* Evolution of Representations. From basic life to Self-Representation and Self-Consciousness *

TSC 2006 * Christophe Menant *   **(1/9)**

Abstract

The notion of representation is at the foundation of cognitive sciences and is used in theories of mind and consciousness. Other notions like 'embodiment', 'intentionality', 'guidance theory' or 'biosemantics' have been associated to the notion of representation to introduce its functional aspect. We would like to propose here that a conception of 'usage related' representation eases its positioning in an evolutionary context, and opens new areas of investigation toward self-representation and self-consciousness.

The subject is presented in five parts:

Following an overall presentation, the first part introduces a usage related representation as being an information managed by a system submitted to a constraint that has to be satisfied. We consider that such a system can generate a meaningful information by comparing its constraint to a received information (Menant 2003). We define a representation as being made of the received information and of the meaningful information. Such approach allows groundings in and out for the representation relatively to the system.

The second part introduces the two types of representations we want to focus on for living organisms: representations of conspecifics and auto-representation, the latter being defined without using a notion of self-representation. Both types of representations have existed for our pre-human ancestors which can be compared to today great apes.

In the third part, we use the performance of intersubjectivity as identified in group life with the presence of mirror neurons in the organisms. Mirror neurons have been discovered in the 90's (Rizzolatti & al.1996, Gallese & al.1996). The level of intersubjectivity that can be attributed to non human primates as related to mirror neurons is currently a subject of debate (Decety 2003). We consider that a limited intersubjectivity between pre-human primates made possible a merger of both types of representations.

The fourth part proposes that such a merger of representations feeds the auto-representation with the meanings associated to the representations of conspecifics, namely the meanings associated to an entity perceived as existing in the environment. We propose that auto-representation carrying these new meanings makes up the first elements of self-representation. Intersubjectivity has allowed auto-representation to evolve into self-representation, avoiding the homunculus risk.

The fifth part is a continuation to other presentations (Menant 2004, 2005) about possible evolution of self-representation into self-consciousness. We propose that identification with suffering or endangered conspecifics has increased anxiety, and that the tools used to limit this anxiety (development of empathy, imitation, language and group life) have provided a positive feedback on intersubjectivity and created an evolutionary engine for the organism. Other outcomes have also been possible. Such approach roots consciousness in emotions.

The evolutionary scenario proposed here does not introduce explicitly the question of phenomenal consciousness (Block 1995). This question is to be addressed later with the help of this scenario.

The conclusion lists the points introduced here with their possible continuations.

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Presentation:

I. Usage related representations and associated meaningful Information:
 * A usage related representation contains a meaningful information (a meaning) built up by the
  organism to determine the action that will be implemented in order to satisfy a constraint.
II. Representations of conspecifics and auto-representation. Associated meanings:
 * Subject organism builds up representations of conspecifics, and can also build up an "auto-
  representation" which is a representation of the organism with no notion of self-representation.
**III. Identification of auto-representation with representations of conspecifics. Merger of
    associated meanings:**
 * Mirror neurons level of evolution indicate the possibility for an identification of subject with
  conspecifics which leads to a merger of corresponding representations and meanings.
**IV. Auto-representation using the meanings associated to the representations of conspecifics to
    build up the first elements of a self-representation:**
 * Due to identification with conspecifics, auto-representation of subject can integrate the meanings
  associated to the representations of conspecifics and so become a representation of an element
  perceived as existing in the environment. Auto-representation starts representing an element existing
  in the environment and so builds up an elementary version of self-representation.
V. Evolution of self-representation toward self-consciousness. Accelerators and inhibitors:
 * Evolutionary advantages of self-representation open the way to self-consciousness.
 * Anxiety coming from identification with endangered or suffering conspecifics is an evolutionary engine
  via a positive feedback on intersubjectivity made possible by the tools developed for anxiety limitation.

