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PREFACE

In the last two decades the most important authors of Bulgarian studies in the philosophy of science - Professor Azarya Polikarov, Dr Sava Petrov, Dr Georgy Bratoev, Dr Stoyan Nikolov, Dr Atanas Danailov, Dr Georgy Gargov, and Dr Nedyalko Merjanov - passed away prematurely. They were many-faceted human beings, whose originality expressed itself in many different ways. We dedicate this volume to the memory of our beloved and distinguished friends and colleagues.

During the years in which this volume has been conceived and written, I have been sustained by the support of all contributors, most of whom are "working scientists". Our aim was to represent as many orientations of Bulgarian studies as possible. The initial project has been significantly improved as a result of our discussions. In addition to our contributions, I also include texts of Prof. Azarya Polikarov and Dr Sava Petrov, written in the 1980s. My belief is that both texts are representative of their authors.

I wish to express my deep gratitude to former Editor of "Boston Studies in the Philosophy of Science", Professor Robert Cohen, who encouraged me to initiate this project. I have a very substantial debt to Mrs. Jolanda Voogd (KLUWER ACADEMIC PUBLISHERS) for her dedicated cooperation. For the final preparation of the manuscript, special thanks go to two charming persons: Ms. Antoinette Koleva and Dr. Lilia Gurova. I am also much indebted to my friend and colleague Jassen Andreev. Conversations with him were instrumental in conceiving the general form of this project.

Dimitri Ginev

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VIHREN BOUZOV

SCIENTIFIC RATIONALITY, DECISION AND CHOICE

1. SCIENTIFIC RATIONALITY

In my view, without a clear-cut understanding of the concept of rationality itself and of scientific rationality in particular, it would not seem warrantable to take in science as a pattern of rationality, and to consider scientific activity as being more rational than other types of human activity. Else, its consideration as an abstract construction with dogmatic and restrictive characteristics – or as a void of content and wholly evaluative concept – will, for sure have serious grounds. Indeed, it is of major importance to find out positive solutions to problems of the nature of rationality in the context of the present existing intellectual crisis, when the criticism of science and irrationalism are in an aggressive offensive and there is talk about 'collapse' of scientism and foundationalist programs in philosophy and of the scientific perception of the world as well (Tuomela, *Science*, 93).

Herein I will try to set out certain innate traits of scientific rationality, by means of making a comparison between leading subjective and objective accounts of it in aspects representative for their explanatory potential.

Scientific rationality might well be taken in as a system of specific norms, originating from, and upheld by, a scientific community; norms offering a choice of best decisions in a set of rival alternatives. Hence, a study may be developed up to the evolvment of a uniform conception of scientific rationality and its variants.

The concept of rationality relates to the instruments of carrying out human activity and suitability in terms of aims. Classical philosophical tradition draws a line of demarcation between rationality of thinking and rationality of action. The former spells out universal laws of the Reason guiding nature, society and knowledge (Toulmin, *Cosmopolis*). This type of rationality is uniform for all people; it does not depend on time and social conditions. It characterizes the development of thinking itself, not the development of reality. The rationality of thinking is an emanation of transcendental Reason; typically it is identified with the laws of logic and other 'innate' truths. The rationality of action is determined by aspects of: situation of choice, limited ability and knowledge of the subject, and free will. These aspects are rational, falling in with aims, and conductive to their scoring.

At present, philosophy stipulates an elimination of the difference between thought and action, theory and practice. Thought itself is a type of practical activity, a singling out of alternative decisions. The subject's development is a process of a

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nature determined by internal and external factors. The distinction made between methodological and practical rationality, between inferential and behaviourist conceptions of scientific reasoning, stems from the unjustifiable thought/action opposition.

Positivist and postpositivist philosophy of science identifies rationality via a set of methodological rules. This conception of rationality presupposes construction of an universal method and systematization of sciences. Scientific theories have to keep up to certain rules and standards, the emanation of logical severity. Rationality is guaranteed by means of abidance by such rules and standards, themselves an expression of the procedures of acceptance, justification and criticism of knowledge. Their uniqueness and logical power determine the priority of science vis-à-vis other forms of knowledge. Those rules are means of gaining an objective, true knowledge or an adequate explanation of phenomena. Its explication leads to the construction of rational models with claims on revealing the nature of scientific change (Newton-Smith, *The Rationality*, 17).

