Integrating Abduction and Inference to the Best Explanation

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1. Introduction

1   Tomis Kapitan's work on Peirce's conception of abduction was instrumental for coming to see how Peircean abduction both relates to and is importantly different from inference to the best explanation (IBE). This is important for many reasons, not the least of which are that IBE is central to human and scientific reasoning and that IBE figures into the debate about scientific realism and anti-realism.[1] In a series of important and influential articles written in the 1990s (Kapitan 1990, 1992 and 1997), Kapitan set out to take on the admittedly daunting task of presenting a coherent explication of the Peircean conception of abduction that was consonant with Peirce's various methodological commitments and which made sense of Peirce's explicit comments about the nature of abductive inference. However, he ultimately concluded that Peirce's conception of abduction was a muddle, importantly involving at least two failures. First, he concluded that Peirce conflates IBE and abductive hypothesis generation. Second, Peirce failed to show that abduction is a form of inference distinct from deduction and induction.[2] Despite the deeply problematic nature of Peirce's theory of abduction in these respects, Kapitan's work on Peircean abduction offers insight into the nature of abductive inquiry that is importantly relevant to the task of making sense of explanatory inquiry in general. Here Kapitan's work on Peircean induction will serve as the touchstone for developing a coherent account of explanatory inquiry that avoids these problems.

2. Abduction, IBE and the Three Contexts

2 IBE plays a central role in many models of inquiry, especially models of scientific inquiry. McMullin (1992) and Lipton (2004), for example, contend that it is *the* central form of inference in science. However, it has also forcefully been contended by Kapitan (1992) that many contemporary discussions of IBE involve the erroneous conflation of (Peircean) abduction and IBE.[3] On this basis, it has been suggested that Peirce's idea of abduction and the more general conception of IBE are both poorly understood. Kapitan developed these points in his 1990, 1992 and 1997 articles and in that sequence of works he made an extensive attempt to sort out the details of Peirce's theory of abduction. Peirce (CP 5.189) characterized abduction famously in the following way:

> Long before I classified abduction as a form of inference it was recognized by logicians that the operation of adopting and explanatory hypothesis – which is just what abduction is – was subject to certain conditions. Namely, the hypothesis cannot be admitted, even as a hypothesis, unless it is supposed that it would account for the facts or some of them. The form of inference, therefore, is this:
> The surprising fact, C, is observed;
> But if A were true, C would be a matter of course.
> Hence, there is reason to suspect that A is true.

3 Ultimately, Kapitan concluded that Peirce's theory of this form of inference was neither clear nor consistent, that the "discovery" and "preference" functions Peirce attributes to abduction at various times are not consonant and that Peirce's attempt to show that abduction was a form of inference distinct from induction and deduction was a failure.[4] Hintikka (1998), drawing importantly on Kapitan's work, further criticized the common view that abduction is a distinct and bona fide form of inference at all. Against this common view Hintikka suggested that abduction is really a *search strategy* in the epistemic attempt to discover truth, as opposed to a form of inference. As Hintikka ultimately saw it, abductive search is the search for true answers to why-questions and why-questions are simply requests for explanations.[5] So, according to Hintikka, abductive search is erotetic – it is a form of explanatory inquiry – and there is no such thing as abductive *inference* per se. As we shall soon see, this amounts to the rejection of what Kapitan (1997: 477) calls Peirce's inferential thesis.

4 The view defended here is, to a significant degree, in agreement with these insightful but critical contentions raised by Kapitan and Hintikka. As it will be understood here, abductive search is the dynamic process of searching for explanatory answers to why-questions. But, the novel contentions made here are as follows: (1) abductive search involves *both* abduction and IBE, (2) abduction comes in two forms, *modal abduction* and *practical abduction*, and (3) the two forms of abduction and IBE all establish very different types of theoretical commitments.[6] So, following Kapitan and Hintikka, the position defended here is that abduction is not precisely the same thing as IBE. However, against Hintikka in particular, the view defended here is based on the idea that modal abduction, practical abduction *and* inference to the best explanation are forms of inference employed in the broader process of abductive search, even if *abductive search* itself is not a form of inference. This is most easily seen when abductive search is characterized in terms of the "contexts" model of inquiry initially developed by Reichenbach (1938) and later extended by Laudan (1977, 1980 and 1981). So, this general framework will be employed here, and it further allows for the clear

determination of sorts of propositional attitudes that should be adopted towards theories in those various contexts of inquiry.

