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Social Representation of the Universe- A Study with Doctors in Human and Natural Sciences

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The present study brings together social psychology and physics in an attempt to contribute to the debate on social representations in science. The socio-psychological approach - equiped with social representation theory (Moscovici,1976,1981) - aims at further understanding of how scientific theories are received by audiences with different levels of knowledge on the subject, when such theories bring new informational elements which put in check previously established knowledge. The descriptions of macro and micro universe phenomena by the theories of physics are inspiring objects to the study of the genesis of social representations, particularly when we take into account the compatibility existing between Newtonian theory and lays perceptions of reality one an hand and the incompatibility between our daily perceptions and the reality as revealed by quantum theory on the other.

Social representations and science

We start from the supposition that scientific theories, as much as beliefs of all types, are representational. Though scientific knowledge traditionally makes use of a more formalised language and uses stricter definitions to build up its systems of axioms and logical sentences than common-sense knowledge, both involve representations.

So far as the social sharing of scientific knowledge is concerned, the media has had an important role in translating the more complex concepts and representations to the general public, with higher or lower fidelity, in relation to the original theories.

The general public, for its part, transforms this vulgarised knowledge into social representations, capable of being understood by members of the group that composes this public. Social interaction as much as communication through the media promotes the transformation of non-familiar contents into familiar ones.

Moscovici (1993) regards scientific theories as privileged sources of social representations, since their new ideas and conceptual framework, when widely spread, provoke at the beginning a feeling of non-familiarity which has to be worked on. When these theories are popularised they are often mystified. Moscovici argues that during this transition from science to common sense, a particular type of social representation called "scientific myth" comes into existence and its main function is to transform the content of scientific theories into something which is capable of being assimilated by the general public. The popularizers of science are the creators of myths in our modern times.

It is important to recognize the fact that when we talk about science, we often dissociate the knowledge produced from the people who actually produce it, as if the content of any knowledge could be conceived independently from the group processes which give the basis to its production. Also, the different groups of scientists do not seem to think of science in a homogeneous way, so that there seem to exist many conceptions of science. Furthermore, the existing groups of scientists seem to be submitted to the same pressures as the groups which we - social psychologists - observe.

The high specialization of knowledge, in increasingly restricted sub-areas in terms of their objects, creates a very interesting condition for scientists and intellectuals, because at the same time that they are included as members of groups of "experts" (in their area of knowledge) they are, simultaneously, excluded from other areas of expertise and consequently excluded from the shared knowledge of other specialists. Thus, they will behave as laymen, largely ignoring relevant scientific topics. This manner of reasoning leads us to think that when re-interpreting a theory from a different scientific tradition and discipline, the non-familiar material will be apprehended with some kind of simplification and distortion, even by scientists.

This reasoning is particularly important when we consider that in our modern societies, also seen as risky societies, we have to trust science and its system of experts to advise us on how to deal with such risks. The technological advances during this century, together with the facilities in possibilities of communication, have changed the relationships between time and space so that simultaneity and instantaneousness become very salient concepts. During this century, significant changes within the basic conceptions of the theories of physics have also taken place, and here lie our actual interests.

Representations of the universe

In the literature on epistemology and sociology of science, the discussions on representations of the universe are well established (Adam,1992, Coveney and Highfield,1993, Bohm, 1980, Capra, 1983,1996, Zohar, 1991, Lenoble, 1969).

The discussion, among other things, reports on the exclusion, by XVIIth century physics theories, of men and women from the studied universe. They become observers, that objectively describe the elements of the universe and its performance in space and time.

The image of the world as a perfect machine, introduced by Descartes and implemented by the mechanist conception of nature of Isaac Newton, puts forward a representation of the world as a "big clock". Concepts such as an absolute space (an empty recipient) and an absolute time (with no links to the material world) were considered as the basic hard and solid

elements of matter, God being responsible for the perfect functioning of the gigantic cosmic machine which was seen as determined by causal principles (Capra, 1983).

