A PLACE FOR PRAGMATISM IN THE DYNAMICS OF REASON?

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Abstract. In *Dynamics of Reason* Michael Friedman proposes a kind of synthesis between the neokantianism of Ernst Cassirer, the logical empiricism of Rudolf Carnap, and the historicism of Thomas Kuhn. Cassirer and Carnap are to take care of the Kantian legacy of modern philosophy of science, encapsulated in the concept of the relativized a priori and the globally rational or continuous evolution of scientific knowledge, while Kuhn's role is to ensure that the historicist character of scientific knowledge is taken seriously. More precisely, Carnapian linguistic frameworks, guarantee that the evolution of science procedes in a rational manner locally, while Cassirer's concept of an internally defined conceptual convergence of empirical theories provides the means to maintain the global continuity of scientific reason. In this paper it is argued that Friedman's neokantian account of scientific reason based on the concept of the relativized a priori underestimates the pragmatic aspects of the dynamics of scientific reason. To overcome this shortcoming, I propose to reconsider C.I. Lewis's account of a pragmatic priori, recently modernized and elaborated by Hasok Chang. This may be considered as a first step to a dynamics of an embodied reason, less theoretical and more concrete than Friedman's Neokantian proposal.

Keywords: Dynamics of reason, Paradigms, Logical Empiricism, Neokantianism, Pragmatism, Mathematics, Communicative Rationality.

1. Continuity of Reason versus Historicity of Knowledge. Michael Friedman's *The Dynamics of Reason* (Friedman 2001, DR in the following) provides an answer to the question of how the role of philosophy of science should be conceived of today. His answer is that the task of philosophy is to ensure the continuity of scientific reason. Philosophy is to provide the conceptual tools to understand the evolution of scientific knowledge as a *globally* continuous and convergent process. The main difficulty for such a conception of scientific development is presented by the apparent discontinuities that occur in those periods that Kuhn called scientific revolutions.

In his book Friedman proposes a kind of synthesis between a Neo-Neokantian philosophy of science that takes up ideas from Carnap's logical empiricism, the Neokantianism of the Marburg school, and from a Kuhnian account that emphasizes the historicity of scientific knowledge. I contend that Friedmans's approach underestimates the pragmatist aspects of scientific knowledge that come to the fore in Kuhn's philosophy of science based on the concept of paradigm. This leads to an overly theoretical account of the relativized a priori that may be considered as the core concept of Friedman's account. In order to overcome this deficiency I sketch an alternative account of what may be called a relativized *pragmatic* a priori, an account that overcomes the theoretical bias of Friedman's notion.

My paper is organized as follows: The first two sections elucidate the Neokantian origins of Friedman's *Dynamics of Reason*: In section 2 Friedman's conception of philosophy of science as a non-scientific endeavor complementary to science is compared with similar proposals of other authors in the course of 20th century philosophy, among them Carnap, Schlick, Cassirer, and Russell. Section 3 seeks to clarify the two basic metaphors on which Friedman's approach is based, namely, continuity and convergence as allegedly necessary characteristica for a rational evolution of scientific reason. In section 4 Friedman's attempt to find a place for Kuhn's pragmatist historicism in the neokantian framework of *Dynamics of Reason* is discussed. It is argued that important aspects of Kuhn's historicism do <u>not</u> find a place in his framework. The aim of section 5 is to bring to the fore the affinity of Kuhn's paradigm-based account with pragmatist conceptions of scientific knowledge. Finally, in *section* 6 we sketch how the overly theoretical account of the a priori in *Dynamics of Reason* can be enhanced by taking into account the notion of a (relativized) "pragmatic a priori" following the lines of Lewis and Chang (cf. Lewis 1929, Chang 2008).

<u>2. A Role for Philosophy in the Age of Science.</u> A central problem for the philosophy of 19th and 20th century was its relationship to the sciences, in particular to the empirical sciences. Bertrand Russell argued for the following model of the coexistence between science and philosophy:

> Just as there are families in America who from the time of the Pilgrim Fathers onwards had always migrated westward, toward the backwoods, because they did not like civilized life, so the philosopher has an adventurous disposition and likes to dwell in the region where there are still uncertainties. ... (Russell 1918, 281).

In other words, for Russell the task of philosophy was to prepare the ground for the scientific conquest of new territories, philosophy was to be considered as a sort of avant-garde of science. In Kuhnian terms, philosophy is a pre-scientific and pre-paradigmatic epistemic enterprise that is eventually substituted by science. Eighty years later we find a similar conception of philosophy in Nozick, who in his last book *Invariances. The Structure of the Objective World* (Nozick 2001) saw the task of philosophy to "open possibilities for consideration". Philosophy is to open new and interesting intellectual territory and raise new questions. Philosophy could raise surprising conceptual possibilities. For Nozick, the opening and exploring of new views, without necessarily aiming at their proofs, is especially suited for expanding philosophical knowledge. Friedman favors a similar conception of philosophy:

> [The] peculiar role [of philosophy] is precisely to articulate and stimulate new possibilities, at the meta-scientific level, as it were, and it cannot, on pain of entirely relinquishing this role, itself assume the position of a normal science. (DR, 24)

According to Friedman, striving for scientificity would be a "folly" for philosophy. In *Dynamics of Reason* he vigorously argues against the project of conceiving philosophy of science as a science:

> [I]t is a folly for philosophy to attempt to incorporate itself into the sciences (as a branch of psychology, say, or mathematical logic).
> ...
> [I]t is also folly of philosophy to attempt to become "scientific," in the sense of finally leaving behind the traditional conflict of opposing schools for a new stable consensus on generally agreed upon rules of inquiry.
> ...
> Finally, it is folly as well for philosophy and for the other humanities to regret this lack of scientific status, and, even worse, to seek compensation by attempting to strip away such status from the sciences themselves. (DR, 24)

For Friedman not only the Carnapian project of *Wissenschaftslogik* is mistaken but also Quine's naturalist account of philosophy of science as a subdiscipline of cognitive psychology. In a similar vein, any conception of philosophy as a science of science, a branch of sociology of knowledge or something like this would miss the point. Instead, for Friedman philosophy of science has the role to ensure or to (re)establish the continuity of scientific reason in the ongoing process of the evolution of scientific knowledge. Occasionally, Friedman even asserts that philosophy "is" the dynamics of reason (cf. Friedman 2004, XX).
For him, <u>scientific reason without philosophy becomes discontinuous</u>, since scientific reason by itself is not able to maintain its global reasonableness that is challenged by scientific revolutions when one paradigm is replaced by an other one. This is the lesson we should have learned from the historicist account of scientific knowledge that emerged in the second half of the 20th century. Indeed, the main role of philosophy in the context of an enlightened scientifically-minded culture is to ensure the continuity of scientific reason without denying its historical character. To put it in blunt Kuhnian terms, then, the task of philosophy of science is to overcome the conceptual gaps that allegedly occur when scientific revolutions take place that separate two paradigms that succeed each other (cf. DR, 105). According to Friedman, we should not be content with a cheap instrumentalism that describes the progress of science just as a progress in terms of problem-solving. This would lead to a philosophically uninspiring and unenlightening relativism. Rather, we should seek for a *reasonable* progress that leads to an ever more profound and united scientific understanding of the world.