So far, the philosophy of science has not been successful in proving convincingly that rationality of scientific knowledge might be perceived of as keeping up to rigid methodological rules. P. Feyerabend thinks that such a rationality is a holdback in the real advance in science; it imposes limitations on human freedom. Scientific progress makes headway through breaking up the constraint of methodological rules (Feyerabend, *Against Method*). The hope that such general and all-embracing directives exist has been dwindling away without let-up, due primarily to the impact of the established pluralism of the forms of rationality. Feyerabend convincingly points to the real variety of 'rational' standards. On their part, the latter determine different cognitive strategies and practices. One might rightfully infer that the interpretation of a certain cognitive procedure as rational could not be pared down to a finite set of characteristic feature qualities. The concept of rationality is of a relative and changeable nature. There exists no idea (or activity or tradition) that might be assessed as 'the one-and-only rational' alone, for good. R. Rorty works out this entirely justified conclusion of Feyerabend to an extreme relativism (Rorty, *Philosophy*, 331), an assertion that is completely unacceptable, since there are evaluative and normative invariants going to the making of rationality as well.

Are scientists rational in terms of their methodological conception of rationality? L. Bergström is right in saying that it 'confuses means and ends, or process and product, in a certain way'. Methodological rules could be perceived of as forwarding some of the aims of science, not as determining any particular behavior of individual scientists (Bergström, *Some Remarks*, 1-3). Science needs no fixed, tight rules of a method; rather, it needs objective criteria in the effective selection of aims, and means of their achievement. This fact should be a guide in the recovery of the until recently neglected problem of scientific discovery. The methodological conception of rationality ignores values with key roles in a practical choice.

The decision theory is the most successful claimant in the evolvement of a model of practical rationality. In terms of practice, rationality is a choice determined by good grounds (Shick, *Making*, 34). The theory of decision seeks to offer a

plausible model of rational action and to formulate general principles of rationality guiding decision-makers under conditions involving risk and unreliability of information. The agent has to make a choice in the presence of several alternatives: their results depend on the actual occurrence of a situation – in a set of situations mutually excluding each other. The agent will be striving to act in a way that might bring about the maximum meeting of his wants or preferences. The choice is rational if it maximizes the expected utility of action (Jeffrey, *The Logic*).

The possibility to use the sophisticated mathematical constructions of the decision theory as a means of analyzing of scientific knowledge is recognized and an expanded debate going on (Howson, Urbach, *Scientific*; Maher, *Betting on*). It is an incontestable fact that scientific researchers act, as a rule, in a state of inadequate availability of tools and incompleteness of information. The choice of hypotheses in a set of competing alternatives, coached to theoretical norms of decision-making and based on empirical tests, is usually viewed as a model of inductive knowledge. C. Hempel assumes that the problem of application of inductive logic in the formation of rational beliefs can be treated as a special case of the more general 'problem of formulating rules for a rational choice or decision in the face of several alternatives'. Scientists act rationally when they seek to maximize certain 'purely scientific, or epistemic utilities' on the basis of beliefs accepted by them (Hempel, *Aspects*, 73, 76). It becomes clear, in the development of further discussions, that the theory of decision embraces, completely or in part, numerous questions of relationships between probability and induction. Yet, it would seem that – irrespective of its, to a certain extent, impressive applications to the topics of confirmation, statistical inferences or economic behavior – P. Suppes's pessimistic conclusion that it has not helped us to understand the concept of rationality and to describe a rational choice in alternative ways of action in an adequate manner still remains unrejected (Suppes, *Decision*, 310). The principles of rational decision theory might only be abstractly justified – though in human behavior they are often violated. Also, their potential to be up to rigid standards is limited (Levi, *The Covenant*, 1):

> Principles of rationality are ill suited for the prediction of human behavior. Nor can they be regarded as prescriptions which rational agents are obliged to obey to the letter. The reason is the same in both cases. Persons, institutions and other alleged specimens of rational agency lack the emotional or institutional stability, the memory and computational capacity, and the freedom of self-deceit required to satisfy the demands of even weak principles of coherence in belief, value and choice. Our rationality is severely bounded.

Scientists pick up problems, definitions, hypotheses, mathematical and other methods, experimental instruments, schools, research traditions, etc. One can hardly assume that – under all circumstances of choice – scientists will be familiar with all the alternatives and their possible outcomes to a sufficient extent. Choice can be conditioned by extrascientific factors of a psychological or social nature.

