Information Science and Cognitive Psychology: A Theoretical Approach

Bilgibilim ve Bilişsel Psikoloji: Kuramsal Bir Yaklaşım

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Abstract: *Information, as a human and social phenomenon, is the object of study of an emergent scientific field named Information Science (IS), which we put forward as unitary and transdisciplinary and open to a rich interdisciplinarity with other fields of knowledge. In face of the new reality, baptized the 'Information Society', and the emergence of a new paradigm, that we name "post-custodial, scientific and informational", as opposed to the previous one, "historicist, custodial and technicist", it is urgent to consolidate the theoretical and methodological foundations of IS in order to develop research, both pure and applied, and to contribute to a definition of its boundaries as a scientific area, in the scope of Social Sciences. Starting from an operative definition of Information, this paper aims to discuss the cognitive and emotional dimension of the info-communicational phenomenon and, for that, it is crucial to start a profound and hard dialogue with Cognitive Sciences. The label of 'cognitivist' given, in IS literature, to some authors like Bertram Brookes, because of the emphasis he put on the passage from a state of knowledge to a new state through an addition of knowledge coming from an increase of information, sounds quite equivocal, because knowledge and cognition are not synonymous and cognitive and emotional activity is not reducible to formalities. It is necessary to compare concepts and to understand the neuropsychological roots of the production, the organization and the info-communicational behaviour, so the contribution of Neurosciences and Cognitive Sciences, namely Cognitive Psychology, is indispensable.*

Keywords: *Information science, cognitive psychology, interdisciplinarity*

Öz: *İnsani ve toplumsal bir olgu olarak bilgi, Bilgibilim olarak adlandırılan ve yeni ortaya çıkan bilimsel bir alanın çalışma nesnesidir. Bilgibilimi diğer bilgi alanlarıyla zengin bir disiplinlerarasılığa açık, tekil ve disiplinlerüstü bir alan olarak düşünüyoruz. "Bilgi Toplumu" olarak bilinen yeni gerçeklik ve önceki "tarihçi, korumacı ve teknikçi" paradigmaya karşılık yeni ortaya çıkan "korumacılık sonrası, bilimsel ve bilgisel" olarak adlandırdığımız yeni paradigma ışığında, hem temel hem uygulamalı araştırmaları geliştirmek ve Sosyal Bilimler içinde bir bilimsel alanın sınırlarının tanımına katkıda bulunmak için Bilgibilimin hem kuramsal hem de yöntembilimsel temellerini acilen birleştirmek gerekir. Bilginin işletimsel bir tanımından hareket ederek bu bildiri bilgi-iletişimsel olgunun bilişsel ve duygusal boyutunu tartışmayı amaçlamaktadır. Bunun için Bilişsel Bilimlerle sağlam ve sıkı bir diyalog başlatılması çok önemlidir. Bilgibilim literatüründe Bertram Brookes –çünkü bilgi (knowledge) durumundan bilgi (information) artışından kaynaklanan bilginin (knowledge) eklenmesiyle yeni bir duruma geçişi vurgulamıştı- gibi bazı yazarlara yapıştırılan "bilişselci" etiketi yoruma açıktır, çünkü bilgi ve biliş eş anlamlı değildir ve bilişsel ve duygusal etkinlik formalitelere indirgenemez. Kavramları karşılaştırmak ve üretim, organizasyon ve bilgi-iletişimsel davranışın nöropsikolojik köklerini anlamak gereklidir. Bu nedenle Sinirbilim ve Bilişsel Bilimlerin, yani Bilişsel Psikolojinin katkısı vazgeçilmezdir.*

Anahtar sözcükler: *Bilgibilim, bilişsel psikoloji, disiplinlerarasılık*

Introduction

In spite of the ancient roots of IS, it was only at the end of the 1950s that the term *Information Science* appeared in the literature, as a natural evolution from Documentation, boosted by the new Information and Communication technologies and by the development of scientific and technical information.