Friedman's conception of philosophy as an institutionalized effort to make sense of scientific knowledge is not so new after all. A classical version may already be found in Schlick (cf. Schlick 1932), who considered it as Wittgenstein's most important insight that philosophy is not a science that investigates its own realm of philosophical problems but rather deals with the elucidation of the meaning of scientific concepts:

> [P]hilosophy is not ... a science. ... [P]hilosophy ... is that activity whereby the *meaning* of statements is established or discovered. ... The content, the heart and soul of science, is naturally located in what its propositions ultimately *signify*; the philosophic activity is thus the alpha and omega of all scientific knowledge. This has no doubt been correctly divined in the assertion that philosophy furnishes both the foundation and the summit to the edifice of science; the only error has been to suppose the foundation to consist of "philosophical propositions" ... and the building also be crowned by a dome of philosophical propositions (called metaphysics). (Schlick 1930, 5)

Schlick's favourite example of a philosophical clarification of the meaning of fundamental concepts of science was the theory of relativity. According to him, this episode in the evolution of scientific knowledge showed how science and philosophy could work fruitfully together and pointed at a future in which science eventually would become philosophical and philosophy scientific. Even Schlick's adversary Husserl agreed with him on the importance of the task of clarifying the meaning of scientific concepts. But he sharply disagreed with Schlick on how this should be done. According to him, only the new science of a phenomenologically enligthened logic could achieve this task (cf. Husserl 1929).

For Cassirer, Natorp and the Marburg school in general it was part and parcel of any Kantian philosophy of science that it did not operate in empty space but had to rely on the historically established facts of science that provided it with its proper content (cf. Natorp 1912, 196-197). The task of philosophy of science was to "justify" these scientific facts by elucidating their reasonableness and making real sense of them. In other words, philosophy of science had to explicate the meaning of science, to make explicit the method of science as "the method of an infinite and unending creative evolution of reason. Fulfilling this task was the "indestructible core of Kant's philosophy" (Natorp 1912, 200).

These examples may suffice to show that in the 20th century many philosophers of science sought to determine the role of philosophy in an age of science in ways that did not insist on the traditional role of philosophy as a foundational discipline. It had become evident that philosophy was not in the position to provide the foundations of science in any direct "onto-logical" sense. In a certain sense, the sciences could take care of themselves and did not de-pend on philosophical foundations. Nevertheless philosophers of all currents insisted that philosophy still had a role to play in the ongoing evolution of scientific reason. But it was far from clear what exactly this role was to be. Many agreed, at least vaguely, that this role had something to do with the semantics of scientific concepts, for instance, with the task of preserving the continuity of meaning over time.

Friedman reserves a rather precisely determined place for philosophy in this enterprise. In a similar manner as Schlick he arrives at the conclusion that there is a happy (even dialectical) division of labour between science and philosophy:

> We should rather rejoice, along with the sciences, in our fundamentally distinct, yet mutually complementary contributions to the total ongoing dialectic of human knowledge. (DR, 24)

This is a rather optimistic view concerning the relevance and scope of philosophy. One may well doubt that philosophy will be able to accomplish this demanding task (cf. Richardson 2002, 273). Moreover, the feasibility of this role depends on the underlying concept of "human knowledge" (see section 7).

3. Continuity and Convergence in the Sphere of Reason. The key concepts for Friedman's account of the evolution of scientific reason are "continuity" and "convergence". They were used already by Neokantian philosophers such as Natorp and Cassirer (cf. Mormann 2005). These concepts function as guiding metaphors or "intuition pumps" (Dennett). Indeed, the basic idea of Friedman's *Dynamics of Reason* is to conceive the evolution of scientific reason - encapsulated in a sequence of theories or conceptual frameworks - as a continuous trajectory in a logical or conceptual space somehow as already Cassirer and other Neokantians imagined.

In order to assess this proposal, first and foremost it should be noted, that "continuity" and "convergence" apply to the development of theories only in a rather indirect manner. Mathematically, these notions make sense only in the case of infinitely many objects that converge or fail to converge in some way or other. In the case of converging theories or paradigms, however, actually only finitely many objects are involved. Nevertheless the usage of mathematical metaphors like these has a tradition in neokantian currents of philosophy of science (and beyond). Already Cassirer, Natorp and other members of the Marburg school used similar mathematical metaphors to elucidate their brand of Neokantian epistemology and philosophy of science (cf. Mormann 2005). Thus, in order to assess the range and the limits of Friedman's approach, it seems expedient to have a closer look on his Neokantian ancestors.

Let us begin with the concept of convergence. At first look, the metaphor of convergence seems to lead us uncomfortably close to some sort of ingenuous realism. Considering a sequence of numbers such as ½, 1/3, ¼, ..., 1/n, ... converging to 0 might suggest that a convergent series of theories T_1, T_2, ..., T_n, ... converges to some ultimate reality, analogously as the arithmetical series $(1/n)_{n\in\mathbf{N}}$ converges to the real number 0 external to it in that 0 itself does is not a member of the sequence $(1/n)_{n\in\mathbf{N}}$. Cassirer vigorously refused this realistic interpretation:

> The system and the convergence of the series take the place of an external standard of reality. Both system and convergence can be established and determined, analogously to arithmetics, entirely by comparison of the serial members and by the general rule, which they follow in their progress. (SF, 321)

This somewhat cryptic remarks can be elucidated as follows. As Cassirer observed, in order to be able to speak meaningfully about a convergent sequence of numbers it is not necessary to assume that there really is a number to which the sequence converges. Rather, as Cauchy's main principle teaches us, an arithmetical series $(a_n)_{n\in\mathbf{N}}$ can be defined as convergent if it satisfies an <u>internal</u> requirement that can be formulated without reference to a possibly not existing external limit:

Cauchy's criterion: $(\varepsilon)\ \exists n_0\ [(\varepsilon > 0) \Rightarrow |a_n - a_m| < \varepsilon \text{ for all } n, m \geq n_0]$

Expressed informally, Cauchy's criterion characterizes a sequence $(a_n)_{n\in\mathbf{N}}$ as convergent iff the differences between the members of the sequence eventually get arbitrarily small. This is a purely *internal* criterion that does not refer to an outside limit. It may happen that a Cauchy sequence lacks a limit point in a space. For instance, consider the sequence 1.4, 1.41, 1.414, ... approximating the positive square root √2; in the rational numbers **Q** this sequence has no limit point, since √2 is not a rational number. Nevertheless, the sequence may be characterized as convergent in **Q** by invoking the Cauchy criterion thereby distinguishing it from a diverging sequence such as, say, 1.4, 1.5, 1.6, ... (= $(1.4 + 0.1n)_{n\in\mathbf{N}}$.

Mathematicians have pushed this "internalization" of the concept of convergence even further. As is well known, the deficiency of the rational numbers **Q** of lacking "real" limit points for certain converging sequences may be overcome by "completing" Q in an appropiate way. More precisely, one can embed the rationals **Q** into a set **C(Q)** of appropriately defined equivalence classes of Cauchy sequences. Thereby it can be ensured that in the new completed realm **C(Q)** that comprises the rational numbers **Q** as a part every Cauchy sequence has a limit point.[1]

Cassirer took these conceptual constructions as more than mere mathematical technicalities in that he considered them quite seriously as the pattern for his internally defined account of the continuous evolution of scientific, i.e. theoretical knowledge:

[1] As Dedekind showed, **C(Q)** may be identified with the real number **R**.