It will not be reasonable to expect that results of competing decisions could be evaluated with precision and could be compared as to degree of preference in all circumstances. It is an essential quality of scientific discovery that neither aims, nor

means of their realization are clear-cut. This leads to the creation of new knowledge; it calls for a specific 'jump into the unknown', itself not inclusively definable by logic or calculations.

The application of the theory of decision in scientific activity calls for a deep-going, convincing philosophical justification. One can have doubts as regards its potential to reveal, by itself, the nature of scientific rationality.

Why should scientists be rational? Which one of the meanings of rationality could be applied to scientific activity? Can we reduce the requirement of coherence of beliefs of scientists as to a change in result in new empirical information? Would rationality be a characteristic feature of the whole scientific development in the world of 'the objective knowledge' (K. Popper)? The giving of answers to these questions would be the tantamount of taking a major step forward in solving the problem of the nature of scientific rationality.

In the following pages I will try to reach that goal by means of comparing, critically, two leading conceptions of scientific rationality, representative in some aspects as regards their explanatory potential: the Bayesian and the Popperian methodologies. Incidentally, one can hardly point to a theory of rationality that might, by itself, gain a complete and adequate insight into this complex matter.

2. BAYESIAN INDUCTIVISM OR POPPERIANISM

I think that one would be justified in asking the question of why – so much after K. Popper's claiming that he has solved the 'major philosophical problem' of induction (Popper, *Objective*, 1), the ambition to work out inductive logical systems continues to be unabatingly popular? Indeed, in trying to find answers to this question one should not rely on basing arguments on the dogmatism of inductivists or on the objective impossibility to find conclusive solutions of philosophical problems. Rather, it would be necessary to delve into the essence of the problem, also by means of comparing the Popperian and the inductivists' conceptions of rationality of scientific knowledge so as to outline their priorities and their drawbacks. This is a difficult research task indeed, involving reasoning on a number of different aspects. Hence, it would perhaps be reasonable to limit the task to an outline-presentation of key premises shoring up the view that the picking-out of a theory of rationality can not be exhausted by the acceptance of Bayesianism or Popperianism. Bayesian inductivism demonstrates a better philosophical and methodological fruitfulness, serious heuristic potential and logical flexibility. It is superior to Popperianism in a number of aspects; however, it does not give what is due to the intersubjective foundations of rationality. The logic of decision calls for an adequate complement, plus development in an objective – even Popperian – spirit.

1. Bayesianism upholds the prospects for pluralism in logical theories while Popperianism sets real bounds to them. According to Popper and his followers (J. Watkins, D. Miller), scientific inferences can only be deductive: starting out from true premises they would always lead to true conclusions. Basing himself on this proposition alone, one could only advance falsificationism. Popper bases his arguments on known logical incorrectness of inferences, ranging from singular

statements of the type of accounts of observational and experimental results to universal statements of the type of hypotheses and theories (Popper, *The Logic*, 27). Refutation by means of *modus ponens* is logically safe; positive confirmation of hypotheses by means of empirical testing of their deductive consequences is not so. Popper rejects quite explicitly the possibility of the existence of deductive logic: he considers as deductive the whole logic of testing and development of scientific knowledge (Popper, *On Rules*). It is beyond any doubt that this is a retreat when compared with the known Humean arguments. D. Hume also questions the logical legitimacy of inductive inferences, but he accepts their consideration in probabilistic terms. Thereby he suggests a positive solution to the problem of induction (Czezowski, *The Problem of*, 258)

It would not be justified to acknowledge the status of arguments of reasonings that are preserving the truth always and to deprive of such a privilege reasonings that are doing so only sometimes. One can not eliminate certain formal regularities, having all the characteristics of logical laws, with the exception of truth dependencies, from the sphere of logicality. That would mean neglect of the wealth of contemporary logic and would be a limitation of the possibility to have it applied to scientific thought.