Therefore, IS growth occurred in a "straight line" from Documentation, with strong input from *special librarians* and *documentalists*, and some contributions from traditional librarians, but without true commitment from archivists and records managers (Silva & Ribeiro, 2002). It has been a path, in great measure, followed by people in professions related to information and stimulated by professional associations, which gradually gained its own space in academic and scientific contexts.

According to Shera and Cleveland (1977), the event that marked the shift from Documentation to IS was the International Conference on Scientific Information that took place in Washington in 1958, as a result of a partnership between the American Documentation Institute, the International Federation of Documentation, the National Academy of Sciences and the National Research Council. Thus, this event brought together the major players at world level.

Hans Wellisch states that the expression, Information Science, was used for the first time in 1959 and Anthony Debons (1986) says that in 1962 the same expression appeared in the name of an international meeting, the Second International Congress on Information System Sciences, which took place in Hot Springs, Virginia (USA) (Lilley & Trice, 1989). In effect, by the 1970s, the expression enjoyed wide-spread acceptance in the USA and the area was more rapidly developed than in other countries. Thus proposals for a definition started to surface, as well as various articles aiming to establish the theoretical grounding of this new scientific field.

The Concept of Information and the Foundations of Information Science

Since the 1960s, multiple definitions have been advanced. However, one of the most accurate and complete came out during the Conferences of the Georgia Institute of Technology (Oct. 1961-Apr. 1962) and was further elaborated upon by Harold Borko in a seminal article titled *Information Science - what is it?* (Borko, 1968). It remains, still today, one of the most consensual and fruitful:

> Information Science is that discipline that investigates the properties and behavior of information, the forces governing the flow of information, and the means of processing information for optimum accessibility and usability. It is concerned with that body of knowledge relating to the origination, collection, organization, storage, retrieval, interpretation, transmission, transformation, and utilization of information. This includes the investigation of information representations in both natural and artificial systems, the use of codes for efficient message transmission, and the study of information processing devices and techniques such as computers and their programming systems. It is an interdisciplinary science derived from and related to such fields as mathematics, logic, linguistics, psychology, computer technology, operations research, the graphic arts, communications, library science, management, and other similar fields. It has both a pure science component, which inquires into the subject without regard to its application, and an applied science component, which develops services and products. (…) Librarianship and documentation are applied aspects of information science.

Looking at the history of IS leads to the realization that this field and the disciplines from which it derives began, above all, as a practical activity. This circumstance raises some problems to the scientific assertion and identity of IS. A study by Emílio Delgado López-Cózar on the research conducted in Librarianship and Documentation focuses precisely on this problem and the author recognizes that:

> The origin and evolution of disciplines of a professional basis, such as IS, cannot be explained through the same conceptual assumptions used in the sciences per se. The latter deepen their roots in the desire, innate to the human being, of knowing in and for itself, that is, to understand the world and to dominate it in benefit of the human species. They are born and grow in function of a dual human need: the cognoscitive (to know and to explain the why and the how of our natural, social and human reality) and the utilitarian (to apply the knowledge to the improvement of our life conditions). This conceptual scheme is valid to shape the history of all sciences, but particularly so of those which justify themselves only as a means to satisfy that dual need. They are sciences per se: the human and social sciences (philosophy, theology, history, sociology…) and the physical-natural sciences (physics, chemistry, biology…). But this is not the case when explaining the history of sciences that have appeared as an activity and as the support to a profession: from

medicine or nursing to education, including a wide range of professions which arose from the economic, social and cultural development of humanity, such as social work or Librarianship and Documentation, which is what concerns us here. In these cases, their very character as a scientific profession is still under discussion (Delgado López-Cózar, 2002).

We absolutely agree with López-Cózar when he states that "in the development of Librarianship and Documentation [and we add Archivistics] theory followed practice, neither directing nor guiding it" (Delgado López-Cózar, 2002). In fact, the professional activity stimulated reflection on the *praxis* and, consequently, the need for some kind of training arose, appropriate to such a professional activity. Reflection on practice therefore led to disciplinary affirmation, to theoretical 'exercises' and to research work. These factors have been fundamental in building scientific knowledge around an object of study (information) and to boost the emergence of a science. But this scientific construction did not occur at the same time and in the same way in every country or context, which means that the degree of IS development is quite variable and reaching a consensus about this scientific field has proved quite difficult.