5   Inquiry, so understood, begins with the recognition that there is some phenomenon C that needs to be explained. This stage of abductive search begins with the posing of explanatory questions of the form "Why C?"[7] It proceeds by searching for and/or creating hypotheses that serve as potential answers to such erotetic requests in light of a knowledge base K. This occurs in the context of discovery and the characteristic form of inference used here is a form of modal abduction. Modal abductions aim to establish a set of plausible answers to the why-question that generated the line of inquiry being pursued. This is followed in the context of pursuit by the pragmatic adoption of a narrower set of hypotheses that are *promising* potential answers to such explanatory queries and the characteristic form of inference employed in this stage of abductive search is practical abduction. Once this set of plausible and promising answers to the guiding question is generated, inquiry then proceeds with the recognition of and/or generation of evidence in test conditions. This body of evidence and set of theories so generated is subsequently used, in conjunction with certain methodological principles and background knowledge, to determine the best explanation of C from amongst that set of promising and plausible provisional answers to the explanatory request. This last bit of reasoning occurs in the context of justification and takes the form of inferences to the best explanation. During this process of abductive searching *two* distinct forms of abduction are employed, one in the context of discovery and another in the context of pursuit. Jointly they are used to generate sets of hypotheses that serve as the solution space for the explanatory request which is to be resolved by using inference to the best explanation in the context of justification.[8]

6   All of this in turn can be used to explain the problematic and inconsistent nature of Peirce's account of abduction (especially as it is employed in the sciences) in a manner that underwrites Kapitan's careful observations in the following way. The position adopted here is that Kapitan was right that Peirce was neither entirely clear about abduction and that his views of the nature of abduction were not always consistent. He was also right that the "discovery" and "preference" functions Peirce attributes to abduction at various times are not consonant and he was right that Peirce's attempt to validate the autonomy thesis (i.e. the idea that abduction is a form of inference distinct from deduction and induction) was a failure. All of this is the case because Peirce conflates *three* different components of explanatory inquiry with different features in his various accounts of abduction and he failed to see that they are, in fact, all distinct components of abductive inquiry, which is not itself a form of inference. However, the three contexts-model of abductive search employed here allows for the disambiguation of the three forms of inference that were wrongly conflated in Peirce's account of abduction. Furthermore, this allows us to see that scientific inquiry is a multi-staged affair involving arguments aimed to establish hypotheses as epistemic/explanatory possibilities, followed by the selection of a set of promising hypotheses from among those epistemic/explanatory possibilities based on epistemic utilities.[9] This, in turn, culminates in inferences to the best explanation that are aimed at establishing hypotheses as likely to be true (or likely to be approximately true) based on evidential considerations. These last inferences then provide us with the best answers to explanatory questions and this process of abductive search is best understood to be an

approach to offering such answers as ways of resolving doubt about the phenomenon in question.

3. Kapitan's Attempt to Explicate Peircean Abduction

7   Let us begin then by looking at Kapitan's reconstruction(s) of Peircean abduction. Doing so will allow us to see precisely how Peirce himself conflated the three distinct kinds of inference involved in the abductive search method noted above and it will point to a resolution of this complex problem. Kapitan (1990, 1992 and 1997) importantly saw that there are several potentially reasonable explications of Peircean abduction that one might think captures Peirce's thoughts about the matter. To this end, Kapitan (1997) carefully pointed out that Peirce is committed to the following important methodological theses about abduction:

> (M1-*The Inferential Thesis*) Abduction is, or includes, an inferential process or processes. (1997: 477)
> (M2-*The Thesis of Purpose*) The purpose of "scientific" abduction is both (i) to generate new hypotheses and (ii) to select hypotheses for further examination. (1997: 477)
> (M3-*The Comprehension Thesis*) Scientific abduction includes all the operations whereby theories are engendered. (1997: 477)
> (M4-*The Autonomy Thesis*) Abduction is, or embodies, reasoning that is distinct from, and irreducible to, either deduction or induction. (1997: 478)

8   Having laid out these theses explicitly, Kapitan then made four attempts to explicate a conception of Peircean abduction that is consonant with M1-M4 and various other specific things Peirce said about abduction. The first of these attempts, Kapitan's (F2), characterizes abduction as follows:

> P1: Some surprising fact C is observed.
> P2 If H were true, then C would be a matter of course.
> P3: H is more economical than the envisioned competitors.
> Hence,
> C1: There is reason to suspect that H is true.[10]

9   The second, (F3), is this:

> P1: Some surprising fact C is observed.
> P2 If H were true, then C would be a matter of course.
> P3: H is more economical than the envisioned competitors.
> Hence,
> C1: H is more plausible than its envisioned competitors.

10   The third, (F4), is this:

> P1: Some surprising fact C is observed.
> P2 If H were true, then C would be a matter of course.
> P3: H is more economical than the envisioned competitors.
> Hence,
> C1: H is more plausible than its envisioned competitors.
> Hence, probationally,
> C2: H.