The Bayesian inductive conception boils down to the application of the theory of decision in logical and epistemological analysis of science and in scientific rationality. It is a leading trend in the American and in a substantial part of the European philosophy of science. Induction is a method of construction of empirical hypotheses and theories; inductive knowledge mastering is viewed as a process of decision-making wherein – on the basis of empirical and theoretical premises – a picking-out of a hypothesis, with maximal posterior probability, is effected, in an initial set of alternatives. The aim: justification of its acceptance in the system of one's beliefs. L. Savage defines Bayesianism as a 'normative theory' seeking to be helpful in our making better decisions – by means of revealing possible contradictions in our relationships with real and hypothetical alternatives and via description of 'the changes in opinion induced by evidence on the application of Bayes' theorem (Savage, *The Writings*, 295-297). Bayesianism overcomes the neopositivist opposition of: reasoning vs. behavior, opinion vs. knowledge, value vs. inference; it perceives of logical argument as a calculation of changes in opinion, caused by new empirical information. According to works by Finnish logicians it is possible to explain the dependence on probability starting out not only from empirical data and logical premises, but also from theoretical and philosophical suppositions. Foremost representatives of the Finnish logical school (J. Hintikka, I. Niiniluoto, R. Hilpinen and others) have developed the conception of inductive systematization in which not only empirical, but also other components of the process of research – theoretical, methodological and philosophical (ontological) - play an active role. The need for theoretical terms of realization of inductive knowledge is convincingly brought out in it. The possibility for generalization of the theory of hypothetico-deductive inference through an adequate account of the inductive aspect of knowledge is forwarded by I. Niiniluoto and R. Tuomela (Niiniluoto, Tuomela, *Theoretical*). This enrichment of the logical theory of

induction stems from the desire to attain conformity with the real complexity of inductive knowledge in modern science; it is, in principle, a new and progressive trend in the logic of science and the theory of rationality. There is no doubt that the fixation of a scientific fact, confirmed in experiment, presupposes inclusion, in different forms, of theoretical knowledge and methodological assumptions, as well as of overt and tacit premises, and even of ontological principles pertaining to the world picture.

2. Thus, giving due consideration to its aspects, Popperianism evidently displays an inadequate picture of knowledge that can not avoid certain contradictions and irrational presuppositions; it opposes, artificially, verification to falsification and probability to informativeness. It would seem that Bayesianism has succeeded in overcoming some of these drawbacks. Contradictions in the Popperian theory of scientific rationality account for its inadequate interpretation by I. Lakatos and T. Kuhn. They see in it certain elements of naivete, imparting an unreal weight to the procedure of falsification. Proceeding from the D-thesis, Popper would not assume the possibility for a final refutation of an established theory on the basis of *modus tollens* (Popper, *The Logic*, 50): he forwards fallibilism and critical attitude. The rationality of science finds its expression in efforts to find out critical refutation on the basis of strong logical schemes. Popper offers no rational foundations for acceptance of the empirical base of the test. Rather, he resorts to a conventional decision. Thereby he avoids, although *ad hoc*, the danger of infinite regress, but not the danger of dogmatism from in Fries' trilemma.

In a brief comment of 1968, Y. Bar-Hillel noticed that the contradiction between degree of corroboration and degree of confirmation, itself basic for the Popper-Carnap debate, is 'completely perverse'. Popper's assertion that his own criteria of comparing theories are not only different from, but are almost diametrically opposed to, those of Carnap, 'is strange' and his 'attack on inductive logic and a denial that there is such an animal cannot be explained on purely rational grounds' (Bar-Hillel, *Inductive*). There are certain facts in support of this assertion.

On the basis of one and the same formalism, inductive logicians, like Carnap, construct measures of confirmation, while the author of *The Logic of Scientific Discovery* constructs measures of corroboration. A hypothesis is better corroborated if it has held out against more vigorous efforts for its refutation. The degree of corroboration is considered as opposite to posterior probability. The first expresses severity of tests, our sincere efforts to falsify theory. The degree of corroboration is identical with its logical improbability. If there is no difference between confirmation and corroboration, from a logical point of view – then there will be a negligible difference from the point of view of philosophical methodology. Falsificationism does not conform to the real behaviour of scientists; hence it is inadequate as a descriptive thesis. It does not provide them with something different from inductive confirmation. Unsuccessful falsification does not increase the probability of a hypothesis, and it does not lead to determination of its veracity. Popper reduces the quest for truth to measuring, via abstract formulae, the degree of closeness of theories to a hypothetical, absolutely complete truth. The approbation of a most verisimilar theory presupposes falsification of all its rivals, but never a

probabilistic confirmation of its truth. The conception of verisimilitude claims to be an anti-inductive account of scientific progress. However, it does not succeeded in asserting itself in this role. Inductivism and Popperianism are found to be faced by the same difficulty. If one has no right to claim that confirmation gets near to truth, then the same is also valid, to a certain extent, for corroboration or unsuccessful falsification. One can conclude that the inclusion of the concept of falsification is only a necessary addition to the inductive theory of confirmation (Wolenski, *O indukcjii*). W. Salmon is right when he says that *modus tollens* without corroboration is empty, but *modus tollens* with corroboration is inducton (Salmon, *The Justification*, 28). In fact, confirmation can only be defined by means of deductive terms – purely logical and epistemological (Stegmüller, *The Problem of*, 87).

