Toward a Normative Exploration of Compositional Abduction

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1. Introduction

Kenneth Aizawa's *Compositional Abduction and Scientific Interpretation* is a philosophically rewarding and stimulating read. Methodologically, the book expertly models a "science-first approach" to history and philosophy of science. As Aizawa points out, philosophers of science often default to a *philosophy-first* approach to HPS, first developing metaphysical or epistemological accounts of various analysanda, and then eisegetically reading their preconceptions and accounts *into* various scientific case studies. By contrast, Aizawa's approach starts with a close examination of the "primary experimental literature" pertaining to a handful of case studies, and only then uses philosophical concepts, when necessary, purely for the sake of describing the "published scientific reasoning" accurately. The upshot is that Aizawa sets aside ontological and normative issues and instead pursues an "exclusively descriptive" account of scientists' own commitments and practices. He insists that such an account is already "challenging enough" without also having to defend metaphysical or epistemological positions.

In this book, Aizawa uses this methodology in order to excavate out of his selected experimental literature a coherent description of one important type of inference scientists use when interpreting experimental results. These "singular compositional abductions" (SCAs) are "abductive," according to Aizawa, insofar as they infer hypotheses on account of the hypotheses' ability to *explain* the results. But SCAs may be

distinguished from other explanatory inferences by specifically invoking "singular compositional explanations." This style of explanation, which Aizawa again extracts from a close reading of his case studies, accounts for experimental results via "representations of compositional many-one ontological dependence [non-causal] relations between spatially and temporally localizable particulars." In effect, scientists take themselves to explain certain experimental results by hypothesizing about the individuals, activity instances, and property entities ontologically *composing* those results. For example, through a careful review of Hodgkin and Huxley's Nobel Prize-winning research on the propagation of action potentials in neurons, Aizawa argues that they inferred that sodium ions carry the initial inward current of the action potential on account of this hypothesis's ability to explain their experimental results pertaining to such currents. More specifically, Aizawa argues that Hodgkin and Huxley thought of their hypothesized influx of sodium ions explaining in the sense of *composing*—or more specifically, *implementing*—the axon's inward current. Hodgkin and Huxley infer an influx of sodium ions by way of that hypothesis's ability to *compositionally explain* such currents.

Strictly following his science-first approach, Aizawa imposes descriptive boundaries around his study of compositional explanation and SCA, "set[ting] aside any number of issues that have occupied epistemologists and philosophers of science for decades." This includes normative questions of "whether any specific abductive inference is justified or whether abduction, in general, is justified" (p. 22). This commentary initiates the normative exploration into SCA, venturing beyond Aizawa's boundaries. This move should not be thought of as clashing with Aizawa's work but as considering ways in which one might normatively examine it. By offering a less philosophically

tainted glimpse into actual scientific practice, Aizawa's science-first, descriptive project sets the stage for more fruitful metaphysical and/or epistemological theorizing about this practice; it provides philosophers with a more accurate glimpse into the scientific practice and commitments upon which they hope to shed light. The exploration below is directed by two big questions: How does SCA relate to extant normative-philosophical theories of explanatory inference? And is SCA a warranted or cogent form of inference in any precise sense? Each of these issues is too big for a commentary of this size. However, I hope that my all-too-brief discussion of each question goes some way toward informing the more elaborate philosophical discussions of SCA that Aizawa's book will surely inspire.

2. Compositional "Abduction" and Abduction

How does Aizawa's concept of *compositional abduction* relate to existing normative-philosophical theories of explanatory inference? In particular, how is SCA situated with respect to Inference to the Best Explanation, or "IBE" (Harman 1965, Lipton 2004)? And how does it relate to the notion of abduction (Fann 1970; Peirce CP 5.145, 5.171)? This section tackles the latter question, while section 3 confronts the question of IBE.

