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Memory, learning and vicarious brain

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ABSTRACT

Memory plays a major role in the access to new apprenticeships and the development of coping mechanisms. Nevertheless, some situations may prevent its functioning due to their constraints and requirements. This is the case for example when the memory is "prevented", "injured or sick" [1-2]. How can today's environments (e.g. physical, social, technological) be designed or transformed so as to enhance human memory and provide all lifelong learning opportunities? This is the question addressed in this paper. Specifically, it is about the role of "memory making" in learning-relearning processes and the development of coping mechanisms. We propose here a new design method, not user-centered, but centered on the essential resources for the individual and/or collective activity. This method is called "Key Interaction Design" - KID (or CIC in French, for *Conception de l'Interaction Clé*). The central idea of this article is to contribute to the advancement of knowledge, methods and pedagogical practices for access to knowledge for all (i.e. visibility, readability, intelligibility and integration).

1. INTRODUCTION

Memory "sets up the future" [3]. It plays a major role in the access to new apprenticeships and the construction of vicarious strategies. Vicariance refers to the "substitution of one mechanism or process by another to achieve the same goal" [4]. Regarding human memory, Eustache defines it as "the function that allows to record information, enables its sustainable storage and retrieval at an appropriate moment" [5]. For Ricœur [11], it is a "trace left by a past event on any medium".

With time and experience, memory can enrich and diversify people's system of resources and latent capacities to act. These other ways of producing and doing are a solution to deal with encountered difficulties [6]. They are conditioned both by the individual's interaction capacities (e.g. perceptual, cognitive, physical) and the contextual situation. The challenge is then to create the conditions to promote perception (e.g. the right level of attention versus inhibition) and the use of resources that are useful for the achievement of the people's activity. The perception and use of these resources, assuming that the person knows how to explore his environment to find relevant information.

The research presented in this article focuses on memory - and its pathologies - and its role in learning-relearning processes and coping mechanisms[(i)]. Specifically, it aims to encourage reflection and contribute to the development of a conceptual and methodological framework that guides design choices and pedagogical practices promoting the development of people's capacities to act, latent, and by therefore actual opportunities for lifelong learning. We argue that it is urgent to rethink educational systems and social organizations in order to bridge the gap between the requirements of situations and the actual people's capacities, especially people with learning disabilities and/or cognitive deficits.

This article has a twofold objective. The first objective is to clarify the concept of "memory making" and the distinction we make between "memory" and "memory making". To achieve this goal, three new concepts, based on the conceptual framework of the "capable human" [8], were developed: "capacity to make memory", "power to make memory" and "desire to make memory". The second objective is to present a new design method, not user-centered, but centered on the essential resources for the individual and/or collective activity. We called this method "Key Interaction Design" - KID (or CIC in French, for *Conception de l'Interaction Clé*).

This article is divided in three main sections: (1) Section 2 defines the concepts of "memory making", "capacity to make memory", "power to make memory" and "desire to make memory"; (2) Section 3 describes the Key Interaction Design method - KID; (3) Section 4 opens some avenues for reflection about the construction of an intervention framework guiding design choices and pedagogical practices for an adequate memory making enabling the development of a "competent to act" status.

2. MEMORY MAKING: CONCEPTS AND DEFINITIONS

2.1 Memory and memory making

The concept of "memory making" was introduced by Ricœur [11] in his book entitled "Memory, History, Forgetfulness" to refer to recalling memories (i.e. recovery process). In this work, memory making also refers to creating memories (i.e. process of recording and retention).

Memory making goes beyond the very concept of memory,

because it refers to memory but is not limited to it. Memory making refers to the coordinated action of all cognitive functions (e.g. memory, perception, attention, locomotion, language, reasoning, executive functions such as flexibility, creativity, inhibition and planning) whose interaction promotes the construction or access to a memory trace left by past facts or "experiences". It is a process of exploring the current environment and mobilizing-combining past learning to guide choices, ongoing actions and new learning. We consider memory making as a process that can be individual or collective; provoked or involuntary (e.g. serendipity[ii]); encouraged, coerced or prevented; conscious or unconscious (e.g. forgetfulness, memory lapses, mishaps).

