On the Fall of Reichenbach's Contexts
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The distinction between the "context of discovery" and the "context of justification" in philosophy of science appears simple at first, but contains interesting complexities. Paul Hoyningen-Huene has catalogued some of these complexities and suggested that the core usefulness of the "context distinction" is in distinguishing between descriptive and normative perspectives. Here I expand on Hoyningen-Huene's project by tracing the label "context of discovery and context of justification" to its origin. I argue that, contrary to initial appearances, Hans Reichenbach's initial context distinction from 1938 does not easily map onto Hoyningen-Huene's distinction between descriptive and normative perspectives on science. However, this is not a reason to reject Hoyningen-Huene's simplified context distinction, nor do I recommend returning to Reichenbach's initial proposal. It is, however, further reason to believe that the context distinction does not have a single, easily understood meaning. Along the way, I revisit Reichenbach's version of a "rational reconstruction" and highlight its usefulness as a tool for philosophy in general.

Contents:

The scientist may use platonic class constructions, complex numbers, divination by inspection of entrails, or any clap-trappery that he thinks may help him get the results he wants. But what he produces then becomes raw material for the philosopher, whose task it is to make sense of all this: to clarify, simplify, explain, interpret in understandable terms. The practical scientist does the business but the philosopher keeps the books.
- Nelson Goodman, *Problems and Projects (1972, p. 168)*

I. Introduction[1]

How is philosophy of science distinct from other fields of science studies? One traditional answer is that philosophy addresses issues about evidence and justification for scientific claims, whereas other fields study the contingent events and attitudes leading up to those claims. This is commonly dubbed the *distinction between the "context of discovery" and the "context of justification"* (DJ or "context distinction"). For example, the arguments and evidence for the theory of relativity would be considered part of the context of justification, while the biographical details of Einstein's life would be considered part of the context of discovery.

For many years, DJ was taken to be a starting point for philosophy of science, delineating the job of philosophers from historians, sociologists, etc. (Steinle and Schickore 2006). After Kuhn, the distinction was reexamined; some scholars threw it out entirely, arguing that it is too restrictive to focus on the content of a scientific argument while setting aside or ignoring the historical context in which the science was developed. Debates ensued with little resolution. (A colleague, reluctant to reopen this can of worms, has called DJ "the dreaded distinction"). Some philosophers continued to focus on the content of scientific theories without reference to the historical background. Others explored historical cases in more detail (Nelson 1990, Anderson 1995). Unfortunately, discussion across the divide was limited for a long time.

Some scholars, however, have closely examined the basis for both the rejection and the acceptance of the distinction (Schickore and Steinle 2006, Kellert 2008). Most notably, Paul Hoyningen-Huene has cataloged several different possible interpretations and uses of the context distinction (Hoyningen-Huene 1987, 2006). Hoyningen-Huene suggests that the core usefulness of this distinction is in distinguishing descriptive and normative perspectives.

Specifically, the context of discovery, he argues, is in its essence referring to a descriptive perspective on science, while the context of justification corresponds to a normative perspective (Hoyningen-Huene 2006).

In this paper, I expand on Hoyningen-Huene's project by tracing the phrase "context of discovery and context of justification" to its origin. I examine one early and extremely influential description of the context distinction and I argue that, contrary to initial appearances, this initial context distinction does not easily map onto Hoyningen-Huene's distinction between descriptive and normative perspectives on science.

Hans Reichenbach introduced the phrases "context of discovery" and "context of justification" in his 1938 *Experience and Prediction,* one of the first books he wrote in English after being exiled from Germany.[2] As I will argue, Reichenbach's context distinction does not line up as a clear distinction between descriptive and normative perspectives; for Reichenbach the context of justification is a blend of normative and descriptive perspectives, with a surprising emphasis on the descriptive. Reichenbach does discuss the importance of a normative perspective, but places this strongly normative perspective outside of the context distinction entirely.

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[2] While the idea has arguably been around much longer (see Hoyningen-Huene 1987, p 502-503, , Reichenbach coined the English phrases "context of discovery" and "context of justification." He mentions the context distinction at least once in German in a 1935 letter to *Erkenntnis* entitled "Zur Induktion-Machine" where he distinguishes between "Auffindungsverfahren" (discovery processes) and "Rechtfertigungverfahren" (justification processes). However, he offers very little explanation, instead directing the reader to his forthcoming book (Reichenbach 1935). Some attribute the distinction to Karl Popper, who first mentions something like it in *Logik Der Forschung* (1934). Referring to Kant's *quid facti* and *quid juris*, Popper distinguishes between "Tatsachenfragen" and "Geltungsfragen," which he translates as "questions of fact" and "questions of validity" respectively for the English edition (1959). Reichenbach and Popper corresponded on these ideas at the time, so some overlap is to be expected even as their conceptions of the distinction differed.

In this paper, I do not seek to evaluate the context distinction (I do that elsewhere; see Author 2010, Author 2009). I do not endorse returning to Reichenbach's original use of the context distinction, and I even agree that Hoyningen-Huene's proposed version of the context distinction can be useful. However, if Hoyningen-Huene's proposal for a "core" essence of the context distinction is incompatible with at least one influential version of the context distinction, then this is support for the idea that the context distinction does not have a single, easily understood meaning. My findings suggest that common ground is more elusive than many think; when we uncover the many meanings and uses of the context distinction, we find fewer, not more, points of agreement.

In the following section, I briefly sketch Paul Hoyningen-Huene's suggestion that we think of the context distinction as a distinction between "descriptive" and "normative" perspectives. It will serve as a point of contrast from which to ask questions about and understand the nuances of Reichenbach's own use of the distinction. Then, I turn to Reichenbach's text. I offer a close reading of the passages in which the context distinction first appears. Reichenbach's primary focus here is to explain the four tasks: the task of psychology, and the descriptive, critical, and advisory tasks of philosophy. It is here that Reichenbach mentions the context distinction, as a way of distinguishing the tasks. I will argue that Reichenbach's context distinction does not distinguish between the task of psychology on one hand, and the three other tasks on the other, as is commonly understood. Rather, I show that Reichenbach uses the context distinction to distinguish between the task of psychology on one hand, and the descriptive task on the other. As a result, the critical and advisory tasks are left out of the context distinction entirely. Using this analysis, I return to Hoyningen-Huene's Lean DJ and show that it does not easily fit with Reichenbach's DJ.

Prominent in these passages is Reichenbach's notion of *rational reconstructions*. Since my reading suggests that Reichenbach's notion of rational reconstructions is importantly different from more well-known accounts of rational reconstructions, such as those put forth by Rudolf Carnap (1928) and Imre Lakatos (1970), I will compare his account with those other accounts. In the end, rational reconstructions as described by Reichenbach turn out to be an incredibly useful philosophical tool. Although I do not necessarily endorse Reichenbach's version of the context distinction, I do recommend using rational reconstructions as Reichenbach defines them.

II. Hoyningen-Huene's "Lean" DJ distinction

One promising line of research is to catalogue the different uses and meanings of the distinction. If we can see that scholars in the debate mean different things, this will help us to identify common ground. Paul Hoyningen-Huene has attempted to do just that. After offering an impressive catalogue of the arguments in the early debates over the distinction, Hoyningen-Huene argues that he has found one universal point of agreement:

> Actually, I do believe that there is a core of the DJ distinction that has, to the best of my knowledge, never been attacked in the discussion about it. …What I have in mind is the distinction between the factual on one hand, and the normative or evaluative on the other hand. … *From the descriptive perspective*, I am interested in facts that have happened, and their description. Among these facts may be, among other things, epistemic claims that were put forward in the history of science, that I may wish to describe. *From the normative or evaluative perspective*, I am interested in an evaluation of particular claims. In our case, epistemic claims, for instance for truth, or reproducibility, or intersubjective acceptability, or plausibility, and the like are pertinent. Epistemic norms (in contrast to, say, moral or aesthetic norms) govern this evaluation. By using epistemic norms we can evaluate particular epistemic claims according to their being justified or not. (Hoyningen-Huene 2006, p. 128-9, emphasis added)

Here Hoyningen-Huene suggests that the controversies surrounding the distinction focus on extraneous features that various authors have added to the distinction and that at its core the

distinction is much less controversial. He offers a "lean" DJ distinction that purportedly isolates the core features of DJ: rather than thinking about the contexts of discovery and justification as processes or events in time, we should think of them as *perspectives*. The part of the context of discovery on which everyone would agree, he claims, corresponds to *a perspective from which one asks about the facts of a scientific case*. The core part of the context of justification, he argues, corresponds to *a perspective from which one asks about the justification of a science claim*. As Sturm and Gigerenzer put it:

> The point of [Hoyningen-Huene's lean] version … is that we should distinguish between different types of *questions*: For any given claim p, we can always ask, "How did someone come to accept that *p*?" This question, which may be understood as a question about the generation or actual acceptance of a claim, differs in principle from the question, "Is *p* justified?" (Sturm and Gigerenzer 2006, p.134)[3]

While many disagree on what is relevant to the "context of discovery," these authors argue that scholars mostly agree that there is a useful distinction between the descriptive and the normative (Hoyningen-Huene 2006, p. 129). This view suggests that discussion of historical context and biographical information is a red herring, since the real issue is the difference between *describing* a scientific discovery and *evaluating* that discovery. Once we agree that the key distinction concerns descriptive v. normative, we can go on to discuss whether historical information is necessary for evaluating the scientific discovery or whether the two are intertwined (Hoyningen-Huene 2006, p. 129).

