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NeuroIS: Neurophilosophical Approach

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ABSTRACT

Recent developments in neurosciences are being used in several fields such as economics, marketing and other social related sciences. Neurosciences are being used in different realms, from theoretical to philosophical, and it is creating new approaches to established fields. We believe that all social sciences should look at how the neurosciences could contribute to their field. We view Information Systems as a conjunction of a Technical System and a Social System, and therefore we think that there is the need to analyze whether the neurosciences can contribute to the field. We propose two different approaches of how neurosciences could contribute to the IS field. The first one analyzes parallelisms between Neuroeconomy and Information Systems, and the second one applies the Neurophilosophical Methodology in an attempt to ground Pragmatism's premises.

Keywords

Information Systems; Neurosciences; Neuroeconomics; Pragmatism; Neurophilosophy; Methodology

INTRODUCTION

Many social sciences are trying to use recent developments in neurosciences in order to contribute to their field. It is common to find the prefix neuro- in established fields as in Neuroeconomics, Neurophilosophy, Neuromarketing or Neuropsychology. We can find it almost everywhere, as in "Law and Neuroeconomics" (Chorvat et al. 2007), Neurotheology or Neurolinguistics. For example, with tools from the neurosciences such as fMRI or DTI and others (Camerer et al. 2005; Charron et al. 2008), neuroeconomists are trying to contribute to economic theory. In (Glimcher et al. 2005): "*There is, however, growing evidence that economists and neurobiologists are now beginning to reveal the physical mechanisms by which the human neuroarchitecture accomplishes decision making. Although in their infancy, these studies suggest both a single unified framework for understanding human decision-making and a methodology for constraining the scope and structure of economic theory. Indeed, there is already evidence that these studies place mathematical constraints on existing economic models*". It is true that not everybody in economics agrees with the usefulness of this approach. Neuroeconomics is even labeled as "academic marketing hype"; it has potential, but there is still work to do (Harrison 2008).

Neuroscience explanations have some kind of "seductive allure" (Weisberg et al. 2008). In a very interesting experiment they presented some explanations of psychological phenomena to 3 groups of people (non experts, students and experts). They concluded that for the two non-expert groups, explanations with logically irrelevant neuroscience information were more satisfying than explanations without.

Being aware of the above, this paper tries to contribute in the development of NeuroIS. Firstly, we will review the literature of NeuroIS and check previous work developed in (Dimoka et al. 2007; Dimoka and Davis 2008; Riedl and Roithmayr 2007b). Secondly we will use the methodological tools from Neurophilosophy to attempt to give ground to pragmatism philosophy for IS.

A short introduction of every field is given: we will begin with a sketch of neurosciences and their available tools. Then a review of the current state of NeuroIS, followed by a longer section about Neurophilosophy, composed of an introduction and a methodology. Afterwards we will comprise our view of the information systems as a field. Special emphasis will have the characterization of Pragmatism as a philosophical approach to IS: we will use it in the example.

The Discussion section is devoted to propose another approach of how neurosciences could contribute to the Information Systems field, through an exercise of trying to ground the pragmatist's philosophical assumptions using a neurophilosophical methodology. We close the paper with some main conclusions and proposed future work in the NeuroIS field.

NEUROSCIENCES

Neuroscience is a field devoted to the scientific study of the nervous system. Such studies span the structure, function, evolutionary history, development, genetics, biochemistry, physiology, pharmacology, informatics, computational neuroscience and pathology of the nervous system. Traditionally it is seen as a branch of biological sciences. However, recently there has been a surge in the convergence of interest from many allied disciplines, including cognitive and neuro-psychology, computer science, statistics, physics, philosophy, and medicine. The scope of neuroscience has recently

broadened to include any systematic scientific experimental and theoretical investigation of the central and peripheral nervous system of biological organisms. The empirical methodologies employed by neuroscientists have been enormously expanded, from biochemical and genetic analysis of dynamics of individual nerve cells and their molecular constituents to imaging representations of perceptual and motor tasks in the brain. The main categories within neurosciences are (adapted from Wikipedia):