Both the discoveries of evolution in biology and the second law of thermo-dynamics, which states that there is a tendency for energy dissipation (suggesting the irreversibility of time), challenged the representation of the world as a "big clock". As it is stressed by Adam(1992), *"the awareness of an arrow of time, of things and processes being irreversible and transient, thus constitutes a central component of 19^{tth} century knowledge. The heat engine is the prime metaphor of the industrial age"*(pp. 183).

The author recognizes that presently, within the natural sciences, there are several attempts of rejection towards Newtonian assumptions, since increasing numbers of biologists are working with non-causal network models, and there is an increasing awareness of the need to represent diversity and plurality, rejecting a master narrative and the principle of causality.

One example of such a challenge to the two above-mentioned representations of the universe is the quantum theory.

At the beginning of this century, physicists such as Max Plank, Einstein, Bohr, De Broglie, Schrodinger, Pauli, Heisenberg and Dirac, whose efforts allowed the formulation of the quantum theory, had their visions of the world challenged when they tried to make sense of the new discoveries about the atomic and sub-atomic world. Quantum physics pictured a universe, on a micro scale, which seemed to be chaotic, always in movement and unpredictable, and which contradicted predictions compatible with our daily perceptions.

Zohar (1991) recalls Einstein when he said that quantum theory reminded him of "the system of delusions of an exceedingly intelligent paranoic, concocted with incoherent elements of thought"(page 8). Zohar argues that the new physics is so new that quantum physicists themselves have not fully come to terms with the conceptual changes it demands, taking refuge instead in the less demanding language of mathematics. Yet, she considers that it is in forging a new conceptual structure for the new physics that the real cultural challenge of modern science lies.

We recognize that old intellectual habits, and a widely spread conceptual framework such as the Newtonian categories of space, time and causality, are so deeply ingrained in our whole perception of reality that they are implicit in every aspect of our thinking. Thus, for example, how can we accept the idea that there is no space between separate objects and that the whole notion of "separate" has no foundation in reality? How can we abandon the idea that one thing causes another to happen? All these considerations put us into a state of strangeness, followed by an attempt to deal with them in some familiar way. The theory of social representations may contribute in this case to the investigation of the process of familiarization with the unknown.

Within the new physics, the basic notions of *being, movement* and *relationship* are very important, and they have been used as the main topics of the present study.

Being. The description of wave/particle duality is one of the most important statements of quantum physics about the nature of matter, and about being.

The theory of quantum physics asserts that all existance at the subatomic level can be described equally well either as solid particles or as waves. Further, neither description is accurate on its own, so that quantum "stuff" is both wave-like and particle-like, simultaneously.

The principle of complementarity, which is an important tenet of quantum theory, states that each way of describing existence, as a wave or as a particle, complements the other, and that the whole picture emerges as a block. Furthemore, there is interaction between the wave/particle presentation and the observed.

Such a conception evokes an elusive representation of matter, distinct from our everyday notion which is compatible with the principles of Newtonian physics. The latter assumes that entities consist of basic particles (atoms), solid and separate, which occupy their own definite place in space and time.

Movement. In classical physics, movement is a concept which is familiar to us in our everyday perception. Objects can travel from point A to point B. Nevertheless, at the quantum level of reality, the whole picture of continuous movement changes. As a physicist puts it, it is a physics of “lumps” and “jumps”.

As pointed out by Heisenberg, there is no possibility of predicting the movement of a particle. When an electron makes a transition from one energy state to another within the atom, it does so in a completely random and spontaneous way. Suddenly, and without any cause, a previously-quiet atom may fall into chaos, as its electrons may change from a higher energy state to a lower one or from a lower energy state to a higher one. Things can happen in both directions, and this is what is called “time reversibility at the quantum level”. And it can get worse still, because things can happen simultaneously in every direction at once.

Relationship.Quantum physics contributes to the transformation of our current notions about relationship. The two previous notions - of being as an inderterminate wave/particle duality, and of the unpredictable movement of the particles - lead us to a different perception of how things relate.

Quantum theorists see things and events, once conceived of as separate, as being so integrally linked that they seem to abandon the previous reality of separate space and time proposed by the classical theory. From this new perspective, particles behave as multiple aspects of some larger whole. It is as if things were always in touch with other things. This non-locality, which can assume mystical overtones, goes against the principles of common sense and of the classical physics.