I applaud Hoyningen-Huene's efforts to identify the true points of agreement and disagreement behind the vague label "contexts of discovery and justification," and I am tempted by the tidy new version of the distinction he has offered. I certainly agree that it could be useful in some discussions. However, I suspect that even this distinction between

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[3] This description is even more specific than Hoyningen-Huene suggests, but I think it nonetheless nicely captures the general attitude of the proposed distinction.

the descriptive and normative is not without its problems. At the very least, I argue, the "core" identified by Hoyningen-Huene is not universal to all versions of the context distinction after all. Reichenbach's use of the distinction is extremely influential, if not foundational, to the use of the distinction in philosophy of science and yet, as I will demonstrate, Reichenbach's context distinction does not line up with Hoyningen-Huene's descriptive v. normative distinction.

III. Reichenbach's Four Tasks

As a founding member of the Berlin Circle, the intellectual cousin of the Vienna Circle, Reichenbach was associated with logical empiricism and its aim to develop methodological principles for characterizing scientific theories; these principles were to be informed by and based on the best science of the time.[4] Where other proposed principles include verificationism and Popper's falsificationism, Reichenbach defends his own proposal that induction is the basis of all science. The bulk of *Experience and Prediction* is dedicated to surveying rival proposals and defending his own, especially against Hume's problem of induction.

The context distinction appears briefly at the beginning and the end of the volume. Don Howard shows how this brief mention of the context distinction is part of an on-going conversation with members of the Vienna Circle. In particular, it is a quick response to Otto Neurath's claim that science is inevitably political (Howard 2011, pg. 62-63). It is significant, I think, that the distinction is relegated to the margins of Reichenbach's broader project. While in many ways it serves as a foundation, the distinction is not the focus of

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[4] To what extent the philosophy was to inform the science, or the science was to inform the emerging philosophy, is a matter of dispute. See Friedman (1996, p. 182-185).

Reichenbach's attention. He offers it in passing to clear up "misunderstandings" (6).[5] He seems to assume, as others did for years following, that once the distinction between discovery and justification was made, it would be accepted as obviously useful.

Yet Reichenbach's meaning of the distinction is far from obvious. Since the context distinction has taken on so many meanings over the years, it is important not to read anachronistic meanings into Reichenbach's DJ. Thus, I seek to explain in detail the context of the passage in which he introduces the phrases "context of justification" and "context of discovery" in order to allow us to see the role these contexts play for him rather than for us.

In the first few pages of *Experience and Prediction*, Reichenbach introduces what he takes to be the one task of psychology and the three tasks of epistemology (or philosophy[6]): the descriptive, critical, and advisory tasks.

The first task that Reichenbach outlines is the *task of psychology*. Philosophers of science, Reichenbach charges, should not engage in this task. Instead, he argues, philosophers should first take care to *describe* the body of knowledge presented by scientists by looking at the arguments these scientists use to reach their conclusions, but not necessarily at every thought that went into creating the argument (5). Second, Reichenbach says that philosophers should *criticize* or analyze those arguments to see whether they can be interpreted as proper scientific arguments when measured against the preferred meta-methodology (for Reichenbach, induction) (5-6). Finally, he explains how philosophers should *advise* scientists on the logical consequences of the decisions they must make.

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[5] All page references to Reichenbach refer to (1938), unless otherwise noted.
[6] Reichenbach's use of "epistemology" is much closer to common use of "philosophy" today. See Uebel (2007, p. 6). Here I use both interchangeably.

Reichenbach's primary aim in this first chapter is to explain these four tasks. He introduces the distinction between the context of discovery and the context of justification as a way of explaining them (6-7). As many readers of Reichenbach have noted, when Reichenbach introduces the context distinction, his general point here, which we will explore in detail below, is that philosophers should analyze a rational reconstruction of the thought process of a scientist, and should not analyze the actual thought process itself. It can be argued that this spirit of the distinction is more or less in line with contemporary uses of the context distinction, as outlined by Hoyningen-Huene and others (Hoyningen-Huene 1987, 2006; Howard 2006; Stadler 2011, p 141).

However, as I will show below, there is a subtle but important clarification that is often missed, namely that for Reichenbach the rational reconstruction may itself have logical errors. Moreover, many readers of Reichenbach have also characterized the context distinction as distinguishing between the task of psychology on one hand (as part of the context of discovery), and the three tasks of philosophy on the other hand (as part of the context of justification). I will argue below that this is an incorrect reading. Rather, Reichenbach is using the context distinction to distinguish the task of psychology from the descriptive task of philosophy. I will argue that the critical task and advisory task are left out of the context distinction entirely. This result is somewhat surprising. Yet, as Reichenbach writes, "many false objections and misunderstandings of modern epistemology have their source in not separating these *two tasks*," the task of psychology and the descriptive task (6, emphasis added).

If Reichenbach is using the context distinction to distinguish the task of psychology from the descriptive task (rather than the task of psychology from all three of the philosopher's tasks together), one might ask whether this surprising result matters. One reason why it is important is because it reveals that Reichenbach's actual vocabulary is out of sync with more contemporary uses of the "context of discovery" and "context of justification." This is further evidence that the

"context distinction" terminology is ambiguous and that perhaps there is no "core," universally accepted meaning to the distinction between the context of discovery and the context of justification. It is surprisingly difficult to pin down exactly what is meant by this distinction.

To show the evidence for my reading, I will examine each of these four tasks in turn, and identify the role that the Reichenbach's context distinction plays in these four tasks.

1. Task of Psychology

According to Reichenbach, the task of psychology is to describe the actual thinking process of the scientist. Reichenbach acknowledges that our thoughts in daily life are not very logical. He maintains that the thinking of a scientist does not need to be particularly logical, either: "The scientific genius has never felt bound to the narrow steps and prescribed courses of logical reasoning" (5).

For example, the psychologist could study Einstein to understand his thought process when he developed the theory of relativity. (It is unclear how this is supposed to happen: perhaps by talking to him, reading his correspondence, or observing his work habits.) A full account of the thought process might include, for example, the trial-and-error of discovery or how Einstein drew associations between clock synchronization at train stations and conceptions of space and time (see especially Galison 2003).[7] The goal of the task of psychology would be to understand how scientists think, using, say, Einstein as a case study.

However, Reichenbach concludes, philosophers should not engage with the task of psychology. Reichenbach writes, "There is a great difference between the system of logical

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[7] Although he mentions his friend and mentor Einstein frequently, Reichenbach does not offer examples as explicit as this. I draw upon (Galison 2003) for this example.

interconnections of thought and the actual way in which thinking processes are performed. The psychological operations of thinking are rather vague and fluctuating processes..." (5).

He argues it would be a mistake to look at the thought process of a scientist to determine whether the scientist's theories are justified. Since, according to Reichenbach, scientific thought as it occurs in real time is not logical, he concludes, "It would be, therefore, a vain attempt to construct a theory of knowledge which is at the same time logically complete and in strict correspondence with the psychological processes of thought" (5). Instead, he proposes that the philosopher should look at the "rational reconstruction" of the scientist's thought process. Creating this rational reconstruction is the philosopher's first task, the descriptive task.

2. The Descriptive Task

The primary purpose of the descriptive task is to create a rational reconstruction of the scientist's thought process. Whereas the psychologist describes the actual thinking process of the scientist, the philosopher should be interested in the *idealized version* of that thinking process, according to Reichenbach. The goal of the descriptive task is to create a "cleaned up" version of the scientist's thought process, which Reichenbach calls a "rational reconstruction" (5).

To create such a rational reconstruction, according to Reichenbach, remove unnecessary information and include logical connections (both explicit and implicit). During this descriptive task, do not evaluate the scientist's thought process or theories, but instead prepare the thought process for analysis and evaluation, which will occur in the text task, the critical task.

One might be tempted at this point to conclude that, according to Reichenbach, the psychologist studies how scientists actually think while the philosopher studies how scientists ought to think. However, this conclusion would be misleading in a subtle, and important, way.