- Molecular Neuroscience
- Cellular Neuroscience
- Developmental Neuroscience
- Neuroanatomy
- Computational Neuroscience
- Sensory Neuroscience / Perception
- Behavioral Neuroscience / Psychology
- Neurology

There is no room in this paper for an extended review of the field, but we will just mention the main techniques used in Behavioral Neurosciences, which are the empirical basis of NeuroIS. This list is based on (Camerer et al. 2005): brain imaging (common techniques being EEG, PET and fMRI), single-neuron measurement, Electrical Brain Stimulation (EBS), psychopathology and brain damage in humans, psychophysical measurement and Diffusion Tensor Imaging (DTI).

One of the most common criticisms is that nowadays those techniques only provide the information of where things happen in the brain. Considering that the long-run goal of neuroscience is to provide more than a map of the mind, mixing information from different techniques scientists are obtaining some understanding of how the brain solves different types of problems.

To conclude this brief introduction, we should remark some terminology issues that could lead to confusion. According to the Stanford Encyclopedia of Philosophy, Philosophy of Neuroscience concerns foundational issues within the neurosciences and Neurophilosophy concerns application of neuroscientific concepts to traditional philosophical questions (Bickle et al. 2006). More detail is given in the section dedicated to Neurophilosophy below.

NEUROIS

The literature about the intersection between Neurosciences and Information Systems is scarce. In (Dimoka et al. 2007) the potential of cognitive neuroscience for IS Research is introduced, and a literature review proposed. Since then, we have the work from the same authors (Dimoka and Davis 2008), where they try to materialize that potential demonstrating how functional neuroimaging tools can enhance our understanding of IS theories through a concrete example. With the same approach we find the works of Riedl as well (Riedl and Roithmayr 2007b; Riedl 2008; Riedl and Roithmayr 2007a).

Their approach to NeuroIS is the same we can find in more 'established' fields as Neuroeconomics or Neuromarketing. For example, Neuroeconomics is an interdisciplinary research program with the goal of building a biological model of decision-making in economic environments (McCabe 2002). We think that contributions from NeuroIS can be, as in the case of Neuroeconomics, incremental (adding variables to conventional accounts of decision making or suggesting specific functional forms to replace assumptions not supported empirically) and radical (asking how the field might have evolved differently if informed from the starts by neurosciences) (Camerer et al. 2005). In (Dimoka et al. 2007) is proposed "IS researchers can use functional neuroimaging tools to inform IS phenomena, offering the following set of opportunities for cognitive neuroscience to inform IS research:

(1) Localize the neural correlates of IS constructs to better understand their nature and dimensionality;

(2) Complement existing sources of IS data with objective brain data that are not subject to measurement biases;

(3) Capture hidden (automatic) processes that are difficult to measure with existing measurement methods;

(4) Identify antecedents of IS constructs by showing how IT stimuli (e.g., designs, systems) spawn brain activation;

(5) Test the outcomes of IS constructs by showing how brain activation predicts decisions, choices, and behavior;

(6) Infer causality among IS constructs by examining the timing of brain activations due to a common stimulus;

(7) Challenge existing IS assumptions and enhance IS theories that do not correspond to the brain's functionality;"

Neuroeconomics is a relatively new field, but NeuroIS is even newer. Reviewing the argumentation around Neuroeconomics can help us understand the challenges NeuroIS will have to face:

- According to (Harrison 2008), there is too much of a marketing hype around neuroeconomics. Although in the future could be a valuable field, right now it is being sold as the work has been done already.
- According to (Ross 2008), nowadays neuroeconomics is not more than behavioral economics in the scanner. The methodology is naively reductionist, and does not consider that economics can model abstract aspects of the target phenomena instead of fully ecologically situated facsimiles of them.
- Finally, according to (Stanton 2008), neuroeconomics is very young and it is not trying to substitute standard economics. Both evaluate two sides of the same coin. Neuroeconomics studies each individual choice, and standard economics looks at the average of the outputs of many individuals (and proposes how the human chooses).