Aizawa follows a general trend in the philosophy of explanatory reasoning (e.g., see Douven 2022) by using the term "abduction" to refer generally to explanatory inference—"a form of inference that infers some hypothesis because of what that hypothesis explains." Aizawa recognizes that Peirce coined this term in order to distinguish that peculiar creative insight humans have for creating new ideas that are surprisingly often right (CP 5.173). Abduction is the "only logical operation which

introduces any new idea" (CP 5.171), while induction and deduction provide the logical operations for testing such ideas. Nonetheless, Aizawa purposefully breaks from Peirce's notion. I find his (and others') reasons for doing so confusing and ill-motivated.

First, Aizawa cites the fact that "scientists use abduction to confirm, and not just introduce, new ideas" (p. 172). Aizawa is surely right that scientists use explanatory inference to confirm, and not just introduce, new ideas. But the idea that both uses of explanatory inference are "abduction" only begs the question, already assuming a break with Peirce's notion of abduction as exactly that inference form which introduces new ideas.

Second, Aizawa (pp. 173-77; cf., section 4.3) argues that Peirce's notion of abductive, creative inference cannot be distinguished cleanly from the HD logic of testing and confirmation. Aizawa makes his point using Peirce's well-known schema explicating the form of abductive inference (CP 5.189):

> 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.

As suggested by Peirce's choice of notation here, abduction so explicated is something of a meta-inferential form, which builds off of the object-level inferential form of *affirming the consequent*:

> C
> A→C
> Hence, A

In abduction, we observe the consequent, C, of a conditional. The antecedent, A, expresses a *new idea* that would account for C, as explicated by the conditional, A→C.

And so there is sufficient reason to suspect that this new idea A is true and test it further. But, as Aizawa (p. 102) notes, HD confirmation associates the confirmation of a hypothesis (*part of the inductive testing stage*) with the same object-level logical structure of *affirming the consequent*:

> If H is true, then so is E.
> As the evidence shows, E is true.
> Hence, H is confirmed.

As Aizawa demonstrates with an example, one can use their common object-level structure to reframe at least some HD confirmations as abductions. Aizawa concludes that "that scientific hypothetical reasoning that philosophers commonly interpret as hypothetico-deductive confirmation can, at least at times, also be interpreted as abductive reasoning." And hence, abduction is not limited to creative inference; sometimes the same form of inference is used in confirmation and inductive testing.

This argument also strikes me as unconvincing. Neither HD confirmation nor abduction are meant to be identified with *affirming the consequent*. Rather, both are properly viewed as meta-inferences to distinct meta-level conclusions—viz., that there is a new idea with some reason in its favor, or that a hypothesis is confirmed—applying in distinct contexts for which the object-level structure of *affirming the consequent* attains. In abduction, the antecedent of the conditional is provided by a new idea, whereas the antecedent in the HD confirmation case is provided by a hypothesis that is already being tested. The consequent in abduction consists of a "surprising fact"[1] that cries out for

[1] Aizawa also takes issue with Peirce's stipulation that abduction must start with the observation of a surprising fact. I agree with Aizawa that abductions need not involve psychologically surprising explananda. However, I disagree that this is a compelling reason to distance ourselves from Peirce's notion of abduction. The fact that the explanandum in an abduction must be "surprising" might simply be taken to mean that, to

explanation while the consequent in HD confirmation cases is established "evidence." These differences lead to important corresponding distinctions in the meta-level conclusion that the reasoner is meant to draw in each case. In the abductive case, the reasoner concludes that the new idea has some reason in its favor, making it worth testing further; in the HD confirmation case, the reasoner is meant to conclude that the hypothesis being tested is confirmed (to some extent) by this evidence. The fact that abduction and HD confirmation both involve the object-level logical form of *affirming the consequent* does not imply that they are indistinguishable from, or reducible to, one another. Nor does it more modestly suggest that some HD confirmations can accurately be reinterpreted as abductions.