Einstein considered the idea of instantaneous influence or synchronism as ghostly and absurd and created a “gedanken experiment” or “thought experiment”, which was later called the “E.P.R. Paradox”. The purpose of such experiment was to show a contradiction in the supposed existence of non-local influences. The E.P.R. Experiment has served as an inspirational element for the methodology to be detailed.

Summarizing, Einstein, in his thought experiment, proposed a method of putting two eletrons into a state in which their total “spin” was zero and in which the twin particles were separated by large distances. Their “spins” were always opposite and the observer could always choose the axes and the moment of measuring. Einstein put forward the idea that whatever happened to particle number 1, the same should also happen to particle number 2. So, the contradiction could be stated in the following manner: how could particle number 2 “know” about particle number 1's movement changes in trajectory, under conditions of large distances existing between them, in which there was no time for communicating such changes? If the changes in movements of both particles were synchronic, such a fact would contradict the principle of causality, that is, that the changes in 1 would cause changes in 2.

This paradoxical idea, which was discussed as an exercise or as a “thought experiment”, was later put into practice by real experiments, which have been carried out many times, using pairs of correlated photons. The startling result shows that non-local influences, in the binding of the particles’ “behaviours” or “life styles”, have been proven. Thus, the twin particles behave as if there were no space between them, or as if they “knew” of each others’ movements.

The three notions of being, movement, relationship (above described) and the E.P.R. experiment, provided us with favourable instruments to investigate the anchorage of new

concepts and phenomena, which can be taken as examples of conditions in which the genesis of social representations takes place. We were particularly interested in observing how the different representations of the universe proposed by the classical and quantum theories are considered by members of different professional groups and how these Ss attempt to make sense of a new and non-familiar reality.

Based on the previous reflexions, a study was designed a to establish the social representations of the universe as shared by professional experts in the areas of human and natural sciences. The expectations were that the informational level respective to the topic would differ from one group of Ss to the other and that the different groups, due to their specialized knowledge, would also display distinct structural fields of representations when communicating their conceptions about the macro and micro universe.

Method

Subjects

Academics from different scientific traditions (human and natural sciences) participated in the study, since it was assumed that the anchoring and objectification of the new knowledge would be necessarily embedded in their previous traditions. Seventeen were doctors in the area of human sciences (10 male and 7 female). Fourteen were doctors in the area of natural sciences (7 female, 7 male). Twenty secondary-school students (10 female, 10 male), also participated of the study.

Ph.D. subjects' ages varied between 37 and 50. Human sciences doctors and natural sciences doctors had experienced a different curriculum at the secondary school level as result of the educational policy of their time. There was then a division between classical studies and scientific studies, the former option being made by students aiming at humanities and social sciences university courses and the later being chosen by students aiming at natural sciences, engineering and more technical degrees. Thus, doctors in human sciences did not take physics as an obligatory subject on the secondary course, while natural sciences doctors did, though at that time only an introduction to classical physics was conveyed.

This educational streaming has changed in the recent past of the Brazilian secondary school national curriculum. Thus, presently, all secondary school students follow the same single curriculum which includes basic notions of physics, biology and chemistry.

Thus, the 3 chosen groups differed in terms of their level of information on classical and modern physics. Taking this into account, a text was produced, centred on the notions of being, movement and relationship, as an attempt to expose all Ss, independently of their previous knowledge, to the same information.

Instruments and Procedure

A short text was produced respective to the approaches of classical physics and modern physics, introducing their singular representations of the universe. The three phenomena of wave/particle duality, the movement of spins, and the synchronic movement of twin particles were described, and also the E.P.R. experiment imagined by Einstein. The text was produced for a lay audience with no information on the topic, although they were capable of mastering a scientific language. The original concepts were maintained and the level of explanation was aimed at maximum simplification while avoiding distortions of the described phenomena .

A Ph. D. in physics, specialized in the teaching of physics in secondary school, analysed the text quality.