In our opinion this approach to the NeuroIS has many possibilities to evolve, and it is well explained in the works referenced in this section. Nevertheless, we think that there is more room where NeuroIS can contribute. In the following sections we try to show a contribution in the field of the philosophy of science of IS, but first we will introduce the field of Neurophilosophy.

NEUROPHILOSOPHY

Introduction

Neurophilosophy is the interdisciplinary study of neuroscience and philosophy. Churchland named it first in her book (Churchland 1986), but there are many examples of similar concepts before (Popper and Eccles 1984). Northoff gives a small classification of the field (Northoff 2004b):

- "Phenomenal or Cognitive Neurophilosophy" and "Empirical Neurophilosophy" as "Neuroscience of Philosophy". It matches with the definition found in (Bickle et al. 2006) for Neurophilosophy, where it is said that "*concerns application of neuroscientific concepts to traditional philosophical questions".*
- "Theoretical Neurophilosophy" as the "Philosophy of Neurosciences" and "Philosophy of Neurophilosophy".

As the base of this paper, we will focus on the latter. According to (Northoff 2004b): "*Philosophy of Neurophilosophy focuses predominantly on the development of a definition and methodological principles and strategies for linkage between philosophical theory and neuroscientific hypothesis*". The summary of his methodology has been taken from (Lerma and Miralles 2008), and is completely based on (Northoff 2004a). Because of the length of this paper we will only focus on the methodology part, with the objective of applying it later on the Discussion section.

Methodology

One of the most important issues to consider before the explanation of the methodology is the asymmetry between logical conditions from philosophy and natural conditions from neurosciences, and how the Neurophilosophical Methodology cops with it. Logical conditions refer to all logically conceivable worlds, both natural and non-natural. But natural conditions only refer to the natural world, and therefore to the physical and biological laws. We will review next the two main aspects of this approach, the transdisciplinary methodology and the Neurophilosophical Hypothesys:

Transdisciplinary Methodology

Transdisciplinary implies the systematic linkage between philosophical theories and neuroscientific hypothesis. The important thing is to be able to link both worlds. Northoff (2004) defines three principles: principle of asymmetry, principle of bidirectionality and principle of transdisciplinary circularity.

- The Principle of Asymmetry informs about the asymmetry between the logical and natural world. Logical and natural conditions are asymmetrical because the former includes the latter, but the latter does not include de former.
- The Principle of Bidirectionality "*consists in the necessity of bi-directional linkage between philosophical theories and neuroscientific hypotheses and thus between logical and natural conditions*".
- The Principle of Transdisciplinary circularity *"describes systematic processes of oscillation and circulation between philosophical theory and neuroscientific hypothesis, with the consecutive development of Neurophilosophical hypothesis".*

Characterization of the Neurophilosophical Hypothesis

The Neurophilosophical Hypothesys is defined as an assumption about the linkage between philosophical theory and neuroscientific hypothesis (Northoff 2004b). Obviously, this linkage has to follow the methodological principles of transdisciplinary methodology, described above. This gives a systematic relation, rather than an intuitive one.

Since a Neurophilosophical Hypothesis can be defined by systematic linkage between philosophical theory and neuroscientific hypothesis, it remains open for three distinct types of falsifications: logical falsification (gives 'logical consistency' as means for 'internal validation'), empirical falsification (gives 'empirical consistency' as a means for 'external validation') and transdisciplinary falsification (gives 'link consistency' as a means for 'cross-disciplinary validation') (Northoff 2004b). The last one focuses on how the neuroscientific hypotheses and philosophical theories are linked with each other. As we have seen, there is link consistency if the linkage is in full accordance with the principles in transdisciplinary methodology.