Aizawa insists that he's free to coopt Peirce's term and reinterpret it however he likes (pp. 179-80). And so he is. Why assume that abduction just is whatever Peirce says it is? But my point here is not that Aizawa should somehow be forbidden from disagreeing with Peirce. Rather, my point is that Aizawa's coopting of this term is neither wise nor helpful. Peirce coins the term "abduction" in order to highlight a critical distinction, that between our *creative* and *critical* reasoning faculties. Unless one denies that there is a human creative inferential faculty, one should be inclined to keep this idea disentangled from related ideas and investigate this important and peculiar notion under the term that was invented for that purpose. Why reinvent the terminology and thereby

some extent, it does indeed stand in need of explanation. Plausibly, all explanatory inferences require that the explanatory idea/hypothesis inferred does indeed so some explanatory work, and the doing of explanatory work would clearly require that there is explanatory work to be done in the first place.

conflate importantly distinct ideas that Peirce and others have worked hard to disentangle?

> In his attempt to forestall these sorts of concerns, Aizawa (p. 180) writes:
>
> > I am not using the Peircean concept of abduction. I am developing another one – taking one element from the Peircean view – that I believe supports a more detailed and accurate description of scientific reasoning in the primary experimental literature than does the Peircean conception. I am not confused at all.

But Aizawa is not really developing a new theory of *abduction* in any sense related to Peirce. Rather, he has an entirely different target concept in mind, which he confusedly calls by the same name. Aizawa's arguments for distancing himself from Peirce do convincingly show something; they show that he is exploring a different analysandum than what Peirce investigates and coins the name "abduction" to denote. To call his target concept by this same name merely because it also is a species of *explanatory* inference only invites confusion. Aizawa is not disagreeing with Peirce in any substantive sense; rather, he is changing the subject.

In defining his project early on in the book, Aizawa clarifies that "a theory that focused on what is happening at the moment of scientific insight, when a scientist first conceives an answer to a scientific question, would likely be quite different" (p. 13). My point here is that, if we are careful with our conceptual distinctions and insist on using unconfusing terminology, then this amounts to an admittance on Aizawa's part that a theory of abduction would be quite different than what he is after in this book. In the remainder of this commentary, I try to keep my own terminology straight by referring to SCA as a variety not of "abduction," but of "explanatory inference."

3. Compositional Abduction as Inference to the Best Explanation

Maintaining the important distinction between abduction (as creative, explanatory inference) and forms of non-creative inference does not imply that explanation can only have a role in hypothesis creation. Indeed, explanatory considerations may have a crucial role in the testing and critical evaluation of hypotheses which abduction puts on the table. This brings us to IBE. In this section, I argue that Aizawa's SCA is best understood as a species of IBE. My hope is that by showing that SCA is a variety of IBE properly and charitably construed, both SCA and IBE will be more clearly understood. Moreover, the main points of this section set the stage for section 4, in which we allow normative discussions of IBE's cogency (or lack thereof) to inform and direct our discussion of SCA's potential cogency.

In discussing accounts of IBE put forward by Harman and Lipton, Aizawa offers several reasons for wanting to draw a sharp line between SCA and IBE *so understood*. Foremost among these reasons is his claim that such accounts describe IBE as a rule of inference that always warrants acceptance of the most explanatory hypothesis.[2] Aizawa (p. 83) rightly points out that scientists' use of SCA runs contrary to this idea:

> There are many instances where, on some page of a scientific journal article, scientists draw an inference to some compositional hypothesis based on what that hypothesis explains, but where it is not clear that, at that point in their published work, they take their explanatory hypothesis to be warranted.

[2] For example, Aizawa suggests that Harman identifies IBE with "warranted abduction" insofar as Harman requires IBE to include an eliminative step ruling out all competitors to the best explanation. Notably, Harman also requires that IBE's best explanations be "sufficiently better than any other hypothesis" (Harman 1965, p. 89).

In other words, Aizawa's science-first approach quickly shows that not all SCAs are taken to warrant or ground justified belief in the conclusion; there are many cases of scientists using SCA without thereby thinking themselves justified in believing or accepting the best compositional explanation.

