elementary and embryonic sense of being an existing entity, has not disappeared during her evolution toward our today full-fledged self-consciousness. Ancestral self-consciousness has been enriched and transformed during that evolution and we consider that she is still existing and active as a diffuse sense of being in the background of our today human self-conscious mind. We humans are not all the time explicitly conscious of being. We are not all the time in self-conscious mental states but most often in a diffuse sense of being, close to the one produced by ancestral self-consciousness. It is an implicit state, ready to make available an explicit 'I am' when our relations with the world or with ourselves request it. Such diffuse sense of being could be what evolution has left in our minds as inherited from the early stages of self-consciousness in evolution. The evolution from ancestral to full-fledged self-consciousness should take into account such possible continuations of ancestral self-consciousness.

We have considered that first or third person perspectives as well as subject or object ones did not apply to ancestral self-consciousness. But these perspectives exist relatively to our today self-consciousness. They are to be taken into account in the evolution of ancestral self-consciousness toward full-fledged self-consciousness. Work is in process on that subject (Menant 2014).

c) Anxiety management:

Our pre-human ancestors have implemented anxiety limitation processes allowing the coming up of ancestral self-consciousness and favoring the evolution toward full-fledged self-consciousness. It is worth considering that these anxiety limitation processes may have by themselves introduced new sources of anxieties (which had in turn also to be limited). We consider that such anxiety management has been part of the evolution from ancestral self-consciousness toward full-fledged self-consciousness, and is still active today. Examples are many. The simple cases about lack of reciprocity in caring and consolation, or about the risk of being excluded from the more and more performant group were new sources of anxities. Identifications with conspecifics also allowed the manipulation of others with reciprocity in counter measures introducing an evolutionary spiraling of 'machiavellian intelligence' (Byrne & Whiten, 1988). Such processes were also sources of new anxieties. Another example is the over usage of imitation: through excessive imitation our ancestors may have over-developed

[11] *Studies exist about the evolution of human cooperation [Tomasello & all, 2012]. But the contribution of anxiety limitation does not figure as a key parameter.*

the desire of what the other had or did up to impacting the overall group stability. Such perspective can be related to the mimetic theory where pre-humans borrowed their desires from conspecifics, leading to mimetic rivalry and to scapegoat mechanisms introducing sacrifice at the foundation of human culture (Girard, 2010). The sacrifice, as an action implemented to limit the anxiety of the group, has developed new individual anxieties coming from the fear of being sacrified.
These creations of new anxieties were mostly unconscious and have penetrated all the aspect of life, leading to a sort of anxiety about being in the world.
Also, as noted above, anxiety management as a permanent constraint brought in a permanent generation of anxiety related meanings in the minds of our ancestors. All these anxiety related meanings have been driving forces in human evolution, marking profoundly the nature of human mind with its potential psychological sufferings.
Overall we can say that the evolution towards self-consciousness has been interwoven with permanent processes of anxiety management becoming an intimate part of human nature and probably contributing to many human specificities at individual and social levels.
Such interdependence linking evolution towards self-consciousness and anxiety management deserves specific studies.

4.2 Possible links with phenomenal consciousness

We have seen that different perspectives can be used to address human consciousness. The choice in the current paper is to focus on self-consciousness understood as 'the representation of oneself as an existing entity like others humans are represented as existing'. But the focus of today philosophy of mind is not on self-consciousness. It is on phenomenal consciousness, a key component of phenomenology. 'Phenomenal consciousness is experience; what makes a state phenomenally conscious is that there is something 'it is like' (Nagel 1974) to be in that sate' (Block, 1995). Phenomenal consciousness has connections with self-consciousness. For phenomenologists 'a minimal form of self-consciousness is a constant structural feature of conscious experience'. And 'this immediate and first-personal givenness of experiential phenomena must be accounted for in terms of a pre-reflective self-consciousness' which is present whenever we are undergoing an experience (Gallagher & Zahavi, 2010). The minimal form of self-consciousness of phenomenology looks close to the implicit sense of being an existing entity that characterizes ancestral self-consciousness in our today minds. This brings up the interest about comparing the nature of ancestral self-consciousness in our today minds with pre-reflective self-consciousness (assuming that the first/third person perspectives have been explicited for ancestral self-consciousness in our today minds). This comparison could introduce links between phenomenal consciousness and the proposed evolutionary nature of self-consciousness. Concerns about keeping self-consciousness firmly distinguished from phenomenal-consciousness are to be taken into account (Block, 1995). More work is needed on this subject.

5) <u>Continuations to the proposed evolutionary approach</u>

Among the points addressed in the above scenario, several call for more developments and could be part of a continuation to the current paper. Some have already been listed above as related to the evolution of ancestral self-consciousness towards full-fledged self-consciousness and to the possible links with phenomenal consciousness. Others can be summarized as related to human mind, to anxiety management and to artificial intelligence.

a) As related to human mind.