Popper has not succeeded in avoiding compromises with psychologism. One can find only psychological justification of the expectation that scientists would strive for falsification, but not for confirmation of their theories. Quite reasonably A. Grünbaum asks the question of the meaning of Popper's statement in his deductivist conception that 'confirmations should count if they are the results of risky predictions' (Grünbaum, *Is Falsifibility*, 234). It, too, has a psychological justification. However, the great philosopher does not want to acknowledge this kind of retreat to psychologism.

On their part, Bayesians shun the psychologism and dogmatism of other inductive theories, albeit to a certain extent. Subjective probability is the expression of a degree of belief, upheld by the subject, on the grounds of the whole knowledge of, experience in and information on the truth of a sentence, or event (de Finetti, *Probability*). It could be measured through the willingness of the agent to accept a bet in favor of the truth of a hypothesis. Nobody accepts bets to his own detriment – it is a warranty for the intersubjectivity of decision (*Dutch Book)*. This requirement is identical with the coherence conditions of the system of subjective evaluations. Br. de Finnetti's Theorem of representation justifies the universal and non-psychological nature of the concept of subjective probability. It also adds the equivalence condition to coherence. This condition assumes the possibility to postulate a certain finite or infinite set of unknown objective probabilities, if true probability is not known. The representation theorem points to the connection between subjective and objective probabilities, expressed in the fact that the subjective probabilities of singular predictions of experimental results tend to the stable value of the relative frequency, therefore they can be considered as approximations to objective probability. This theorem proves that a maximization of expected utility is necessary and not a sufficient condition for rationality (Maher, *Betting on*, 30-32). L. Savage's theorem of confirmation reveals the internal structure of the process of confirmation – the knowledge of the truth of a hypothesis presupposes an ever more exact prediction of the value of its objective probability (Svetlov, *Sovremennie*, 180-188). These important results are the necessary justification in the application of Bayes's theorem to scientific reasoning, required by A. Grobler in his defence of the Popperian conception of rationality (Grobler, *Justification*, 305). He, and some other authors are right – to a certain extent – when

they pay attention to the element of arbitrariness in the initial distribution of prior probabilities in the Bayesian analysis. It reflects a situation of lack of knowledge and hesitation at the beginning of every cognitive process.

Bayesianism evolves from analysis of the methodological meaning of Bayes's theorem. It relates to a set of mutually excluding, and basic knowledge exhausting, alternative hypotheses. The theorem formulates the dependence of the posterior probability of a scientific hypothesis H on the ratio of the product of its prior probability and its likelihood in the light of certain experimental evidence E, and the probability of this evidence in the light of a whole set of alternatives:

$$P(H|E) = \frac{P(H).P(E|H)}{P(E)} \qquad (1)$$

Bayes's theorem explicates the necessary connection between verification and falsification in the process of inductive knowledge: the confirmation of a hypothesis is close to 1, when the probability of its rivals tends to 0. And vice versa: its falsification in an empirical test is usually accompanied by verification of alternatives. Popper is not right in saying that the amount of compared theories always remains infinite in an empirical test (Popper, *The Logic,* 418). This is only an abstract supposition. In fact, we are faced with the case of competition, wherein the winner is the one who is considerably behind the others (R. Jeffrey). Bayesian inductive logicians are trying to avoid the difficulty of the final choice through formulation of specific rules of acceptance; some of them though, are affected by the lottery paradox (Kyburg, *Probability*, ch.14). The rules of acceptance are analogous to deductive rules of inference, but they have no cogent pragmatic justification.

