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Objectivity on Quantum Events: The Principle of Complementarity and the Rortian Perspective

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In this writing, I reconstruct the Principle of Complementarity in Quantum Mechanics, elaborated by Niels Bohr, and the conception of objectivity implied in it (and in Bohr's writings). Then, I connect it with the epistemological pragmatism of the philosopher Richard Rorty. My aim is to reinterpret some issues of this quantum description that concern the category of objectivity from the Rortian perspective in a plausible way. This allows me to connect in a positive and a negative sense some quantum (and Bohrian) assumptions to the Rortian perspective, but mainly, it allows to reconsider the framework of scientific objects from the modern perspective to a new pragmatist and anti-essentialist point of view.

Keywords: Quantum Mechanics, pragmatism, Bohr, Rorty, Complementarity, postmodernity, inter-subjectivity

1. Introduction

Undoubtedly, one of the most important transformations concerning the scientific thinking was initiated by the development of Quantum Mechanics. Furthermore, this transformation reached our deepest conceptions of knowledge, reality, and objects in general. The scientific revolution aroused in 1900 with Planck's hypothesis of the quantum postulate and reached, in 1925 and 1926, two consistent and equivalent formalisms. These mathematical structures gave account of all the atomic phenomena discussed during those years concerning the behaviour of radiation and matter in microphysical events. However, a clear and consistent interpretation in relation to physical processes was lacking.

Finally, after a long debate among physicists, the Copenhagen Interpretation was born in 1927, founded in the Principles of Complementarity and Uncertainty, elaborated by Niels Bohr and Werner Heisenberg respectively. Those principles were developed almost simultaneously: Bohr, in his holidays in Norway, while Heisenberg stayed on Copenhagen for thinking about their previous discussions on the new theory. The general logical and conceptual framework provided by this interpretation became, since then, the orthodox explanation in relation to Quantum Physics, even if it was not a perfectly delimited interpretation, but a general perspective on the microscopic physics. It came to be the prevailing frame in the physicists' community.

Nevertheless, once established the physical interpretation, the polemic did not end, but grew more intensive. Despite of the predictive success, some scientists did not agree with the assumptions and implications of this new interpretation. That was the case of co-authors of the theory, such as Einstein and Schrödinger themselves. Thus, the philosophical debate became central for the main figures of the physicist community

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during several decades. Even so, the Copenhagen Interpretation has survived to its opponents until now, but every time other alternatives to interpret Quantum formalism or even more, other theories to explain microscopic events have been proposed.[1] Actually, the discussion on the physics departments is relatively marginal, but it is still alive in philosophy of science departments, so it is clearly not closed or concluded because implicitly or explicitly there is no consensus or general agreement about it, so there are still several interesting philosophical elements to analyze about it.

On the other hand, there was a philosophical proposal that was developed in the second half of the 20th century by the Northern American philosopher Richard Rorty. This philosopher was trained in the analytic tradition but later recovered some continental thesis, especially, some thesis of the American Pragmatism. Thus, he reinterpreted conceptions such as Dewey's knowledge proposal or James' truth definition for criticizing the modern philosophical tradition.[2] In this way, Rorty created an eclectic and polemical scheme concerning all the issues about knowledge, reality, and the objects. His statements about knowledge unwrapped the suppositions that he named "metaphysical," which were mainly developed with the modern epistemological framework. Instead, he established a neo-pragmatist perspective of knowledge that implied a new characterization of all the categories related to it, in particular, of objectivity.

The controversial description and argumentation on Rorty's discourse has evolved in several and long philosophical discussions with his *friends* and *enemies*, such as Habermas or Putnam, among many others. His definitions of truth, language, reference, objectivity, justification, etc., break up with a scheme usually accepted especially on scientific assumptions. Some of these theses often identified him with the postmodern philosophical tradition.

It is clear that the interpretation of Quantum Mechanics is an *old and frequent target* in the philosophy of science, as well as the Rortian perspective of knowledge has been often debated by the most outstanding philosophers. I am not going to criticize or to look after the Copenhagen Interpretation or the pragmatist conceptions in general. I pretend neither to make an alternative interpretation of Quantum Physics nor to give general arguments against or for any of the Rortian perspectives. I will rather apply this epistemological proposal to the quantum case, focusing in the conception of objectivity.