It is not at all surprising that Aizawa sees a connection in the literature between IBE as commonly explicated and defended by philosophers and warranted acceptance of IBE's conclusions (best explanations). Virtually all commentators on IBE today assume, following van Fraassen (1980, p. 142), that "[IBE purports] to be a rule to form warranted new beliefs on the basis of the evidence, the evidence alone, in a purely objective manner." The common assumption that critics and defenders of IBE all seem to adopt is that IBE, insofar as it is a good inference form, must warrant belief in best explanations. It is this assumption that leads critics to attack IBE by pointing out that this inference rule could lead one to conclusions that are not epistemically justified (e.g., explanatory hypotheses that are the best of a bad lot). And it is this assumption that leads would-be defenders of IBE to hedge the inference form in various ways, either strengthening IBE's premises or weakening its conclusion so that the conclusion can be more plausibly justified in light of the premises.

However, as I argue at length elsewhere (Schupbach 2026; cf., Schupbach 2014), this way of characterizing IBE is misguided—and not just on account of Aizawa's point that it fails to describe the inferential practice of scientists. The idea that IBE is a pattern of inference which is only defensible insofar as it justifies belief in its conclusions involves a deep philosophical confusion about the very notion of inference. This reading ultimately confuses the act of inference with just one of the doxastic payoffs—warranted

or justified belief in the conclusion—that may come about as a result of that act in a particular case. This point is worth dwelling and expanding on here since its appreciation helps motivate the idea that SCA is a species of IBE.

The act of inference need not involve acceptance of the inferred conclusion; after all, a reasoner might infer a conclusion out of merely conjectured or even disbelieved premises. A theoretical inference (the sort of inference of which IBE is supposed to be a type) is an intellectual bearing of a proposition from out of other propositions. The performance of such an intellectual act is entirely consistent with any number of doxastic attitudes the reasoner might take toward those propositions. Accordingly, an inference is not appropriately evaluated by gauging whether the reasoner has justified belief in the conclusion; the inference might be good while the conclusion is nonetheless unjustified for any number of reasons (most obviously, the reasoner may not justifiably believe the premises). An inference is instead appropriately evaluated by gauging whether its conclusion does truly follow in some clear sense from the premises. Similarly, a pattern of inference or inference form such as IBE is not properly evaluated by inquiring whether it provides us a rule for reliably forming justified beliefs. Rather, an inference form is evaluated by investigating whether it provides a pattern of reasoning the instantiating of which results in inferences that are good in a precise *following-from* sense.

Note that this is equally true of deductive inference forms. When deductively evaluating an inference form, we do not ask how often it is used to ground justified beliefs in its conclusions. Rather, we test whether its conclusions (conclusions of the specified form) validly follow from its premises (premises of corresponding, specified forms). Similarly, it is a mistake to think that IBE or any other non-deductive inference

form must reliably result in justified beliefs in order to provide a warranted, cogent, or otherwise good pattern of reasoning. IBE's cogency turns on whether there is a defensible, clear sense in which its conclusions follow from its corresponding premises. And as with any other inference form, any goodness this IBE is demonstrated to have is consistent with its instances grounding a variety of doxastic payoffs beyond justified belief in the conclusion. When we discover that an inference form is good, we learn that its instances' conclusions follow from corresponding premises, but we learn nothing about what to do with that information doxastically across particular cases. Any such epistemic advice is necessarily specific to the case, taking into account such contextual factors as the reasoner's prior commitments, the total evidence, and so on.

It is incredibly refreshing that Aizawa sees his way through this confusion. The fact that there could be other doxastic payoffs to explanatory inference apart from new justified beliefs does not go missing on Aizawa; that is why he insists that "not all abductions are warranted abductions." As Aizawa points out from his examination of the scientific literature, other doxastic responses are often called for by an SCA (withholding assent, increasing one's confidence, putting/keeping an hypothesis on the table for further testing, "abductive disconfirmation" of a hypothesis, etc.), and indeed, it might take a long sequence of repeated cogent abductions, perhaps augmented by other inferences from other sort of evidence, before scientists ever feel warranted in believing the most explanatory hypothesis:

> It could be that such warrant as scientists take there to be for some hypothesis emerges only through a prolonged program of scientific research, a program spanning more than just a few pages of a journal article. Scientists typically take a

program of research, not one experimental result, to eliminate rival hypotheses (pp. 83-84).