On the one hand, we must acknowledge that Archivistics has been neglected (or even self-neglected) and archivists have essentially been left out of the evolutionary process of IS, even though they try to show their scientific identity, albeit without a theoretical basis; on the other hand, there is no scientific consensus about the epistemological unity of the field, which could contribute to an understanding of IS as an interdisciplinary field; furthermore, some perspectives still persist, sustained by the traditional paradigm that considers only recorded information (=Documentation) as the object of study, which restrict the understanding of the informational phenomenon to an epiphenomenon, causing perverse effects from a scientific point of view.

In spite of this multiplicity of positions, we think that it is possible to contribute to clarifying this issue by defending IS as a unitary yet transdisciplinary field of knowledge, included in the overarching area of the human and social sciences, which gives theoretical support to some applied disciplines such as Librarianship, Archivistics, Documentation and some aspects of Technological Information Systems. The way in which we see the cartography of the IS scientific field at the University of Porto is represented in a diagram, designed in 2002 (Silva & Ribeiro, 2002), and later rebuilt (Silva, 2006), so as to better illustrate its transdisciplinary dimension and, at the same time, its interdisciplinary relationships (see Figure 1).
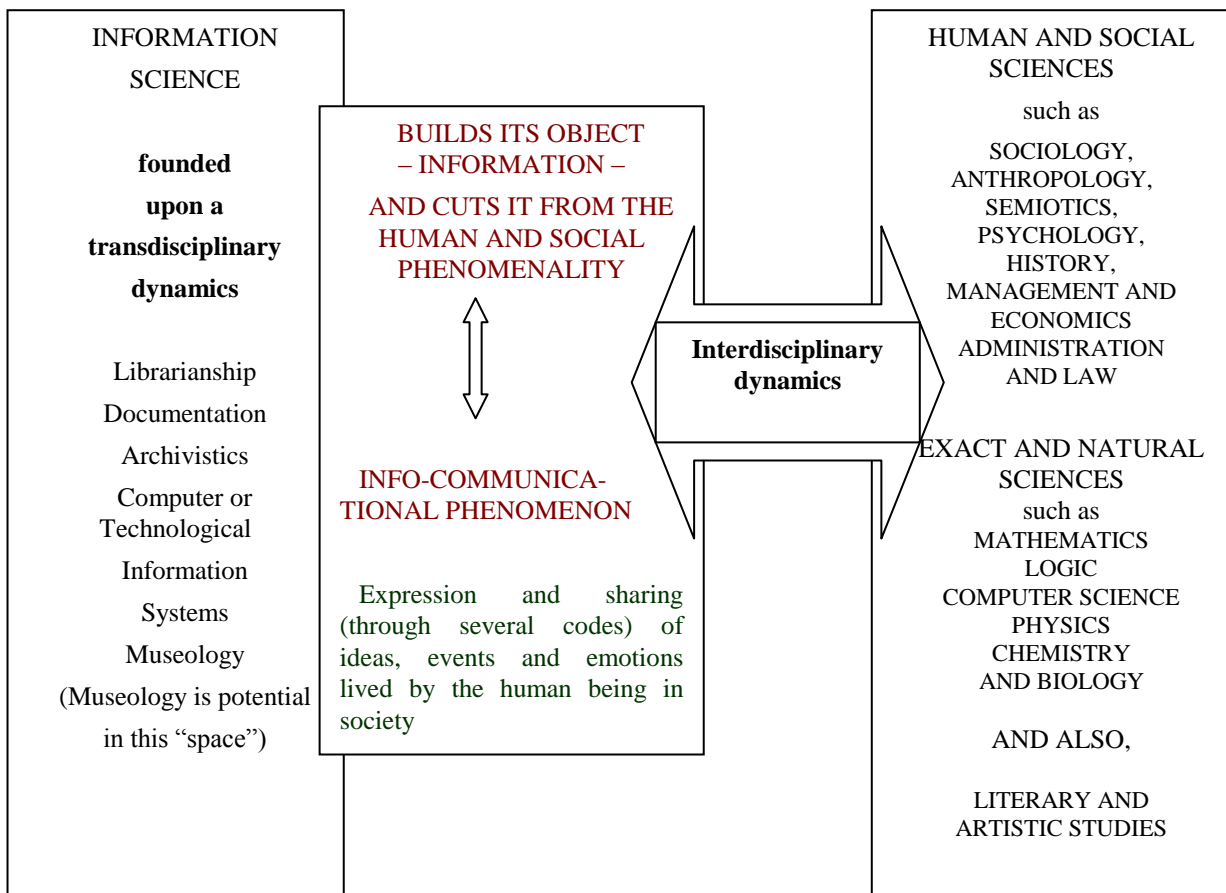