> No single astronomical system, the Copernican as little as the Ptolemaic, can be taken as the expression of the "true" cosmic order, but only the whole of these systems as they unfold continuously according to a definite connection. (SF, 322)

In other words, the "true cosmic order" is not given by a single theory T but by a convergent series T_1, T_2, T_3, ... of theories. In line with Cassirer Friedman's dynamics of scientific reason does not assert that our theories (ontologically) converge to a mind-independent realm of substantial things; rather, they (mathematically) converge *within* the historical progression of our theories as they continually approximate, but never reach, an ideally complete mathematical representation of the phenomena. This ideal representation is not waiting "out there" to be approximated, rather, it is, so to speak, the reification of the approximation process that comes into being through this very process itself. For Cassirer, this kind of idealization or completion was to be considered as the essence of modern mathematics *überhaupt* (cf. Mormann 2008). The mathematical fruitfulness of this process is beyond doubt, but its transfer to the domain of "converging" empirical theories is far from trivial.[2]

While Cassirer was content to vagely assert that two theories T_n and T_{n+1} of such a sequence, say, the astronomical systems of Kepler and Newton, were somehow related to each other such that their relation could be understood in analogy to the Cauchy criterion of numerical convergence, Friedman is at pains to explain in much more detail what is to be understood by internal convergence of successive paradigms. Indeed, three complementary conditions are required:

> [F]irst, that the new conceptual framework or paradigm should contain the previous constitutive framework as an approximative limiting case, holding in precisely defined special conditions; second, that the new constitutive principles should also evolve continuously out of the old constitutive principles, by a series of natural transformations; and third, that this process of continuing conceptual transformation should be motivated and sustained by an approproriate new philosophical meta-framework, which, in particular, interacts productively with both older philosophical meta-frameworks and new devolopments taking place in the sciences themselves. (DR, 66)

Denoting by P_n and P_{n+1}, the old and the new paradigm, their relation might be depicted as follows (s = series of natural transformations, r = reduction of the new framework, thereby conceiving the old one as a limit case) a succinct graphical presentation of the complex relation between a "Cauchy series" of succeeding paradigms may be given as follows:

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[2] It would give us a means of making sense of the „standard locution ... [that] ... successive scientific laws and theories grow closer and closer to the truth." (Kuhn 2000, 115). For Kuhn, such a talk does not make sense, less „we had a fixed Archimedean platform [that] could supply a base form which to measure the distance betwen current belief and true belief. In the absence of that platform, it's hard to imagine what such a measurement would be, what the phrase „closer to the truth" can mean."

----s_{01}--→ ----s_{12}---→ ---s_{23}--→ ....
P_0 P_1 P_2 P_3
←--r_{01}---- ←--r_{12}----- ←--r_{23}---- ....

In (DR) Friedman does not delve deeper into the task of what precisely is to be understood by concepts such as “approximative limiting cases”, “continuous evolution of new constitutive principles from old ones through natural transformations” etc. In the 1970s and 1980s philosophers of science spent a lot of ink and effort to elucidate many kinds of intertheoretic reduction concepts that sought to maintain in some way or other deductive and explanatory relations between succeeding theories. Perhaps this work could be useful to substantiate further Friedman’s general remarks on this issue. The starting point for this endeavor was Nagel’s reduction concept (Nagel 1961, Chapter 11). In the decades following the publication of Nagel’s account a huge literature on the topic of reduction has been produced to a variety of rival reduction concepts evidencing that the relation between succeeding paradigms is quite complicated.

A promising way to disentangle this thicket is to distinguish between the formal and the ontological component of empirical theories as already Duhem did in *The Aim and Structure of Physical Theories* (Duhem 1906). According to him, physical theories have two components, a descriptive one, and a metaphysical one that, allegedly, yields exhaustive explanations why things happen as they happen. The evolution of scientific reason was cumulative with respect to the descriptive part, and chaotic and irregular with respect to the allegedly explicative component. In other words, Duhem was content to conceive the dynamics of scientific reason essentially as the dynamics of its mathematical component.

For Duhem, in the evolution of physics the mathematical part either remained constant, or underwent a purely cumulative development that did not threaten the continuous character of the evolution of physics. The scientific revolutions of the 20th century showed that Duhem’s picture was too simple. The history of modern physics has shown that also the theoretical part of the sciences might undergo dramatic changes that might well be characterized as “revolutionary”.

Even if one wants to maintain the continuous character of the evolution of scientific reason only for its mathematical component, one has to go beyond Duhem’s simplistic cumulative model, since even the evolution of the theoretical component of sciences such as physics did not follow a simple cumulative pattern. The continuity, or, in Kantian terms, the unity of scientific reason is not secured by an unproblematic, purely cumulative evolution of its

(ibid.) So Cassirer’s „Cauchy account“ contends that one does not need such an Archimedean platmathematical part. The mathematical continuity of scientific reason cannot be conceived in so simple terms, as Duhem seems to have thought.[3]

According to Friedman, philosophy should not leave the problem of continuity and convergence of scientific knowledge to mathematics, rather, it has to play an active and indispensible role in the ongoing evolution of scientific reason, and its interventions are particularly important in transitional periods in which one paradigm is replaced by another one. Philosophy has the task of mediating between different paradigms by providing a space for communicative reason or communicative rationality in which the members of different paradigms may reach a sort of consensus that they cannot reach in the narrower sphere of purely scientific reasoning.

Friedman borrrows the notion of communicative rationality from Habermas's theory of communicative action (Habermas 1984 (1981)), but adapts it to his particular purposes in a somewhat idiosyncratic way. Indeed, Friedman's foray into the territory of the "theory of communicative action" can be considered only as a first step and results in a rather sketchy account of how the devices of communicative rationality may help to ensure the continuity of the dynamics of scientific reason. One reason for this less than fully satisfying state of affairs is that communicative rationality in Habermas's sense is part of practical rationality. Friedman's concept of scientific reason may be criticised as exhibiting a certain theoretical bias. Following the accounts of Cassirer and Carnap, Friedman's reason is essentially theoretical. As I will argue, this deficiency could be overcome by putting a greater emphasis on the pragmatical aspects of Kuhnian paradigms. Friedman fails to do this, since for him Kuhn's paradigms are essentially nothing but informal versions of Carnapian linguistic frameworks, which "by definition" are deprived of any pragmatic aspects.

Without trying to provide a comprehensive account of Habermas's concept of communicative rationality the modest aim of the following remarks is just to recall the bare bones of this notion and discuss how Friedman conceives its role in the task of ensuring the continuous character of the dynamics of scientific reason.

According to Habermas one should distinguish between two kinds of rationality – instrumental rationality on the one side, and communicative rationality on the other. Instrumental rationality concerns the relation of speakers and agents to the world:

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form, since convergence is defined internally.

[3] Even for Duhem the continuous evolution of the mathematical components of empirical theories did not suffice to adequately describe the evolution of physical theories. According to him, physical theories somehow tended to become natural classifications. In order to bring about the change from instrumentally more or less adequate theories toward natural classifications, scientists had to use their *bon sens* to choose between rival candidates that were to replace a given theory. Similarly as Duhem, later Kuhn emphasized that there did not exist an algorithm to be employed in theory choice. Rather, *bon sens* in theory choice amounted to the capacity of making an educated and wise decision taking into account often conflicting values. In Kantian terms, it is a matter of practical reason.