In the same way, interaction between ontological/epistemological assumptions and empirical hypotheses should be investigated within philosophical theory and neuroscientific hypotheses. We should add ontological/epistemological assumptions to empirical hypotheses in order to be able to include logical falsification to check for logical consistency. The opposite way around occurs with philosophical theories: there is the need to add empirical hypotheses, in order to be able to apply empirical falsification. It is important to note that Neurophilosophical hypotheses do not predetermine and predefine the terms as in philosophical theories: the definition itself could be changed depending on empirical grounds which may lead to so called "definitorial shifting" (Northoff 2004b).

At last, we will define both "conceptual clarification" and "conceptual re-clarification": "Conceptual clarification" focuses on explication of implicit presuppositions and definitions in terms and theories, which are then subjected to logical and/or linguistic analysis. In contrast, Neurophilosophical Hypotheses focus on implicit empirical hypotheses in philosophical theories. The adjustment between philosophical theory and empirical hypothesis requires conceptual clarification, logical analysis and linguistic analysis. Therefore, "conceptual re-clarification" stands for the modification of both definitions and concepts consecutively. At the same time, conceptual re-clarification is used to evaluate link consistency, as a test for systematic interaction between philosophical theory and empirical hypothesis. Thus, Neurophilosophical Hypotheses have the possibility of transdisciplinary falsification, through conceptual re-clarification and with consecutive investigation of link consistency. In order to clarify the concepts shown in this section, we propose the following Table 1 as a summary:

Neuroscience of Philosophy	- Phenomenal or Cognitive and Empirical Neurophilosophy - Application of neuroscientific concepts to traditional philosophical questions
Philosophy of Neurosciences and Philosophy of Neurophilosophy	- Theoretical Neurophilosophy - Focuses on the development of a definition and methodological principles and strategies for linkage between philosophical theory and neuroscientific hypothesis
Transdisciplinary Methodology	Systematic linkage between two fields (philosophical theories and neuroscientific hypotheses)
Principle of Assymetry	Informs about the asymmetry between the logical and natural worlds
Principle of Bidirectionality	Informs about the need of bi-directional linkage between the logical and natural worlds
Principle of Transdisciplinar Circularity	Describes systematic processes of oscillation and circulation between philosophical theory and neuroscientific hypothesis, with the consecutive development of Neurophilosophical hypothesis
Neurophilosophycal Hypothesis	Assumption about the linkage between philosophical theory and neuroscientific hypothesis
Logical Falsification	Gives 'logical consistency' as means for 'internal validation'
Empirical Falsification	Gives 'empirical consistency' as a means for 'external validation'
Transdisciplinar Falsification	Gives 'link consistency' as a means for 'cross-disciplinary validation'
Definitorial Shifting	Philosophical Theories predetermine and predefine the terms, but in Neurophilosophical Hypotheses definitions could be redefined based on empirical grounds.

Conceptual re-clarification	Required for the adjustment between philosophical theories and empirical hypotheses. Stands for the modification of both definitions and concepts consecutively

Table 1. Neurophilosophical Concepts

INFORMATION SYSTEMS

What is Information System for us? We view Information Systems as a conjunction of a Technical System (information technology) and a Social System (the organization, humans). There are information requirements the Social System poses to the Technical System, and organization requirements the Technical System poses to the Social System. Therefore, an Information System (IS) is the system that emerges from the mutually transformational interactions between the information technology and the organization (Lee 2004).

Furthermore, Information Systems is both a practical and an academic practice, which has some first reference disciplines, as Computer Science, Management Science, Organization Science, Cognitive Science and Economics; and then some other second reference ones as Sociology, Information Science, Linguistics, Anthropology, Ergonomics and Systems Science (Khazanchi and Munkvold 2000).

In this research-in-progress paper there is no space to review the problems the Information Systems are facing as a field, neither to give a complete review of the main philosophical approaches to IS research. What it is relevant for our purposes is that scholars are demanding more papers on the philosophy of Information Systems (Benbasat and Zmud 2003; Mingers and Willcocks 2004). This paper focuses only on the theoretical and philosophical part.