The inductive rationality of science can be considered as a dynamic totality of ideals and norms, evaluative standards and rules of action (acceptance of hypotheses and theories), methods of model construction and explanation of phenomena related and applied by scientists to all scientific research. It can be understood by a pragmatized theory of inductive knowledge like Bayesianism, in its different forms and trends. The inclusion of pragmatic concepts such as acceptance, decision-making, choice, preference, and its tendency of relying on a certain universal logic of decision, testifies to a new progressive problem-shift (in the sense of I. Lakatos, in spite of his own reservations (Lakatos, *Changes*)) in the inductive program. Its main characteristic is the recovery of a new psychologism ('antipsychological' in the words of M. Notturno (Notturno, *Objectivity*)), which is in conformity with some innovatory phenomena in modern science. They are connected with increasing the theoretical attention paid to the role of the subject in scientific knowledge. It can not be an empirical individual. The subject of knowledge and reality are in a process of development and interaction. The concept of subject is an idealization – a fact guaranteeing the objectivity of logic. "The metamorphosis of science' has occurred in logic in a form of pragmatic theory of the kind of decision logic. The narrow conception of induction as an inference from the singular to the general, coming

from Bacon's epoch of optimistic inductivism, cannot live up to new needs. Popper makes war against precisely this conception, thereby missing the goal.

3. On the basis of Bayesianism one can defend infallibilism and scientific realism, whereas Popperianism rejects the former in principle, as it does not succeed in justifying the latter. I. Levi considers that corpus K of our knowledge (beliefs) ought to be true. It is a standard of serious possibility and of choice of the 'best' hypothesis. If it is not true, it could not play its proper role. The functioning of this corpus of knowledge is not in conformity with fallibilism. For every accepted proposition h in this corpus we can say that 'h is true in the language L for the subject X at the moment t'.Thus the truth remains atemporal and objective (Levi, *The Enterprise*, 13-22). A scientist can put to test a hypothesis not with the aim to confirm or reject it, but to make relevant corrections to it. The choice of options that maximize the acquisition of new information with minimum risk of errors is the aim of inductive knowledge. I. Levi is right in discriminating between legitimate and illegitimate inductive expansion in his theory of inductive rationality. He even identifies both Popper and Carnap as anti-inductivists in their denying the legitimacy of inductive expansion in science. Inductive, more generally nonmonotonic, inferential relations are a generalization of deductive ones (Levi, I., *For the Sake of*, 160-193). The subject alone, and his system of true knowledge are in a process of development in the search for new information. Every cognitive act is, in itself, a transformation from ignorance to knowledge. By accepting new information, it proceeds to corrections in available information.

Bayesianism shows how subjective probabilities can approximate an objective index in results in empirical tests and can augment knowledge. The truth is a real basis for an assessment of their adequacy. According to Popper, the truth is absolutely unattainable; verisimilitude alone is a realistic goal of scientific research. However, he has not succeeded in formulating correct measures for it. Popper's conception of truth and verisimilitude is not in chime with the philosophy of active scientists. I. Niiniluoto has proved that the verisimilitude of a theory depends on the degree of its inductive justification (Niiniluoto, *What*). J. Worrall shows that the Popperian theory of rationality is feasible in practice (Worrall, *Why*).

For sure, I cannot maintain that the conclusion in favor of the Bayesian inductive conception of rationality is largely justified. It presupposes an unacceptable internalism.

3. INTERNALISM OR EXTERNALISM

Internalism presents rationality as an attribute of the thought of individual agents. For externalism, the rationality of knowledge is determined by its relation to reality and by its influence on social factors. The Bayesian decision logic is dominated by an internalist approach, while Popperianism claims to be an externalist conception of rationality.

It could not be denied that the greater part of critical arguments concerning the conceptual foundations of the inductive theory of decision are justified. Its conception of rationality is 'only formal and thin' and its account of the situations of

choice is internalistic. It is subordinated to a psychological monism, which questions its relevance as a normative theory. It is reasonably observed that the judgments of subjective probabilities are 'not yet well understood' (Satz, Ferejoin, *Rational*, 72-74). The theory of decision also gives a simplified notion of deliberation by paring it down, unjustifiably, to some sort of information processing (Moya, *The Philosophy*, 94-95). M. Hesse questions the analogy between bets and scientific research (Hesse, *The Structure*, 109):

> Nature is not an ingenious opponent who seeks out just those bets, which will result in certain loss. And there is no clear relation between reasonable expectation of truth and the willingness to gamble on financial reward. The point does not need labouring that there is no close analogy between games and games against nature.