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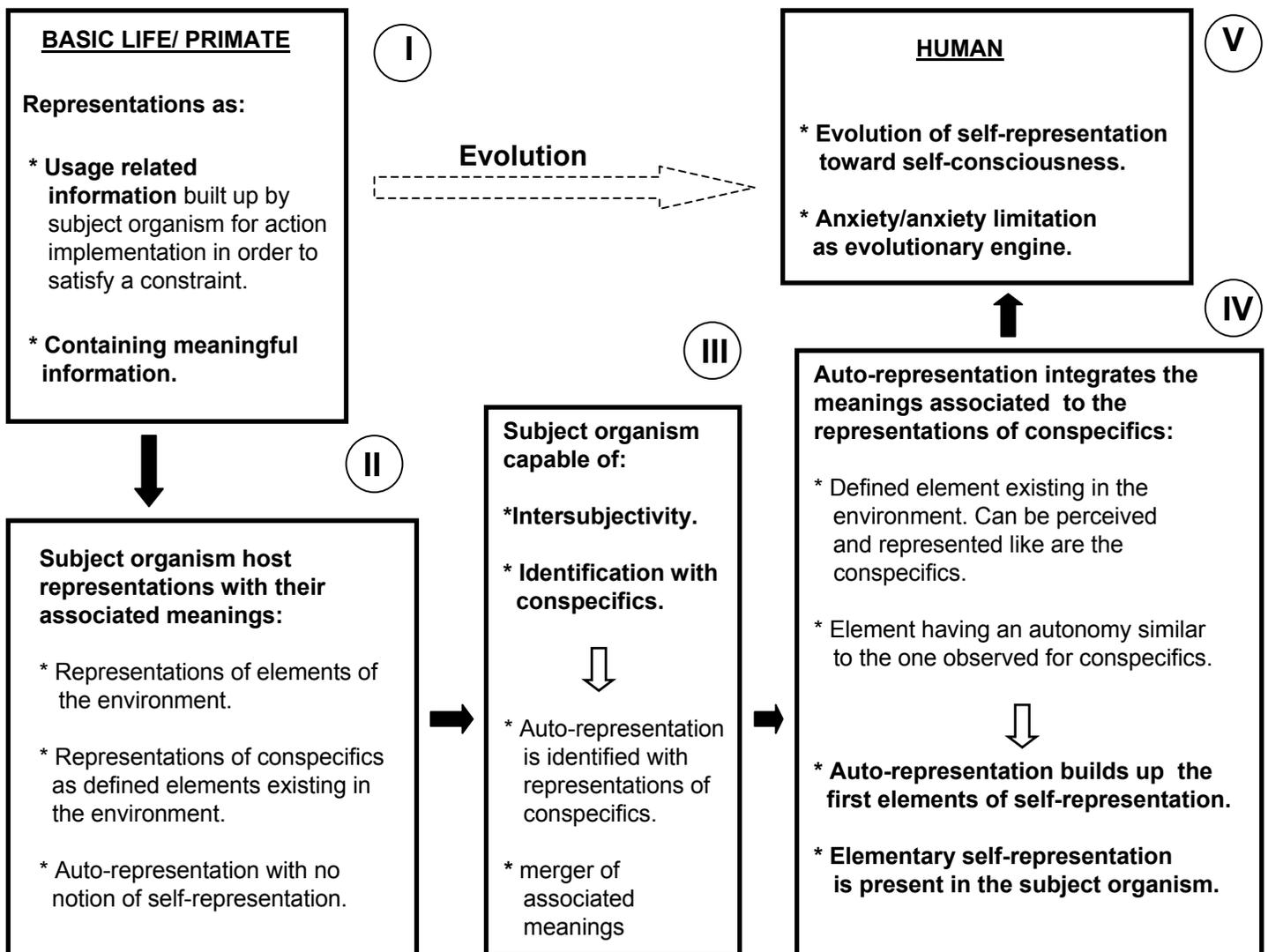
I. Usage related representations and associated meaningful Information:

* An evolutionary approach to representations starts with representations built up by an organism submitted to constraints (survive, mate, live group life,..).