Additionally, it is a common complain that the field has much larger amount of papers based on the positivistic view, and that there is the need to explore more (Mingers 2004) since three out of four are positivistic (Orlikowski and Baroudi 1991; Peffers and Ya 2003; Chen and Hirschheim 2004; Pratt et al. 2005).

Our paper approaches information systems from the Pragmatic and Action-Oriented perspective. The next section is devoted to explain de pragmatic and action-oriented perspective.

Pragmatism and the action manifesto

The first approach to pragmatism is through its ontology and epistemology. In the pragmatist ontology there is an objective external reality as in positivism, but it is grounded on the environment and experience of each individual and can be only imperfectly understood, as in antipositivism. The choice of one version of reality or another is governed by how well that choice results in anticipated or desired outcomes (Goles and Hirschheim 2000).

According to pragmatists, knowledge acquisition is done in a continuous way, and in every moment of the process the researcher can choose the best method: i.e. in some cases knowledge can be treated as objective and acquirable and use methods from positivism, and some other cases knowledge can be treated as relative and too complex to be 'known' and use methods from antipositivism. That is why Pragmatism is seen as the alternative to end with the positivism and antipositivism wars (Goles and Hirschheim 2000).

Nevertheless, we need to further characterize Pragmatism for IS Research. On (Goldkuhl 2004), *"Meanings of Pragmatism: Ways to conduct information systems research"*, pragmatism means:

- an interest for actions
- an interest for actions in their practice of context
- an acknowledgment of action permeation on knowledge
- an interest for practical consequences of knowledge
- an interest in what works and what does not work
- an acknowledgement of the full dialectics between knowledge and action: proper action is knowledgeable action and knowledge is actable knowledge

The paper closes with the action manifesto that can be seen in Figure 1, which *"in very condensed form espouses the fundamental views of action significance"* (Goldkuhl 2004).

Action manifesto
❖ A human life is a life in activity ❖ A human acts continually and accomplishes changes – differences – in her environment and/or to herself ❖ A human's doings permeates her thinking, conceptualisation and language use ❖ Our continual action is so natural and evident to us, that we tend to take it for granted and thus do not always recognize how thoroughly our consciousness is influenced by our actions ❖ The human consciousness is a practical consciousness in constant interplay with intervening, inquiring and evaluating actions ❖ Experiences from own earlier actions and socially mediated action experiences form the practical consciousness ❖ Collective conceptions, valuations and categories – linguistically expressed and mediated – serve the active life of humans

Figure 1. Action Manifesto (Goldkuhl 2004)

To close this section, we would like to mention that Technical Systems from the pragmatic and action-oriented perspective are not viewed as "container of facts" or "instruments for information transmission". They are viewed as communication systems; there is an emphasis on what users do while communicating. "*The IS*[1] *is used as an action medium for the user to perform actions. […] Their special character is that they are formalized sign systems and as such are used for human communication*" (Goldkuhl and Agerfalk 2002). One of the reasons to choose pragmatism is because of its emphasis in the human being.

DISCUSSION

So far we have been reviewing Neurosciences, NeuroIS and Neurophilosophy. Afterwards a small review about Information Systems and Pragmatism has been given. In this section we would like to offer a different approach of how neurosciences could try to contribute to the Information Systems field. This approach is based on the philosophy of science of IS. We try to ground the pragmatism paradigm through the use of the Neurophilosophical methodology.

The fundamental views of action significance presented in Figure 1 are philosophical theories in terms of ontological/epistemological assumptions, based on how humans know and act (both individually and socially). Therefore, if we understand Neurophilosophy as the application of neuroscientific concepts to philosophical questions, we can treat these fundamental views as Neurophilosophical Hypotheses.

Applying the neurophilosophical methodology, we could imply the following set of possible advantages (see Figure 2 as well):

- We can apply three falsification processes to every fundamental view, thus making them more reliable than before.
- We can take approach of the 'definitorial shifting' and 'conceptual re-clarification' circles, in order to improve the statements of the action manifesto.
- The knowledge or experience obtained through the process could be used in a practical or theoretical realm, as we have seen before.