We can conclude that internalism leads the Bayesian inductive theory – to a large extent, in a wrong direction – to an inadequate explanation of scientific knowledge. Owing to this, inductivists are trying to dissociate themselves from extreme internalist subjectivism. Thus, R. Jeffrey does not consider that the settlement of opinion is the sole end of inquiry – he wants to see 'how much mileage it can get out of the fact that man is an agent' (Jeffrey, *Dracula*, 157). In another work by him he notices that probabilism, as a logic of uncertain expectations, supplements nonfoundational thinking; that there is no bedrock of certainty underlying our probabilistic judgments. Probabilism is an alternative of dogmatism, which relies on deductive logic and truth. Very often we do not have in mind judgmental probabilities for propositions, but we consider relations only, characterized by conditions for probabilities (Jeffrey, *Probability*). Fr. Schick is justified in claiming that a theory of rationality can be subjectivist without being internalist (Schick, *Making*, 136-137):

> On the theories we have presented, nothing external to you (the agent) bears on what is rational and what social. What is one or the other depends on your beliefs and desires. But this says nothing about the question of what you ought to, or might, believe and want, of what defines *oughtness* and *mightness*, here, and that is the question the internalist speaks to. Yes, we all are subjectivists...But we needn't be internalists too.

In preceding papers we have pointed to some results making up for the subjectivist orientation of Bayesianism – in its striving for an objective presentation of the development of knowledge in the process of scientific research. In this respect, one can borrow some ideas from the Popperian conception.

In an objective sense, rationality is an attribute of scientific development as a whole. Science is rational because scientific knowledge is intersubjective and overpersonal. According to Popper, the development of science is an evolutionary process going on in the World 3 of objective knowledge. His follower J. Watkins tries to harmonize the subjective and the objective approaches in the theory of rationality. If we can establish that 'certain aim is the optimum aim for science' and that we have, at hand, the one and only best corroborated theory in the respective field, then we will have 'the best possible reason to accept this theory' (Watkins, *A New View*, 73). Rationality is expressed in the successful combination of individual efforts to achieve truth plus the emphasis on objective tasks of science (problems,

aims). Rationality in the subjective sense is impossible without rationality in the objective sense. We can see their relationship in the concept of norm of rationality.

4. NORMS OF SCIENTIFIC RATIONALITY

When we say that a certain action is rational, we do not mean to express an assertion, whether true or false. We express a speaker's acceptance of some norms, permitting an action. Rationality cannot be identified with justification, it can be identified with a decision to accept a norm (Maher, *Betting on*, 25). Norms are prescriptions for action and they are of an objective nature. They are in World 3. A norm regulates the behavior of particular addresses in specific circumstances by means of imposing obligations (prohibitions) and giving rights. Following J. Wolenski, we can say that norms are introduced by performative utterances of the type of: 'I state that A is obligatory (prohibited)', which expresses a decision of certain normative authority. Norm-formulation appeals to 'the will', but it is not devoid of rational grounds. A decision cannot be reduced to only its linguistic formulation; it is an act of evolvement of normative regulation, a process of forcing through an authoritative will; the result of it is a division of all possible actions into three mutually-disjoint sets: obligatory, forbidden and indifferent. In the context of logic "normation" spells out a choice of normative function (Wolenski, *Deontic*).

Normative decision is a choice called upon to substantiate the aims of normative authority. The scientific community is this authority in science. It enacts and guarantees the binding force of the norm of scientific rationality, doing it on the basis of knowledge, traditions, general view of science and its aims, and through giving an account of social factors and prescriptions. These norms are absolutely objective in the context of individual scientists. Their violation dooms a scientist's research to failure. However, this fact does not question their statute of norms. Following analogy with laws of nature, norms are independent of normative decisions. The agent makes the decision to accept rational norms or not, because such decisions fall in with his own interpretation of science's aims and problems. The choice of a norm is determined by the interest taken in maximizing epistemic utility. A norm only defines the common framework and principles of scientific problem-solving – its application is a question of professional skills and creative attitude to the particular problem. It is of no importance if the cogent's cognitive abilities do not satisfy the requirements of a norm. Such a discrepancy can be compensated by the fact that he works in a conceptual and normative framework, established by the overall scientific community. There is an invariant core in the norms of rationality, accounting for their being not so liable to change. Such a core might be the subject of another analysis.

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