* Such representations are usage related and are build up by an organism that will use them for the satisfaction of its constraints (1).

* We propose to formalize this usage related aspect of representations by identifying a component of meaningful information in their content .

* We define a meaningful information (a meaning) as being an information produced by a system submitted to a constraint when the system receives an incident information that has a connection with its constraint. The meaning is that connection. The meaning will be used by the system to determine an action that will satisfy the constraint. (Menant 2003).

* We define a basic representation as made of the received information and of the associated meaning relatively to the system (Fig I.1). The Meaning Generator System (MGS) is a building block linked to other functions (memory, simulation, ….). This definition of a representation combines objectivism and constructivism (2).

* A global representation would be multimodal and combine several basic representations with memorized information.

* The MGS can be related to the Peircean triadic theory of sign.

* Groundings in and out for meaning or representation refer to the build up of the meaning from information and data processing located in the system, and from incident information originated out of the system (Menant 2005).
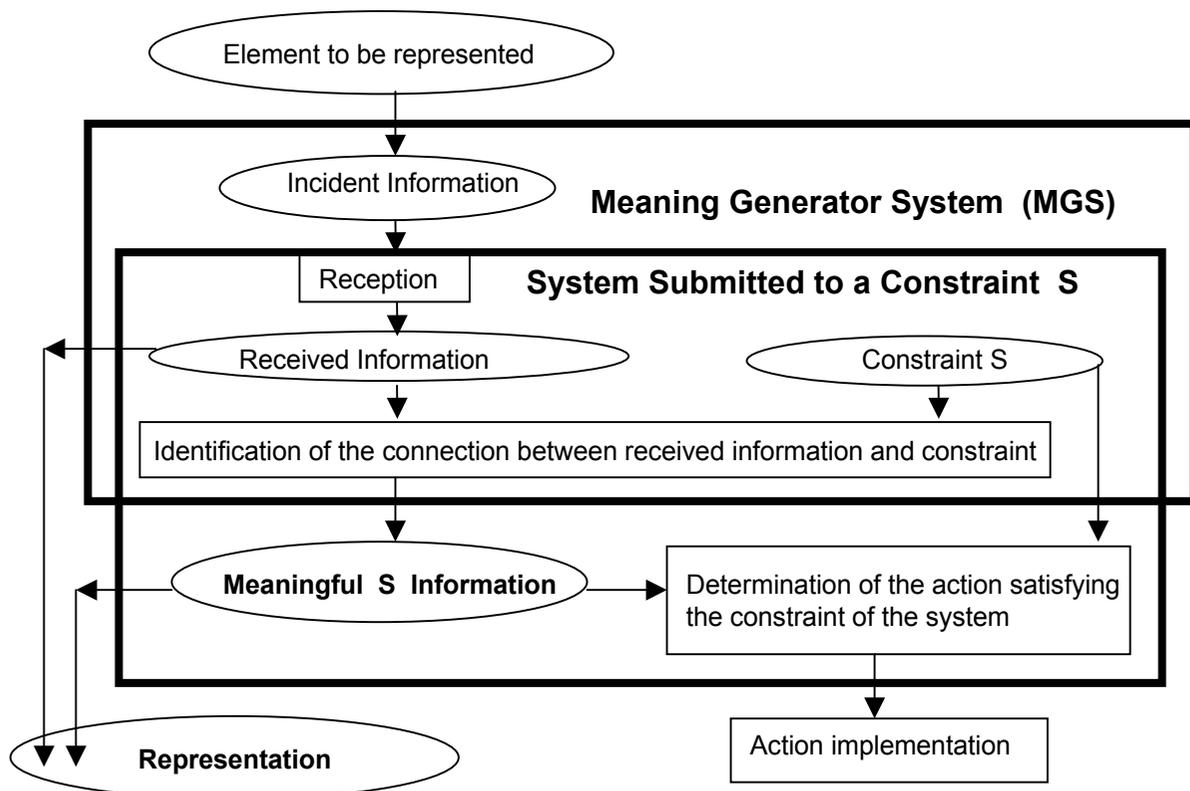
Fig I.1   Representation as Received Information plus Associated Meaning

(1) Usage related aspect of representations has already been introduced for Biosemantics (Millikan), Guidance Theory (Rosenberg and Anderson 2004) Embodiment (Anderson 2005), Intentionality (Freeman 1997).