[1] We would use ICT instead of IS here.

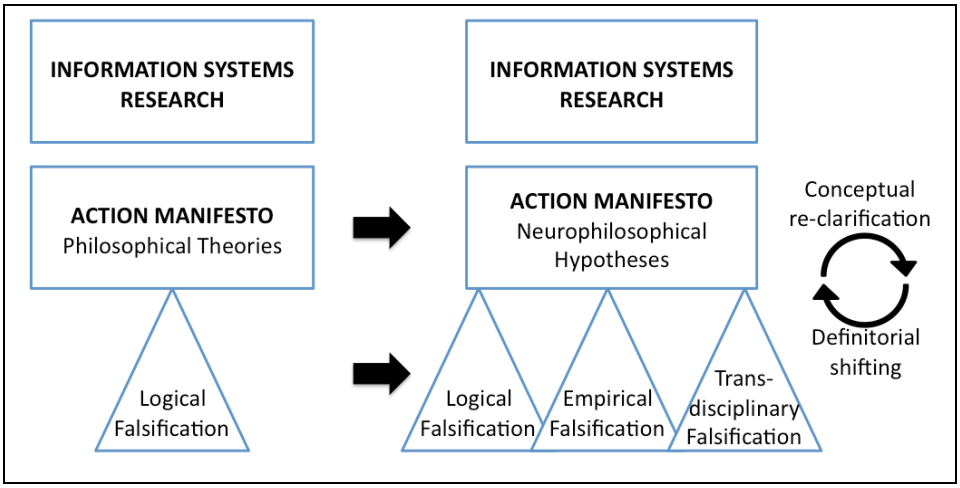

Figure 2. From Philosophical Theories to Neurophilosophical Hypotheses

Therefore, we suggest that philosophical assumptions converted to Neurophilosophical Hypotheses and showed to be consistent, are better grounded than the ones that are not.

We have chosen the following fundamental view from Figure 1 in order to build an example: *"A human acts continually and accomplishes changes – differences – in her environment and/or to herself."*

Our interpretation of this fundamental view is that the human being evolves. While acting the human being has a new experience, learns something new, which makes a different person. This different person will have these changes 'inside' while acting next time (it could yield to different behavior/ thoughts or not). So, this is our first "philosophical theory". What does the methodology say now? "…*there is the need to add empirical hypotheses, in order to be able to apply empirical falsification*" (Northoff 2004b).

Now we should be able to propose a neuroscientific hypothesis. With this hypothesis we could design an experiment, and check if the results of the experiment support the premises of the hypothesis. This part of the process is out of the scope of this paper. Another possibility is to benefit from experiments already done. In this case, we are using some examples taken from neuroeconomics. We find some useful experiments in (Camerer et al. 2005): we will check the "Tetris experiment" (Haier et al. 1992). We have found this experiment related to another application on the previously mentioned (Riedl and Roithmayr 2007b). In Figure 3 we can see regions of brain activation, first of a player with no previous experience on the left and second of the same player after several weeks of practice.

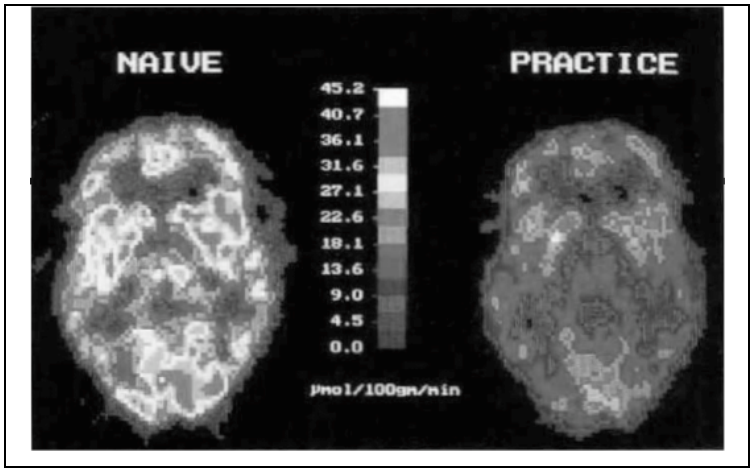

Figure 3. Regions of brain activation when first playing Tetris (left) and after several weeks of practice (right) (Haier et al. 1992)