A team of tecnicians, specialized in video-clips with computerized animations, produced a video of 7 minutes whose animations followed the descriptions in the text, read by mylsef.

The following steps were adopted for each individual subject. Firstly, the S received the 3-page text and was instructed to read it once to recognize its content. Secondly, the video was shown, with the same text being read in the background, and related to visual representations of the 3 phenomena (wave/particle duality, spin movement and twin particles, and E.P.R. experiment). At the end of the video, it was stressed that the 3 above-mentioned phenomena, studied by quantum physics, disconfirm certain aspects of reality as we perceive it in daily life, such as the solid aspect of material objects, the stability of stationary objects, and the notion of cause and effect.

After, Ss were asked about the impact of the 3 phenomena on their perception of the universe and daily life. They were also asked about their conception of the universe

Treatment and Analysis of Data

The interview material was transcribed and organized by selecting the interview passages related to questions on the 3 phenomena studied and on the universe. The passages were organized in a single text for each group.

The computer program Alceste (Reinert, 1990) was used for the analysis of data, to study the distribution of the vocabulary of this particular corpus of words.

Alceste was used as a tool to explore the field of social representations as associated to a particular object (in this case the theories on the universe).

The program accomplished its analysis in several distinct steps in which it firstly recognized the units of initial contexts, i.e.., the 51 interviews. It then divided the text into elementary context units (U.C.E.)[1] and repertorial forms. The words were reduced to their roots and regrouped. The analysis has to be made taking into account the words which are passive of analysis (plein analysables) such as nouns, adjectives, verbs and adverbs. The program also divides the U.C.E. into two classes, associated to a particular vocabulary. To interpret the classes, one has to take into account the specific vocabulary within the class which characterizes a particular contextual field. This field recovers the words associated to the same sector of reality.

Thus, the program allows the association of the most frequent words to the context in which they are used within a particular class of discourse. This association provides a given representational field.

Results

Each of the tables described below indicates the semantic content, frequency and percentage of the item within the class, and also the respective significative chi-squares.

Human Sciences Doctors

The data from doctors in human sciences presents a corpus with a total of 5,114 occurrences of U.C.E., and 560 of them were analysed. Two classes are presented below, which contain the highest percentages of U.C.E.

The first class involves 284 U.C.E., which correspond to 28% of the total set. The most relevant words are displayed in Table I.

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[1] The U.C.E. are segments of sentences which represents a particular class and are associated with the most frequent words.

Table 1
Class 1: Significant salient items
Human Sciences Group I.A.I. 9,13 – 284 U.C.E. – 28.01% of answers.

Frequency in the class	n	% in the class	χ-square	item
	45	50	23.69	thing
	52	49	26.01	people
	49	61	47.060	isn't it? (question tag)
	17	47	6.83	wave
	25	60	22.00	particle
Above mean	13	45	4.19	person
>9,13	13	57	9.49	sense
	28	42	6.76	universe
	20	50	9.99	goes
	11	73	15.51	chaos
	11	69	13.38	body
	11	61	9.96	own
	17	77	27.07	synchronicity
Below	09	90	19.25	effect
< 9,13	09	69	11.10	order

This class is identified by categories and expressions which particularly characterize the contributions of female Ss. A close examination of the sentences produced by these subjects reveals a tendency to include the "Self" in the explanations of the research objects. This becomes evident when we observe the significative frequency of the words "ourselves" and "body" displayed in Table I. . Some examples of the sentences related to the frequent words are:

"I remember participating in a conference where the researcher stated that we have the same particles of the universe in our bodies..."

"It confirms my body because we are made of waves, we are also waves"...

"... because for example, it says that when we sleep, our spirit travels, it goes to other universes..."

The strong use of the word "thing" indicates difficulties in articulation and expression on behalf of Ss and a lack of knowledge on the topic.The idiomatic expression "isn't it", which was very much used, indicates a search for the interviewer's acceptance.

Still in the first class, the phenomena of "wave/particle duality" and "sinchronicity" were significantly considered by the Ss and were also associated to subjective experiences, as the following example shows:

"The topic of sinchronicity reminds me of a spiritual question, that is, it is something which I experience, which I try on ..."