Figure 1. Diagram of the trans-and interdisciplinary construction of Information Science

In this perspective, besides establishing the boundaries of IS, it is also crucial to define its object of study and to assume a research method adapted to the characteristics of Information as a social phenomenon, emphasizing its qualitative component, as is appropriate in the scope of the social sciences.

When it comes to IS's object of study and work – Information – it is essential to have a definition as a starting point, because it acts as an operative and foundational concept. The definition we propose is as follows:

> *Information* is a structured set of mental and codified representations (significant symbols), created in a specific social context and capable of being recorded on any medium (paper, film, magnetic tape, compact disc, etc.) and, therefore, communicated in an asynchronous and multidirected way (Silva & Ribeiro, 2002).

Complementing the definition, the characterization of the informational phenomenon is broadened by the enunciation of its properties. In his book *A Ciência da Informação* [Information Science], Yves-François Le Coadic (2004) attempted to formulate the properties of information, but, in our opinion, in a way that is rather unclear. So, we attempt to complete the above definition by listing the *properties* of information, formalized as general axioms. Information is:

> 1 – *structured by an action* (human and social) — the individual or societal act structurally establishes and models information
> 2 – *integrated dynamically* — the informational act is involved with, and results from, conditions and circumstances both internal and external to that action
> 3 – *has potentiality* — a statement (to a greater or lesser extent) of the act which founded and modelled the information is possible
> 4 - *quantifiable* — linguistic, numeric or graphic codification is capable of quantification
> 5 - *reproducible* — information can be reproduced without limit, enabling, therefore, its subsequent recording/memorization
> 6 - *transmissible* — informational (re)production is potentially transmissible or communicable.

These six properties, and especially the last two, characterize information, not only as a *phenomenon* but also as a *process*. In this second dimension we include the idea of information behaviour, as well as all the activities related to the creation, organization, representation, storage, retrieval and use of information. So, information comprises the core (single and cross-disciplinary) of an academic field, which is itself dynamic and closely interrelated with other disciplines, as the diagram in the Appendix demonstrates.

The assumption of social information as the object of knowledge has wide-ranging and unexpected implications. The main one is the emergence of a *scientific-informational* paradigm, shaped by the following factors:

a) the value of information (and not the medium on which it is recorded) as a human and social phenomenon/process, with its own historicity (organic and contextual) and its cultural importance;
b) the statement of the natural and continuous dynamism of information in opposition to documental immobility;
c) the impossibility of keeping the traditional divisions of information according to the institutional or technological space where it is preserved (archival service, library or computer package) because such a criterion does not embrace the dynamic context of its production, of its recording and of its use/access (functionality);
d) the need to know (to understand and to explain) social information through theoretical-scientific models, increasingly more effectively, instead of an empirical practice reduced to a set of technical procedures such as arrangement, description and retrieval;
e) the replacement of the process-oriented perspective evident in the terms 'records management' or 'information management' by a new scientific view that tries to understand the information involved in the management process of any organization; this means that the informational practices/procedures are aligned with managers' conceptions and practices and with the organizational culture.

These characterizing elements, together with the definition of Information, can be considered the minimum and fundamental basis of a scientific approach to that which we consider to be the object of study and work of IS, understood as a theoretical and practical field in consolidation that supports multifaceted professional competencies, in accordance with the contexts and demands of professional activities.