Crucially, the rational reconstruction must retain any logical errors, according to Reichenbach (6). This distinguishes Reichenbach's notion of rational reconstruction from that of others (such as Carnap or Lakatos, which I will explain in more detail below). Reichenbach expects any illogical steps that occurred in the scientist's thought process to be included in the rational reconstruction, though now these logical errors would be easier to see. Reichenbach writes,

> We must retain the notion of the descriptive task of epistemology. The construction to be given is not arbitrary; it is bound to actual thinking by the postulate of correspondence. It is even, in a certain sense, a better way of thinking than actual thinking. In being set before the rational reconstruction, we have the feeling that only now do we understand what we think; we admit that the rational reconstruction expresses what we mean, properly speaking. (6)

According to Reichenbach, if the original thought process is not logical, the rational reconstruction should reflect that, and remain an accurate report of the thought process. "Although the description as it is here meant, is not a copy of actual thinking but a construction of an equivalent, it is bound by the postulate of correspondence and may expose knowledge to criticism." (8)

So the descriptive task really is a descriptive perspective. During the descriptive task, the philosopher is charged with creating a rational reconstruction that describes the thought process of the scientists, taking care to accurately represent the logical connections of the thought process, even if those logical connections contain logical errors.

We can now see that both the psychologist and the philosopher describe aspects of scientific research, but each describes a different aspect (see Chart 1). However, while the task of psychology is entirely descriptive, the descriptive task does include a normative aspect to it. That is because the rational reconstruction is constructed using normative elements to determine what to include and what to leave out. As Reichenbach writes, "The fictive set of operations occurring here [in the rational reconstruction] is chosen from the point of view of justifiability" (7).

So we see that the descriptive task of philosophy is *both* descriptive and normative. However, the descriptive task is not the task during which the thought process is itself evaluated. That evaluation occurs in the critical task, which Reichenbach is clear to distinguish from the descriptive task.

This is the crux of my argument: Reichenbach's descriptive task cannot be characterized as a strictly a normative perspective. More specifically, Reichenbach's version of a rational reconstruction does not line up with what Hoyningen-Huene defines as a normative perspective ("Is P justified?"). Since this is such an important point, I will return to it below and consider possible objections. In particular, I will show that the descriptive task of philosophy (the purpose of which is to create a rational reconstruction) is what Reichenbach means by the context of justification. This means that Reichenbach's context of justification does not correspond with a "normative perspective." I will also explain Reichenbach's account of rational reconstructions in more detail. However, to first understand the setting in which the distinction is presented, let us continue the explanation of Reichenbach's four tasks.

3. The Critical Task

As I described above, the purpose of Reichenbach's descriptive task for philosophers of science is to *describe* the body of knowledge presented by scientists. During that task, the philosophers should not look at conclusions, rather but at the arguments these scientists use to reach their conclusions (5).

The descriptive task is distinct from the critical task. Reichenbach writes, "In addition to its descriptive task, epistemology is concerned with another purpose which may be called the *critical task*. The system of knowledge is criticized; it is judged in respect of its validity and reliability" (7).

During Reichenbach's second task, "the critical task," philosophers should *criticize* or analyze those arguments to see if they are indeed good science (5-6). Do they contain valid or invalid reasoning? Ultimately, can they be interpreted as proper inductive arguments? According to Reichenbach, the bulk of the work for the analysis of science occurs within the critical task, and the rest of Reichenbach's book is dedicated to elaborating on this second task; Reichenbach explains what he means by induction and what we can reasonably expect to be able to know through induction (a lot, but nothing with certainty) (87).

The critical and descriptive tasks overlap, but they are not co-extensive. To continue the previous passage from Reichenbach:

> This [critical] task is already partially performed in the rational reconstruction, for the fictive set of operations occurring here [in the descriptive task] is chosen from the point of view of justifiability; we replace actual thinking by such operations as are justifiable, that is, can be demonstrated as valid. But the tendency to remain in correspondence with actual thinking must be separated from the tendency to obtain valid thinking; and so we have to distinguish between the descriptive and critical task. (7)

Here Reichenbach explains the difference between the descriptive task and the critical task. In the descriptive task, the philosopher uses normative ideas to create a rational

reconstruction, which is a cleaned-up version of a scientist's "chains of thoughts" (8). What is included in the rational reconstruction (and what is left out) is determined by normative ideas of what is a good justification and what is not (as quoted above: "chosen from the point of view of justifiability" (7)). However, despite these normative elements, the descriptive task remains a primarily descriptive perspective; the original thought process is not evaluated during the descriptive task. One does not ask whether the original thought process is logically sound. Instead, the thought process is prepped for evaluation. We can see this most clearly when Reichenbach clarifies that the rational reconstruction must faithfully describe any logical errors that were in the original thought process ("remain in correspondence with actual thinking" (7).

In contrast, the critical task is where the rational reconstruction is evaluated and judged to be justified or unjustified ("The system of knowledge is judged" (7)). It is the critical task, then, that can unambiguously be called normative.

4. The Advisory Task

Finally, Reichenbach maintains that yet another task occurs. As Howard explains, the context distinction is Reichenbach's response to Otto Neurath's claim that political values have a legitimate role to play in scientific decision-making. Howard writes, "Neurath is not named as the target of the DJ distinction… But it would have been crystal clear to Reichenbach's former Viennese and Berlin colleagues" (Howard 2006, p 7). It especially clear that Reichenbach is addressing Neurath when Reichenbach writes about the advisory task. For instance, Reichenbach suggests that, during the advisory task, philosophers can give guidance to the "wanderer in the forest" that Neurath discusses so much (14).

Reichenbach acknowledges and agrees with the controversial claim that logic alone does not determine which scientific ideas we should accept, and which we should not. "There are certain elements of knowledge… which are not governed by the idea of truth, but which are due to volitional resolutions…" (9). However, as we will see below, Reichenbach claims that these arbitrary elements have been greatly exaggerated.

Reichenbach concedes that because of these arbitrary elements, there arises a third task for philosophers, the "advisory task." In the *advisory* task, philosophers recognize when the "decisions of science cannot be determined precisely" and then gives advice as to the best (practical) decision. For example, a scientist must choose a measurement system (metric, Imperial, etc.). Philosophers can help point out the practical advantages of some measurement systems over the others (12, 13). Or a scientist might be dealing with key terms that have vague meanings (12). Presumably, Reichenbach enlists philosophers to propose valuable ways of defining terms.

Reichenbach describes the advisory task in the following way: "In such a case, it will be the task of epistemology to suggest a proposal concerning a decision; and we shall speak, therefore, of the *advisory task* of epistemology as its third task. This function of epistemology might turn out to be of great practical value; but it must be kept clearly in mind that what is to be given here is a proposal and not a determination of truth-character" (13).

So the philosopher, Reichenbach maintains, is in a good position to advise the scientist as to which choice to make (when there is no epistemic reason to choose one way over another). Yet one choice is never more likely to be "true" than another, since the advisory task would apply precisely in those situations in which there is no way to determine which is choice more likely to be "true" because there isn't enough evidence (or the right

kind of evidence). In addition, the advisory task would also apply to those situations in which the characterization of "true" or "false" simply does not apply. For example, the metric system has many advantages over the Imperial system, but it is nonsensical to say that the metric system is "true" or more likely to be true than other systems of measurement.

Thus, Reichenbach continues: "We may point out the advantages of our proposed decision… but never can we demand agreement for our proposal in the sense that we can demand it for statements which we have proven to be true" (13).

So, according to Reichenbach the advisory task needs to be separated from the critical task because "Scientific method is not, in every step of its procedure, directed by the principle of validity; there are other steps which have the character of volitional decisions" (9).

Then Reichenbach's discussion of the advisory task takes an interesting turn, which Howard has discussed in detail (Howard 2006). Reichenbach notes that although these situations exist where scientists must make a decision with no epistemic basis, the frequency of such situations seems to have been "highly exaggerated" (15). Reichenbach argues that this is because, in many cases, we can reduce the number of arbitrary decisions to a "minimum" by showing how many of these decisions are logically connected to each other.

Reichenbach argues that philosophers can help scientists foresee the logical results of different decisions that are underdetermined by the evidence, and thus reduce the number of arbitrary decisions that need to be made. For example, in discussions of space-time, the scientist must choose a geometry (Euclidian or non-Euclidian), from which certain philosophical consequences will follow (Reichenbach 1938, p. 14 and 1928, ch. 1).

> Some decisions are bound together; one decision, then, involves another, and though we are free in choosing the first one, we are no longer free with respect to those

following. (Reichenbach 1938, p. 13)

There are points at which a scientist can make a decision, but once that decision is made, certain consequences logically follow.[8] These are called "entailed decisions."

Once the philosopher stops advising on which decision to make, but instead engages in mapping out the entailed decisions, the philosopher's advisory task "reduces" to the critical task:

> We may therefore reduce the advisory task of epistemology to its critical task by using the following systematic procedure: we renounce making a proposal but instead construe a list of all possible decisions, each one accompanied by its entailed decisions. So we leave the choice to our reader after showing him all factual connections to which he is bound. (14)[9]

Once the philosopher stops advocating one choice over the other, this "advisory" task becomes another part of the critical task. Rather than advise, the philosopher's critical task is simply to make clear what conclusions logically follow, so that the scientist can make his decision with as much information as possible.

Although Reichenbach names this third task the "advisory" task, Howard convincingly demonstrates that Reichenbach's goal in mentioning the advisory task is to respond to the argument that *scientists often make arbitrary decisions and therefore scientific knowledge is arbitrary.* Reichenbach concedes that scientific decisions may be guided at times by practical considerations and so may be arbitrary in some sense, but he contends that the consequences of those decisions are constrained by logic and nature and so knowledge is not arbitrary (15).