With this aim, first, I am going to make a conceptual clarification of the Principle of Complementarity. This clarification will be focused not only in what the principle states, but also in Bohr's reflections on it. Then, I will spell out the concept of objectivity that is implied in this principle and conceived by his author in contrast with the classical concept. After that, I will elucidate the conception of objectivity developed in the Rortian proposal as an alternative. With these elements, I will try to link both conceptions in both, a positive and a negative way. If this application results plausible and fruitful, we can support Rortian characterization of objectivity for this example of scientific objects and the consequences that his author states.

2. The Perspective of Niels Bohr

By the end of 1926, the quantum formalism was clearly established but its physical interpretation was full of contradictions. There were some phenomena that sometimes presented particle behaviour and others wave behaviour in both, the radiation and matter experiments (in a fanciful way). Consequently, it seemed that there was not a classical concept that could be use in a coherent way with each of the experiences, avoiding contradictions.

Bohr had particular concerns and doubts about the conceptual considerations of the quantum formalism. He often analysed the physical situations and the importance of language when we made each measurement explicit, and he concluded that the quantum formalism lead us to the review of our most fundamental ideas. According to him, experience allows us to find natural laws to explain phenomena, but at the same time, these laws usually modify the guidelines that arrange the experience itself.[3] Thus, a conceptual scheme is the logic representation of facts without ambiguities, but it can always be modified in a process in which experience and ideas determine each other.

Even if Bohr was convinced that science gives account of phenomena that do not depend on the individual and subjective judgements,[4] for him the reality is not previously or *a priori* determined. Science develops methods to understand and control a dynamic experience and reality, and then, the latter becomes determined.[5] At the same time, the classical conditions of physical reality, such as causality and continuity, are idealized situations, which are necessary to modify according to the new experiences of the microscopic world. This leads him to the conclusion that explanations in atomic physics cannot be reduced to just one of the two classical conceptions, wave, or particle.

On the other hand, Bohr stated that the objectivity requested the non-ambiguous communication,[6] so he paid special attention on the usage of an *adequate language* to express the mathematical results. According to him, our experiences are imbedded in the classical language, thus we cannot conceive reality without it, because it is the *universal scheme*[7] that is usual and intuitive for us.[8] Daily language is a basic tool that arises from practical and social life, and science as a social activity is made up with the language required for every communication.[9] Hence, Bohr is, undoubtedly, convinced that every description requests common language, which is expressed in the classical physics or rather, using the concepts of particle and wave. For him, these concepts allow us to link the quantum formalism and the experiments because mathematical language is an improvement of our common language that we need for every objective description.[10]

Finally, as Heisenberg, Bohr had the aim to develop an interpretation of the theory that only described observable events, in which any non-observable state cannot be expressed. As a result, there are no meanings behind the observable facts, or in other words, there is no ontology behind the measurements.[11]

These were Bohr's considerations and concerns when he was making an interpretation of Quantum Mechanics. After the confusing situation at the end of 1926, Bohr and Heisenberg were discussing all the time the possible outcomes for the interpretation with each hypothetical example. Next, Bohr went to Norway some days for skiing, and when he returned, he had elaborated the Principle of Complementarity, while Heisenberg had concluded the Uncertainty Principle.[12] Both principles remained the basis of the interpretation of the formalism. Bohr presented the Principle of Complementarity for the first time in September 1927 in the Physics Congress in Como (Italy).

3. Principle of Complementarity: The Base of the Interpretation

According to what I have said before, the premises or assumptions that Bohr considered to establish this principle are:

(1) The request of classical language, and so, the necessary usage of the concepts of wave and particle;

(2) The hopelessness of attempting to reduce all the descriptions to just one of these concepts;

(3) The requirement of a new logical framework that provides a consistent explanation, avoiding the contradictions introduced by the quantum postulate;

(4) The statement that only what we observe, that is to say, what we measure, is considered as real or with meaning in the quantum description.

As a result, the Principle of Complementarity establishes the wave-particle duality to describe every phenomenon in atomic physics. It uses the classical conceptions, but assuming new principles to use them. According to it, every fact about radiation or matter can be explained with one of these concepts, but not with both of them at the same time because they have epistemologically excluding properties. Thus, some phenomena will be described by means of the particle category and another by means of the wave one, depending on the experimental context.

