KATZ'S REVISABILITY PARADOX DISSOLVED

Allard Tamminga and Sander Verhaegh

Quine's holistic empiricist account of scientific inquiry can be characterized by three constitutive principles: *noncontradiction*, *universal revisability* and *pragmatic ordering*. We show that these constitutive principles cannot be regarded as statements within an holistic empiricist's scientific theory of the world. This claim is a corollary of our refutation of Katz's [1998; 2002] argument that holistic empiricism suffers from what he calls the Revisability Paradox. According to Katz, Quine's empiricism is incoherent because its constitutive principles cannot themselves be rationally revised. Using Gärdenfors and Makinson's logic of belief revision based on epistemic entrenchment, we argue that Katz wrongly assumes that the constitutive principles are *statements* within an holistic empiricist's theory of the world. Instead, we show that constitutive principles are best seen as *properties* of an holistic empiricist's theory of scientific inquiry and we submit that, without Katz's mistaken assumption, the paradox cannot be formulated. We argue that our perspective on the status of constitutive principles is perfectly in line with Quinean orthodoxy. In conclusion, we compare our findings with van Fraassen's [2002] argument that we should think of empiricism as a stance, rather than as a doctrine.

Keywords: Quine, holistic empiricism, constitutive principles, revisability paradox, logic of belief revision, empirical stance.

1. Introduction

Is empiricism coherent? In his *The Empirical Stance* [2002], Bas van Fraassen argues that it is, provided we think of empiricism as a cluster of epistemic and evaluative attitudes, rather than as a doctrine. Starting from the assessment that empiricism stands and falls with the rejection of metaphysics, van Fraassen argues that it would be self-defeating to equate an empiricist position with a commitment to a metaphysical doctrine, because this would amount to using metaphysics to fight metaphysics. Likewise, empiricism cannot be characterized by any high-level factual claim, van Fraassen argues, because no factual claim could ever justify the empiricist's principled rebellion against metaphysics.[1] Therefore, no doctrine can provide a basis for the rejection of metaphysics and at the same time be itself acceptable to the empiricist.[2]

It is important to note that van Fraassen's argument only applies to those types of empiricism that are strongly anti-metaphysical. It does not affect W.V. Quine's holistic empiricism, where the differences between science and metaphysics are 'differences only in degree and not in kind' [Quine 1951b: 211]. The present paper develops an independent and additional argument for the thesis that empiricism cannot be characterized by statements that are on the same footing as the factual claims of science. We formulate our argument against the background of holistic empiricism.

Quine's holistic empiricism offers a pragmatic account of the nature of science: scientific inquiry consists in the continuous revision of our current theory of the world in the light of contradicting experience, given nothing but an inherited and consistent set of currently accepted beliefs and some basic methodological principles. In this revision process, Quine argues, none of our beliefs is sacrosanct – each and any belief is revisable

[1] See [van Fraassen 1995: §3; van Fraassen 2002: 40-6]

[2] van Fraassen's notion of a stance and his plea for a non-doctrinal empiricism triggered a substantial debate, which was mainly conducted in special issues of *Philosophical Studies* 121/2 and *Synthese* 178/1.

in principle. A clash between our current theory of the world and experience never uniquely determines which revision of our beliefs is required, because, for Quine, beliefs can only be tested in conjunction with background theory.[3] This multiplicity can be significantly reduced, although it will not vanish completely, if the choice of a particular revision from among the possible revisions is guided by extra-logical and pragmatic considerations, such as the pragmatic maxim that we are to choose a revision of our current theory of the world that ensures 'the maximization of simplicity and the minimization of mutilation' [Quine 1990b: 11].

Pragmatic maxims other than simplicity and conservatism also have a say in how to reevaluate our system of beliefs. Quine, however, is not very consistent as to his pragmatic maxims of choice: his writings contain different lists of pragmatic maxims.[4] To avoid a protracted discussion of the relative importance of these pragmatic maxims for the reevaluation of our theory of the world, we prefer to think of these maxims in terms of what they are intended to ensure. Most generally, Quine's maxims give rise to a *pragmatic ordering* of the statements in our current world-theory according to 'the relative likelihood, in practice, of our choosing one statement rather than another for revision in the event of recalcitrant experience' [Quine 1951a: 43].

Jerrold Katz [1998: 72–3] proposes to characterize holistic empiricism by three principles: *noncontradiction*, *universal revisability*, and *simplicity*. These three principles together constitute holistic empiricism, each one of them playing its own role: 'One tells us when we "must" reevaluate, one tells us where we can reevaluate, and one tells us how we should reevaluate' [Katz 1998: 72]. Rather than adopting Katz's principle of simplicity as constitutive of holistic empiricism, in our view it is better, for the above reasons, to characterize Quine's empiricism in terms of the following three constitutive principles: *noncontradiction*, *universal revisability*, and *pragmatic ordering*.[5]

Katz [1998: 67–74; 2002: 374–5] claims that holistic empiricism is incoherent. Zooming in on the revisability status of holistic empiricism's constitutive principles, Katz offers a two-step argument for his claim. The first step consists in arguing that all of holistic empiricism's constitutive principles are themselves revisable in principle. Katz reasons as follows: Quine's claim that 'no statement is immune to revision' [Quine 1951a: 43] is a concise formulation of the principle of *universal revisability*. The principle is itself a statement, of course. Hence, Quine is forced, on pain of incoherence, to accept its revisability in principle. Because the other constitutive principles of holistic empiricism are obviously statements too, their revisability in principle follows immediately from *universal revisability*.