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[8] This section is similar to the debate between Andrew Pickering in *Mangle of Practice* (1995) and Ian Hacking in *The Social Construction of What?* (1999) over decision points in scientific research.

[9] It is unclear whether Reichenbach intends to say that the advisory task and critical task overlap in these situations, or that the philosopher stops engaging in the advisory task and starts to engage in the critical task instead.

According to my reading, then, Reichenbach offers two possible actions under the advisory task: 1) To advise the scientist on which arbitrary choice to make, based on the best practical outcomes. And 2) To describe the ways in which some arbitrary decisions are linked together and thereby show that there are fewer arbitrary decisions to be made.

Below we will consider to what extent either of these actions of the advisory task could be considered normative, in the sense conveyed by Hoyningen-Huene.

IV. Lean DJ and Reichenbach's Contexts and Tasks

a. Lining up the four tasks with Hoyningen-Huene's Lean Context Distinction

So, as we have just seen, Reichenbach proposes a procedure for the evaluation of scientific theories. First, the scientist thinks. The psychologist investigates this thought process for a study on how people think. Meanwhile, the philosopher engages in the descriptive task of epistemology: she also investigates the scientist's thought process. She then changes the words, like a good editor. She clarifies vague passages, eliminates unnecessary steps, and presents the passage in its best light. She thereby creates a rational reconstruction of the original thinking process. This document is then ready to be submitted to the next task, the critical task, where the revised scientific argument is evaluated for logical rigor and either passes the test or fails. Then, in the advisory task, the philosopher focuses on arbitrary decisions that are underdetermined by the evidence. Acknowledging that one cannot say which decision better reflects the "truth," the philosopher here simply advises as to which decision will lead to the best practical outcomes, as determined by non-epistemic values. However, Reichenbach does add that the philosopher can greatly reduce the

arbitrariness of science by pointing out the ways in which decisions are connected with one another, and thereby reduce the number of independent arbitrary decisions. (5-14)

We now recall Hoyningen-Huene's Lean DJ distinction between the descriptive and the normative. Hoyningen-Huene suggests that contemporary philosophers will recognize his distinction as identifying the shared core and clarifying the common ground amidst the confusion. But is the normative v. descriptive distinction at the core of what Reichenbach had in mind? Is his DJ captured by Lean DJ, or, at the very least, is Reichenbach's DJ consistent with Hoyningen-Huene's Lean DJ? I contend that it is not. I will consider where each of Reichenbach's tasks would fit into the categories created by the Lean DJ distinction. I then compare this with where Reichenbach himself places each task in his own context distinction. [10]

Hoyningen-Huene's suggestion is to identify the Lean Context of Discovery (LD) as descriptive and the Lean Context of Justification (LJ) as normative, according to which each context is really a perspective from which to ask a question. To review, Hoyningen-Huene writes, "From the descriptive perspective, I am interested in facts that have happened, and their description. Among these facts may be, among other things, epistemic claims that were put forward" (Hoyningen-Huene 2006, p. 128-9).

Sturm and Gigerenzer identify the appropriate question of the Lean Context of Discovery as: "How did someone come to accept that p?" For example, Shapin and Schaffer

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[10] To be clear, Reichenbach might very well embrace the Lean DJ as a useful distinction. For instance, de Campos offers an intriguing argument that even Neurath would have endorsed Hoyningen-Huene's Lean DJ (de Campos 2015). But whether Reichenbach would, in theory, endorse the distinction between "descriptive" and "normative" perspectives is a separate issue. I argue merely that Reichenbach's own DJ did not contain this distinction.

(1985) ask about the personal and political influences that drew Boyle to accept experiments as evidence for his natural gas law.

In contrast, the question of the Lean Context of Justification is: "Is *p* justified?" Is Boyle's law justified? As Hoyningen-Huene defines it,

> From the normative or evaluative perspective, I am interested in an evaluation of particular claims…. Epistemic norms govern this evaluation. By using epistemic norms we can evaluate particular epistemic claims according to their being justified or not. (Hoyningen-Huene 2006, p. 128-9)

The question from a normative perspective is no longer: What was said? but rather: Is what was said true/reproducible/intersubjectively acceptable, plausible, etc.? With this distinction in mind, let us return to Reichenbach to recall where each of his tasks would fall under Lean DJ, and explore the nuances in more detail.

As we discussed in Section III, Reichenbach's psychologist's task is descriptive. Reichenbach's "descriptive task," however, is both descriptive and normative. For instance, the psychologist's task and the descriptive task each describe different aspects of the scientific theory and its development. In their "retelling," both the psychologist and the philosopher must remain true to the original object of their inquiry. That means, for example, there must be a correspondence between the rational reconstruction created within the descriptive task and the actual thought process it is meant to repackage.

In contrast, the critical task is clearly normative, given that Reichenbach describes the critical task as follows: "The system of knowledge is criticized; it is judged in respect of its validity and its reliability" (7). The critical task fits very well with Hoyningen-Huene's Lean Context of Justification, since the critical task is where the philosopher evaluates whether the rational reconstruction leads to a justified conclusion, or not.

Finally, the second part of the advisory task can be considered normative, just like the critical task. Recall that this part of the advisory task "reduces" to the critical task. Here philosophers identify the ways in which decisions are logically connected to one another, and how one choice can thereby lead directly to a certain set of outcomes ("entailed decisions").

However, the first part of the advisory task is not normative in the sense Hoyningen-Huene describes. This is somewhat surprising, considering that "advising" generally means providing direction based on a normative goal. However, remember that the first part of the advisory task involves giving advice in precisely those cases in which epistemic values cannot apply. The philosopher must appeal to political, practical, aesthetic, or other values. And Hoyningen-Huene specifies that the "normative perspective" of the Lean Context of Justification is governed by Epistemic norms, and not "moral or aesthetic norms" (Hoyningen-Huene 128). So during the first part of the advisory task, the philosopher does not use epistemic norms to determine whether the conclusion is warranted, but instead uses non-epistemic norms to advise on which decision to make. So this part of the advisory task is not normative in the sense of epistemic norms. Nor does the philosopher describe historical events or thought processes, so this task is not descriptive. Thus, the first part of the advisory task is best understood as outside of Hoyningen-Huene's Lean DJ entirely.

So it might appear at first that the Lean Context of Discovery aligns with both the psychologist's task and the descriptive task, since both are descriptive, and the Lean Context of Justification encompasses the critical task and the second part of the advisory task, since the critical task is more obviously normative.

However, the descriptive task is also normative, so maybe it belongs in the Lean Context of Justification. Remember that Hoyningen-Huene's Lean Context of Discovery

and Lean Context of Justification are perspectives from which to ask questions. If we were concerned with the question of the Lean Context of Discovery, "How did someone come to accept that *p*?" then we would perform the psychologist's task to get the answer. But if we were concerned with the question of the Lean Context of Justification, "Is *p* justified?," then we would need to perform *both* the descriptive and the *critical* tasks: First create a rational reconstruction using a certain standard of justification, and then evaluate whether the claims made in the rational reconstruction are indeed justified. Reichenbach even acknowledges a connection between these tasks: "This [critical] task is already partially performed in the rational reconstruction, for the fictive set of operations occurring here is chosen from the point of view of justifiability" (7). It appears that the two tasks partially overlap, since the rational reconstruction within the descriptive task identifies and organizes information about some scientific claim *P* in the service of precisely asking: "Is *p* justified?" That information is then sent to the critical task to be evaluated and used in answering the normative question. Thus, placing Reichenbach's descriptive task within the Lean Context of Justification, even though the task is primarily descriptive, might seem reasonable since, when performing the normative task, the philosopher must do some amount of describing so that she knows what she is evaluating.

In sum, we have seen that if we apply Hoyningen-Huene's formulation to Reichenbach's tasks, the psychologist's task is part of Lean Context of Discovery and the critical task is part of Lean Context of Justification, as is the second part of the advisory task. The first part of the advisory task would be outside of the Lean DJ entirely. More challenging is placing the descriptive task. It is not entirely clear whether the descriptive task would be part of the Lean Context of Discovery or the Lean Context of Justification. The

descriptive task does not match clearly with either one, but rather seems to be a mix of both descriptive and normative perspectives (see Chart 3).

b. Lining up the four tasks with Reichenbach's Context Distinction

Now let's turn to Reichenbach's own distinction between the context of discovery and the context of justification. If Hoyningen-Huene is right that most scholars will recognize the Lean DJ as the core of the context distinction, and given that Reichenbach's work is an influential original formulation of the context distinction, then we should expect to find Reichenbach's own contexts matching Hoyningen-Huene's descriptive and normative perspectives. That is, if Hoyningen-Huene were right, then we should expect to find Reichenbach placing the psychologist's task in the context of discovery and placing the critical tasks and second part of the advisory task in the context of justification (with the descriptive task placed in one context or the other, or both).