2.2 Memory, capacities and powers

What is a capable – and unable – person to remember and what is a capable –and incapable – person to forget? For Ricoeur, to remember "is declaring that we have seen, done or acquired this or that" [1]. It's not just about remembering something past, it's also about "remembering yourself," your story and your emotions. Remembering involves "a work of memory elaboration, selection in what is known or reinvented from the past" [10]. In the literature, many works, like Ricœur's [11], consider that memory "fights against forgetfulness". In this article, we consider, along with other researchers (e.g. [5, 12] that the opposite of memory is not forgetting, but forgetting to forget, since apart from any pathology of memory, forgetting is essential to its functioning [5]. Moreover, in this article, forgetting, which refers to information stored in long-term memory ("we must have learned to forget"), is distinguished from inhibition that is more concerned about information stored in the working memory [5]. Forgetting and inhibiting irrelevant information is essential for learning and acting effectively [13].

This article highlights three factors that from our point of view are essential to the description of memory making process from a developmental perspective: "capacity to make memory", "power to make memory" and "desire to make memory". The distinction we make between the concepts of "capacity to make memory" and "power to make memory" is based on the difference that Rabardel [8] makes between the concepts of "capacity to act" and "power to act", i.e. "what the individual can mobilize as opposed to what particular situations and conditions of activity will allow". We consider "capacity to make memory" as one of the dimensions of capacity to act and "power to make memory" as one of the dimensions of power to act. In this sense, these concepts share the same properties defined by Rabardel: capacity to act and capacity to make memory are generic, linked to a field of daily life activities and have a medium and long evolution; while power to act and power to make memory are situated skills, related to the action or the activity in progress and have a singular evolution.

Capacity to make memory is the set of resources that an individual can mobilize and combine to input or retrieve information in memory. Power to make memory is the set of conditions allowing to create or arouse a memory or to induce a use (e.g. sensory elements - visual, sound, olfactory or tactile, cues, primers, environmental affordances) through the system of mobilized resources. Finally, desire to make memory reflects the need to "be willing to do: we can know how to do and be able to do, but refuse to do" [14-15]. We define desire to make memory as willingness and motivation of a person (or a group) to make memory. Here, motivation is related to the ratio between the costs or investments (e.g. physical and cognitive) required and the benefits of the efforts provided. Willingness refers to the consequences of creating memories and/or reminiscences.

2.3 Links between memory making and resources

Memory-making is an activity mediated by and mediatizing through resources. To Memory-making, people mobilize a set of internal resources (related to the individual) and external resources (provided by the environment). In a previous article [16], we showed how the opportunities for action [and learning] offered by the resources mobilized, through the presence of adequate conversion factors (i.e. personal, social and environmental factors), allow in turn the development and mobilization of new resources enriching the individual's system of resources. The interested reader may refer to it for a literature review of definitions and typologies of resources.

Cognitive deficits[iii] result in the weakening of internal cognitive resources. Their impact on people's capacities and powers to act, and more specifically on their capacities and powers to make memory, varies according to the type of memory altered (e.g. sensory, work, semantics, episodic, procedural). However, the decrease of capacities and powers to make memory is not necessarily due to an impairment of memory. Beyond cognitive deficits, which imply considerable efforts from the people concerned, the difficulties can be explained by a gap between the available resources useful for the achievement of the activity's objectives and what the ecological conditions allow to really emerge and/or use. We consider the resulting difficulties as a lack of possibilities for action (or capabilities, according to Sen [17] related to a lack of accessibility and/or usability of available resources.

Figure 1 illustrates the links between people's resources, capacities and powers. To do this, we used the Resources-centered Human Development Model (R-HDM) [6]. R-HDM allows to explain that the resources mobilized by the person will allow, at first, the development of his/her power to make memory, and therefore of his/her power to act. Then, with time and experience, these same resources will be mobilized for the development of his/her capacity to make memory, and therefore his/her capacity to act (e.g. skills, knowledge, instruments). The two-way arrow between the powers to make memory and to act means that the development of power to make memory will contribute to the development of the power to act, which in turn will allow the development and mobilization of new capacities to make memory. In the same way, the two-way arrow between the capacities to make memory and to act means that the development of one will contribute to the development of the other.