> [Instrumental rationality] carries with it connotations of successful self-maintainance made possible by informed disposition over, and intelligent adaption to, conditions of a contingent environment." (TCA I, 10)

The aim of instrumental rationality is to obtain knowledge of how the world is in order to achieve certain goals by choosing appropriate means. Instrumental rationality is concerned with technical problems. In this way we can distinguish instrumental rationality from communicative rationality that belongs to the realm of practical reason as Habermas explicated as follows:

> Technical questions are posed with a view to the rationally goal-directed organization of means and the rational selection of instrumental alternatives, once the goals (values and maxims) are given. Practical questions, on the other hand, are posed with a view to the acceptance or rejection of norms, especially norms for action, the claims to validity of which we can support or oppose with reasons. (Theory and Practice, Habermas 1973(1971), 3)

The concept of communicative rationality as an ingredient of practical rationality is introduced to deal with questions typically concerning practical decisions, i.e. decisions that do not concern the strategies that an individual has to pursue in a certain situation to achieve a given end but how a community of individuals comes to agree on what ends they should pursue as common aims that all do concern all members of the group. Since usually a consensus about the aims to be pursued cannot be taken for granted, communicative rationality entails the possibility of a rational discussion of values that may appear as incompatible in the beginning:

> [The] concept of *communicative rationality* carries connotations that ultimately trace back to the central experience of the non-coercively uniting, consensus creating power of argumentative speech, in which different participants overcome their initially subjective points of view, and, thanks to the commonality of reasonably motivated convictions, assure themselves simultaneously of the unity of the objecive world and the intersubjectivity of their context of life. (Habermas 1981(1984), 11)

Communicative rationality is founded in the practice of the life-world. This practice goes beyond a merely instrumental and descriptive relation of the agents to reality. Rather, the agents who are engaged in this practice are seen and see themselves as competent and knowledgeable participants of a common project realized through coordinated work. An important component of this coordination is the construction of a common language so that the involved agents reach a mutual understanding and consensus, even if they started with mutually incompatible values. In other words, according to Habermas's communicative rationality is an essential ingredient for ensuring the pragmatic continuity of the life-world.

In *Dynamics of Reason* Friedman is not interested in the practice of the life-world. Rather, he seeks to employ Habermas's concept of communicative rationality to a revolutionary situation in which the members of a scientific community lack a common paradigmatic framework that defines the problems and methods that they may put on their agenda. From a very general perspective agents that are confronted with problems concerning their life-world and members of a scientific community confronted with the breakdown of a commonly accepted paradigmatic framework may be seen to be in analogous situations, it is far from obvious, however, how far this analogy actually goes. For instance, the role of mathematics has certainly no counterpart in the communicative rationality of the life-world:

> The mathematical exact sciences still serve as the very best exemplars we have of universal communicative rationality in spite of, and even because of, their profoundly revolutionary character. (DR, 118)

One reason for this is the fact that revolutionary transitions in mathematics, say, that from classical Euclidean geometry to Riemannian geometry then, have the striking property of continuously

> preserving what I want to call *retrospective* communicative rationality: practitioners at a later stage are always in a position to understand and rationally justify ... all the results of earlier stages (DR, 96).

As it seems, for Habermas there is one and only one communicative rationality that ensures the continuity of the practice of the life-world in all historical situations. At least, he never thematizes questions concerning the development of communicative rationality in history. In contrast, Friedman denies that communicative rationality is a historical constant. According to him, each paradigm has its own communicative rationality, and moreover, the communicative rationality of our everyday rationality is of little help to overcome the Kuhnian interparadigmatic discontinuities. The lesson that we should have learned from modern history of science is that

> Different constitutive frameworks or paradigms employ different – and even incommensurable or non-intertranslatable – standards of communicative rationality and precisely thereby raise the threat of conceptual relativism. (DR, 93)

This entails that the real problem for philosophy of science is to explain how a revolutionary transition from one scientific paradigm or constitutive framework to another can be communicatively rational (cf. (DR, 95)). This is only possible if communicative rationality is considered as a variable that changes with the evolution of scientific reason itself. It is the task of philosophy to provide meta-frameworks or meta-paradigms that render the interparadigmatic evolution of scientific reason communicatively rational, i.e., philosophy to provide a space of conceptual possibilities, in which the ongoing transparadigmatical evolution of scientific reason becomes continuous.

In other words, if we conceive communicative rationality as a necessary ingredient for a "continuous" conceptual change we should learn from mathematics that a trajectory or a function (in physical or mathematical space) is not continuous *an sich*; rather, it is continuous (or discontinuous) with respect to some given topological or geometrical structures. These structures are not fixed once and for all but may change in the light of pragmatically chosen preferences in such a way that a function may be rendered continuous. In particular, any function may be rendered continuous if one is prepared to sufficiently drastic changes in the involved topological structures. This observation from post-Cauchy mathematics might have provided an inspiration for Friedman's account of a communicative reason changing over time and context. It should be noted, however, that concepts such as "continuity", "convergence", "limit point", "continuous transformations", and so on, in the context of the conceptual evolution of scientific reason remain highly metaphorical. Moreover, by claiming that (ordinary) communicative rationality does not help to solve problems concerning the choice of paradigms, Friedman reveals that his notion of communicative rationality and that of Habermas essentially differ. For Habermas, the choice of linguistic frameworks is a practical problem par excellence that has to be treated by the methods of practical rationality, in particular those of communicative rationality. So for Habermas as well as for Carnap the choice between linguistic frameworks is a pragmatic question. Yet unlike Habermas, Carnap reserved no role for philosophy in the task of deciding this kind of question, he was content to assert that science takes care for itself in this area (cf. Carnap 1950, Mormann 2007). Friedman adopts still another stance. According to him, besides instrumental rationality and communicative rationality there is a third realm, namely, that of philosophy whose role is

> to provide meta-paradigms or meta-frameworks "which play an indispensable role in mediating the transmission of (communicative) rationality across revolutionary paradigm shifts, despite the fact that they are incapable, by their very nature, of the degree of (communicatively) rational consensus as first-level or scientific paradigms. (DR, 105)

One may find this three-tiered account of rationality (instrumental rationality, communicative rationality, philosophical rationality) compelling or not, it is obvious that it differs from that of Habermas in important aspects.

<u>4. Defusing Kuhnian Discontinuities</u>. Friedman's assessment of Kuhn's contributions to philosophy of science is a mixed one. On the one hand, "it was Kuhn's merit ... to have reinstated the history of science as perhaps the most important object considered in philosophy of sci-

ence." (Friedman 2003, 35), on the other hand, Kuhn's "historization" inevitably raised the problem of social and cultural relativism that philosophy of science is struggling with till today. Kuhn himself had not much to offer for overcoming the threat of relativism, since his paradigm-based account seemed to render the evolution of scientific reason only locally rational, leaving its global development open to arbitrariness. According to Friedman, the main reason for this failure was Kuhn's inadequate conception of rationality. For Kuhn, rationality meant instrumental rationality. So, since instrumental rationality is evidently not very useful for tackling problems of assessing the merits and shortcomings of rival paradigms, he gave up altogether the hope of dealing rationally with issues of paradigm choice, or at least, he underestimated the still exististing rational continuity in the revolutionary transitions of scientific reason (cf. DR, 117). A reason for this failure is that

> Kuhn gives insufficient attention to the contemporaneous philosophical developments associated with these revolutionary changes, and he is thereby led to both an inadequate understanding of the true philosophical sources of the challenges to scientific objectivity that have resulted from his historiographical work and a fundamental inability to adequately respond to these challenges. (Friedman 2004, 209)

Friedman generally criticises Kuhn for his lack of understanding that scientific philosophy may help to connect succeeding paradigms by constructing a space of conceptual possibilities in which the move from one conceptual framework to another is continuous. According to Friedman's neokantian scientific philosophy the most successful tool for achieving this task is mathematics. As is well-known there are many possibilities to play down - post festum - the ontological differences between different paradigms. From the perspective of the new theory, the old theory may appear as a limiting case, as an idealization, a special case, a simplification, where some parameter has been kept constant. For instance, one may conceive of Aristotelian spacetime, Galilean spacetime, or Newtonian spacetime as members of a continuous sequence of conceptualizations, which (for the time being) culminates in the spacetimes of the theory of general relativity (cf. Norton 1990).