While Aizawa rightly distinguishes SCA from accounts that confusedly portray IBE as a general rule for forming justified beliefs, he officially leaves open the possibility that SCA might be understood as a variety of IBE on some other account (e.g., in section 8.3). Indeed, this seems to me to be the most natural way to understand SCA once IBE—and inference itself—is properly understood. In an SCA, one infers the best explanation in the straightforward sense of inferring the hypothesis that proffers the best singular compositional explanation of the relevant experimental result(s).[3] The inference of such a hypothesis reflects the perception or judgment that it follows (in some sense, to some extent) from its ability to compositionally explain the relevant evidence. And this following-from judgment is consistent with any number of different doxastic responses to the inference being appropriate on a case-by-case basis.

4. Evaluating Compositional Abduction

Viewed in this way, how might one approach the philosophical-normative evaluation of SCA? Are the scientists right to use this inference form and think of it (at least in some cases) as confirmatory? While Aizawa tables this question for the sake of his book, it is worth starting to explore here for a couple of reasons. First, Aizawa has nicely set the stage for such a study by excavating from primary experimental literature an accurate description of this inference form. As I will show, such descriptive detail has

[3] In cases where there is only one such hypothesis under consideration, insofar as this hypothesis is truly explanatory, the "best explanation" very naturally corresponds to the "only explanation" (Aizawa, p. 195).

important implications for the normative evaluation. Second, we have also gleaned important insight into how we might formally evaluate SCA by arguing that it is a species of IBE.

Early in the book (section 1.4), Aizawa notes that explanatory inferences can be taxonomized according to the variety of explanation that they invoke. Thus, for example, insofar as causal-mechanical explanations and unificationist explanations are distinct, legitimate modes of explanation, inferences to best causal-mechanical explanations may be distinguished from inferences to the best unificationist explanations. Aizawa individuates his notion of SCA in just this way; by convincingly arguing that *singular compositional explanations* are a unique mode of explanation, he shows that SCAs provide a distinct variety of explanatory inference.

While I agree with this insight (Schupbach 2017, p. 41, fn 43), I have also argued that another way of taxonomizing explanatory inferences is especially useful for normative investigation (Schupbach 2022, p. 79):

> Potential explanations may be prized for their great simplicity, unification, generality, power, coherence, consilience, or some combination of these (or other) virtues. One immediate consequence of this […] is that the nature and value of an inference to the best explanation will depend upon the notion of explanatoriness at work therein. […] There are at least as many distinct forms of IBE as there are distinct dimensions along which hypotheses may be judged more explanatory than one another. Inference to the Best (i.e., Most Unifying) Explanation, for example, differs (prima facie, quite substantially) from Inference to the Best (i.e., Simplest) Explanation.

This point is important for present purposes because the question of whether a particular sub-form of IBE is generally cogent (i.e., per the previous section, whether it describes a genuine *following-from* pattern) very plausibly turns on what explanatory virtue(s) they

involve. Insofar as some explanatory virtues (or combinations thereof) can be explicated as having normative upshot, IBEs employing such virtues may be defended as having general normative-confirmatory import.

Aizawa discusses the explanatory virtues in various places throughout his book (e.g., sections 8.3, 8.4, and 9.3). Overall, he argues that these virtues, as explicated for example by Lipton (2004), "do not contribute much to the theory of SCA" (p. 214). The reasons he offers alternate between the virtues being explicated in such a way that does not fit with the practice— not being called upon by the scientists in the instances of SCA he explores—and the virtues being potentially relevant, but too little understood to illuminate the practice (p. 196).

The first point to highlight in response here is that there need be no clean virtue-based normative account of any form of explanatory inference when that inference form is distinguished by the mode of explanation it involves. Taxonomies of explanatory inference based on mode of explanation cross-cut taxonomies based on explanatory virtues. This is because explanatory virtues like simplicity, coherence, power, generality, and so on each plausibly may be had by hypotheses that explain in different senses. A causal explanation may be explanatorily virtuous in the same sense as a compositional explanation—e.g., both may have the virtue of generality, explaining (causally or compositionally) all the salient features of the explanandum.