11   Relatedly, he offers this final alternate construal (F5):

> P1: Some surprising fact C is observed.
> P2 If H were true, then C would be a matter of course.
> P3: H is more economical than the envisioned competitors.
> Hence,

C1: H is more plausible than its envisioned competitors.
Hence,
C2: It is recommended, for one who desires an explanation of C, to further examine
H.

12   Kapitan (1992) addresses these re-constructed argument forms in great detail and concludes on this basis that Peirce failed to provide an account of abduction that satisfies the autonomy thesis. Moreover, in adopting the thesis of purpose he argues that Peirce insisted that abduction was a source of new hypotheses, but abduction so understood is not a form of inference the conclusions of which were evidential.[11] As Kapitan puts it, Peircean abduction properly understood has an abductive-discovery function but not an abductive-preference function.[12] So Kapitan argued that Peircean abduction does not exclusively have the (F2)-form. Peircean abduction occurs prior to the sort of inference to the best explanation necessary to resolve explanatory inquiry and Peirce rejected the claim that the conclusions of abductions are to be taken as probable and belief worthy. Thus, Kapitan makes it clear that the sort of plausibility involved in (F3) has to be properly understood as something other than belief worthiness. This constitutes further reasons to suspect that (F2) is not an appropriate explication of Peircean abduction. Kapitan also notes the autonomy thesis rules out (F3) as an adequate explication of abduction because it is a deductively valid argument and so he argues that (F3) cannot be a complete explication of Peircean abduction.[13] This leaves us with (F4) and (F5) (both of which incorporate (F3) as a component) as candidates for the proper explication of Peircean abduction, but Kapitan ultimately finds them both to be unsatisfactory. (F4) fails in so far as it involves the conflation of Peircean abduction with IBE and in doing so fails to capture the abductive-discovery function of the Peircean concept of abduction. It founders on the thesis of purpose, and he argues that (F4) ultimately reduces to (F3) because probationary acceptance is nothing more than acceptance as plausible. What remains in the way of a potentially adequate explication of Peircean abduction is then (F5). As Kapitan saw it, (F5) does reveal some important things about Peircean abduction. One of the most important of these revelations is that Peircean abduction involves a form of practical inference aimed at recommending a course of action. So understood, this sort of argumentation is (at least in part) aimed at determining which hypotheses from among a set of competitors are, from a practical (i.e. non-evidential) perspective, worthy of further investigation. Based on these complex considerations of Peirce's work, Kapitan concludes that Peirce's account of abduction is really a muddle involving the conflation of IBE, creative abductive inference, practical considerations, induction, and deduction.[14] Nevertheless, sorting through this morass by following Kapitan's thinking is useful. Importantly, it allows us to see that teasing apart the various components involved in Peirce's convoluted account of abduction can lead us to a clearer understanding of the nature of explanatory inquiry along the lines of Hintikka's conception of abductive search understood in terms of the TC-model of science introduced by Reichenbach and further developed by Laudan.

4. Reichenbach and the Three Contexts-Model of Inquiry

13   The distinction between the context of discovery and the context of justification, that can be traced back to the work of Hans Reichenbach's (1938), has been a familiar,

though controversial, theme in the philosophy of science ever since its introduction. The distinction between these two phases of scientific investigation was intended to mark off the boundary between scientific activities that involve the irrational and often capricious process of hypothesis introduction from the rational and rule governed process of confirmation/disconfirmation.[15] But, long after Reichenbach made this initial distinction, Larry Laudan (1977, 1980 and 1981) importantly pointed out that these are not the only two phases of scientific investigation. Laudan insightfully noticed that there is a third phase of scientific investigation: *the context of pursuit.* Temporally, this phase of scientific investigation typically lies between the context of discovery and the context of justification, although the temporal ordering of these phases is not essential to the distinction.

14   In any case, the basic story concerning the context of pursuit goes as follows. Hypotheses are introduced in the context of discovery by any variety of means, but this process is purely psychological, it is not governed by any methodological rules, and it is evidence-independent. Hence, activity conducted in the context of discovery is *epistemically* irrational.[16] Nevertheless, it still serves a deeply important role in the overall context of scientific investigation. Specifically, the hypotheses that are subsequently to be subjected to empirical testing and which were proposed the context of discovery are examined in this stage of science. This is a period in which articulated hypotheses are examined with respect to their implications and in terms of their pragmatic virtues. But, this stage of inquiry involves neither proposing new hypotheses nor the confirmation/disconfirmation of hypotheses. This stage of science involves the *investigation* and *development* of hypotheses initially proposed or identified in the context of discovery, and this phase of scientific investigation is, like the context of discovery, supposed to be epistemically irrational. There are supposed to be no strictly factual truth-aimed methodological rules that govern such activity. Nevertheless, this sort of work is a necessary precursor to the rule-governed and epistemically rational testing that goes on the context of justification. As we shall see, this negative characterization of both the context of pursuit and the context of discovery is not exactly true, but it is the standard view of these important phases of scientific inquiry.