A second class makes itself evident, involving 228 U.C.E., or 22.49% of the total answers.This class is characterized by the contribution of both male and female Ss. (see Table 2)

This class reveals a significative number of words above the mean and indicates a very definite representational field. The representational field conveyed by these words suggests the subject's agency in the construction of knowledge, science and reality.

This dimension includes statements which refer to the role of scientists as constructors of theories and knowledge. Examples:

"The individual is not an object, he is a subject, he is a relational being.

"There is a reality which is constituted by the subject; I am not denying reality, it is a reality which is being constituted..."

"We are trying to establish another form of the relation subject and object in the act of knowledge"

Table 2
Class 5: Significant salient items
Human Sciences Group I.A.I. 9,13 – 228 U.C.E. – 22,49% of answers.

Frequency in the class	n	% in the class	χ-square	Item
	24	57	30.20	science
	17	63	26.08	knowledge
Above mean	12	67	20.52	to say
>9,13	12	43	6.86	human
	12	41	6.11	reality
	11	61	15.69	]to do
	10	59	13.10	social
	09	47	6.88	history
Below mean	09	60	12.29	know (+)
< 9,13	09	82	22.46	human
	08	100	27.80	subject

Natural Sciences Doctors

The general data obtained from the group of natural sciences doctors shows a total of 4,590 occurrences of U.C.E., among which 468 were analysed.

For this group of Ss, the data is basically concentrated in 2 classes. Sex appears again as an important variable with Class 1 involving 396 units of context (42%) mainly produced by female Ss, while Class 2 was constituted by 440 U.C.E. (46,46%) given mainly by male subjects (see respectively Table 3 and 4)

Table 3:
Class 1: Significant salient items
Natural Sciences Group I.A.I. 9.7 - 396 U.C.E. – 42% of answers.

Frequency in the class	n	% in the class	χ-square	Item
	57	63	18.92	I think
	62	50	3.59	thing
	11	73	6.22	exists
Above mean	15	63	4.33	to do
>9,7	37	55	5.33	people
	45	67	19.04	me
	36	83	32.51	know
	16	59	3.48	sense
Below mean	04	100	5.59	beautiful (feminine)
< 9,7	08	100	11.23	beautiful (masculine)

As already observed with the previous group, female Ss tend to include themselves in the descriptions of objects. They also use the term "thing" very often.

Although female interviewees were acquainted with the theories of physics and with the phenomena approached by the video and text, they still expressed their perplexity towards them. Examples:

"I find it difficult to imagine. Maybe because the mental models somehow have to be different, don’t they?"

"Every time I begin to think about it, I have to stop and change my thoughts because I cannot imagine it!"

"My arbitration does not allow me to express a judgment over what I see."

Table 4:
Class 2: Significant salient items
Natural Sciences Group I.A.I. 9.7 – 440 U.C.E. – 46,46% of answers.

Frequency in the class	N	% in the class	χ-square	Item
	20	91	17.89	Behaviour
	18	75	8.06	space
	22	92	20.00	phenomenon
Above mean	21	66	4.89	physics
>9,7	21	84	14.55	matter
	13	68	3.76	moment
	31	36	23.65	wave
	53	79	30.88	particle
	15	71	5.38	quantum
	19	66	4.37	question
	20	74	8.52	theory
	10	83	6.64	comprehension
Below mean	12	100	14.00	common
< 9,7	10	11	8.84	(period)
	10	91	8.84	exactly
	12	80	6.89	experiment
	10	83	6.64	large (big)
	14	78	7.23	mechanics
	12	92	11.14	observer
	11	73	4.42	point
	12	92	11.14	problem
	09	75	3.98	physicist
	09	100	10.47	distance
	09	75	3.98	Einstein
	07	100	8.13	Frontier
	09	100	10.47	Interpretation
	06	100	6.96	Interpreted
	09	90	7.70	Model
	09	100	10.47	origin
	06	100	6.96	real
	09	82	5.59	sychronicity
	06	100	6.96	system

As may be observed in Table 4, Class 2 involves 46.46% of the U.C.E., and the semantic contexts stem by and large from male doctors' interviews. The contents reveal a constellation of concepts such as: “wave”, “particles”, “spin” and “sinchronicity”. Ss also mention aspects from the experimental method.