The essence of the Quantum Theory is the quantum postulate, and it states that there is a finite magnitude of the action quantum. This means that every interaction or energy exchange has values that match with the minimal quantity requested by the action quantum or multiples of it (this is an inherent discontinuity in every physical process). This finite magnitude that cannot be reduced more than a certain limit prevents us to make the sharp distinction between the phenomenon and the measuring device, which is assumed in the classical conception of observation. Classically, the interaction between the phenomenon and the device is negligible (due to the continuity of the process, it is *infinitely reducible*), thus, we can suppose that the interaction due to the observation process does not disturb the phenomenon.[13] In this way, it is plausible to suppose a complete distinction between object and instrument in the classical framework. However, in the quantum case, such a distinction is not possible because we cannot disregard the interaction with the instrument; moreover, this link is an essential part of the *phenomenon*.

On the other hand, the devices are characterized in classical language, so we need it to express the results of measurements. We cannot talk any more about the object development without talking about the observation means, or rather, the measurement device. The complete description of an atomic event requests that the experimental device be included in it. Depending on this device, we can observe corpuscular or wave behaviour in radiation as well as in matter.[14] This means that quantum events are integral, because any sharp distinction implies a change on the experimental device that is contradictory with the phenomena we observe.

We can say that the formalism is applied to the objects and device together, so there is not any property in the classical sense, as Bohr says. This duality is also expressed in terms of the kinematic or dynamical categories: If we use a device to get the spatial and temporal localization, we cannot get the dynamical (energy or momentum) state of the system and vice versa.[15] In the same way, different experimental results request corpuscular interpretations in some cases and wave interpretations in other cases about the *same* object.

At that point, the quantum formalism becomes a symbolic procedure whose unequivocal interpretation requests the inclusion of the complete experimental device. Otherwise, we could think that the phenomena *are disturbed* by the experiment or the properties *are created* by the measurement. We avoid this subjective interpretation if we use the word phenomenon for the complete information that will be communicated without ambiguity, the whole relation between object and instrument.

Consequently, knowledge on Quantum Theory cannot be interpreted as independent information about autonomous properties in objects. Moreover, there cannot be conferred an independent reality in the common physical sense to the phenomena nor to the measuring devices. The information about quantum objects cannot be included in a unique representation, but only in a complementary one. There is not just one (classical) description system or scheme that could be well suited with every fact. In other words, if we use one set of classical concepts (particle for example), we should exclude the usage of the other (wave) which is

complementary. However, as Bohr says, both of them are useful to summarize and unify the experimental results.

In this way, the Complementarity tries to harmonize apparently contradictory conceptions as two sides of the same reality, as a generalization of classical descriptions.[16] Thus, the mutual exclusion and the unavoidable interaction are fundamental for the interpretation. The object sometimes will have particle behaviour, like a point in the space and time and others like something extended, as a wave. These ideas translate the formal consistency to the common language modifying its scope.

4. Objectivity in Complementarity

Once the Principle of Complementarity has been established in a general sense, we can clarify which is the conception of objectivity that is implied in it. For Bohr, Complementarity provides a consistent and complete description for all the atomic events, because it can explain any possible experiment.[17] The dual behaviour of quantum objects leads us to the conclusion that we should not think any more about independent properties in atomic objects, but only in relations established in particular contexts.

Now it becomes evident that we are not talking anymore about the concept of objectivity usual in classical physics. On the latter, the observed object has a perfectly defined sense or meaning independent of the observer. This is because, even if every measurement device supposes an energy exchange, or in other words, an interaction between the object and their observations means, in the classical case, we consider that this interaction is negligible and therefore our system to be isolated. Thus, we found the objective description on the assumption that we can describe phenomena without perturbing it, in other words, without interacting with them, just as passive spectators.

At the same time, this supposition is supported on the idea that the development in every transformation process from one state to another occurs throughout every intermediate state between them. If we have no minimal value, we can consider that the disturbance due to the interaction can be arbitrarily reduced and then, in principle, it can be negligible. So in this way, we can obtain information about the object *as it is*. Even if it is an idealization, it is justifiable because the interaction is controllable and avoidable. This assumption is known as the *spectator doctrine*, in which the subject observes and describes what happens completely separated and independently of his object. In this case, we can describe, simultaneously, spatial and temporal localization as well as dynamical states using the conservation laws.