15   The three-contexts model (the TC-model) of scientific investigation raises several important issues, at least two of which have not been adequately discussed in the relevant literature. The first issue concerns the nature of the propositional attitudes that scientists, or scientific communities themselves, have towards hypotheses both in the context of discovery and in the context of pursuit. In the context of justification it is reasonable to suppose that the proper propositional attitude towards hypotheses being subjected to empirical testing is evidentially grounded belief/partial belief and, in optimal cases, knowledge. In the course of testing, a scientist should commit to a given hypothesis only as a possibility. This is just the standard evidentialist perspective on the matter and in the context of justification evidence is marshalled in order to determine factual truth.[17] However, this is not clearly the case with respect to hypotheses in either the context of discovery or the context of pursuit. For, in those stages of scientific activity, there is no evidence being considered in the familiar sense that we see evidence being employed in the context of justification. In the context of justification empirical evidence is used to determine *factual* truth with respect to the actual world. As a result, it would appear to be the case that the hypotheses being considered in the other two contexts should not be believed in the same manner if we

take evidentialism seriously. But then why should hypotheses in the context of discovery be entertained and why would any scientist continue to consider any such theory as a candidate for development in the context of pursuit? The answer cannot be that the empirical evidence establishes the factual truth of the hypothesis in question and warrants belief in the factual truth (or approximate truth) of hypotheses in either case. On this basis, it would seem to be the case that hypotheses in the context of discovery and in the context of pursuit are either irrationally believed or they are the objects of some other propositional attitude that is governed by some other standards of rationality. In this paper the latter option is developed, and it is preferable to the former option in that it entails the rationality of such inquiry. More specifically, it will be suggested here that the appropriate rational attitude to have with respect to unconfirmed hypotheses in the contexts of discovery is a kind of epistemic modal belief about hypotheses and in the context of pursuit the appropriate rational attitude to exhibit towards hypotheses is that of pragmatic acceptance.[18]

16   The second issue related to these matters that has also received too little attention in the relevant literature has to do with the relationship between the TC-model of science and the natures of both abductive inference and of inference to the best explanation (IBE). After dealing with the problem concerning propositional attitudes towards theories in the TC-model, a way of integrating the TC-model with abduction and IBE will be proposed. It will be shown here that this integrated model illuminates much about the nature of both. So, this approach helps to delineate the nature of the methodological filters that are used to winnow down the set of hypotheses from which IBEs are ultimately made in the broader abductive search for the truth. Moreover, in properly distinguishing and integrating IBE and abduction this model provides a framework that allows for the answering the criticisms levelled at Peirce and others about the conflation of abduction and IBE. Let us begin then by looking at the issue of propositional commitments as they are manifested in the contexts of discovery and pursuit.

5. Acceptance versus Belief

17   An important task then when we are considering situations or models that involve propositional commitments is to distinguish cases involving factual belief from those that do not involve factual belief. This is important because it seems that we all too often default to factual belief as the only sort of propositional commitment. One important example of doing this involves distinguishing commitments that involve the norm of factual truth from those that do not involve the norm of factual truth. This is of course because it is widely agreed that the norm of factual belief is factual truth. By distinguishing such cases we can thereby avoid attributing inappropriate features to such situations, especially with respect to judgments of rationality. More specifically, if we take seriously the claim that there are commitments that do not involve the norm of truth, then it is reasonable to believe that we can make sense of the idea that there are propositions that are believable and even plausible that are not actually believed. This is because there can be non-factual-truth-normed rational commitments, some of which involve things other than factual truth and some of which do not involve belief at all.[19] As we shall see, some of these commitments are driven by considerations that are either broadly pragmatic or based on plausibility.

18   The upshot of this is that it is reasonable to believe that propositions can be rationally entertained but not believed because they are modally plausible or pragmatic rational to endorse.[20] Once this possibility is seriously entertained it is apparent there are many cases of commitments that are not reasonably understood to be factual beliefs or even beliefs, but which allow us to achieve certain important and rational goals. In accordance with the recognition that many commonplace propositional commitments are not beliefs, L. J. Cohen (1992) usefully distinguished belief from a particular form of acceptance.[21] He treated the latter as voluntary and pragmatically motivated, whereas the former is non-voluntary and epistemically motivated and showed how belief and acceptance have often been conflated with serious negative implications for a number of philosophical issues. These kinds of weaker but voluntary propositional commitments turn out to be quite commonplace attitudes to have toward propositions and they play roles in all sorts of behaviors like acting, exploring ideas, etc. More to the point, it will be argued here that a form of acceptance plays an important role in the proper understanding of the contexts of discovery and of pursuit. In virtue of this recognition, the determination of the specific kind of acceptance that is at work in the different phases of the TC-model is a crucial goal of this paper.