Nonetheless, the second point to highlight is that a theory of explanation can sometimes imply that hypotheses proffering explanations of that sort thereby have some

particular explanatory virtue.[4] Aizawa runs through a list of candidate virtues and, in each case, dismisses the idea that compositional explanations are generally taken to have that virtue. I think he overlooks one important possibility. The explanatory virtue of power has been explicated with great clarity and precision in formal work on explanatory reasoning (e.g., see Good 1960; McGrew 2003; Schupbach and Sprenger 2011; Sprenger and Hartmann 2019, Schupbach 2022); I will argue that SCAs (as described by Aizawa and understood by the scientists) generally are explanatorily virtuous at least in the sense of being powerful in this precise sense. But then the normative implications of a hypothesis having the virtue of power carry over to hypotheses which provide SCAs.[5]

In the recent literature, an explanatory hypothesis is said to have the explanatory virtue of "power" to the extent that it renders the explanandum "more expected" or "less surprising."[6] If one uses the Bayesian apparatus to investigate this idea formally, then power is explicated using the notion of positive probabilistic relevance.[7] That is, H having

[4] DN and IS models of explanation are examples. Any hypothesis that satisfies the conditions laid down by sophisticated versions of these models not only thereby counts as an explanation according to these models, but also thereby has the virtue of explanatory power discussed in this section. Aizawa (section 2.1) makes the important point, from his ontic approach to explanation, that these accounts (or at least the common "empiricist versions" of them) are not appropriately thought of as accounts of the nature of explanation—or rather they don't adequately capture the metaphysical, "worldly" implications of explanation as used and conceptualized by scientists. I agree. It seems to me that such empiricist accounts are attempts to reduce the nature of explanation to the logic and epistemology of explanation (Schupbach and Sprenger 2011, section 1), and this move inevitably confuses importantly distinct issues. Aizawa's theory of singular compositional explanations may be thought of as an aptly metaphysical account of the nature of (some) explanation, which then effectively outputs the DN model's epistemology and logic of explanatory inference.

[5] The following discussion is drawn from (Schupbach 2022, sections 3.2.1-3.2.3). Further details expanding on the points I make here can be found in that work.

[6] This informal characterization is inspired and often motivated by appeal to Peirce's form of abduction, as reviewed in Section 2 above. Recall that A has the effect of making the surprising fact that C a matter of course. However, note that our informal statement of the virtue of power here generalizes on Peirce's comments; there is no implication that the explanandum has to be surprising to begin with. Nor is it implied that the explanandum has to end up being a "matter of course" in the light of the explanans.

[7] Though, judging from his comments on p. 22, it should be noted that Aizawa would presumably not want to go this route in exploring the normative implications of power formally.

explanatory power *apropos* E is probabilistically explicated as $Pr(E|H)>Pr(E)$. Additionally, one might use this formal apparatus to explicate maximal power, i.e., the case in which E is rendered a matter of course: $Pr(E|H)=1>Pr(E)$.

Recall that "Singular compositional explanations are representations of natural ontological dependence relations among spatiotemporally localizable explanandum and explanans entities" (p. 7). In this style of explanation, one explains a result by hypothesizing about the composition of the individuals, activities, and/or properties at work in that result, the explanans entities ontologically determining the explanandum. Aizawa effectively suggests that any such explanation would have the virtue of power—and indeed, *maximal* power—in his discussion of "abductive confirmation" and HD confirmation (sections 4.2 and 4.3). As he summarizes, "The explanation presupposes that the existence of certain entities does determinative work" (p. 100); "[A] configuration of entities referred to in hypothesis H ontologically determines the configuration of entities referred to in some evidence E" (p. 84). Given the "configuration of entities" conjectured by H, the configuration of entities represented by the explanandum becomes a matter of course; the former ontologically determines the latter, and so, as Aizawa states, there is an entailment from H to E, the appreciation of which makes E certain in light of H. The explanandum of a singular compositional explanation is made maximally expected (or minimally "surprising") in the light of the explanans of such an explanation. And thus again, any singular compositional explanation's explanans will have maximal explanatory power *apropos* that explanandum.