Kuhn never considered mathematics as a legitimate conceptual tool that may help overcome the gap between two paradigms separated from each other by a scientific revolution. He always vigorously protested against these procedures. For him, Newtonian mechanics was not to be understood as a limiting case of relativistic mechanics in which the velocity of light goes to infinity. More generally, one may say that, if there is a component of modern scientific thought that Kuhn seriously underestimated, certainly it is mathematics. One can read *Structure* without ever realizing that modern science is mathematized science in sharp contrast to, say, Aristotelian science. The fact that modern science is <u>mathematized</u> science seems to have been irrelevant for Kuhn. Consequently, Kuhn and Friedman reconstruct the (arguably) most important case of a paradigm change that ever happened in the history of science, to wit, the change from classical to relativistic mechanics, in an exactly opposite manner. Friedman is at pains to make appear the transition as smooth as possible, while Kuhn insists on its discontinuous character.

The opposition of Friedman's and Kuhn's views on the role of mathematics in the evolution of scientific knowledge, in particular in the issue of overcoming interparadigmatical "ontological" differences evidence that their accounts of the dynamics of reason differ in important aspects. The different esteem of mathematics, however, is not the only important difference. Another obstacle for the incorporation of Kuhn's historicist approach in Friedman's neokantian framework are the pragmatic aspects from Kuhn's paradigm-based approach that Friedman rigorously excises from his concept of scientific reason. The essential step in this operation is to conceive Kuhnian paradigms as informally formulated Carnapian linguistic frameworks. Thereby Kuhn's central distinction between revolutionary and normal science is seen to be similar to Carnap's distinction between change of linguistic framework and rule-governed operations carried out within such a framework. Thereby affinities of Kuhn's historicism to pragmatic currents of philosophy of science can be ignored.

Determining Kuhn's place in the intellectual landscape of the 20th century is difficult. Taking into account Kuhn's sensibility to the historicity of scientific knowedge one might have expected that he had a good sense for the localization of his own philosophical standpoint in history of philosophy. This, however, is not the case. He seldom showed much interest to reflect in more detail on the philosophico-historical position of his own approach. Occasionally we find remarks that point at some affinity of his stance with historical figures and currents but they are hardly relliable. For instance in his *Metaphor in Science* Kuhn one find the brief remark that he was an adherent of a „Kantianism without „things-in-themselves“ (Kuhn 1979, 418/419). In *The Road since Structure* (Kuhn 1991) he characterizes the position he was developing then as a „sort of post-Darwinian Kantianism“ (ibid., 12). These contentions are nowhere explained in any further detail, however. Hence, the problem where to localize Kuhn in the philosophical landscape of 20th century is therefore a far from trivial problem of the recent history of philosophy of science. Put it differently, understanding the (often subliminal) philosophical influences that informed Kuhn's philosophical stance help spot its weak points. Friedman put forward an interesting diagnosis:

> The historiographical tradition Kuhn attempts to assimilate in his theory of scientific revolutions ... is characterized by a deep philosophical opposition between a mathematical idealist tendency taking its inspiration from Kant and a more realistic, substantialistic tendency taking its inspiration – via the thought of Meyerson – from a mixture of Platonic, Cartesian, and Hegelian ideas. ... The latter tendency ... maintains an ontology of substantial things, and accordingly, it emphatically rejects the attempt to reduce the task of science to the formulation of precise mathematical laws. ... [T]his deep philosophical tension is echoed in

> Kuhn's theory of scientific revolutions, particularly where he considers the question of continuity over time at the theoretical level. Here Kuhn shows himself ... to be a follower of the Meyersonian tendency, for he consistently gives the question an ontological rather than an mathematical interpretation. Thus, for example, when Kuhn considers the relationship between relativistic and Newtonian mechanics ... he rejects the notion of a fundamental continuity between the two theories on the grounds that the "physical reference" of their terms is essentially different; ... (Friedman 2003, 33 -34).

As Friedman rightly remarks, there are tendencies in Kuhn that strictly separate him from the Neokantian idealism of the Marburg school, in particular the claim that the continuity of mathematical structures does not suffice to overcome "ontological" discontinuities. Friedman's strategy to cope with this discrepancy is simply to dismiss Kuhn's "ontological" inclinations as a symptom of a philosophically doubtful legacy - "a mixture of Platonic, Cartesian, and Hegelian ideas". What remains from Kuhn after this conceptual surgery is Kuhn the "Kantian mathematical idealist". At first glance it is certainly plausible to characterize Kuhn as a thinker with strong idealist tendencies. For instance, when Kuhn asserts that after the change of a paradigm the scientists "live in a new world", this thesis is easily interpreted as a radical idealist claim. Kuhn can hardly be characterized as a simplistic idealist who maintains doctrines such as that "reality is fundamentally mental" or "the world is a construction out of our ideas" (cf. Hoyningen-Huene (1987, 1989). Kuhn's idealism is more respectable. For Friedman, the core of Kuhn's (reasonable) idealism is the concept of the relativized synthetical a priori encapsulated in a paradigm as a framework within which alone empirical claims have a definite meaning (cf. Friedman 1993, 54). It is not clear, however, whether it is the best way of interpreting Kuhn. Next I'll argue that one should resist the temptation of interpreting Kuhn's paradigms idealistically equating them directly with Carnapian linguistic frameworks. Rather, it might be expedient to pay more attention to their pragmatic aspects that do not have a direct counterpart in the accounts of Cassirer and Carnap that inspired Friedman's dynamics of reason.

5. Pragmatic Aspects of Kuhnian Paradigms. Notoriously, Kuhn never gave a clear definition of what was to be understood by "paradigm". On the contrary, the concept of paradigm became famous for the variety of meanings that Kuhn and later many authors who followed him attributed to it. Famously, Masterman compiled not less than 21 different meanings (1) – (21) of the concept of paradigm that appeared already in *Structure* (cf. Masterman 1970, 61 - 66). The later Kuhn's introduction of "disciplinary matrix" and "structured lexicon" adds further items to Masterman's list. The following selection from Masterman's list should suffice to show that paradigms indeed possess a strong pragmatical component that intended to

capture the various roles paradigms played in the practice of science (Later I will provide philosophically more substantial evidence).

Perhaps the best-known pragmatic characterization of a paradigm is (1) that appears on the first pages of *Structure* and describes a paradigm "as a universally recognized scientific achievement ... that for a time provides model problems and solutions to a community of practitioners" (*Structure*, x). According to the similar description (5) a paradigm may be characterized as "some accepted examples of actual scientific practice from which spring particular coherent traditions of scientific research"; further, a paradigm can be seen as a "source of conceptual and instrumental tools" (10), as a "device or type of instrumentation" (12), "a machine-tool factory" (14), or as an "organizing principle" (18). There is no need to discuss these aspects and their relationship in detail here, it is evident that they go well beyond any purely theoretical conception of scientific knowledge. Even this rather cursory overview shows that one needs a lot of conceptual surgery to equate a paradigm in Kuhn's sense with a Carnapian "linguistic frameworks". To declare inessential all of the just mentioned pragmatic aspects would appear plausible to philosophers for whom only the formal carries philosophical weight.