19   Let us then begin by looking at the various concepts of acceptance in contrast to the concept of belief. The first important distinction to make with respect to the various attitudes of acceptance concerns the extent of such commitments. So, as we will understand it here, S's acceptance of p is *full*, if and only if S's commitment to p is governed by an appropriate closure principle.[22] A modest and reasonable version of such closure for acceptance can be simply rendered as follows:

$$(\text{CLO1}) \text{ If } A_S p \text{ and } JB_S(p \supset q), \text{ then } A_S q.$$

20   Where S's commitment is not full in this sense we will call such acceptance *limited*. The second important distinction to make among the various forms of acceptance concerns the norm that governs such cases of acceptance and thus fixes the kind of rationality that such commitments involve. So, if S's acceptance of p is *strong*, then S's commitment to p is such that p should be maximally plausible for S. Here plausibility will be understood in the following sense. S is plausible for p, if and only if, S does not know that $\neg p$ and p does not *prima facie* seem to be false to S.[23] It should be clear then that plausibility is a form of epistemic possibility. Where S's commitment is not strong in this sense we will call S's commitment *weak* and the norm that governs such weak forms of acceptance will be understood to be pragmatic utility. So, if S's acceptance of p is weak, then S's commitment to p is such that p should be pragmatically justified for S. Adopting the attitude of weak acceptance towards a proposition *may* involve propositions that are plausible, but this is not required to weakly accept a proposition. An agent might be pragmatically entertaining a proposition that happens to be plausible, but the plausibility of that proposition may not be the *rational basis* on which it is being entertained. In other words, plausibility may not be among the ultimate reasons for the adoption of that proposition. So, many such pragmatic commitments involve propositions the adoption of which is not motivated by plausibility and many commitments that aim at the adoption of plausible propositions may not be adopted for

pragmatic reasons. But, where we have commitments that are plausible and aim at pragmatic utility we have cases of what we can call *mixed acceptance* and in such cases we must be clear that the rational basis for accepting a proposition involves *both* plausibility and pragmatic utility. So understood these two important distinctions yield six important categories of acceptance: strong full acceptance, weak full acceptance, strong limited acceptance, weak limited acceptance, mixed full acceptance and mixed weak acceptance. Further, more-refined versions of each of these forms of acceptance can then be determined by specifying additional features definitive of each of these types of propositional attitude.

21   To begin, let us consider the weakest form of acceptance so understood, weak limited acceptance. As it is to be understood here, *weak limited acceptance* is a propositional attitude like belief and knowledge. Its main features are as follows:

WL1. Accepting *p* is purely voluntary.
WL2. Accepting *p* is non-evidential.
WL3. Accepting *p* is a form of supposition.
WL4. Accepting *p* is a pragmatic matter.
WL5. Accepting *p* is contextual.
WL6. Accepting *p* is not a commitment to the literal truth of *p*.
WL7. Accepting *p* is not governed by any closure principle.

22   Paying careful attention to the features of various commitments will then allow us to discriminate truth-normed commitments like belief from non-truth-normed commitments like this particular form of acceptance on the basis of the norm(s) it does involve. In any case, the view endorsed here is that accepting a proposition in this particular weak and limited way is a sort of voluntary, non-evidential but suppositional, pragmatic and contextual commitment that is something like "trying out" or "using" a proposition and *some of its implications in some contexts.* While the account of weak limited acceptance offered here shares some features in common with Cohen's account it is appreciably different because on Cohen's account acceptance is characterized by subjective closure under material implication.[24] This principle is typically understood as follows:

$$(\text{CLO2}) \text{ If } A_S p \text{ and } B_S(p \supset q), \text{ then } A_S q.$$

23   This closure principle is however too weak and as full acceptance is characterized here it will be understood to involve CLO1. This is simply because CLO2 is far too subjective in closing acceptance only under what are *believed* to be the material implication of an accepted proposition. Nevertheless, Cohen's form of acceptance is still a form of weak *full* acceptance since it does obey a form of closure. So, we can demonstrate that a given commitment is/is not a case of full acceptance by exploring whether an agent's acceptance satisfies some appropriate closure principle.