(2) The representation is objectivist by the received information and constructivist by the meaningful information.

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II . Representation of conspecifics and auto-representation. Associated meanings:

* We now consider usage related representations at a level of evolution where primates are not capable of self-representation (say, lemurs) and we introduce for these primates the notion of auto-representations that contains no notion of self-representation.
* At this level of evolution, a representation of a conspecific is multimodal as different senses and constraints are involved. The associated meanings are many. We will focus on some precise ones.

II.1 Representations of conspecifics and associated meanings:
* Primates live in group and interfere with each other. Representations of conspecifics for a subject results mostly from her interactions with them and from the sensorial perceptions of their bodies and actions. The representations and meanings are very many due to different sensorial perceptions of conspecifics (and memorized information).
  We select the following meanings associated to the representation of a conspecific for a subject organism:
- Existing in the environment with an identity. Can display some autonomy that separates it from the background of the environment and from other conspecifics.
- Identified and recognized as an existing entity by the subject and by other conspecifics.

II.2 Auto-representation and associated meanings:
* In our evolutionary approach on representations, we want to avoid introducing a priori the notion of self-representation which can be looked as close to self-consciousness (Levine). To avoid circularity, we take as a starting point an organism only capable of what we call an 'auto-representation' which is a representation of the subject organism to the subject organism, with no notion of self-representation. Self-representation will be introduced later on as an evolution of this auto-representation.
* Auto-representation is a dynamic process encompassing lived experiences with two types of information sources (and no reference to self-representation):
  - External sources: what the subject can perceive with her senses about her body and her interactions with the environment (seen feet, smelled fingers, heard shouting, …; consequences of actions, interactions with conspecifics, …).
  - Internal sources: the inner signals coming from inner states of the body (physical pain, hunger, …).
* Meanings associated to these information are the ones related to the various constraints that have to be satisfied (stay alive as an individual and as a species, live group life).
* Simple primates like lemurs are capable of auto-representation, but this auto-representation is not a specificity of primates and exists in lower levels of life regarding evolution. We focus here on primates as we believe they represent an evolutionary stage where auto-representation can progressively reach the level of self-representation, opening a path to the evolution toward self-consciousness.

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III. Identification of auto-representation with representations of conspecifics. Merger of associated meanings:

* Recent scientific results on mirror neurons bring to believe that pre-human primates acquired progressively the performance of intersubjectivity which allowed them to mentally identify with each other.
Following our approach, this means that pre-human primate have been in a position to identify their auto-representation with the representations they had of their conspecifics. This brought the possibility for a merger of the meanings associated to both types of representations.

III.1.Mirror neuron level of evolution. Intersubjectivity and identification of subject with conspecifics:

* The discovery of mirror neurons in macaques about ten years ago (Rizzolatti & al 1996, Gallese & al 1996) has allowed the build up of a new conceptual tool for intersubjectivity in great apes and in humans. Mirror neurons are neurons that discharge when a subject executes an action as well as when the subject observes a conspecific executing the action. Such characteristics have allowed the idea that mirror neurons identify a possibility for intersubjectivity between subject and conspecifics.
Mirror neurons have been identified in humans also and discussions exist about the fact that "human beings "identify" with conspecifics more deeply than do other primates" (Decety, Chaminade 2003).
* Studies based on brain size and skull shape indicate that our early australopithecus ancestor that lived on earth about 4millions of years ago was probably not much different from modern apes in its behaviors. This brings us to consider that our ancestor did possess some level of intersubjectivity performance and was capable to mentally identify with his conspecifics in a limited way. It is not possible to address this level of performance more precisely. We can however consider that it probably began at a very low level and went up progressively with the evolution of the human linage.