But we do not. Instead, I will argue, we find the context distinction drawn between the psychologist's task and the descriptive task, with the critical and advisory task left out of the contexts all together (see Chart 2). This does not necessarily mean that we should reject Hoyningen-Huene's Lean DJ, which might prove to be a useful heuristic device, but it does suggest that the distinction between normative and descriptive has not been lurking in the original context distinction all along, but rather has been read into it more recently. [11]

The line between the Reichenbach's context of discovery and context of justification is most clearly seen near the end of the book, where Reichenbach mentions the context distinction one last time in *Experience and Prediction*,

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[11] One should not overlook Popper's influence here, which is of course also worth further study.

> We pointed out at the beginning of our inquiry (section 1) [pg 3-16] the distinction between the context of discovery and the context of justification. We emphasized that epistemology cannot be concerned with the first but only with the latter; we showed that the analysis of science is not directed toward actual thinking processes but toward rational reconstructions of knowledge. It is this determination of the task of epistemology which we must remember if we want to construct a theory of scientific research. (381-382)

Here we see that Reichenbach aligns the context of discovery ("the first") with actual thinking processes, and claims that epistemology should not be concerned with them. I interpret this as placing the psychologist's task within the context of discovery. Reichenbach then aligns the context of justification ("the latter") with rational reconstructions of knowledge. Recall that the descriptive task is where the rational reconstruction is created. Thus, I interpret this passage as placing the descriptive task within the context of justification. The critical task (the "analysis of science") is "directed toward" the context of justification (and thus is outside of the context of justification).

Here it is worth noting the importance of the word "context." We see that the critical task is performed *on* the context of justification (on the rational reconstruction) and not *on* the context of discovery (the actual thinking process). So the descriptive task provides the "context" that is necessary for philosophers to evaluate a claim. If correct, then justification, for Reichenbach, does not occur *within* the context of justification, but rather *on* the context of justification. This discovery is surprising, but then also somewhat anti-climactic. Under this reading, we can see that the spirit of Hoyningen-Huene's context distinction is present, but the terminology is different. What is exciting, though, is that we see Reichenbach including an additional step that is often left out: the rational reconstruction. This step is so useful that I will return to it in more detail in the next section.

To further show that Reichenbach draws the context distinction between the psychologist's task and the descriptive task, with the critical and advisory tasks left out of the contexts all together, it is important to examine the setting of the original context distinction. Reichenbach introduces the famous phrases in the first pages of his book, in the opening section entitled "Three Tasks of Epistemology" where he first states that systems of knowledge are sociological facts. He explains, "If knowledge were not incorporated into books, speeches, and human actions, we would never know it" (3). Therefore to study knowledge the philosopher must in part study "features of sociological phenomenon." Here Reichenbach names the first task of epistemology, the descriptive task, as part of sociology. He warns, however, that there are two kinds of social: internal relations and external relations. The descriptive task of epistemology concerns only the internal relations, specifically the "system of connection as it is followed in thinking" (4). Noticing that his definitions of sociology and thinking might differ from the norm, he emphatically warns against confusion: he means thinking at its logical best, not actual thinking. So Reichenbach introduces the task of psychology to distinguish it from the descriptive task, and the term rational reconstruction to indicate the proper logical substitute for real thinking. He says that philosophers should study this rational reconstruction and not actual thinking.

In the next paragraph, where he offers a clarification of rational reconstruction, Reichenbach first introduces the words "context of discovery" and "context of justification." He describes the meaning of the distinction, and then labels it accordingly. Note that we are still in the section dedicated to the descriptive task:

> If a more convenient determination of this concept of rational reconstruction is wanted, we might say that it corresponds to the form in which thinking processes are communicated to other persons instead of the form in which they are subjectively performed. The way, for instance, in which a mathematician publishes a new

demonstration, or a physicist his logical reasoning in the foundation of a new theory, would almost correspond to our concept of rational reconstruction; and the well-known difference between the thinker's way of finding this theorem and his way of presenting it before a public may illustrate the difference in question. I shall introduce the terms *context of discovery* and *context of justification* to mark this distinction. Then we have to say that epistemology is only occupied in constructing the context of justification … Our comparison [indicates] the way in which we want to have thinking replaced by justifiable operations; it may also show that the rational reconstruction of knowledge belongs to the descriptive task of epistemology. It is bound to factual knowledge in the same way that the exposition of a theory is bound to the actual thoughts of its author. (6-7, Emphasis in the original)

Reichenbach's aim in this paragraph is to distinguish between actual thinking processes and rational reconstructions. To help clarify what he means by rational reconstruction, Reichenbach offers the analogy with scientists publishing their results. Actual thinking is like "the thinker's way of finding his theorem" and the rational reconstruction is like "his way of presenting it before a public." "Context of discovery" is coined to correspond with the former (actual thinking), and "context of justification" with the latter (rational reconstruction). Reichenbach describes the context of justification as "constructed" and emphasizes that a scientist's public presentation is "only an approximation of what we mean by the context of justification" because, Reichenbach explains, scientists are generally not philosophers and might make logical mistakes despite their best attempts. [12] Having now associated the context of justification with rational reconstruction, Reichenbach reminds us that "the rational reconstruction of knowledge belongs to the descriptive task of epistemology" and that rational reconstructions are bound to actual thinking (7).

So far the text is consistent with our discussion of Lean DJ. We expected to find the LJ perhaps encompassing both the descriptive and critical tasks, so it is not surprising that

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[12] Note that for this reason "the way a scientist presents his theorem" is offered as an analogy only. For more on the difference between how scientists think versus how they present their thought process in public, see Schickore 2008.

Reichenbach's own context of justification includes the descriptive task. However, when we turn to the critical task, our expectations are confounded. Reichenbach's context of justification does not include the critical task! The very next sentence is the start of a new paragraph in which Reichenbach begins a new section: "In addition to its descriptive task, epistemology is concerned with another purpose which may be called its *critical task*" (7). Reichenbach has just shifted gears to the next task, starting a new section. Nowhere in that section (7-12), nor in the following section on the advisory task (12-16), does Reichenbach mention his new terms "context of discovery" and "context of justification."[13] Indeed, he appears not to mention those terms again until three hundred pages later, when he returns to them briefly to make a separate point, as quoted above (381-384).[14]

Given Hoyningen-Huene's Lean DJ, we should expect to find Reichenbach's context of discovery and the context of justification distinguishing between the psychologist's task on one hand, and the descriptive, critical, and advisory tasks, on the other. But we do not. Instead, we find Reichenbach using DJ to distinguish between the psychologist's task (concerned with actual thinking) in the context of discovery and the descriptive task (concerned with rational reconstruction) in the context of justification. The critical task and advisory task are left out of the contexts all together (see Chart 2).[15]

We can then connect this with Hoyningen-Huene's distinction between "descriptive" and "normative" perspectives. We find that Reichenbach's context of justification corresponds with the "descriptive task" which, I have argued, is a mix of descriptive and

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[13] He continues to refer to "rational reconstructions," however, in order to clarify the differences between the critical and descriptive tasks.

[14] This latter text is well worth study. Here Reichenbach defends his meta-methodology, arguing that even if scientists do not consciously use induction, any good scientist is implicitly relying on it.

normative perspectives, but is primarily descriptive. Thus we see that Hoyningen-Huene's

descriptive perspective corresponds with Reichenbach's context of discovery *and* part of

Reichenbach's context of justification. Hoyningen-Huene's normative perspective

corresponds partially with Reichenbach's context of justification, but most strongly with

Reichenbach's critical task. Furthermore, Reichenbach presents the critical task as an

unambiguous normative perspective, but leaves the critical task outside of the context

distinction all together. Whatever Reichenbach meant by the distinction between the

context of discovery and the context of justification, it was not a distinction between

descriptive and normative perspectives (see Charts 2 and 3).

V. Further discussion of Rational Reconstructions

Some might object to my claim that Reichenbach's descriptive task, with its rational

reconstruction, cannot be clearly identified as a "normative perspective." To understand

why the descriptive task cannot be characterized as a "normative perspective," but rather as

a mix of normative and descriptive perspectives, it can be helpful to explore Reichenbach's

particular conception of rational reconstruction.[16]

The object of study of the rational reconstruction process is itself a process, namely a

thought process (5).[17] The product is a series of logical symbols. Reichenbach writes,

> Epistemology does not regard the processes of thinking in their actual occurrence;
> this task is entirely left to psychology. What epistemology intends is to construct
> thinking processes in a way in which they ought to occur if they are to be ranged in a

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[16] Unfortunately, the phrase rational reconstruction refers to a product, as well as a process, just like the words "film production," and "test," and even the adjective "objective" (see Fine 1998).