24   We are then able to distinguish cases of weak acceptance from cases of strong acceptance and from cases of mixed acceptance by determining whether they involve the requirement that S's acceptance of *p* presupposes and is motivated by considerations of plausibility (i.e. epistemic possibility), whether *S*'s commitment to *p* is merely pragmatically motivated, and/or whether *S*'s commitment to *p* involves

considerations of both plausibility and pragmatics. Given this distinction, *strong full acceptance* can be understood to be characterized in terms of the following principles:

SF1. Accepting *p* is purely voluntary.
SF2. Accepting *p* is non-evidential.
SF3. Accepting *p* is a form of supposition.
SF4. Accepting *p* requires that *p* is plausible for *S*.
SF5. Accepting *p* is not a commitment to the literal truth of *p*.
SF6. Accepting *p* is governed by JBCM.

25 *Weak full acceptance* can, similarly, be characterized as follows:

WF1. Accepting *p* is purely voluntary.
WF2. Accepting *p* is non-evidential.
WF3. Accepting *p* is a form of supposition.
WF4. Accepting *p* is a pragmatic matter.
WF5. Accepting *p* is not a commitment to the literal truth of *p*.
WF6. Accepting *p* is governed by JBCM.

26 *Mixed full acceptance* can be characterized as follows:

MF1. Accepting *p* is purely voluntary.
MF2. Accepting *p* is non-evidential.
MF3. Accepting *p* is a form of supposition.
MF4. Accepting *p* requires that *p* is plausible for *S*.
MF5. Accepting *p* is a pragmatic matter.
MF6. Accepting *p* is not a commitment to the literal truth of *p*.
MF7. Accepting *p* is governed by JBCM.

27 Notice that all of these cases are cases of voluntary, complete and total commitments and that the completeness and totality of these attitudes is due to the fact that they are governed by closure principles, specifically by CLO1. They are all suppositional, non-evidential and non-factual-truth-normed kinds of commitments and they differ only in terms of the non-evidential norms which govern them. Importantly, strong full acceptance has plausibility as a norm, weak full acceptance has practical utility as a norm and mixed full acceptance has both plausibility and practical utility as norms.

6. Discovery, Pursuit and Justification

28 This framework then allows us to identify and distinguish the cognitive aims that guide activity in all three contexts in the TC-model of abductive search in such a way that they are all rational, although not in the same way. In the context of justification the standards of rationality at work are epistemic and the stance towards hypotheses therein is full belief or partial belief. Typically, these standards will involve truth, approximate truth or probability as it applies to putative facts. In the context of pursuit, the standards of rationality at work are broadly pragmatic and the stance towards hypotheses therein is one of mixed full or limited acceptance. The specific pragmatic standards at work in this stage of abductive search involve utilities of some appropriate sort. Finally, the context of discovery involves the generation of sets of potential answers to scientific problems. It involves beliefs about the modal status of hypotheses and is governed by epistemic standards pertaining to epistemic modal truth. The stance towards hypotheses in this context involves specific kinds of beliefs about what is physically and epistemically possible. It then turns out that these three contexts serve as a sequential, recursive, and putatively reliable search procedure for determining what is true by the successive winnowing down of the set of hypotheses

considered at the outset of inquiry and ultimately selecting the best answer to the why-question that generated a given case of explanatory inquiry. What then does this framework allow us to say about Peircean abduction and Kapitan's attempt to disentangle Peirce's ideas on the matter?

7. Kapitan's (F5), Abduction and IBE

29 Recall that Kapitan settles on (F5) as the most sophisticated explication of Peircean abduction, but he concludes that this account of abduction runs together the discovery and preference functions of abduction and that it also founders on the independence thesis. Again, (F5) is presented as follows:

> P1: Some surprising fact C is observed.
> P2 If H were true, then C would be a matter of course.
> P3: H is more economical than the envisioned competitors.
> Hence,
> C1: H is more plausible than its envisioned competitors.
> Hence,
> C2: It is recommended, for one who desires an explanation of C, to further examine H.

30 What the TC-model of abductive search allows for is the identification of (F5) inferences as complex inferences that involve two distinct components that have been erroneously run together. To a first approximation, these take the following distinct forms (F6) and (F7), respectively, where H is the set of plausible explanations of C, K is an established body of background knowledge and H* is a sub-set of H each member of which, H_i, meets or exceeds a threshold utility value v*:

> P1: Some surprising fact C is observed.
> P2: K.
> P3: If H_i and K were true, then C would be a matter of course.
> Hence,
> C1: H_i is K-plausible.
> P1: The members of H are K-plausible.
> P2: The members of H* are more economical than their competitors (i.e. for each H_i $u(H_i) \geq v*$).
> Hence,
> C2: It is recommended, for one who desires an explanation of C, to further examine the members of H*.