III.2. Merger of representations and of associated meanings:

* The performance of mental identification of a subject with her conspecifics can be translated in terms of merger of representations.
As developed above, a subject carries two types of representations we are interested in: an auto-representation and a representations of her conspecifics. If the subject can mentally identify with her conspecifics, her auto-representation will merge with the representations she has of her conspecifics. Consequently, the associated meanings will also merge. This brings the possibility for the auto-representation to have access to the meanings associated to the representations of the conspecifics.
We propose in the next paragraph that an access to these new meanings can introduce some first elements of a self-representation on top of the existing auto-representation.

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IV. Auto-representation using the meanings associated to the representations of conspecifics to build up the first elements of a self-representation:

* We have considered that evolution has made possible that a subject organism merges the
  meaning associated to her auto-representation with the ones associated to the representations
  of her conspecifics. We propose here a hypothesis about how such a merger can give
  birth to a first version of self-representation for our pre-human ancestor. We then
  introduce the possible developments of these first elements of self-representation through
  evolution (3) .

IV.1. Auto-representation accessing the meanings associated to the representations of conspecifics. Birth of the first elements of a self-representation in evolution:

* The identification of the auto-representation of a subject organism with the representations
  of its conspecifics make possible the merger of associated meanings. The auto-representation
  of the subject that initially, and by definition, did not carry any notion of self-representation will be
  enriched with the meanings coming from the representations of the conspecifics.
  The auto-representation will then carry the following meanings:
  - Organism existing in the environment with an identity that can display some autonomy
    and be separated from the background of the environment and from other conspecifics.
  - Organism identified and recognized as an existing entity by the subject and by the other
    conspecifics.
* The auto-representation of the subject now represents her as existing in the environment
  as her conspecifics do for her. This is what we propose to consider as being the first elements
  of self-representation where a subject considers that she is existing as an entity of the
  environment as her conspecifics are existing for her.
  It is clear that the meanings associated to the auto-representation and to the representations of
  conspecifics did not merge all at once, and that self-representation came up progressively
  through evolution.
  Such approach avoids the homunculus risk as the nature of self-representation is presented as
  an evolution of auto-representation.

IV.2. Possible developments thru evolution for these first elements of self-representation:

* Following the proposed scenario, identification with conspecifics is a key event in the build
  up of the first elements of self-representation thru evolution, as it allowed the pre-human
  primates to progressively represent themselves as existing elements in the environment,
  as their conspecifics are represented. However, the development of self-representation
  may not be the only consequence of the identification with conspecifics. Other effects may
  have occurred with positive or negative impact on the development of self-representation.
  These other effects have to be taken into account.
* The build up of the first elements of self-representation has been presented as applied to
  the primate species, but it has taken place in individual primates, each with its specific
  history and auto-representation. So self-representation, on a phylogenetic basis, is also to
  be looked at as a sum of individual constructions encompassing personal experiences.

(3): It is considered that dolphins have access to some self-awareness (Marten and Psarakos) as they seem to
     succeed a variant of the mirror self-recognition test used for primates (Gallup & al). Dolphins are not primates and
     their possible access to self- representation is to be analyzed.

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V. Evolution of self-representation toward self-consciousness. Accelerators and inhibitors:

* Identification with conspecifics and first elements of self-representation has been a great step in the evolution toward self-consciousness. But the same identification process can also create an increase of anxiety that may inhibit the evolutionary trend. We propose that the tools implemented by the organism to limit its anxiety can also benefit to the evolution of the first elements of self-representation and accelerate the evolution up to self-consciousness, thus creating an evolutionary engine.