Returning to the context, or statements in which such concepts are produced, it becomes evident that male doctors attempt to explain the approached phenomena. They also search for theoretical alternatives to the puzzling phenomena. Ss argue in favour of including consciousness as a present variable in the observational framework; they argue in favour of including the scientist as one more element within the observed universe, and some Ss introduce systemic explanations to make sense of the apparant dichotomy between the micro and macro universe. Examples follow:

"... where we place consciousness as having a fundamental role in all observed phenomena in real life."

"... They are atoms which are touching each other and which are part of molecules, which are part of proteins, which are part my finger."

"... and then in the moment you recognize yourself as making part of all those phenomena, they cannot be coldly observed anymore..."

Secondary School Students

Results obtained from the secondary school interviews, in comparison with the two previous groups of doctors, present a strong difference among the corpus, revealing a total of 2,000 U.C.E. and 361 analysed words.

Once more, the gender variable is responsible for the division of classes.

Table 5:
Class 1: Significant salient items
Secondary School Group I.A.I. 5,5 – 143 U.C.E. – 27.98% of answers.

Frequency in the class	n	% in the class	χ-square	Item
	47	57	41.70	Thing
Above mean	22	39	3.99	people
>5,5	27	43	7.89	isn't it? (question tag)
	07	87	14.28	person
	08	53	4.93	matter

Class 1 involved answers mainly produced by female subjects (27.98% of U.C.E.). There is a high frequency of the word "thing", as was prexiously registered in the data of other groups.

A more detailed examination of the sentences which define the present class demonstrate a great emphasis given to individual perceptions and to an inclusion of the subject in the descriptions, with a total omission of a conceptual framework.

Table 6
Class 3: Significant salient items
Secondary School Group I.A.I. 5,5 – 151 U.C.E. – 29.55% of answers.

Frequency in the class	n	% in the class	χ-square	item
	25	100	62.67	energy
Above mean	12	52	5.92	world
>5,5	11	73	14.23	life
	10	100	24.32	force
Below mean	05	100	12.04	layer
<5,5	05	100	12.04	feeling

Male secondary school students were the major contributers to a 2nd class (involving 20.90% of answers). What becomes evident here is a strategy used by Ss of answering the questions, where they search for a certain rationality which excludes their own experiences from the narratives. Nevertheless, male Ss also clearly demonstrated their difficulties in mastering the topics.

Separately from the results obtained by Alcest's analysis, the phenomena of resistance have to be registered here as having been explicity observed in different instances, as a form of denial of the new ideas brought forward by quantum physics.

Resistance was firstly observed during the first attempt to produce the video–clip. A team of engineers was involved in it, but, they were doubtful about the scientific contributions of quantum physics. During several encounters, the working sessions developed into heated discussions on the validity of the research findings, instead of concentrating on the production of the graphic solutions.

It became evident, after the 3rd meeting, that the impossibility of arriving at an output was due to a resistance towards the ideas and concepts to be visually represented. Consequently, we employed a new technical team.

Among several others, one explicit example of resistance was given by a mathematician, Ph. D. in his area of study. When questioned on the impact of the ideas represented in the video, he said:

"The theory of quantum mechanics enters more and more into a universe that gets each time smaller and smaller.....and it pushes away the Newtonian ideas. However, I am an animal who lives in a Newtonian universe and I have strong Newtonian prejudices. I can state with social and political faith the impact of those other principles, but I don't have enough clarity about them..."

Discussion

The results hereby obtained, though related to the representations of the universe as discussed by social theorists and epistemologists (Adam,1992, Coveney and Highfield,1993, Bohm, 1980, Capra, 1983,1996, Zohar, 1991, Lenoble, 1969) are of a different nature. When the authors refer metaphorically to the universe as a “clock” or as a “steam engine”, or even as a more chaotic element, they are referring to a central element which characterizes a given representation within a particular theory that represents a cosmovision. The results of the present study relate to a shared representational field of the micro-universe as described by quantum physics. They also relate to the ways in which groups of individuals with a certain tradition of knowledge and with different levels of information on the issue, deal with the unfamiliar. Or, they show that people explore common cognitive strategies in the search of a new version of reality. Thus, the non-familiar in this particular case, stands for both: lack of information on the topic and the paradoxical aspects of reality as described by the new physics.