A second look at the pragmatic aspects of the concept of paradigm reveals that they do some real work in Kuhn's approach in that they help defuse at least some of the charges that his approach subscribes to an implausible "idealism". Ian Hacking has shown that the pragmatic aspects of paradigms, may help solve the so called "new world" problem, i.e., Kuhn's contention that "though the world does not change with a change of paradigm, the scientist works in a different world" and that philosophers of science "must learn to make sense of statements that at least resemble these" (Kuhn 1970, 121).

The "new world thesis" makes proper sense only if we abandon the traditional philosophical stance that Dewey called the "spectator's view of world". Instead, we should adopt a pragmatic vision of the world according to which we are agents that *do* something in the world (cf. Hacking 1993, 280). Kuhn did exactly this, when he described a paradigm as a kind of communal platform of a working community that brought about not only the problems but also the solutions and the instrumental and conceptual tools that characterized the "world" as a working context of a community of active agents.

Because Kuhnian paradigms possess important pragmatic features they can capture not only the theoretical but also the pragmatic dimensions of scientific knowledge. These pragmatic features of a paradigm belong to the very core of this concept, they should not be considered merely as illustrations or elucidations that might help to this notion plausible or intuitively appealing. Hence, it is misleading to conceive Kuhnian paradigms just as informally presented Carnapian linguistic frameworks, since the latter lack pragmatic features. Till the very end of his philosophical career Kuhn insisted that "having a paradigm" was more than just “having a structure”: “You don’t have a structure unless you include in it at least a few examples.” (Kuhn 2000, 318). These “examples” were to be taken as blue-prints that organized the common scientific work of a community of practionners by providing for them model problems and solutions for them (cf. *Structure*, 10 - 11).[4]

To sum up: Kuhnian paradigms and Carnapian frameworks may be conceived as (non-equivalent) modern versions of a relativized synthetic a priori. A relative a priori that is to comprehend not only the theoretical but also pragmatical aspects of a Kuhnian paradigm should be a pragmatic a priori. In other words, any account of the dynamics of reason that aims to explicate the historicist character of scientific knowledge and its global continuitiy (in a sense to be specified) should comprise a theory of the relativized *pragmatic* a priori.

6. Toward a Theory of the Pragmatic A priori: Lewis and Beyond. In his days C.I. Lewis (1883 – 1964) was one of most prominent American philosophers, but today he is much lesser known than the other three classical great pragmatists Peirce, James and Dewey. So some introductory remarks on his life and philosophy may be in order.[5] Lewis may be characterized as the most Kantian of all pragmatists although of a rather peculiar kind. He is reported to have characterized himself as “a Kantian who disagrees with every sentence of the *Critique of Pure Reason*.” Beside Peirce he may be said to have been the “most logical” pragmatist. After having finished his dissertation “The Place of Intuition in Knowledge” (1911) under Royce his research interests switched to logic. He spent a lot of work to overcome the shortcomings of the standard extensional logic and may be considered as one of the founding fathers of modern modal logic. More generally, he considered the question of what should be considered as the “correct” logic of science or of our everyday reasoning as an empirical problem the solution of which had to take into account the empirical facts of the practice of scientific investigation. In the early 1930s he contacted Schlick and Carnap and invited them to make an effort to overcome the gap between the two philosophical currents of Logical Empiricism and American Pragmatism. For him, practice played a constitutive role in experience. In agreement with all other classical pragmatists Lewis contended that experience is active and interferential. It is shaped by interactions with our surroundings and our specific interests and habits as agents. Beside the strict separation between facts and values, this thesis was one of the key differences between the two traditions of scientific

[4] In his later works, when he preferred to speak of „disciplinary matrices“ and „lexica“ instead of „paradigms“ once he even used the term „synthetic a priori“ for those elements of a theory that must be stipulated in order to apply it. He insisted that some such stipulations had to be made even if they were not uniquely determined (cf. Kuhn 1990, 306, 317).

[5] For comprehensive presentations of Lewis’s life and work the reader may consult Murphey (2005) or Rosenthal (2007); for a succinct presentation of Lewis’s philosophy, and a comparison of his views with those of Carnap and Quine, the reader may consult Baldwin (2007).

philosophy of logical empiricism and pragmatism.[6] In the end, this project was less than successful. Both movements did not succeed in finding a closer rapprochement and remained reserved allies each pursuing its own projects. For a final assessment of this issue from Lewis's side, see (Lewis 1941).

A first sketch of his theory of a pragmatic *a priori* is to be found in his paper *A Pragmatic Conception of the A priori* (Lewis 1922), in *Mind and the World Order* (MWO, Lewis 1929) he presented his account in mature form, further elaborations may be found in his later book *An Analysis of Knowledge and Valuation* (Lewis 1946). In this section first we will recall the essentials of Lewis's account as presented in MWO and some early papers pointing at some interesting affinities between Lewis's account of the pragmatic a priori with Kuhn's paradigms; then we will discuss the reconsideration of Lewis's ideas recently proposed by Chang (2008) and finally we will point at some possible points of encounter that Lewis's account of the pragmatic a priori may have with some recent developments in cognitive science, particular with Lakoff's theory of human embodied rationality (cf. Lakoff (1986), Lakoff and Núñez 2000).

Following Reichenbach, one may distinguish in Kant's concept of the *a priori* an apodictic and a constitutive moment (cf. Friedman 1999, chapter 3).[7] Lewis's notion of the a priori only keeps the constitutive element. For him, the *a priori* in the empirical sciences is always relative and local. There need not be a universal agreement on what is to be conceived as a priori nor complete historical continuity (cf. MWO, 239). Even the *a priori* principles of logic, which represent the most stable of our categories, and are least likely to be affected by the opening of new ranges of experience, are not beyond the possibility of alteration (ibid.). On the other hand, the a priori exhibits a certain kind of necessity in that it is true *no matter what* experience may bring. The acceptance of a set of concepts as a priori is a matter of decision or legislation, something for which there are alternatives, but for which the criteria are not empirical but pragmatic. The necessity of the *a priori* has nothing to do with inescapability. On the contrary:

> The *a priori* has its origin in an act of mind; it has in some sense the character of fiat and is in some respects like deliberate choice. The *a priori* is a peculiar posse-ssion of mind because it bears the stamp of mind's creation. (MWO, 213)

Consequently

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[6] For a comparison between Carnap's „pragmatism" and the pragmatism of the American pragmatists, see Richardson (2007).

[7] For Reichenbach the a priori as a „contribution of reason is not expressed by the fact that the system of coordination contains unchanging elements, but in the fact that arbitrary elements occur in the system" (Reichenbach 1920/1965, pp. 88-89). Lewis in (MWO) proposes a similar characterization: „The *a priori* ... represents the contribution of the mind itself to knowledge, it does not require that this mind be universal, or absolute ... . The determination of the *a priori* is in some sense like free choice and deliberate action" (MWO, 231, 233).