Nonetheless, in the quantum case, the assumption of continuity in every change of state is rejected because the (finite) quantum postulated introduces an element of inevitable discontinuity. So that, we cannot keep the dynamic and cinematic (geometric) descriptions at the same time; now they exclude each other. If we have the exact localization, we lose the possibility to measure the exact moment and vice versa. The same thing occurs with energy and time. Hence, in Quantum Mechanics, it is impossible to sustain on the classical model in which the observed object is independent of the framework of reference. The conception of the isolated system cannot be kept; every observation implies an unavoidable interaction that makes the object a non-isolated system, linked to the measurement device. This situation forbids a sharp distinction between what we watch and the means we use to do it: The phenomenon depends on the conditions of observation.

Therefore, in Complementarity, we cannot talk about the independence of objects in the classical sense. From this viewpoint, an experiment is a situation that allows us to communicate what we have made and learned, without ambiguity. The description of the device as well as the observation results should be expressed

in an unequivocal language, using correctly the classical conceptions. For all of this, in quantum formalism, we require the complete description of the measurement device. Complementarity expresses an objectivity that makes reference to the experimental conditions, which shows the dependence between our knowledge and our possibilities of research. The objectivity has its foundation in the phenomena, but also in the essential communication.

This new situation is translated into two important issues: that it is impossible to describe physical reality in the classical sense, measuring at the same time with accuracy all the variables in the system. And that, we cannot represent this reality with substances, or in other words, that all the properties of objects are not in *their self* but only relations in a particular framework. We cannot talk about objects independently of the context, so we cannot assign properties without considering the circumstances in which they are observed and measured.[18] In the classical theory, objectivity was the possibility to represent properties independently of any interaction with the observation; this condition cannot be applied any more in the quantum case, according to this interpretation.

Then, objectivity as the description of an independent reality has to be substituted by objectivity as communication without ambiguity. Physics are objective in the quantum context if they give us unequivocal information using precisely delimited concepts. Complementarity establishes a new conceptual framework that provides this limitation, which gives the conditions for the usage of classical terms, and overall, that implies a conception of objectivity that is not *outside* or autonomous of the observers but applicable for each subject that describes the system. When we watch, we should care about the conditions in which we do it. In others words, as Bohr says, it is unavoidable that we are not anymore just spectators but actors too.

5. Objectivity in the Rortian Perspective

I cannot be exhaustive here with the Rortian conceptions, but I am going to summarize his main epistemological ideas to conclude effortlessly the perspective of objectivity that results from them.

One of the main targets of his critics is the Cartesian distinction between mind and body and the modern assumptions and epistemological problems implied by it. As a result, Rorty refuses the conception that knowing is to represent (*internally*) objects of an *external reality* and all the assumptions inferred in what he calls the *mirror´s metaphor*.[19] In allusion to the subject that concerns us, the relation that Rorty establishes between the world and our beliefs about it cannot support the classical concept of objectivity. In it, knowing is completely separated from doing, and what is true is independent of our interactions with the environment. Rather, Rorty dissolves the objective-subjective ontological dualism, and defines objectivity as an inter-subjective consensus (thus the distinction is social, practical, pedagogical).

For him, knowledge establishes practical and useful relations among objects, but it does not find intrinsic properties of them. At the same time, these relations are contextualized according to the norms we justify in a particular framework without a definitive justification (rather it is historical) or a previous definitive supposition. Thus, objectivity is founded on the agreement on the relations we set up according to a set of norms. As a result, the difference between the objective and the subjective is the relative agreement in each case, but an agreement that has been justified and experienced in practice.[20]

This conception is founded in Wilfred Sellar’s thesis that all knowledge is linguistically made up. Following this thesis, Rorty states that all that we know about an object is a belief that results from our interaction with our environment, that is, with the object, and when such interaction becomes intelligible, it is

expressed in a statement. Consequently, Rorty recovers Dewey's thesis that knowledge is intelligent and directed action established in a language.