So, SCAs are not only, as I have suggested, a species of IBE, but they are more specifically a variety of Inference to the Best (maximally powerful) Explanation. This

observation has several important normative ramifications, as can be explored in the extensive literature on explanatory power. I will just touch on a couple of the most basic such implications here as they relate directly to Aizawa's example SCAs. In these cases, there is only one explanatory hypothesis under consideration. Since this hypothesis proffers a singular compositional explanation and so has positive (indeed maximal) explanatory power, it follows that it is positively confirmed (to some extent) by the explanandum. Aizawa's example SCAs all correspond to *confirmation* of the best (i.e., only) explanation. This is true (and observed by Aizawa) in terms of HD confirmation. But it is also demonstrable using the Bayesian notion of incremental confirmation (and explications of power mentioned above). Given that H has explanatory power over E, $Pr(E|H)>Pr(E)$. A quick algebraic adjustment to the simplest form of Bayes's Theorem gives us the following equality:

$$\frac{Pr(H|E)}{Pr(H)} = \frac{Pr(E|H)}{Pr(E)}$$

And so it follows from $Pr(E|H) > Pr(E)$ that $Pr(H|E) > Pr(H)$, which is the Bayesian's explication of the proposition that E incrementally confirms H.

This provides us with a clear sense in which we can spell out the general cogency of Inference to the Only Singular Compositional Explanation—i.e., the SCAs appearing in Aizawa's case studies. Insofar as H provides a singular compositional explanation of E, it will have the explanatory virtue of power. And insofar as H has power *apropos* E, E incrementally confirms H (i.e., E raises H's probability). This explication of SCA's normative upshot makes sense of Aizawa's repeated point that not all such inferences result in justified belief. Indeed, E might incrementally confirm H and still leave H

wildly improbable. It might take a long sequence of such SCAs, all to H, before H's probability becomes at all substantial in light of the total evidence—if ever it does. The notion of incremental confirmation thus provides us with a clear sense in which Aizawa's SCAs may both be said to be generally cogent (a sense in which they describe a general *following-from* relation) and to be consistent with any number of appropriate doxastic stances toward their premises and conclusion across different instances.

Matters quickly become more complicated for contexts in which there is more than one compositionally explanatory hypothesis under consideration. Insofar as multiple hypotheses all offer singular compositional explanations of the same explanandum, they apparently tie in terms of power, all having *maximal* power. Accordingly, the normative upshot of such SCAs will not be determined in terms of differences in power. Insofar as such SCAs may generally be defended as cogent, warranted forms of inference, it will be on account of some other tie-breaking consideration(s) or virtue. Aizawa's science-first methodology to HPS provides a promising approach toward such a general evaluation of SCA. Further study of the primary experimental literature would, one hopes, shed much light on how scientists adjudicate between multiple, candidate compositional explanations. For example, as Aizawa (p. 31) briefly points out, when they do explicitly consider the possibility of other singular compositional explanations of their results, Hodgkin and Huxley start to talk about the relative *simplicity* of their theory compared to such alternatives.

Needless to say, a more complete normative evaluation of SCA goes beyond the scope of this commentary. While I hope to have shed some evaluative light on such inferences when they involve only one candidate compositional explanation, there is

much more to be said about this pattern of inference more generally. Perhaps in studying SCA further, we may learn that this inference form is useful not just in our critical reasoning, but also in the creative inferences by which we reason out intelligent, new ideas. But unless that can be shown to be the case, I suggest that we keep our terminology tidy by distinguishing this inference form from "abduction" and instead calling it Inference to the Best Singular Compositional Explanation.

Aizawa's science-first methodology provides us with crucial granular insight into scientific, inferential practice. Moreover, his theory of SCA nicely summarizes much of what is peculiar and interesting in the specific inferences featured in Aizawa's case studies. I have argued that the philosophical theory of Inference to the Best Explanation, in turn, captures and situates these granular insights into a more familiar, general theory. It also provides us with much direction when it comes to exploring SCA's normative implications.

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