> The paradigm of the a priori in general is the definition. It has always been clear that the simplest and most obvious case of truth which can be known in advance of experience is the explicative proposition and those consequences of definition which can be derived by purely logical analysis.
> ...
> If experience were other than it is, the definition and its corresponding classification might be inconvenient, useless, or fantastic, but it could not be false. (MWO 239)

The best historical example of such an analytical *a priori* is mathematics. It would not be entirely misleading to assert that traditional conceptions of the a priori are the historical shadow of Euclidean geometry (MWO, 240-241). But Euclidean geometry gave the wrong impression that the *a priori* were unique and apodictic. The invention of non-Euclidean geometries should be taken as evidence that the true a priori of scientific knowledge should be taken as an *a priori* of a different kind that does not insist on uniqueness and apodicticity (MWO, 242). Rather, an essential feature of any *a priori* component in knowledge is that it could have been chosen differently.

In order to grasp the specific character character of Lewis's account of the *a priori*, it is important to note that for him the *a priori* element in the empirical sciences goes beyond the mathematical:

> All order of sufficient importance to be worthy of the name of law depends eventually upon some ordering by mind. Without initial principles by which we guide our attack upon the welter of experience, it would remain forever chaotic and refractory. In every science there are fundamental laws which are a priori because they formulate just such definitive concepts or categorial tests by which alone investigation becomes possible. (MWO, 254)

As an example of such an operational *a priori* Lewis discusses in detail Einstein's definition of simultaneity for events at a distance.[8] It is a *stipulation* that one can make of one's own freewill in order to arrive at a definition of simultaneity (cf. MWO, 256). In other words, Einstein's definition of simultaneity is an a priori law. Only by presupposing such a law one can enter upon the investigation by which further laws are sought. This is to be generalized as follows:

> Indeed *all* definitions and *all* concepts exercise this function of prescribing fundamental law to whatever they denote, because everything which has a name is to be identified with certainty only over some strech of time. (MWO, 257)

> The *a priori* element in knowledge is pragmatic, not empirical. It is present whenever there is classification, interpretation, or the distinction of real from unreal – which means that it is present in all knowledge (cf. (MWO, 266)). Yet it should also be pointed out that, in Reichenbach's terminology, Lewis's *a priori* is constitutive but not apodictic. Lewis again and again emphasized that *a priori*

[8] For a defence of Lewis's interpretation of Einstein's definition of simultaneity against certain modern objections see Stump (2009, section 2).

laws in his sense are subject to abandonment if the structure, which is built upon them, does not succeed in simplifying our interpretation of the phenomena.

This brief review of the most important features of Lewis's pragmatic *a priori* suggests that Kuhnian paradigms may be conceived as systems of pragmatic *a priori* in that they provide frameworks for the conceptual and practical activities and operations of a community of scientists for some time.[9] Pragmatic *a prioris* as well as Kuhnian paradigms determine what is to be understood as a meaningful problem and what counts as a solution, what methods are admissible and what are the standards according to which the results are assessed. To put it in a nutshell, then, in a paradigm "knowledge, action and evaluation are essentially connected" (Lewis 1946, 5). This entails that paradigms cannot be equated with theories or languages not even with "worldviews" since this would underestimate their pragmatic and operative character.

Hasok Chang has recently reconsidered Lewis's concept of the pragmatic *a priori* in his *Contingent Arguments for Metaphysical Principles* (Chang 2008). As Chang remarks, although there may be no direct contradiction between Lewis's remarks and Friedman's statements about the *a priori*, the difference of emphasis is very clear. Lewis's emphasis on the freedom of choice tends to go against Friedman's "universalist" (Chang) account of scientific reason that insists on a rather strict conception of "continuity" (cf. DR, 66).

In modern mathematics "continuity" is a variable we can stipulate a function to be continuous according to our needs. Hence, in the spirit of Cassirer's mathematical philosophy of science the problem of the continuity of scientific reason should not be treated as a question of yes or no, rather, the problem is to formulate a good concept of continuity. Thus, proposing a concept of the a priori that takes into account the pragmatic features of the a priori should not be understood as an attempt to refute Friedman's project of devising a continuous dynamics of reason but rather as an attempt to enhance it.

Going beyond Lewis's rather sketchy remarks, Chang proposes as an essential task of a theory of the pragmatic a priori to give an account of the "epistemic and conceptualizing activities of an embodied subject" whereby these activities can be carried out meaningfully only if certain a priori principles are satisfied. In a first approximation, then, such a theory of the pragmatic apriori can be conceived as a list of such "principle-activity" pairs (cf. Chang 2008, 125ff). Fortunately, philosophy need not develop a theory of the "epistemic activities of an embodied subject" from scratch. For some two decades now, cognitive scientists have been engaged in the task of elaborating such a theory as part of cognitive science (cf. Lakoff 1986, Lakoff and Núñez 2000).

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[9] Baldwin (2007) points out that there are important similarities between Lewis's *a priori* principles and the „L-rules" of Carnapian languages (Baldwin 2007, 189). This is correct as far as it goes. This comparison misses an important aspect, however, since the *„L-apriori"* , to dub it thus, does not have any pragmatic features.

In contrast to the traditional approach in epistemology that conceives reason is abstract and disembodied the new account emphasizes that

> Thought is *embodied*, that is, the structures used to put together our conceptual systems grow out of bodily experience and sense in terms of it; moreover, the core of our conceptual systems is directly grounded in perception, body movement, and experience of a physical and social character.
>
> - Thought is imaginative, in that those concepts which are not directly grounded in experience, employ metaphor, metonymy, and mental imagery – all of which go beyond the literal mirroring, or representation, of external reality. ... every time we categorize something in a way that does not miror nature, we are using general human imaginative capacities. (Lakoff 1986, xiv)

The embodied human reason, is not an instantiation of transcendental reason, it grows out of the biological nature of the organism. This fact not only marks the more mundane parts of common sense reasoning but also holds for the most abstract reasoning, e.g. mathematics. Although mathematical structures may be defined in the abstract framework of set theory this often leads to artificial constructions hardly used in mathematical practice; moreover, there is no unique notion of a set (cf. Mac Lane 1986, 455). According to Mac Lane the real nature of these structures lies in their relation to basic human activities. In this regard, Mac Lane proposed a list of "human activities, each one of which leads more or less directly to a corresponding portion of mathematics" a part of which is the following (cf. Mac Lane 1986, 35):

Activity	Idea	Formalization
Collecting	Collection	Set of Elements
Computing	Combination of Numbers	Addition, Multiplication
Timing	Before and After	Linear Order
Observing	Symmetry	Transformation Group
Measuring	Distance, Extent	Metric Space
Estimating	Approximation	Continuity, Limit

Lakoff (1986) and Lakoff and Núñez (2000) compile many more lists of this kind (cf. Lakoff (1986, 361ff), Lakoff and Núñez (2000, Part I - III). They make an essential step beyond Mac Lane by offering a detailed empirical theory based on findings of cognitive science and neuroscience of how the aweful edifice of modern mathematics was erected from the humble beginnings of the primitive activities of collecting, observing and so on that we share with many of our animal relatives.