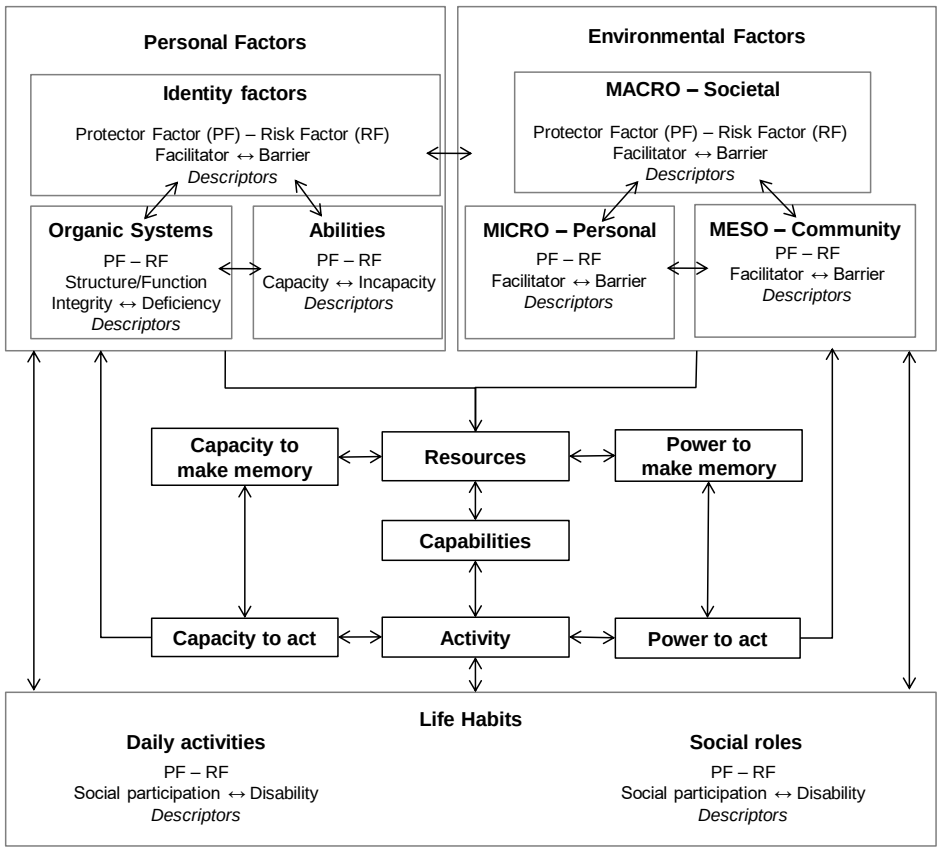

Figure 1. Description of memory making process based on the resources-centered human development model (R-HDM)

3. MEMORY MAKING, RESOURCES AND VICARIOUS BRAIN: DESIGNING FOR "OTHERWISE CAPABLE" PEOPLE

3.1 Access to knowledge for all: bridging the gap between the situations requirements and the actual people's capacities

For Aberkane, "the exchanges of knowledge are proportional to attention multiplied by time devoted to a task ($\varphi(k) \propto At$)[iv] [22]. In other words, the more time and attention we spend to achieve a task, the more knowledge to which we have access is important. But, what about the value of these exchanges and the role of the environment in access to information? What about people who have cognitive deficits affecting especially memory or attention? From our point of view, Aberkane's vision leaves little room for developing people's capacities and powers to act. Access to knowledge does not justify their understanding, integration and use.

The design challenge, beyond the educational content, focuses on the means for transmission, acquisition, retention and consolidation of knowledge (e.g. cognitive development, conditions promoting cognitive stimulation and metacognition). Therefore, valuing Aberkane's equation by adding conversion factors (personal, social and environmental) influencing the development of capacities and powers to make memory would allow to evaluate the value of knowledge flows, in terms of efficiency/benefits and cost (e.g. cognitive, physical). For example, Conway's work [23] shows that people keep longer in memory what is related to their identity (i.e. their values, beliefs principles, individual choices and personal goals).

3.2 Proposal for a new resources-based design approach: "key interaction design" (KID) method

3.2.1 Objectives and motivations

"Key Interaction Design" (KID) is a design approach centered on "key resources" for the finalized activity. Its purpose is to define and provide people with the minimal help they need to achieve their targeted goals autonomously and safely; and if necessary, to get them out of the deadlock in which they find themselves. The objective is not just to compensate for the difficulties encountered, but to provide them with the means to look ahead and build their future through resources and activity situations that make sense to them.