V.1. Identification with conspecifics as source of anxiety increase:
* Identification with conspecifics also means that the subject can feel what the conspecifics feel. The environment of our pre-human ancestors was one of survival of the fittest where many dangers and risks were present. At that time, the subject that identified with a conspecific had to feel all the dangers, sufferings and pains encountered by the conspecific in addition to her own.
We propose that this significant increase in felt dangers and sufferings or pains has generated an increase of anxiety for the subject.
Such anxiety increase generated discomfort and pain that the subject had to limit.

V.2. Anxiety limitation possibilities. Evolutionary engine:
* Our ancestors had various means to limit the increase in anxiety they were encountering:
  - Limit the source of anxiety, i.e.help the conspecific getting out of the dangerous situation or act in order to reduce his suffering or pain. This calls for a development of empathy with possibility of reciprocity and strengthening of group solidarity.
  - Reduce the occurrence of dangerous situations by improving group and individual efficiency on the environment thru improvement of imitation, communication (language) and group life.
* These actions to limit anxiety are an evolutionary advantage and develop the performance of intersubjectivity, which creates a positive feedback evolutionary engine (fig V.1.) (4)
* We propose that such evolutionary engine has contributed to the evolution of the first elements of self-awareness up to self-consciousness, which is then rooted in interpersonal relationship among pre-human primates.
* If the level of anxiety resulting from identification with conspecifics is acceptable with no real need for anxiety limitation, then the species can look at surviving in an ecological niche and not care about potential evolutionary advantages (today great apes ?) (fig V.1).
* If the level of anxiety resulting from identification with conspecifics is too important to be limited, then the evolutionary engine will not operate and the species may disappear through evolution (fig V.1).
* Anxiety limitation can be considered as an evolutionary engine that roots self-consciousness in emotions by the key role of anxiety/anxiety limitation in evolution toward humans.
* Today's humans are the result of that evolutionary engine which we can consider as still active.

(4) This positive feedback loop begins to increase anxiety by the development of intersubjectivity before offering tools to limit it . The loop will continue, assuming the overall result is positive evolutionary wise.

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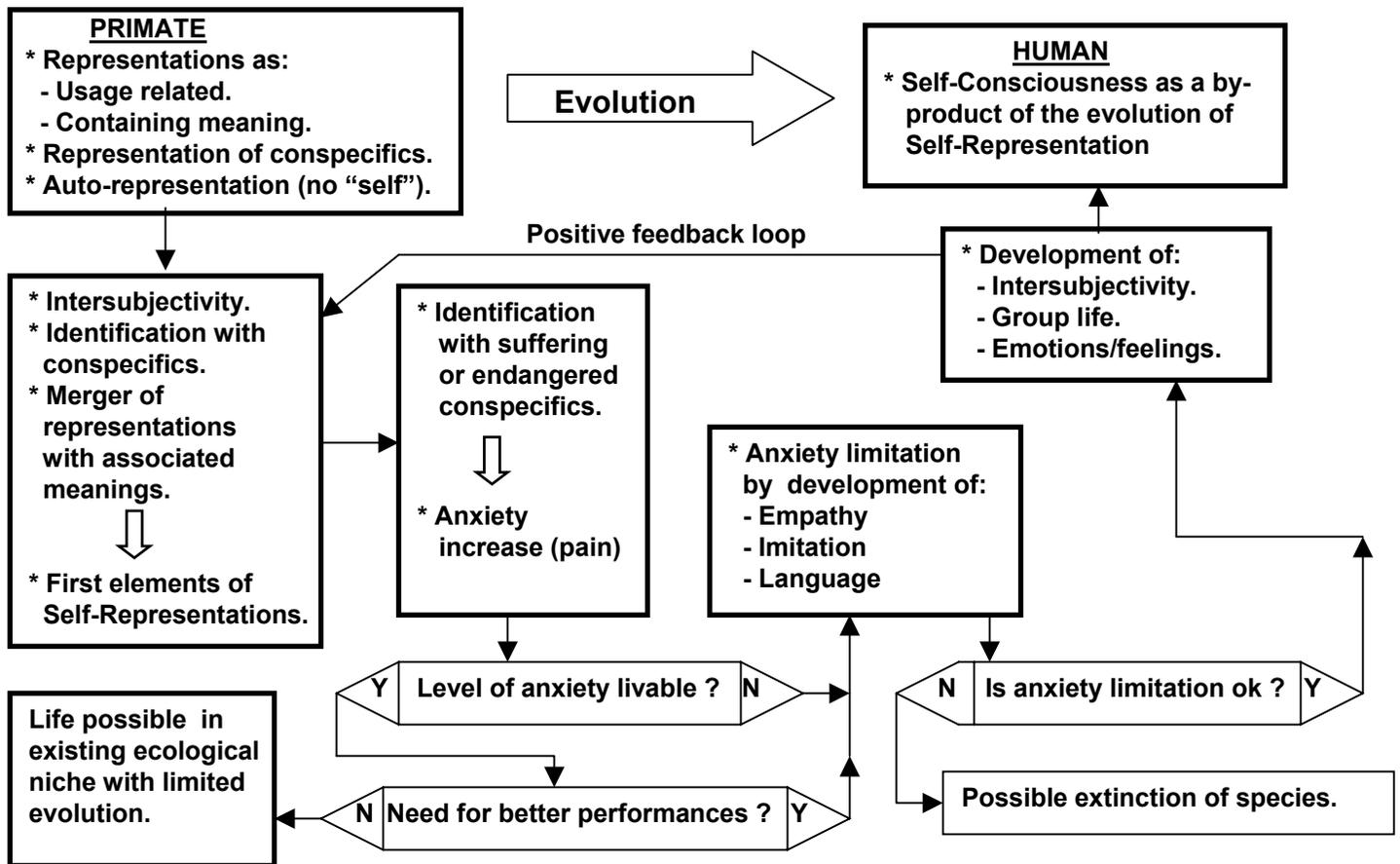
FigV.1. Anxiety Limitation and evolutionary options