- Ancestral self-consciousness has been introduced as the first step of our pre-human

ancestors in an elementary form of self-consciousness which has evolved up to our today full-fledged self-consciousness, while staying active in our human mind.
As proposed above, evolutionary relations are to be looked for between pre-reflective self-consciousness and what remains in our today mind from ancestral self-consciousness. Such relations could also be looked for regarding primitive self-consciousness.
- The concept of self has not been used in our evolutionary approach as it was not needed. But that concept is part of other approaches to human mind like proto-self, core-self or, autobiographical self (Damasio, 1999). The concept is also used when defining self-consciousness as 'the possession of the concept of the self and the ability to use this concept in thinking about oneself.' (Block, 1995). It would be interesting to look at positioning a concept of human self relatively to self-consciousness as introduced here, and see how such concept could eventually be transposed to animals.
- The proposed evolutionary scenario uses meaningful representations as generated by systems submitted to constraints. Human constraints are not well known. They are complex and difficult to define. 'Limit anxiety' and 'look for happiness' can be generic ones. Work is needed to better address and understand human constraints (Menant, 2011).
- Inter-subjectivity is key to our evolutionary scenario. But its nature is not clearly understood by today science or philosophy. The performances associated to mirror neurons could probably be used as a starting point to gain some understanding about the nature of inter-subjectivity (Ferrari & Gallese, 2007).
- Human evolution is still active today and will probably go beyond us. We do not think that our today full-fledged self-consciousness represents the ultimate version of human self-consciousness. A continuation of the proposed evolutionary scenario could provide a thread for that subject.
- Our evolutionary scenario has not addressed the concept of free will. The issue of free will is a philosophical problem which has complex links with self-consciousness. We propose, as a continuation, to look at how the issue of free will could be linked to the nature of self-consciousness as presented here.
b) As related to anxiety management.
- We humans share with animals basic emotions like fear and anger. But other emotions like happiness or contempt look more human specific. The proposed evolutionary scenario for self-consciousness could be used as a tool for investigating a phylogenesis of human emotions.
- We have proposed that anxiety management has been a key contributor to the evolution of self-consciousness. It has been part of the birth of ancestral self-consciousness and of its evolution toward full-fledged self-consciousness. A more finalized analysis about the interactions of anxiety management with self-consciousness could bring new understandings on human nature in terms of motivations and actions. This subject deserves more developments including a possible dark side with human evil possibly rooted in anxiety management. As our evolution is not over this could shed some light on a possible maturing of human self-consciousness. Also, anxiety disorders being among today most common mental illnesses, analyzing the couplings between anxiety limitation and new anxieties creations could bring openings on that subject.
- It has been proposed here that too much anxiety may have stopped the ongoing evolution of some pre-human primates and has guided them on a side track that led to today great apes. It would be interesting to transpose such a phylogenetic process on ontogenetic ones and consider excessive anxiety at individual level as a contributor to severe human mental

disorders.
- Existential angst as presented by existentialism could be analized as an elaborated consequence of anxiety management being an intimate part of human mind (the sort of anxiety about being in the world introduced above).
c) As related to artificial intelligence.
The purpose of artificial intelligence is to design artificial agents that can be as intelligent as humans. Making available an evolutionary scenario for self-consciousness brings up the question about its usability for artificial agents.
- Applications of the scenario to artificial intelligence bring to consider an inter-agentivity as being to artificial agents what inter-subjectivity is to living entities (Menant, 2007). The MGS can be used to define derived meaningful representations in artificial agents. The notion of inter-agentivity is to be developed, keeping in mind the intrinsicness of animal and human constraints and meanings as compared to the derived nature of the ones in artificial agents. Such differentiation of constraints and meanings as derived or intrinsic to the agent can be used to analyze the possibility for machine thinking (Menant, 2013).
- In order to bring intrinsic constraints in artificial agents, the need to extend living entities into artificial agents may have to be considered. Such perspectives (which are beyond today hybrid artificial agents and neurons in artificial agent data processing) are to be investigated. Such approach also highlights specific ethical concerns (Menant 2013).

6) Conclusion

The proposed scenario about an evolutionary nature of self-consciousness is based on an evolution of inter-subjectivity and meaningful representations that has brought our pre-human ancestors to identify with their conspecifics. This process has led our ancestors to access an elementary and embryonic representation of themselves as existing entities, like conspecifics they identified with were represented as existing. We have named it ‘ancestral self-consciousness’ and assumed that it is still present and active as a diffuse sense of being in the background of our today self-conscious minds.
By the same process, identification with suffering or endangered conspecifics has generated an important anxiety increase, unbearable if not properly limited. To limit that anxiety our ancestors have favoured the development of coordinated action, understanding of other’s mental states, tasks simulation with action programs improvements and communication. These performances were interdependent and have called for the development of other ones like social rules, social learning and teaching, and language. These performances, associated with a positive feedback on inter-subjectivity, have built up an evolutionary engine which has allowed our ancestors to develop their ancestral self-consciousness up to our today full-fledged self-consciousness. This evolutionary engine is based on anxiety limitation and positions human nature as closely interwoven with anxiety management processes that have become part of our behaviors and social organizations.
It has been proposed that the evolutionary scenario could be used as a tool for investigating a phylogenesis of human emotions, and also as a thread for a better understanding of severe human mental disorders. Possible forking paths in evolution related to unsuccessful anxiety managements have also been presented, one leading to our today modern apes.
The proposed approach also shows that the evolutionary advantages that can be attached to self-consciousness come from the evolutionary engine that has favoured her coming up rather than from self-consciousness by herself.
Similarities between ancestral self-consciousness and pre-reflective self-consciousness have

introduced links to be investigated between phenomenal consciousness and the proposed evolutionary nature of self-consciousness.
Possible continuations to the above scenario have been highlighted as related to human mind, to anxiety management and to artificial intelligence.

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