KID came into being further to the fact that despite efforts in social and educational policies, the lack of appropriate cognitive planning/adjustments often limits the access and use of available resources [16-24]. How can ergonomics then contribute to the development of practices, services or educational devices adapted to people with particular disorders affecting cognitive functions (e.g. memory, attention)? In the literature, the works in design often oscillate between a Universal Design/for all (UD) approach and a User Centered Design (UCD) to identify and respond to people's actual needs-expectations. Yet, taken separately, they are, from our point of view, useful but insufficient to meet this objective. Beyond needs analysis, it is essential to find effective ways to provide assistance. How to design for all considering the complexity (e.g. multihandicaps) and evolutionary character of the handicaps? The UCD is based on the principle that end-users would be best placed to guide the design of a product or service [25]. But, how do we respond to the needs of people who cannot express them

either because they do not have the capacity or because they are not aware of their needs? Also, how to express the need for a product or service that does not exist yet?

The UCD and UD focus on people's abilities-disabilities and the impact of services and assistive devices on their daily lives to overcome-compensate their deficiencies and/or incapacities (UCD) and to improve the environment accessibility (UD) [25]. In KID, the focus is on what people want to be, have and do (e.g. goals, choices, goals, expected results, values, principles), as well as on developing alternative ways to create the conditions for perception, choice and use of the necessary resources to achieve this. The nature and format of the resources depend not only on people's functional level and their stage of development, but also, on the resources and compensatory strategies already implemented, obstacles encountered, goals and personal choices.

3.2.2 Definitions and characteristics of a key interaction

The key interaction is the set of essential conditions that will enable a person to find what they are looking for (or need without knowing it) and use it autonomously. It reflects the enabling potential of an environment of which it has the three characteristics, as defined by Falzon [19-20]:

- From a preventive point of view, it has no adverse effects on the person and preserves his/her future capacities to act (e.g. preservation of physical and cognitive capacities, maintenance of competencies).
- From a palliative/universal point of view, it takes into account inter-individual differences and compensates for functional limitations (e.g. aging, disease, incapacities) to: (1) prevent professional disinheritance, non-employment, school/social/generational drop-outs, and (2) foster integration, inclusion and social recognition.
- From a developmental point of view, it encourages the expansion of capacities and powers to act by: (1) developing new knowledge and competencies, (2) broadening the possibilities for action and the degree of control on the task and activity, (3) fostering autonomy and (4) contributing to the cognitive development of individuals and collectivities.

3.2.3 Method

The Key Interaction Design (KID) consists of three iterative phases: analysis phase, design phase and evaluation phase.

The *analysis phase* aims to clarify, not the needs, but the targeted objectives and the competencies required to achieve them. This involves describing the tasks to be performed and the expected results (e.g. properties, steps). The assistance is discussed here, in connection with the activity situation (e.g. objectives and targeted results, location, environment, presence and activity of third parties), and in terms of consequences on the individual and/or collective activity. Considered solely on the basis of functional limitations and deficits, assistance is, from our point of view, insufficient to meet the changing needs of people. For example, based on a user-centered design approach, cognitive stimulation exercises aim to stimulate-preserve the cognitive functions of people with cognitive deficits. However, since these exercises require literate abilities (e.g. reading, writing, numeracy) and are based on socio-cultural knowledge, they exclude, in fact, people who do not master them (e.g., allophones, immigrants). Resources centered, KID allows to think the assistance, not from people's capacities-incapacities, but from the objectives and resources required to achieve them. It allows, beyond the poor ergonomics of technological tools, to anticipate the difficulties related to the nature of the exercises.

The *design phase* focuses on alternative resources and possible planning/adjustments solutions (e.g. scale-model, prototype, method) to enable people to acquire and develop the competencies identified during the analysis phase to achieve the targeted objectives. This involves identifying the constraints and difficulties related to the activity and any potential disabling disorders and handicapping diseases. At this stage, the replacement values of alternative resources should be defined in order to increase the level of sensitivity and the adequacy of assistance. The Method of Failure and Substitution of Resources (MDSR in French), developed by Rabardel and Bourmaud [26], can contribute to this objective by analyzing the resource/ conditions/substitution values of resources usually used by people.