[17] Much confusion arises out of this, since the philosopher does not have direct access to the scientist's thought process. At best, she has an oral account or a written document produced by the scientist, describing what he takes to be his own thought process.

consistent system… Epistemology thus considers a logical substitute rather than real processes. For this logical substitute the term *rational reconstruction* has been introduced. (5)

The philosopher begins with a scientist's thought process, then writes down an idealized version of that thought process, thereby creating a written chain of reasoning that can be subjected to logical evaluation: "rationally reconstructed knowledge can only be given in the language form … for thinking processes enter into knowledge ... only in so far as they can be replaced by chains of linguistic expressions" (16-17). I imagine that Reichenbach has in mind something like the following: In describing his own thinking process, Einstein writes that considerations of Maxwell's equations led him to reconsider the nature of gravity. Seven years passed between this realization and his formulation of the general theory of relativity because "it is not so easy to free oneself" from traditional notions of space and time (Einstein 1979, p. 63). A rational reconstruction of this process would result in a logical formulation of the evidence for relativity without necessarily mentioning Einstein's detours on this path to developing the theory. Note that the rational reconstruction must be performed with the end goal in mind, which is to evaluate the scientist's argument using the prescribed logical system. This means that in constructing the rational reconstruction, the philosopher must highlight important features necessary for induction and eliminate distracting features such as "abbreviations and silently tolerated inexactitudes" (Reichenbach 7).

I have described three features of Reichenbach's rational reconstruction: the input, the output, and the process that creates that output. The rational reconstruction must take a scientist's own thinking and transform it. Although many transformations are possible, the required one will be that which best prepares it for logical analysis. At first glance, this

seems like a typical description of a rational reconstruction. But the fourth feature of Reichenbach's rational reconstruction, I think, is what distinguishes it from other versions. Namely, Reichenbach requires that a rational reconstruction must adhere closely to the original thought process. It must *not* be transformed beyond all recognition. Now, the philosopher may change the argument, adding logical steps that were hidden in an enthymeme, or adding whole new steps, but these changes must be performed with caution. The philosopher is required to stay true to the original meaning. Reichenbach writes, "The construction given is not arbitrary; it is bound to thinking by the postulate of correspondence" (6). The scientist must always be able to recognize the cleaned-up version, to look at it and say, *Yes, that is what I meant all along.* It must not be transformed beyond all recognition (6). Thus, although many different reconstructions are possible, not all are permissible.

So we see that Reichenbach's rational reconstruction is constrained from two sides. On one hand, the process is constrained by the tools and standards of the evaluation process (in this case, rules of logic), and so must transform a scientist's thinking into a format that makes it susceptible to, and ready for, evaluation. On the other hand, the product must remain true to the input, that is, to the scientist's actual thought process. One can take an argument with obvious but unspoken premises and add them; however, one cannot take an invalid argument and transform it into a valid one if that would risk losing some of the original meaning.

These constraints have significant consequences. In particular, the end product (the rational reconstruction) may yield a claim that is not justified. Reichenbach writes:

> It may happen that the description of knowledge leads to the result that certain
> chains of thoughts, or operations, cannot be justified; in other words, that even the

> rational reconstruction contains unjustifiable chains. … This case shows that the descriptive task and the critical task are different; although description, as it is here meant, is not a copy of actual thinking but the construction of an equivalent, it is bound to thinking by the postulate of correspondence and may expose knowledge to criticism. (8)

The process of the rational reconstruction might reveal a justified final claim, or it might not, instead revealing an unjustified final claim. Thus the rational reconstruction (and so the descriptive task) does not answer the question, "Is P justified?" Rather, the rational reconstruction describes P in such a way that it will be easier later, in the critical task, to answer that question. As I will argue below, this is in contrast to more prominent accounts of rational reconstruction, such as those of Carnap or Lakatos, in which the end product of a rational reconstruction is, by design, logically or rationally justified.

b. *Contrast with Carnap's Rational Reconstruction*

Perhaps one of the better-known accounts of rational reconstruction appears in Rudolf Carnap's 1928 *Logical Structure of the World* (The *Aufbau*).   Reichenbach refers to Carnap's rational reconstruction ("*rationale Nachkonstruktion"*) (Reichenbach 5). However, as we will see, his notions and uses for rational reconstructions differ from Carnap's in important ways.

In the *Aufbau*, Carnap sets out to create a construction theory in which one builds "the rational reconstruction of the concepts of all fields of knowledge on the basis of concepts that refer to the immediately given" (Carnap 1969, p. v). That is to say, although Carnap offers several changes to his account over the years, he generally aims to translate direct sensory experiences into linguistic form so that scientific knowledge can be objective.[18] For Carnap, objectivity requires intersubjective agreement; different people must be able to

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[18] See (Uebel 2007, p. 19-24, 54-60) for an account of those changes. See also Friedman (1996), Richardson (1996) and (2000) for challenges to traditional interpretations of Carnap.

have the same experience. Yet how do we know that intersubjective agreement has been reached? Since no one can share their direct sensory experiences with others, they must share instead the language to talk about their experiences (Carnap 1969, § 3 p. 7; Uebel 2007, p. 16). Both constructions and rational reconstructions, for Carnap, are the translation of direct experiences into linguistic form (Carnap 1969, p. 308).

At first glance, Reichenbach's reference to Carnap seems perfectly on target. Carnap offers a precise definition of rational reconstruction that fits very well with Reichenbach's usage: "… an inferential procedure whose purpose it is to investigate whether or not there is a certain logical dependency between certain constituents of the experience" under consideration (Carnap 1969, p. 310). This definition includes the necessary emphasis on the logical relationship/logical dependency between the experiences, and at the same time excludes the subjective perception of those experiences (the evaluation of which belongs to psychology, according to Reichenbach). However, there are important differences between Carnap's idea of a rational reconstruction and Reichenbach's.

We can use Carnap's definition of *construction* to make sense of his *rational reconstruction* if we keep in mind that for him a reconstruction is simply an after-the-fact construction (*Nach*konstruktion):

> To *construct a* out of *b, c* means to produce a general rule that indicates for each individual case how a statement about *a* must be transformed in order to yield a statement about *b, c*. (Carnap 1969, §2, p. 6)

If a concept *a* can be constructed out of concepts *b* and *c*, then *a* is also reducible to *b* and *c* and all the information about *a* can be expressed in statements about *b* and *c* alone (Carnap 1969, §2, §35 p. 6, 61). Carnap builds his whole system on the notions of construction and

reduction, his goal being to recognize that scientific theories reduce to certain key concepts, and to articulate how that works. He writes,

> It is in principle possible to place all concepts in all areas of science into this [constructional] system, that is to say, they are reducible to one another and ultimately to a few basic concepts. (Carnap 1969, p. 308)

and

> It is the goal of each scientific theory to become, as far as its content is concerned, a pure *relation description*. (Carnap 1969, §10, p. 20, emphasis added)

Carnap wants to create a constructional system in which scientific concepts are described *in relation to* more basic concepts. Carnap has a very particular notion of construction in mind, and a *re*-construction is just an extension of that. Specifically, a rational reconstruction is a process that creates statements about a certain concept out of other concepts to which the first one reduces, after the actual thinking process has already occurred. Each step is logically related to the last step. As Richardson puts it, Carnap aims to construct "the purely mathematically expressible relations of physics" which then "takes us beyond the merely qualitative and private relations of sense-experience" (Richardson 1996, p. 314).

Carnap's notion of rational reconstruction is actually a combination of two ideas: 1) the construction of concepts consisting of mathematical relations 2) and after-the-fact logical reorganization of concepts.[19] However, Reichenbach's notion of rational reconstruction involves only the second idea, since his after-the-fact reorganization can apply to other logical relationships besides Carnap's notion of construction. For example, Reichenbach writes,

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[19] I do not mean to overemphasize the temporal aspect here. Although the German certainly suggests this notion of a sequence in time, the important aspect is the separation between the actual thought processes and logical orderings of those thought process, not the idea that one happens before the other.

> In being set before the rational reconstruction, we have the feeling that only now do we understand what we think; we admit that the rational reconstruction expresses what we mean, properly speaking. (Reichenbach 1938, p. 6)

Here Reichenbach suggests that any sort of thought can be rationally reconstructed. He continues with this idea when he suggests that "even the rational reconstruction [can] contain unjustifiable chains" and that it "may expose knowledge to criticism" (Reichenbach 1938, p. 8). For Reichenbach, then, rational reconstructions are not limited to constructing valid logical inferences, and so we can conclude that they cannot be limited to constructing valid mathematical relations. Although Reichenbach might aim to create valid relations, for him the rational reconstruction often falls short of that goal, since giving the best version of an *actual thought process* restrains one to be true to the original process. So while Carnap's rational reconstructions always contain logical relations on which we can base the objectivity of science, Reichenbach's rational reconstructions provide organized versions of thought. While Carnap's rational reconstructions are always perfectly logical and contain only justified inferences, Reichenbach's rational reconstructions faithfully maintain any failures of logical and thereby allow us to judge those organized thoughts against Reichenbach's proposed methodology of science.

c. *Contrast with Lakatos's Rational Reconstruction*

Another prominent version of rational reconstruction was developed after Reichenbach's *Experience and Prediction*. Like Reichenbach, Lakatos aims to contrast rational reconstructions against proposed methodologies of science. Like Reichenbach, he is also more flexible than Carnap in the type of relations allowed in his notion of rational reconstruction. For Lakatos, the methodology under consideration shapes the relations that

should be chosen in a rational reconstruction. For example, if one wants to evaluate Popper's falsificationism, then one should create a rational reconstruction of Einstein's experiments in which you highlight bold conjectures and record which conjectures are falsified and which ones are not (yet) falsified. If one evaluates a different methodology instead, such as Lakatos' own methodology of research programmes, then one creates a rational reconstruction that highlights researchers' resistance to *ad hoc* adjustments to theories, and that shows how certain claims are fruitful or can lead to further possible experiments. Relations that seem irrational in one kind of rational reconstruction can be very rational in another kind of rational reconstruction (Lakatos 1970a, p. 112-113).