31 Iterations of (F6) are used to populate H and this is *modal abduction* where the K-plausibility of H_i is just understood to be a kind of epistemic/explanatory possibility relative to knowledge base K.[25] (F7) is then a form of practical abductive reasoning distinct from modal abduction where the conclusion is advice about which hypotheses to consider seriously on the basis of utilities, understood broadly.[26] In light of all of this, we can also see why Kapitan's (F2) is such a muddle. Recall that Kapitan's (F2) is presented as follows:

> P1: Some surprising fact C is observed.
> P2 If H were true, then C would be a matter of course.
> P3: H is more economical than the envisioned competitors.
> Hence,
> C1: There is reason to suspect that H is true.

32   Notice that this explication of Peircean abduction runs together both forms of abduction and IBE, but, after disambiguation, this final stage of abductive search is best understood as follows:

P1: The members of H* are K-plausible and economical explanations of C.
P2: Methodological criteria M are known to be reliable guidelines for explanatory inquiry.
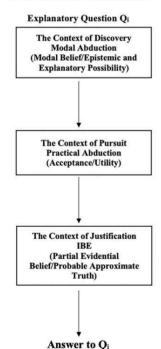P3: Evidence e is known.
P4: There is no better explanation of C than H_i in terms of M and e
Hence,
C1: Probably H_i.

33   Here H_i is a member of H*. This is IBE proper and these inferences are what terminate abductive searches, they are what terminate inquiries concerning explanatory questions about observed facts. But, all cases of IBE so understood presuppose modal abduction and practical abduction, and so abductive search comprehends IBE and two distinct forms of abduction (which are themselves supposed to be distinct from deduction and induction). The TC-model of abductive search then vindicates Hintikka's contention that abduction is not a form of inference. It is a reliable belief-forming procedure incorporating three distinct kinds of inference. It also resolves Kapitan's worries about conflation of abduction and IBE and Peirce's failure to present a theory of abduction meeting all of M1-M4. In particular, this model of explanatory inquiry firmly establishes the autonomy thesis. This is because modal abduction, practical abduction, and IBE are distinct from deduction and induction. The following diagram serves to illustrate the steps involved in this model of inquiry:

The TC-Model of Abductive Search

Explanatory Question Q_i

```
┌─────────────────────────────┐
│  The Context of Discovery    │
│      Modal Abduction         │
│ (Modal Belief/Epistemic and  │
│   Explanatory Possibility)   │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│   The Context of Pursuit     │
│     Practical Abduction      │
│      (Acceptance/Utility)    │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│ The Context of Justification │
│            IBE               │
│   (Partial Evidential        │
│ Belief/Probable Approximate  │
│          Truth)              │
└─────────────────────────────┘
              │
              ▼
```

Answer to Q_i

8. Conclusion

34 So, the main contention made here is that Peirce's conflation of abduction and IBE and his failure to establish the autonomy these are likely just (predictable) consequences of the fact that modal abduction, practical abduction, and IBE are all components of explanatory inquiry. Peirce simply failed to see that there were three *distinct* inferential components involved in this sort of inquiry. Treating abductive inquiry as an explanatory search procedure allows us to see that modal abduction, pragmatic abduction, and IBE are independently identifiable components of this kind of inquiry and they are employed at different stages of such inquiry with very different aims. This is made particularly manifest in the TC-model of abductive search articulated here and this view is grounded in Kapitan's insightful exegetical work on Peircean abduction and its relation to contemporary explications of IBE. So, we owe him great debt for showing us the way out of Peirce's abductive morass.

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NOTES

1. See, for example, van Fraassen 1989, Leplin 1984, Churchland & Hooker 1985, McMullin 1992, Chakravarrty 2017, Khalifa 2010, Wray 2006, 2007 and 2008, Psillos 1996 and 1999, McCain & Poston 2017, de Regt, Leonelli & Eigner 2009, Shaffer 2019 and 2021.

2. See Park 2015 for a additional consideration of these points.

3. See also Campos 2011, McKaughan 2008 and Chiason 2001.

4. See Niiniluoto 2018, ch. 1 and Park 2015 on this point as well.

5. It is also worth noting that this model would apply equally well in the case of "How" explanations, as well as other sorts of explanation.

6. There are many complications involved here worth noting. First, there are important issues involved concerning abduction in science versus abduction in other contexts. The focus here is primarily on abduction in science. Second, there are serious issues to be addressed concerning the propositional attitudes involved at different stages of inquiry (especially in the case of newly introduced versus already introduced hypotheses). This issue will be addressed at some length in what follows. Third, there are significant issues concerning the role that cognitive economy and allocation of resources play in abductive search and this was a central matter of concern for Peirce. This matter will be addressed subsequently in the discussion about the context of pursuit. Finally, Peirce distinguished between the methodeutic and critical aspects of abduction. The methodeutic aspect of induction studies the further features that critically distinguish explanatorily adequate hypotheses from hypotheses worthy of pursuit and validation. The critic of abduction focuses only on the simple recognition that a given hypothesis is explanatorily adequate. This issue is also discussed in what follows and will be addressed in terms of the stages of abductive search.