Therefore, the objective world, with positive content, independent of our interaction with it and our language about it, has no meaning. Rorty agrees, of course, that there is a world completely independent of us, but it is just in a causal way (not linguistic or cognitive). The objects are external stimuli that interact with us, but their properties can appear only in a linguistic context in which communication is essential. There are a lot of stimuli in the world independent of us, but our beliefs of them ask for an active and linguistic context, so they are a social issue.[21]

The objective description rises from an inter-subjective consensus because it involves a community that describes how the world is (even if the world's behaviour is independent of such descriptions). The more shared attitudes and habits about the objects we have, the broader the consensus about them will be. However, the justification of those habits is relative to the advantages of this description in a normative framework that could be modified later, in another context, culture, theory, etc. Every justification depends on a particular language, so that objectivity is the conformity with the justification rules in a social context.[22]

Accordingly, it is not that the objects of knowledge are subjective descriptions; it is rather that they are objective in our language and rules. They are objective because the stimuli are independent of us and our point of view, but our interactions and relations with them, so our knowledge about them can only have meaning in our *own community*, in an extensive sense. The bigger the community, the bigger the consensus will be (scientific, western, modern community, etc.).

Objectivity as inter-subjectivity puts us in a direct relation with the object because its properties arise from the interaction with it and our shared beliefs of it. We find a clear difference with the objectivity that is autonomous, with an independent justification and existence. According to Rorty, the completely independent entity is not just obscure and metaphysical, but unidentifiable too.

6. Linking Rorty's and Bohr's Objectivity

I have just outlined the main ideas established in the new conceptual framework of wave-particle duality, as well as the redefinition of objectivity made by Rorty. I will try to link and clarify in which senses a relation can be established between them. I will approach this issue on three different aspects related to: Interaction in objectivity, Consensus (and communication) in objectivity, and Independence in objectivity.

6.1. Interaction in Objectivity

It is possible that this is the most simple and clear issue that is analogous in Complementarity and in Rorty's framework. In the Copenhagen Interpretation, the quantum postulate implies that every observation entails an unavoidable interaction. This means that in Quantum Theory we could say that everything we know about an object is an active issue. Then, as Bohr says, the passive idea of the knowledge is no longer justifiable.

This idea suits accurately with Rorty's conception of knowledge. As I have said, Rorty recovers Dewey's naturalism, which conceives knowledge in continuity with the other human activities of the adaptive process. Hence, knowledge implies active interaction. In particular, Rorty supports the idea that every belief is a habit that we have gotten as a result of an adaptation process to the environment. Therefore, knowledge is a belief that can be translated in a successful activity to satisfy our needs.

Hence, even if Complementarity or Bohr's reflections did not reach a deeper conception of the meaning of the active character of knowledge, we can state that Complementarity and Rorty's conceptions coincide that in knowing we are not passive spectators but active agents, so wave-particle duality can be considered as the new adaptation to handle the atomic context. Quantum knowledge is a practical result.

6.2. Consensus (and Communication) in Objectivity

Bohr was particularly worried about the problem of communication in physics. As I have said, for him objectivity requests unequivocal or unambiguous communication. This implies that the interpretation of the formalism is a linguistic question too. Communication, and so, the possibility of agreement are necessary conditions to get an objective description because science is a social activity.

In a very similar way, according to Rorty, knowledge is linguistically made up. Then, in his scheme, communication and agreement are two of the main issues involved in objectivity. Actually, objectivity is defined by the agreement according to the justifications relative to a particular language or scheme, but this agreement only becomes possible through communication. Thus, the socialization process creates the conditions for consensus, which are required elements in an objective description.

Consequently, we can say that in Complementarity's as well as in Rortian scheme, communication and the consequent consensus are central and constitutive of objective knowledge. However, Bohr is an empiricist, so he confers some kind of foundation to the phenomena themselves, which is inadmissible for Rorty. The latter appeals to the historicity of knowledge and supports that every description obeys contextual (so historic and contingent) justifications. Therefore, there is no universal and ahistorical foundation of any kind to any belief or knowledge behind our local norms. According to the Northern American, objectivity cannot be founded in anything behind communication and agreement; it emerges from what we use to accept about our causal relation with the world. We could say that the prevalence of the social priority of the norms in Rorty's case is the main difference between both conceptions.

6.3. Independence in Objectivity

Maybe the key conception to understand the relation between our two conceptions of objectivity is what Bohr and Rorty mean with *independence of subject*.

In Bohr's thinking, the object is not an isolated system but a relation between the object and the device (in this sense, the subject is involved). Then, any property in atomic physics is a contextual relation, which determines the set of categories we are allowed to use in the atomic description. This is what Bohr means with *independence*: what we know about the object and even more, what the object *is* cannot be established outside of the observation process (of the intention, the set of variables we are measuring when we interact with it). The object cannot be understood independently of our research possibilities.