In what concerns the methodological component of IS, we can sum up the ideas largely explored in the book mentioned previously (Silva & Ribeiro, 2002). According to the topological model proposed by Paul de Bruyne, J. Herman and M. de Schoutheete for research in the social sciences (De Bruyne et al., 1974; Lessard-Hèbert, Goyette, & Boutin, 1994), the method of information science is achieving greater acceptance and tends to find consolidation

through quadripolar research dynamics, which are operated and continuously repeated within the field of knowledge itself. This action combines quantitative approaches (there are aspects of the object which can be observed, experimented on and measured) and qualitative approaches, in which the subject's interpretative/explanatory ability necessarily has modeling implications. The research dynamics mentioned thus imply permanent interaction on four poles, that is, the epistemological, theoretical, technical and morphological.

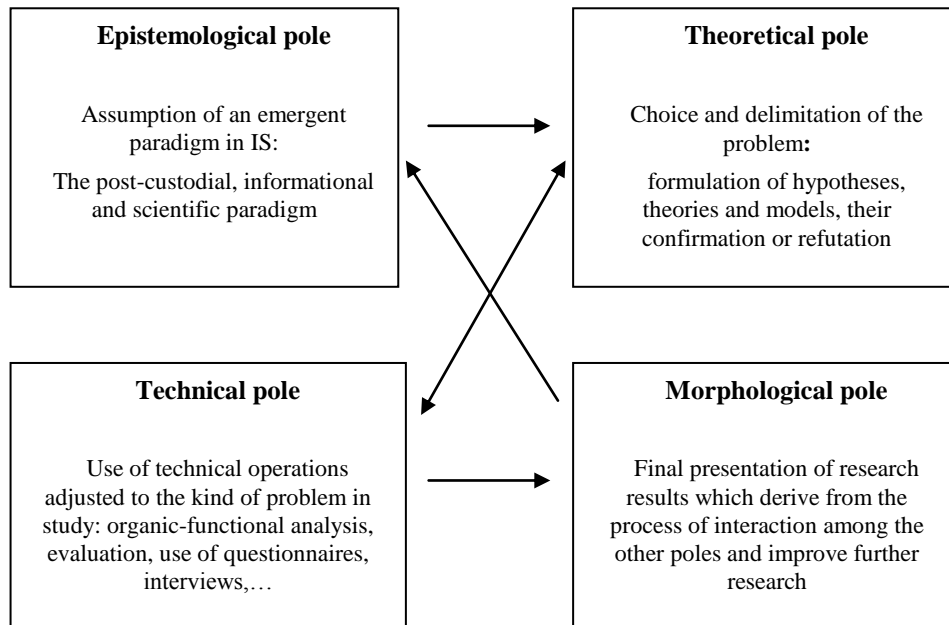| **Epistemological pole** Assumption of an emergent paradigm in IS: The post-custodial, informational and scientific paradigm	**Theoretical pole** Choice and delimitation of the problem: formulation of hypotheses, theories and models, their confirmation or refutation
Technical pole Use of technical operations adjusted to the kind of problem in study: organic-functional analysis, evaluation, use of questionnaires, interviews,…	**Morphological pole** Final presentation of research results which derive from the process of interaction among the other poles and improve further research

Figure 2. Quadripolar method of research: interactions between the four poles

The *epistemological pole* — the scientific community of archivists, their schools, institutes, working places, with their own political, ideological and cultural references — operates the permanent construction of the scientific object and the definition of the boundaries of the research problems. The discursive parameters are constantly reformulated, as are the paradigms and scientific criteria (objectivity, reliability and evaluation) which guide the whole research process. Empirical procedures and archival knowledge gradually substantiate this pole, which is by no means static but, on the contrary, must be subject to periodic reflection on the occurrence, or otherwise, of epistemological continuity or gaps.

The *theoretical pole* operates the rationality of the subject (who knows and approaches) over the object, as well as the postulation of laws, the formulation of hypotheses, theories and operational concepts and the consequent validation or refutation of the "theoretical context" elaborated.