The experiment suggests that when the brain faces a new problem, it uses many different regions. With practice, i.e. through action, activity moves to more specialized regions of the brain, and the task is done more efficiently than at the beginning: "*it seems that the brain shifts processing towards brain regions and specialized systems that can solve problems automatically and efficiently with low effort*" (Camerer et al. 2005). It has not been understood yet how is this process possible, but the empirical fact is that the brain is modified through training.

There are similar examples in the same paper by Camerer (2005) that suggest the same conclusion about the plasticity of the brain:

- Chess players (Gobet and Simon 1996): expert players can store game positions instantly, but only if they were in positions corresponding to a plausible game.
- Stock Exchange Traders (Lo and Repin 2002): the emotional answer of experienced traders is much lower than novices.
- London Taxi Drivers (Maguire et al. 2000): the hippocampus (brain region responsible for navigation and spatial memory) of London taxi drivers is larger than comparable areas in non-taxi drivers.

We are going to review again the Neurophilosophical Methodology in order to check whether we have a proper Neurophilosophical Hypothesis or not. We have defined it as the assumption about the systematic linkage between philosophical theory and neuroscientific hypothesis, and in the example above we have proposed such a linkage. As said in the review, this new hypotheses must be distinguished from a philosophical theory and from a neuroscientific hypothesis. It has both realms, philosophical and empirical, logical and natural, comprised in it. Mutual adjustments between empirical hypothesis and philosophical theory are required, through logical and linguistic analysis and conceptual re-clarification. Conceptual re-clarification may allow for investigation of link consistency, as a test for this systematic interaction.

So, to conclude this section, we should be able to test for link consistency: falsification of the unit of neurophilosophical significance should aim predominantly at the linkage between natural and logical conditions. This means that we have to test logical consistency of natural conditions and empirical consistency of logical conditions. According to (Northoff 2004a) we should apply empirical and logical experiments in a novel way.

CONCLUSIONS AND FUTURE WORK

This paper has stated that if some other social sciences are already using the recent developments in neurosciences, IS should try to do the same. Afterwards we have reviewed one realm where NeuroIS is already taking place, and we have proposed another realm where it can be applied. In the first one researchers make use of functional neuroimaging tools to enhance our understanding of IS theories. In the second one we base our work on neurophilosophical methodology in order to ground the fundamental views of action significance of pragmatism (Goldkuhl 2004).

We think that nowadays the neurosciences have enough knowledge and tools to start contributing with valuable insights to the Information Systems fields, and that it could be done in different realms: philosophy of science, research, design and practice.

Even though it hasn't been the main focus of this paper, we think that the main contributions in the future will be in research, as the works reviewed in the NeuroIS are showing. We think that their evolution will have many parallelisms with neuroeconomics or neuromarketing. Nevertheless, we propose a new approach to what is being done in NeuroIS, working in the philosophical realm in order to give coherence to the NeuroIS field. Furthermore, our approach is expected to add more elements in order to use pragmatism as a philosophical approach in the IS field.

As of future work, in first place we propose to continue with the rest of the action manifesto. Furthermore, using this methodology the fundamental views of action significance could be improved giving more insight. In second place, in the same realm of philosophy of IS, we propose to extend the work to the rest of the philosophical paradigms.

It is too soon to tell about the usefulness of these tools, although they seem to be very promising. If Neuroeconomics is in its infancy (Camerer et al. 2005), NeuroIS is still in its conception stage.

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