We distinguish two categories of resources: (1) resources directly useful for the finalized activity, namely, attainment of milestones, results, properties or specific objectives (e.g. use of a diary or calendar for putting or recovering information in memory) and; (2) "resource resources", which will allow their perception and use through appropriate cognitive planning/adjustments [27] (e.g. specific fonts, affordances, color helpers, explicit images). Resource resources are also involved in evaluating the choices made and monitoring the current action using the information detected or collected.

The *evaluation* phase consists of evaluating the accessibility, intelligibility and usability of the proposed solutions (e.g. via user tests). It is also about defining and evaluating the "right level of assistance" to provide the best possible guidance and reassure people who need it [28]: too simple, assistance will not foster mobilization and development of people's latent capacities to act (e.g. infantilization); too complicated, it will exceed them. In both cases, it will lead to rejection (e.g., demotivation, defeat).

"Right level of assistance" is located between the "floor level" and the "ceiling level" of assistance. Since all three vary from one situation, and from one person to another, it is necessary to define levels of granularity for the proposed help. The "floor level" of assistance (or minimal assistance) corresponds to the network of minimum and sufficient resources on which priority will be given to efforts for cognitive development (e.g. construction of affordances-indices, taking into account the values, beliefs, and people's individual principles) to enable the mobilization of latent capacities to act, the development of coping mechanisms and access to learning. Indeed, because if it allows the realization of the activity, this level of assistance is not sufficient to satisfy the basic criteria of the ergonomics of the interfaces (e.g. guidance, workload, adaptability, protection against errors, human compatibility) [29]. The "ceiling level" refers to the maximum level of assistance that can be provided. If it allows the realization of the activity by the compensation-removal of the difficulties encountered, this level nevertheless leaves little room for learning and development of people's capacities to act. The latter then no longer have the possibility of continuing to do things differently by themselves since the assistance is done for them by others (e.g., third parties, devices).

4. DISCUSSION: FROM DISABILITY TO CAPABILITIES: TOWARDS AN INTERNATIONAL FRAMEWORK FOR HUMAN DEVELOPMENT?

This section aims to open some avenues for reflection about the construction of an intervention framework guiding design choices and pedagogical practices for an adequate memory making enabling the development of a "competent to act" status. To do this, we choose to resonate two models that can, from our point of view, contribute to this objective; the conceptual framework of disability [30] and the Resources-centered Human Development Model (R-HDM) [6].

In 2002, the World Health Organization (WHO) proposed an International Classification of Functioning, Disability and Health (ICF) [30]. The ICF is based on a functional approach that highlights the role of socio-environmental factors in the disability creation process (Figure 2). Thus, it moves away from the linearity "Deficiency-Incapacity-Disadvantage" and the causal link between disability and deficiency (consequence of a disease) proposed by Wood [31]. For an in-depth presentation of the ICF, the interested reader may refer to Jamet [32] and Laffont et al. [33].

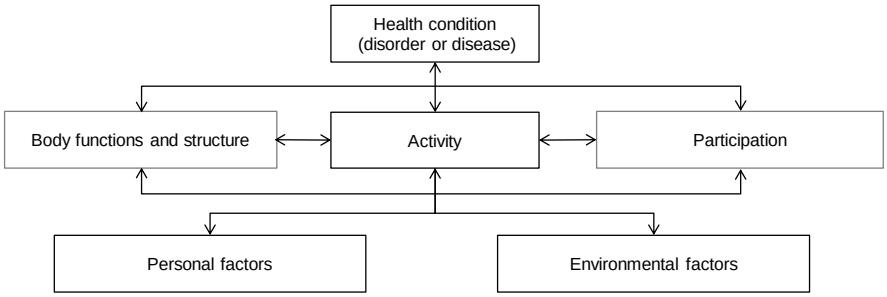

Figure 2. Conceptual framework of human functioning according to ICF [30]

Based on Fougeyrollas' works [34], the ICF's framework allows to understand people's functional limitations and their impact on the realization of daily activities. However, these works do not agree on the role that activity plays and, while ICF emphasizes the crucial role of the environment, it makes no distinction between environment and resources [35-36]. ICF does not integrate personal choices and goals [36-37] or the subjective consequences of disabling disorders and diseases (e.g. emotions, quality of life, experience). Finally, the lack of clear representation of the fields in which an action can be initiated makes its practical application difficult. Several authors, e.g. Jamet [32], have pointed out its lack of operationality.