In many ways, then, Reichenbach's notion of rational reconstruction is more similar to Lakatos' than to Carnap's. However, Lakatos famously shares Carnap's desire to move away from reconstructions that reflect actual thinking processes and towards reconstructions that embody the ideal thinking process. He writes,

> In constructing internal history, the historian will be highly selective: he will omit everything that is irrational in the light of his rationality theory. (Lakatos 1970a, p. 106)

If a scientist fails to follow the thinking process that a given methodology requires, Lakatos advocates replacing it with the "correct" thinking process in the rational reconstruction (Lakatos 1970a, p. 107, 1970b, p. 146).[20] Lakatos considers the rational reconstruction to contain the *internal* thinking, the epistemically important relations (the thinking that *should have* occurred), rather than the external thinking (the thinking that actually occurred).

This external/internal distinction that Lakatos employs is close to the descriptive/normative distinction that Hoyningen-Huene proposes. It is notable, then, that

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[20] This controversial view did not go unnoticed. For objections to it, see Kuhn (1970, p. 256) and McMullin (1970).

when Lakatos identifies *rational reconstruction* with *internal relations*, Lakatos is not in a position to "expose" the rational reconstruction "to criticism" in the way that Reichenbach requires.

There is also textual evidence that Reichenbach's notion of reconstruction does not follow the internal/external distinction. Reichenbach shares Lakatos' definition of internal/external relations. External relations involve, for example, the extracurricular activities and social status of scientists. The sociologist might note that,

> Astronomers are frequently musical men, or that they belong in general to the bourgeois class of society; if these relations do not interest epistemology, it is because they do not enter into the content of science – they are what we call external relations. (Reichenbach 4)

In contrast, internal relations involve epistemic relations such as "the content of knowledge" and the "system of connections as it is followed in thinking" (Reichenbach 4, 5).

Reichenbach distinguishes the sociologist, on one hand, from the psychologist and the philosopher, on the other. The sociologist studies external relations of knowledge, while the psychologist and philosopher both study the *internal* relations of knowledge. For Reichenbach, philosophers and sociologists differ in *what* they study, while philosophers and psychologists study the same thing but differ in *how* they study it. Philosophers and psychologists emphasize different parts of thought processes. My reading of Reichenbach thus resists putting together *the internal, normative,* and *context of justification* on the one hand and *the external, descriptive,* and *context of discovery* on the other.

We have seen that while Reichenbach appears to use a familiar concept in philosophy of science, he maintains a distinct conception of it. 1) For Carnap and Lakatos, rational reconstructions contain completely logical or rational relations, respectively. But for Reichenbach, rational reconstructions might contain logical fallacies. 2) Carnap used rational reconstructions to provide a basis for objectivity in science. In contrast, Lakatos and

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Reichenbach both connect the concept of rational reconstructions to competing methodologies of science, though in different ways. For Lakatos, a methodology is judged by whether it produces fruitful rational reconstructions. His own methodology of research programmes is judged the best.[21] For Reichenbach, the judgment goes the other way – the rational reconstruction, not the methodology, is judged. The methodology of induction provides the rubric for judging or evaluating an episode in science, but instead of judging that episode directly, we evaluate a rational reconstruction of it. Constructing that rational reconstruction is part of the descriptive task.

We can now see more clearly that the evaluation of the rational reconstruction does not happen until the next task. Determining whether the scientific claims are justified (Hoyningen-Huene's "normative perspective") is part of the critical task, not the descriptive task.

VI. Historical Context of "Contexts"

Don Howard provides valuable historical context for Reichenbach's context distinction. In part, the distinction is a response to left-wing factions of the Vienna Circle. In 1913, Neurath argued that claims toward objectivity and access to universal truths are no more than "pseudo-rationalism." In 1935, Neurath argued that Pierre Duhem's empirical underdetermination thesis means that politics play an inevitable role in science, and so we should make sure to use the right values (Howard 2011, 62). According to Howard,

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[21] That is, Lakatos suggests that adopting this methodology, as a way of approaching science, will allow philosophers to successfully pursue interesting questions. Another benefit of this methodology is that it explains scientific activities that otherwise do not appear rational.

Reichenbach's distinction can been seen as a response to this, and a reassertion of the claim that science can be based on logical reasoning, and thus free of values and politics.

Reichenbach's contexts can also be seen as a natural psychological response to an extreme political situation (Reichenbach was forced out of Nazi Germany shortly before writing *Experience and Prediction* in 1938). Thus it can be seen as a defense against accusations of "Jewish Science" by placing the evaluation of a claim as separate from the thought processes of the person who proposed it (Howard 2011, 64).

Howard suggests that later, during the Cold War, Reichenbach's distinction took on new life largely in this second role. Philosophy of Science presented itself as "inherently apolitical" and so was immune to Red Scare and McCarthyism, unlike the philosophies of Neurath and Dewey, which were explicitly political (Howard 2011, 64). Later, when the political situation (and ad hominem attacks) had eased, philosophers began to return to the question of values, politic, and historical context of science.

This account of the historical role of the context distinction shows that perhaps even then, the context distinction was playing the kinds of multiple roles that Hoyningen-Huene lists out – distinguishing values from logical evaluation, trying to disentangle philosophical and scientific arguments from their historical setting, separating the original thought process from the evaluation of the claims. But as Hoyningen-Huene demonstrates, and I argue elsewhere, the context distinction cannot fulfill these multiple roles (Author 2009, 2010).

VII. Conclusion

I am not suggesting we should return to Reichenbach's original meaning.

Nor do I mean to say that Hoyningen-Huene is wrong; his Lean DJ may prove promising and he may be right that critics of DJ in the 70s and 80s such as Kuhn and Feyerabend, and maybe even Reichenbach himself, would agree to a Lean DJ that distinguishes descriptive from normative perspectives (Feyerabend 1975). I *do* suggest, however, that the meaning of the words "context of discovery" and "context of justification" in Lean DJ have shifted away from Reichenbach's meaning as he originally presents them in *Experience and Prediction*. For Reichenbach, the context of discovery refers to the task of psychology, which deals with the actual thought process of a scientist, whereas the context of justification refers to the descriptive task, in which a philosopher creates a rational reconstruction of that thought process. Crucially, for Reichenbach a rational reconstruction does not necessarily contain valid or logical connections. Although it contains normative elements, the context of justification is simply a sophisticated *description* of what is in the context of discovery; it is *not an evaluation* of that content. Instead, the evaluation occurs in the critical task and part of the advisory task, which, I am arguing, occur outside of the two contexts. This means that for Reichenbach, the context distinction does not, in fact, distinguish between descriptive and normative perspectives. Thus, Hoyningen-Huene's Lean DJ contexts do not align clearly with Reichenbach's original contexts.