The analysis produced by Alceste raised important elements related to the representational field and to the anchoring of the new concepts.

Female human sciences doctors revealed a new way of anchoring the idea of non-causal or synchronic relations. They discussed it in a context of indissociability among the elements of the universe and also included themselves and their “selves” as integrative elements of the universe. In this sense, they overcame the old dichotomy conceived between man and nature and argued in favour of a self-body-universe unity which seems to be a creative way of coping with a new conception.

The second relevant Alceste class shows that human sciences doctors (male and female) considered both concepts, universe and knowledge, as human constructions. This assumption of human beings as constructors of their own reality has been broadly discussed within the human sciences epistemological debates, but is now also present in discussions of natural scientists such as Ilya Prigogine (1984) when he states that:

“Whatever we call reality, it is revealed to us only through an active construction in which we participate” (pg. 293)

The debate was also present in some of the individual interviews of natural sciences doctors, though it did not appear as the central articulating element in the Alceste analysis.

Natural sciences doctors seemed to focus their explanations of the quantic phenomena in two different ways, specifically used by female and male subjects.

Following a tendency manifested by female subjects of the other two groups, natural science female doctors coped with the non-familiar facts, by describing their own perplexity, and by referring to their own experiences. Such results are intriguing, since female subjects of this group had the same instrumental capacity to discuss the puzzling phenomena as male subjects, but chose not to do it. The results suggest that following studies on gender differences related to the topic of representations in science should be carried out by examining the phenomenon of anchoring new knowledge on self-experience.

Male natural scientists, different from female subjects, attempted to give an answer to the challenges posed by quantum physics. Their common arguments reflected a description of a macro and micro universe.

Their approach is similar to the systemic perspective for the study of the living systems (Capra, 1996) in which an integrated universe is pictured as a “web of life”. Such a perspective is also sponsored by the ecological paradigm, in which the elements of the universe are seen as interdependent and as forming an organized and complex entity. Thus, the representation of our world as a “web of life” contrasts with the representation of the universe as a clock/mechanical engine. One main distinction between them is that while man is included in the first, in the second he is excluded and plays the role of an observer.

For both groups of doctors, there was a tendency to see the universe, in its micro and macro version, as unfolding itself in a contradictory way. However, this fact seems to be more or less disturbing depending on the person’s style and on other generational factors.

Most academics were in their forties while youngsters’ages varyed from 17 to 20. In fact, secondary school students seemed not to find any elements to cause perplexity when they were faced by the 2 world views, as if such views were not associated to their daily lives.

One possible explanation is that such contradictory information can only provoke a dissonance in subjects’ representations of the universe when there is a certain level of information on the subject. These facts were not observed in secondary school students’ answers.

Another finding tobe considered is the phenomenon of resistance towards the new information. It has been previously acknowledged by researchers (Moscovici,1976; Bauer,1995) as associated to a defence on the part of individuais, groups or communities, with respect to new representations or ideas which can threaten their established perceptions of reality.

The idea of constructing representations as a form of symbolic coping (Wagner,1998) could be useful to understand not only the phenomenon of resistance as here presented but also the other strategies used by the doctor members of the two professional groups. Thus, the attempts of female human sciences doctors of anchoring the new knowledge on their self-experiences, or the attempts of natural sciences male doctors of recurring to the debates on the unseparability of researcher and object of study, or even the denial of quantum physics as a valid theory (hereby described as resistance) could be identified as instances of symbolic coping towards the "new look” of quantum physics which demands an elaboration of the novelty on the cognitive level and also on the level of the enactment of such representations

Thus, the present research has allowed us to examine how professional groups structure the representations of a relatively new object (micro universe), using strategies compatible to their academic traditions.

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