On the *technical pole*, contact with objectified reality is operated through instrumental application, thus verifying the validation capacity of the methodological mechanism. It is here that crucial operations are developed, such as the study of cases and variables and retrospective and prospective evaluation, always keeping in mind the confirmation or refutation of the postulated laws or principles, the theories elaborated and the operational concepts formulated.

On the *morphological pole*, the results of the research carried out are formalized through the representation of the object of study and the description of the whole research process which enabled the scientific construction around it. It deals with the organization and presentation of data, objectively checked on the theoretical and the epistemological poles, which shows the interactive character of the quadripolar method of research.

In this quadripolar dynamic, the theoretical pole assumes particular relevance, because it supports the technical and instrumental component and gives meaning to the explanation of the results in the morphological pole. There are, naturally, different theories and models applied to the interpretation of the informational phenomenon/process, but we prefer the Systemic Theory, whose origins derive from Ludwig von Bertalanffy's studies, developed since the 1920s. This preference is based on the fact that Systemic Theory enables a holistic view and adjusts quite well to the complex and diffuse universe of Information (Mella, 1997).

This epistemological, theoretical and methodological foundation of IS, here briefly reviewed, is mirrored, obviously, in research projects, in educational and training models and in professional activities, developed in the most diverse organizational contexts and applies, obviously to interdisciplinary approaches with other scientific fields.

Some Contributions of Cognitive Psychology

During the last years Information Science, which is related with the production, conservation and communication of information, has changed in a way where the knowledge of the user's cognitive functioning is a priority. The development of both Information and cognitive sciences makes it possible to better understand, for instance, memory and linguistic human functioning and use this knowledge to create powerful information systems related with new information and documentation practical issues.

In order to access complex and numerous information sources the users must have not only some special knowledge but also some abilities, namely for reading, searching, assessing and treating information. Underlying those actions there are the cognitive processes traditionally studied by Cognitive Psychology.

The first steps in Cognitive Psychology were made in order to understand the human psychological functioning, namely the mental processes, aspects completely ignored by Behaviorism, a radically different perspective. However, two different ways of studying these aspects appeared: connectionism, addressing particularly the neural network and its states of equilibrium, and cognitivism (e.g. Ellis & Hunt, 1993). The concept of representation and the notion of process are fundamental in this last perspective. In fact, those mental representations are stable at a time, constituting our knowledge or they may be developed when necessary to a specific action. This is the way, for instance, that memory works updating and reconstructing knowledge as in the case of information seeking. Those representations have different forms and organization, namely declarative and procedural knowledge, schemata and so on.

The notion of process was inspired by computer functioning, meaning the treatment and transformation of information. Thus, human mental activity was supposed to work either with sequential, parallel or cascade treatment modalities having an automatic and/or controlled treatment of information. Studying the cognitive processing also meant to understand the processes involved in specific functions. This was the case of memory, reasoning and language which have been studied for a long time and are more and more well known. Memory is no longer seen as storage but as a dynamic system that detects and treats new information. Aspects as contexts and intentions are now being related with reasoning (e.g. Matlin, 1994). Language, although much studied, needs probably to be seen differently by Cognitive Psychology, once it is mostly seen as an instrument for representing the world, and not as a system of communication as it is seen by Information Science.

Cognitive Psychology has mainly studied processes like perception, memory structure and functioning and knowledge organization. Nowadays it is also concerned, in a different perspective than cognitivism alone, with interaction situations where information becomes significant for individuals.

Besides those core processes, Cognitive Psychology also studies learning, problem solving, decision making and the processes involved in information seeking. Learning is an important aspect of information processing characterized by the ability to adaptively change behavior. It is also the capacity to understand contingencies between events and actions, a process that facilitates causal reasoning and induction leading to the development of categorization which organizes our knowledge (Newell & Bröder, 2008). Learning is behind judgments and decision making as they depend on prior experience and on related information that can be useful in the future (Newell, Lagnado & Shanks, 2007). Cognitive learning theories view learning as an individual construction and emphasize the active transformation of information needed to achieve changes in individual knowledge structures and to create personal meaning. Knowing about those aspects brings some light about the concept of information literacy which is an enabler of learning (Markless, 2009). In fact, information literacy means to be able to process information and to reconstruct it meaningfully. It helps to identify whether the information found is relevant, an issue that is fundamental in the process of information searching (Saracevic, 2007), whether the source is authentic, and also to accept or reject the viewpoints encountered in various data sources. Although it mostly refers to individual processes, it is also related to social construction if attention is paid to the rapid expansion of collaborative learning, online learning communities and formal mechanisms for peer support.