In response to these findings, we used the Resources-centered Human Development Model (R-HDM) to enrich the ICF's conceptual framework by highlighting the major role of resources in building people's capacity and power to act (Figure 3). R-HDM, which is based on the conceptual framework of "capable human" developed by Rabardel [8], allows to consider people as instrumented individuals, with their own resources (e.g. schemes, tools), and not only psychological as is the case in ICF. R-HDM also allows to envisage the construction of an international framework, which beyond the human functioning, allows a description of the conditions that can guide the practices and design choices for a "successful" human development chosen by the people.

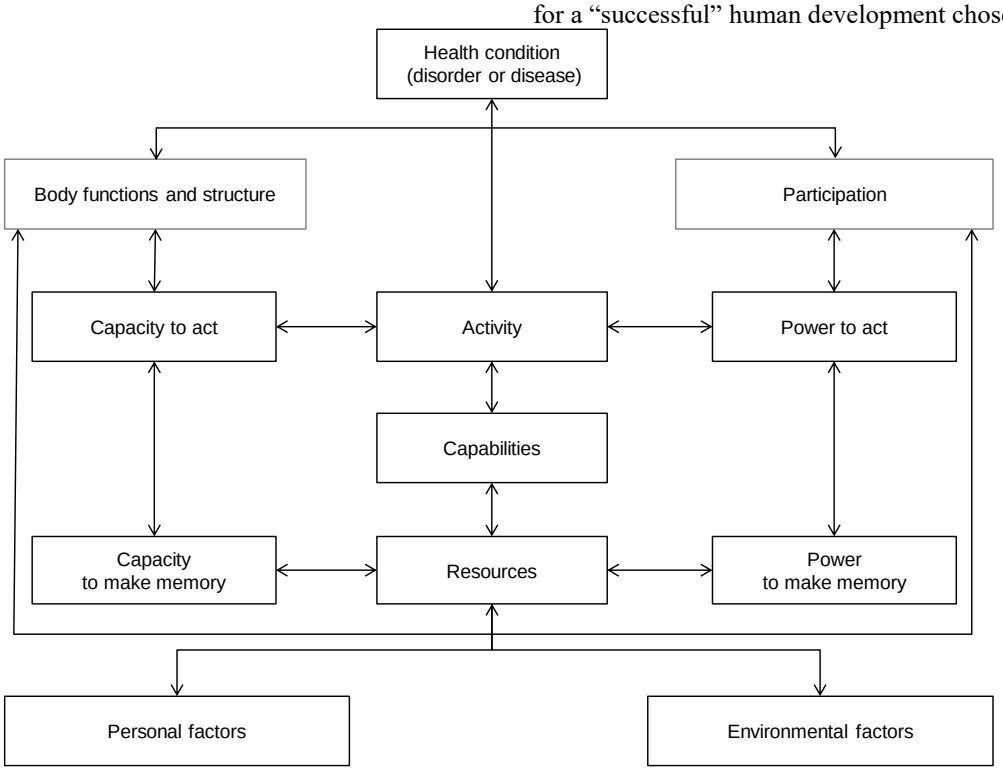

Figure 3. From human functioning to human development: Toward a new international framework?

5. CONCLUSION

Memory is timely. In order to promote access to new apprenticeships and the construction of vicarious strategies, it is necessary to provide people with the means to use, among all available means, those who will enable them to reach, under the best conditions, the targeted objectives and expected results. These resources include both resources useful for the finalized activity and "resources for resources" that will allow their perception and use. Beyond the gestures, the challenge of innovations (e.g. pedagogical, technological) is to identify and develop the conditions to promote the opportunities to choose (or learn to choose) the appropriate resources, in a free and informed manner.

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APPENDIX

(i) The people's "adaptive power" to new situations is defined by Masciotra and Medzo [7] as one of the essential characteristics of the "competent to act" status.

(ii) The term "serendipity", created by H. Walpole in 1754, refers to "the ability to discover by chance and sagacity things that we did not seek" [9].

(iii) Cognitive deficits are defined by Lévesque et al. (1990), as "alterations of intellectual capacities such as memory, language, orientation, concentration, attention, judgment, abstract thinking, learning ability, etc."

(iv) This principle, taken up by Aberkane [22] in his knowledge economy approach, derives from the work of Davenport and Beck [21] on attention economy. It is translated by the following equation: φ (k) α At, where k refers to knowledge, A to attention and t to time.