7. Again, it is worth noting that what is said about abduction with respect to "Why" questions can be applied equally well (in most cases) to other types of questions.

8. See Shaffer 2012, 2019 and 2021 for elaboration and defense of a contextual and dynamic theory of abductive search and IBE and Shaffer 2020 for defense of a local rather than global version of IBE. The various issues to be discussed here are made most clear in terms of the three contexts model of inquiry and, fundamentally, the contexts theory of inquiry is worthy of adoption for this purpose based on its own explanatory power.

9. The kind of epistemic utilities involved are "explanatory" utilities rather than utilities related to accuracy and available resources. See Pettigrew 2016 and Marxen forthcoming for discussion of epistemic utilities.

10. Compare this with Woods 2013 treatment of abduction.

11. Another reason for supposing that abduction and IBE aren't the same thing stems from Peirce's idea that abduction does not prove anything because it does not remove doubt.

12. This is (at least in part) due to the idea that such processes are resource-bound. See Woods 2013.

13. It is not entirely clear that F3 is deductive, but what is clear is that abductive reasoning does not abide by the leading principles that, respectively, govern induction and deduction. As such, if F3-style reasoning is to be distinctively abductive it must not collapse into either deduction or induction when the leading principle is made clear. Kapitan claims that this is why F3 founders on the autonomy thesis.

14. Compare Hanson 1958, 1960 and 1965 on these issues.

15. See Kordig 1978, Gutting 1980, Zahar 1983, Leplin 1987 and Hoyningen-Huene 1987 on the distinction between the context of discovery and the context of justification.

16. This criticism originated with Popper (1959 [1934]: 7-8). See also Schickore 2018. As we shall see, the view developed here importantly treats the logic of discovery as a form of modal and explanatory abduction.

17. See Conee & Feldman 2004 and Dougherty 2011 for various perspectives on evidentialism.

18. So, epistemic modal belief is a commitment to further investigation of a possibility.

19. On this matter Peirce agrees and explains that "One and the same proposition may be affirmed, denied, judged, doubted, inwardly inquired into, put as a question, wished, asked for, effectively commanded, taught, or merely expressed, and does not thereby become a different proposition" (Peirce 1976, vol. 4: 248).

20. See Foley 1994 and Zemach 1997 for discussion of pragmatic and epistemic justification.

21. See Shaffer 2006, 2011, 2013a and 2013b for various discussions of acceptance and belief.

22. Here we do not need to settle the issue about whether closure principles should be understood as involving logical or material implication, whether such closure principles should be objective rather than subjective and whether the closure principle should involve closure under belief or justified belief. So, these matters will be ignored for the purposes at hand. See Shaffer 2013a and 2013b for further discussion of these issues. What matters here is that we understand that full acceptance involve commitment to all of the implications of an accepted proposition.

23. It is useful to compare this idea with the robust/fragile distinction about propositional attitudes from Gabbay & Woods 2005.

24. One might also believe that such attitudes are governed by other closure principles such as closure under logical implication. Since this matter plays no role in the context of this paper, it will be ignored here. See Shaffer 2013b for some discussion of the issue of closure in the context of different forms of acceptance.

25. The orthodox view is that H_i is epistemically possible relative to knowledge base K just in case $\neg(K \rightarrow \neg H_i)$. The related idea here then is that, relative, to knowledge base K and fact to be explained C, H_i is an explanatory possibility just in case H_i explains C and $\neg(K \rightarrow \neg H_i)$. On the notion of epistemic possibility, see DeRose 1991 and Huemer 2007.

26. Again, as mentioned previously, this involves factors including resource allocation.

ABSTRACTS

Tomis Kapitan's work on Peirce's conception of abduction was instrumental for our coming to see how Peircean abduction both relates to and is importantly different from inference to the best explanation (IBE). However, he ultimately concluded that Peirce's conception of abduction was a muddle. Despite the deeply problematic nature of Peirce's theory of abduction in these respects, Kapitan's work on Peircean abduction offers insight into the nature of abductive inquiry that is importantly relevant to the task of making sense of explanatory inquiry in the sciences in general. The view developed here stems from his work and involves disambiguating three forms of inference involved in Peircean abduction in terms of Reichenbach's and Laudan's context models of inquiry. Importantly, this includes understanding that abduction involves the context of pursuit.

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