Nowadays, the use of the Web as a channel of communication and as an important vehicle for information dissemination and retrieval has enlarged and improved information-seeking behavior (Nahl, 1998). However, seeking behavior studies, focused on traditional systems, are not able to provide sufficient information about users' interactions when searching the Web. They do not offer information about the different information needs, cognitive and affective characteristics and experience of individual users. Research on Web information searching is useful for examining behavior and actions but is not adequate for explaining the factors and processes that have led to that behavior (Martzoukou, 2005).

Another field of Cognitive Psychology is the study of emotions, important components of cognitive activity. Seen nowadays as generated by our cognitive evaluations of the environment, they are also important in the way they

interact with cognitive processing (e.g. Damásio, 1995). Studies that analyze, for instance, the relations between emotions and attention, memory and decision making either elicit by emotional stimuli or by individual emotional states. Obviously those emotional aspects are of great importance to Information Science, since information users are human beings processing information also emotionally. Information Science professionals are interested in knowing more about users' emotions, above all, about which emotions they should be concerned with. This is the case of knowing if the sources for information seeking and for decision making preferred by individuals affect their levels of satisfaction.

The developments of the humans' emotions knowledge underline most work on human-computer interaction that is currently being done. Although this area involves aspects like very technical issues, ergometrics, effectiveness and efficiency, it is also concerned with psychology and emotions particularly in many works in Information Science (Saracevic, 1995)

It is clear that users of technology products and interactive computing systems are no longer only interested in the product efficiency and effectiveness but that they are also looking for emotional satisfaction. Those emotional aspects are related with the trust in the service or product, the pleasure in the interactive experience, and the satisfaction with Web sites or products (Shih & Liu, 2008). Positive emotions create positive affect leading to better decisions, and increase intrinsic motivation in people engaged in the activities.

The way emotions have been reached in most research studies in this area includes the use of behavioral indicators of frustration like false starts and input errors. Most often researchers use: (1) questions to users after the event; (2) verbal self-report; (3) users' responses to questions about satisfaction; (4) grids with semantically different words; or (5) standardized measuring instruments (e.g. Brave & Nass, 2003). However, more recently, some researchers, in order to assess emotions in a more authentic way, analyze the non-verbal aspects of emotional communication, particularly facial expression, based on the classical work of Paul Ekman (e.g. 1993). Emotional expression is videotaped for later observation and classification of the facial activity and facial expressions allowing easier recognition of the difficulties users may be feeling (e.g. Cristescu, 2008; De Lera & Garreta-Domingo, 2007). All those efforts are to achieve to users' satisfaction with the purpose of minimizing frustration, annoyance, anger and confusion.

Cognitive sciences are still concerned with the understanding of cognitive processes and use several methods to reach that goal, including traditional psychological experiments, observations of cognitive processing in practical action, or simulating cognition in robots or programs. Research is also increasingly connected with neuroscience and thus with new techniques of brain imaging allowing better understanding of brain functioning. Moreover the use of other techniques, like eye-tracking, will help enlarge our knowledge about the cognitive interaction with the world, and the practical applications of cognitive sciences will allow the creation of interfaces to information technology more and more adapted to the demands of human cognition (Gärdenfors, 1999).

Final Remarks

The conception of IS that is being developed at the University of Porto (Portugal) makes strategic and indispensable the construction of interdisciplinary approaches with several human and social sciences. What has been described previously clarifies themes and issues that can and must be deepened with the important contribution of Cognitive Psychology, namely through research on users' informational behaviour and over the complex processes of post-custodial mediation (Silva, 2009). Thus, some promising fields of work have arisen, which have kept, in the meantime, a progressive interest and the attention of researchers involved in academic post-graduate programmes.

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