The key concept of their approach is the notion of conceptual metaphor. According to them, mathematics is a conceptual system based on our mundane reasoning grounded in the sensory motor system of our bodies and generated by conceptual metaphors. For instance, elementary arithmetics is a conceptual system generated by four grounding metaphors: “object collection”, “object construction”, “the measaring stick” and “motion along a path”. Conceptual metaphors are structured schemata of the form

$$S \Rightarrow T$$

S being the source domain and T the target domain of the conceptual metaphor, respectively, while $\Rightarrow$ is to be interpreted as a conceptual mapping that maps entities of the source domain into that of the target domain. The primary function of conceptual metaphors is to allow us to reason about relatively abstract domains T in terms of relatively concrete domains S (cf. Lakoff and Núñez 2000, 42). An important feature of conceptual metaphors is that they may be iterated in such a way that we obtain ever more complex metaphorical nets. As Lakoff and Núñez (2000) show in detail the construction of such metaphorical networks allows us to reach, i.e. to constitute, ever-higher levels of mathematical conceptualizations.[10]

Chang offers a list of a somewhat different type (cf. Chang 2008, 127):

Epistemic Activity	Metaphysical Principle
Counting	Discreteness
Prediction	Uniform Consequence
Explanation	Sufficient Reason
Narration	Subsistence
Ordering	Transitivity
Assertion	Non-Contradiction

He not only considers activities that are more or less directly related to mathematical theories but seeks to provide an account of the pragmatic a priori that comprises general epistemic activities and their underlying principles as they appear in any kind of science.

With a little good will, then, one may interpret the a priori principles of Lewis and Chang as being encapsulated in Mac Lane’s “ideas” *cum* “formalizations”. As Chang rightly emphasizes and what is amply confirmed by the research on the issue of the “rationality of the embodied mind”

> … there is a large element of choice in the types of epistemic activities we enter into. I would like to say the synthetic a priori only exists in a contingent way - not

[10] Lakoff and Núñez’s „conceptual metaphors“ are structurally and conceptually similar to „morphisms“ in the sense of the mathematical category theory one of whose founding fathers was Mac Lane (cf. Mac Lane (1982). Certainly, this is no coincidence.

> as universal conditions of human cognition, but as local conditions of particular brands of cognition. (Chang 2008, 122)

Putting more weight on the pragmatic aspects of the a apriori has the advantage not only of a greater freedom than Friedman's account of the evolution of scientific reason, it also offers better chances to conceive this evolution as continuous, since the requisites for being continuous are less demanding.

As Chang remarks (130), in real science we are hardly ever engaged in the simple practices that have been discussed in this section. Rather, the practices of real mathematics, physics, or of any other science are more complex than those encapsulated in the (principle, activity) pairs mentioned so far. Hence, the sketch of a theory of the pragmatic apriori presented here may seem to be utterly inadequate. Here, Kuhnian paradigms may come to the rescue. One may conceive Kuhnian paradigms as complex systems of pragmatic aprioris or systems of activity-principle pairs that determine the scientific practice of a scientific community for some time. A scientific revolution takes place when essential components of such a system are replaced by new ones as might happen under certain circumstances:

> In the typical case in which old methods of interpretation are discarded in favor of new ones, it requires new empirical data, which offer some difficulty of interpretation in the old terms, to bring about the change. ... The advantage of the change must be considerable and fairly clear in order to overcome human inertia and the prestige of old habits of thought. (MWO, 269)

An important trigger for changing an established system of pragmatic a prioris is the invention of new machines, measuring instruments and experimental set ups that sometimes lead to totally new problems, perspectives, and solutions. As examples Lewis briefly mentioned the invention of the telescope and microsope that have led to an alteration of our categories of perception (cf. MWO (268)). Since the advent of "big science" the importance of this kind of "instrumental a apriori" has steadily grown. To have some concrete examples, think of a particle collider such as the Large Hadron Collider (LHC) in Geneve designed to collide opposing particle beams or the new types of protein sequencers in molecular biology. These machines allow to formulate questions and eventually to solve problems that before the advent of these machines did not make sense at all. These machines provide something like a complex material apriori that determines for some time the practice of a scientific community.

<u>7. Concluding Remarks.</u> Friedman's a priori is tailored for the needs of a strictly theoretical account of scientific knowledge, whose classical formulation may be found in, say, *Philosophy and Logical Syntax* (Carnap 1935) where Carnap put forward the equation

(ibid., 32). Pragmatic aspects of scientific knowledge are explicitly said not to belong to science proper, and a fortiori they are not an issue for philosophy of science proper. This stricly theoretical philosophy of science is in stark contrast with the philosophy of science favored by pragmatists such as James, Dewey, and Lewis. As Lewis so succinctly put it at the very beginning of *An Analysis of Knowledge and Valuation* (Lewis 1946):

> Knowledge, action, and evaluation are essentially connected. The primary and pervasive significance of knowledge lies in its guidance of action; knowing is for the sake of doing. And action, obviously, is rooted in evaluation. For a being which did not assign comparative values, deliberate action would be pointless; and for one which did not know, it would be impossible. Conversely, only an active being could have knowledge, and only such a being could assign values to anything beyond his own feelings. (Lewis 1946, 5)

Recall once more Kuhn's characterization of a paradigm "as a universally recognized scientific achievement ... that for a time provides model problems and solutions to a community of practitionners" (*Structure*, x). Kuhn subscribed to a pragmatic account of scientific knowledge for which "knowledge, action and evaluation are essentially connected", see in particular (Kuhn 1977).

This connection makes it difficult to maintain a rational discourse between scientists that subscribe to rival paradigms, since they employ different criteria for assessing the advantages and disadvantages of rival theories. This entails, in particular, different standards of values. Kuhn never claimed that a rational discussion were impossible *tout court*, yet he insisted however on the fact that the rationality of such a discussion was not the ordinary scientific rationality. The main reason for this is that the rationality of these discussions was not an ideal rationality of a disembodied transcendental scientific reason but a historically situated local reason whose criteria and values could not be abstracted from the historical circumstance and moreover might change over time. Thus, one may conceive the interparadigmatic rationality envisaged by Kuhn as a sort of practical or communicative rationality in Habermas's sense. Carnapian linguistic frameworks lack these value-related aspects, they are outsourced to the „practice of science" that allegedly is of no concern for philosophy of science proper:

> The acceptance or rejection of linguistic forms ... will finally be decided by their efficiency as instruments, the ratio of the results achieved to the amount and complexity of the efforts required ... the work in (any scientific) field will sooner or later lead to the elimination of those forms which have no useful function. (Carnap 1950, 40).

In other words, Carnap conceived the competition between rival linguistic forms as analogous to „the struggle for life“ within individuals in biological evolution. Evidently, in the case of linguistic forms, this selection process involves a complex net of preferences, evaluations and practical assessments. But for Carnap this fact was not an issue of philosophy of science proper but belonged to the “pragmatic of science” that .[11]

According to Dewey, James, or Lewis science was not a set of results or a system of scientific theorems, but rather a process or an activity, an organized practice to solve problems. In concentrating exclusively on the theoretical aspects of scientific reason Friedman’s dynamics of reason does not take into account an essential component of reason’s continuity, namely, the unity of reason determined by the unity of practice. Actually, this restriction is not necessary. Friedman’s key concept of the relativized *a priori* can be pragmatized in a natural way thereby making room for pragmatism in the dynamics of scientific reason resulting in a better, more realistic description of the real dynamics of scientific reason - least, that’s I have argued for in this paper. Moreover, a pragmatist understanding of scientific reason that takes into account the intimate connection between knowledge, action and evaluation may be better prepared to make its contribution to “the ongoing dialectic of human knowledge” (DR, 24) than an abstract, purely instrumental philosophical reason that has to compete with mathematics as a tool for ensuring the global continuity of scientific reason (cf. Richardson 2002).

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[11] This is not to deny that Carnap’s philosophy of science exhibits some pragmatic features. As Richardson points out, Carnap himself believed that his own philosophy possessed considerable pragmatic elements (cf. Richardson 2007, 297). „Real“ pragmatists such as Lewis did not agree, to put it mildly. For a discussion of this issue, see (Mormann 2007).

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