VI. Conclusion. Summary and continuation

VI.1 Summary

The following points have been introduced in the above paragraphs:

a) A definition of usage related representation based on information and meaning.

b) An evolutionary scenario from primates up to humans starting with primates capable of carrying representations of conspecifics as well as an auto-representation (devoid of any notion of self-representation).

c) An identification of auto-representation with representations of conspecifics allowed by a performance of intersubjectivity among pre-human primates (mirror neurons level in evolution). This roots the evolutionary scenario in interpersonal relationship among pre-human primates.

d) A merger of meanings allowing auto-representation to carry the meanings associated to the representations of conspecifics.

e) The build up of first elements of self-representation resulting from auto-representation becoming able to carry the meanings corresponding to an entity existing in the environment as do represented conspecifics.

f) Self-consciousness considered as a by-product of the evolution of self-representation.

g) The identification with suffering or endangered conspecifics as creating an anxiety increase that has to be limited.

h) Anxiety limitation as developing empathy, imitation, language, group life and emotions, and initiating an evolutionary engine through the positive feedback on intersubjectivity.

i) Self-consciousness as rooted in emotions through the role of anxiety limitation in evolution.

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VI.2 Continuation
The following points are to be analyzed as a continuation of the above:
a) Formalize the characteristics and contents of usage related representations by using the ones existing for meaningful information.
b) Position homo sapiens on the anxiety limitation evolutionary loop with history of steps.
c) Analyze the nature of self-consciousness based on the evolution of self-representation.
d) Consider further evolutions of consciousness beyond today status of humans with evolutionary engines still active.
e) Look at implementation of auto-representation in robots and at the possibility for a development of self-representation resulting from interaction between robots.
f) Look for phenomenal consciousness as a consequence of self-consciousness.
g) Analyze evolutionary possibility for dolphins to access some kind of self-representation.
h) Consider the possible accelerating or inhibiting factors which are beside and beyond the stage of first elements of self-awareness in the evolution toward self consciousness.
i) Analysis of a possible phylogenesis of emotions and feelings from anxiety limitation process.

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