To be clear, I am not endorsing a return to Reichenbach's original meaning of the context distinction. However, I do think that his descriptive task, which focuses on creating a particular kind of rational reconstruction, is quite a valuable tool for philosophers of science, and for philosophers more generally.
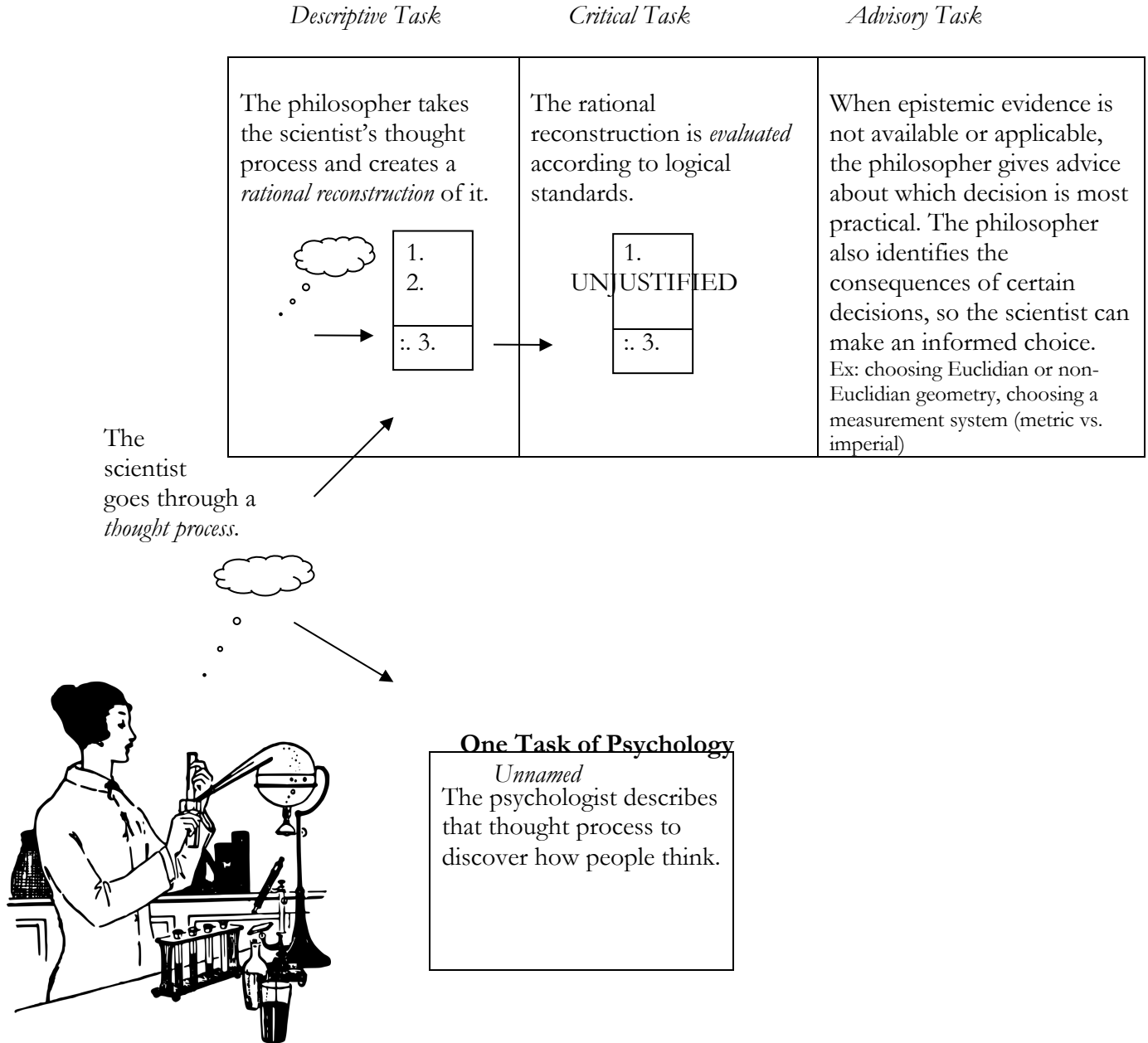
Furthermore, this discovery about the shifted meaning of the context of justification can serve as a call for caution. When we debate the context distinction and cast around for

common ground and common definitions from which to frame the debate, we should

recognize that even a proposal as seemingly lean as Lean DJ between descriptive and

normative perspectives on science can be contentious and far from universally maintained.

VIII. CHART 1

Reichenbach's Three Tasks of Epistemology

Descriptive Task	*Critical Task*	*Advisory Task*
The philosopher takes the scientist's thought process and creates a *rational reconstruction* of it.	The rational reconstruction is *evaluated* according to logical standards.	When epistemic evidence is not available or applicable, the philosopher gives advice about which decision is most practical. The philosopher also identifies the consequences of certain decisions, so the scientist can make an informed choice. Ex: choosing Euclidian or non-Euclidian geometry, choosing a measurement system (metric vs. imperial)

1.
2.

∴ 3.

1.
UNJUSTIFIED

∴ 3.

The scientist goes through a *thought process.*

One Task of Psychology

Unnamed
The psychologist describes that thought process to discover how people think.

Created from Hans Reichenbach's
Experience and Prediction, 1938
Chapter 1

CHART 2

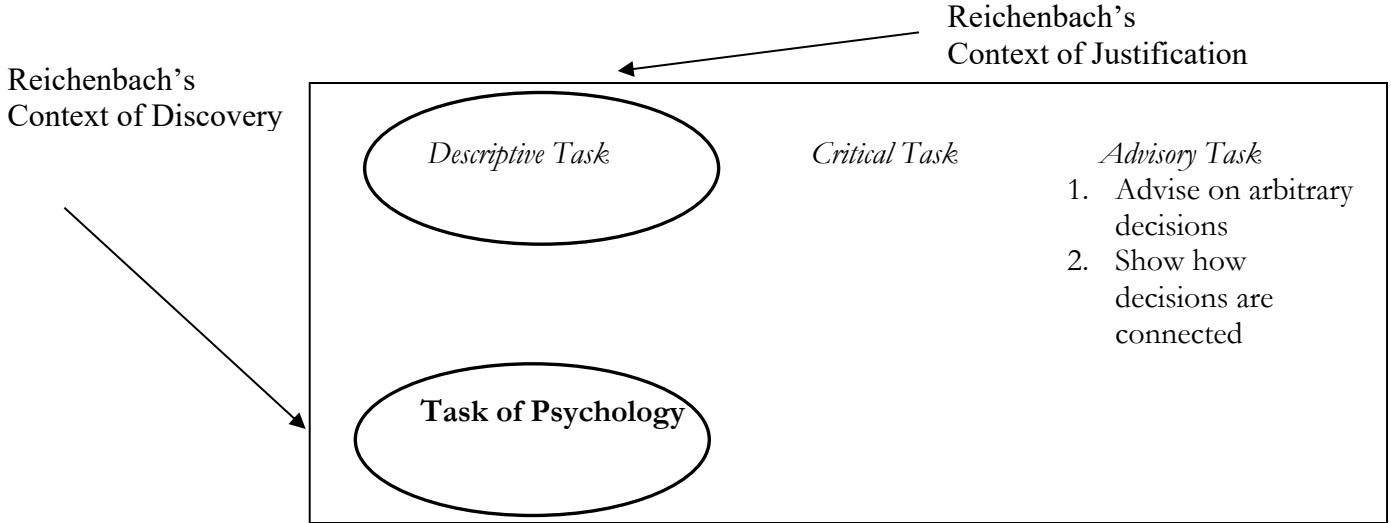**Mapping Reichenbach's Context Distinction onto Reichenbach's Tasks**

Chart 2. Reichenbach's Context of Justification refers to the descriptive task. Reichenbach's Context of Discovery refers to the task of psychology.

CHART 3

Mapping Hoyningen-Huene's Context Distinction onto Reichenbach's Tasks
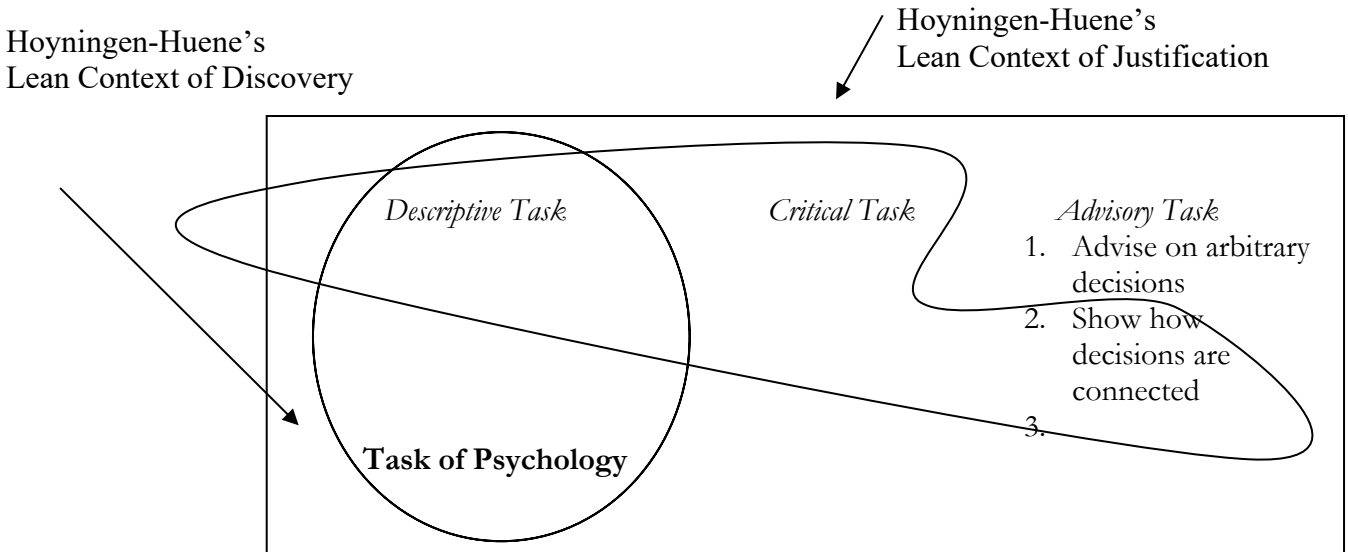

Chart 3. Hoyningen-Huene's Lean Context of Justification ("normative perspective") would include the Critical Task, and arguably parts of the Descriptive Task, and the second part of the Advisory Task. Hoyningen-Huene's Lean Context of Discovery ("descriptive perspective") would include the Task of Psychology, and parts of the Descriptive Task.

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