On the other side, Rorty states that knowledge establishes useful and justified relations about objects, but not intrinsic properties of them. These are justified by the contextual norms we have adopted, so they are not *independent* from this rule. Summarizing, objects are causally independent (we do not generate reality), but cognitively dependent of our descriptions. Then, some characteristics that define the object on Rorty's proposal can be found too in Complementarity.

According to Rorty, there is not any independent property because knowledge is holistic, and then a property cannot be autonomous, as in Complementarity in which it depends on the relation with the measuring

device. As these relations are formulated in a language, the object has no meaning outside of it. So that anything behind what we state as a result of the measurement process in the quantum language can be formulated or conceived as part of the quantum reality.

Subsequently, we can say that there is a positive parallelism between Bohr's idea of objectivity and Rorty's perspective. For the former, objectivity is not outside of the subject but applicable for each subject and for the latter it is an inter-subjective consensus. As for the pragmatist philosopher, in Complementarity reality cannot be independent of the practical process and it requires (quantum) language to express experimental results. However, Rorty goes further and emphasizes the social factor of objectivity, inevitably linked to the language we use.

Then, it is also clear that they do not mean the same things with it, because their analysis is different. Bohr is analysing a physical situation new to the scientific scheme. He understands that we have to modify some fundamental assumptions, like causality and space-time conceptions, and to establish a new logical conceptual framework, but he does not carry his analysis any further. He also thinks that the classical language is necessary and definitive that's why we have to describe atomic events with such categories. On the other hand, Rorty is analysing the general modern assumptions related to objectivity in knowledge and he is trying to dismantle what he considers its metaphysical statements. In addition, he considers that knowledge is linguistic and refuses empiricism as a foundation of it. On the contrary, it has a historical character, so there cannot be any definitive or universal language, including classical or quantum descriptions. Definitely, Bohr would refuse the Rortian anti-essentialism, his social ontological priority, as he embraces an empiricism that Rorty avoids.

However, there is a resemblance of pragmatism, and a social and linguistic concern about science that allows linking them in some interesting senses. Therefore, it becomes plausible that we apply some of Rorty's conclusions for reinterpreting scientific objects. If the device is the mean through which we will establish a property of the object, it defines the language in which we elaborate our atomic description. At the same time, the rules of language are decided by the quantum formalism. Anything outside of this relation cannot be elaborated in the Complementarity's interpretation. We cannot say anything about quantum objects behind these rules and experiments (for example to describe a trajectory as in the classical case). However, this description is a result of a long debate that nowadays is still controversial. Therefore, we can relate the conclusions that Rorty makes with the wave-particle duality and support that objectivity is an inter-subjective agreement product of our adaptation activities, and then that every object is a result of a set of relations embedded in a language, in this case, the quantum language. Finally, as Rorty says, that old objectivity as a completely independent substance results not only obscure but unidentifiable too.

Notes

1. For example the Bohmian Mechanics.
2. Rorty, 2001.
3. Bohr N., 1988, 52.
4. Ibid., 29.
5. Ibid.
6. Bohr N., 1964, 83-84.
7. Some scholars state that Bohr makes a Kantian justification of the classical conceptions; however, I think that there are also some social and practical arguments for this use.
8. Feyerabend P., 1962, 228-31.

9. Bohr N., 1988, 40. Prólogo de Ferrero, M.
10. Ibid., 35.
11. Feyerabend P., 1962, 239-40.
12. At this time, they had an intense debate in relation to the logical priority of their conceptions that was finally decided in favor of the Bohr's perspective.
13. Bohr develops this idea in his essay "The Quantum Postulate and The Recent Development of Quantum Theory" (1961, Translation to Spanish 1988).
14. Bohr N., 1964, 49.
15. Bohr N., 1988, 100-2.
16. Bohr N., 1988, 102.
17. Bohr N., 1970, 113.
18. Rioja A., 1992, 278.
19. Rorty, 2001.
20. To deepen in the Rorty's conception of objectivity see his essay: "Objectivity or Solidarity?" in Rorty, 1996.
21. Rorty develops these ideas in several essays in his book *Truth and Progress*, see for example: "John Searle on Realism and Relativism," 89-114.
22. Rorty, 1996, 327-30.

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