In the second step Katz reasons by cases. He distinguishes two ways in which a statement might be revised: (1) a revision that 'consist[s] in a statement's changing from being marked true to disappearing from the system', and (2) a revision that 'consist[s] in a statement's changing from being marked true to being marked false' [Katz 1998: 74]. In both cases, Katz claims, a *rational* revision of the constitutive principles of holistic empiricism is impossible.

In the first case, suppose that an holistic empiricist argues for the conclusion that one of holistic empiricism's three constitutive principles is to be dropped from her web of belief. The set of premises from which she develops this argument must include, Katz implicitly (and questionably) assumes, the principles that characterize holistic empiricism. Hence, the

[3] There is a much simpler, logical reason for non-unique revisability: in general there are many subtheories of our current world-theory that do not contain the beliefs contradicted by experience.

[4] See, for example, [Quine 1955: 247; Quine and Ullian 1978: Ch. 6; Quine 1995: 49].

[5] Katz is well aware of the fact that the principle of simplicity induces an ordering of the statements in our current theory of the world: 'It provides guidance about which statements are the best to revise in conflict with experience' [Katz 1998: 73].

premises of her argument must contain all of holistic empiricism's constitutive principles, including the one that is to be dropped. The problem is, Katz argues, that such an argument 'now lacks a premise essential to drawing the conclusion that the principle […] ought to be revised (i.e., dropped from the web of belief). The argument for revision is now invalid' [Katz 1998: 74].

In the second case, suppose that our holistic empiricist argues for the conclusion that one of holistic empiricism's three constitutive principles is to be marked false. Then again the premises of her argument must contain all of its constitutive principles. But every argument containing a premise A and a conclusion $\neg A$ is unsound (or so Katz claims):[6]

> Since the constitutive principles are premises of every argument for belief revision, it is impossible for an argument for belief revision to revise any of them because revising any one of them saws off the limb on which the argument rests. Any argument for changing the truth value of one of the constitutive principles must have a conclusion that contradicts a premise of the argument, and hence must be an unsound argument for revising the constitutive principle. [Katz 1998: 73]

In summary, Katz claims that holistic empiricism suffers from what he calls the Revisability Paradox: the constitutive principle of *universal revisability* implies that all of holistic empiricism's constitutive principles are revisable in principle, although every argument for a revision of such a principle is of necessity unsound. A *rational* revision of holistic empiricism's constitutive principles is therefore impossible. This is why incoherence seems to loom large over Quinean holistic empiricism.

Some authors have criticized Katz's conclusions, others have tried to reformulate them in such a way that these criticisms do not touch them.[7] In short, Katz's Revisability Paradox has given rise to a debate. Three of its participants, Mark Colyvan, Daniel Elstein, and James Kennedy Chase, note that *belief-revision logic* is relevant to the matters under discussion [Colyvan 2006: 5; Elstein 2007: 312; Chase 2012: 357]. They are correct in this observation. Unfortunately, they remain silent on the formal particularities of such a belief-revision logic. Nor do they refer to the wealth of literature on the logic of belief revision that started with Carlos Alchourrón, Peter Gärdenfors, and David Makinson's 1985 paper 'On the logic of theory change: partial meet functions for contraction and revision'.

In the present paper we introduce the logic of belief revision into the debate on Katz's Revisability Paradox. Through the prism of belief-revision logic we reconsider Katz's central arguments. We argue that the logic of belief revision (1) offers a welcome and precise perspective on Katz's Revisability Paradox, (2) shows us that, contrary to Katz, the three constitutive principles of holistic empiricism *cannot* be regarded as statements within an holistic empiricist's scientific theory of the world, but (3) are best seen as (revisable) properties of an holistic empiricist's theory of scientific inquiry.

Our paper is set out as follows. First, we present the logic of belief revision based on epistemic entrenchment [Gärdenfors and Makinson 1988] and show that the resulting formalism is a faithful reconstruction of the key tenets of Quine's holistic empiricism. Secondly, we use this belief-revision logic to show that Katz wrongly assumes that the three constitutive principles of holistic empiricism are statements within an holistic empiricist's scientific theory of the world, arguing that without this central assumption

[6] An argument is *sound* if and only if it is valid and all of its premises are true. A referee noted that Katz misses the logical point that a set of premises K and a premise A together entail a conclusion $\neg A$ if and only if that set of premises K entails $\neg A$. This observation undermines the 'and hence' in the following quote.

[7] See [Resnik and Orlandi 2003; Adler 2003; Colyvan 2006; Elstein 2007; Chase 2012]. The first three papers target Katz's argumentation, the last two offer a formal reconstruction of his Revisability Paradox.

Katz's Revisability Paradox cannot be formulated. Thirdly, we argue that rejecting the assumption is perfectly in line with Quinean orthodoxy. In conclusion, we compare our findings with van Fraassen's proposals for formulating a coherent empiricism.

2. A Belief-Revision Logic for Holistic Empiricism

In the twenty-five years of research into logics of belief revision, a wide variety of logical formalisms have been proposed. These proposals vary along different dimensions: depending on the goals of the formalization the answers to the following questions differ considerably. How should we give a formal representation of the relevant beliefs? How should we incorporate extra-logical considerations into the formalism? Which properties should a logic of belief revision ideally have? What underlying logic should we use?[8] Our present goal is to find a formalism that is a faithful reconstruction of the key tenets of Quine's holistic empiricism. Of all the logics of belief revision, Gärdenfors and Makinson's belief-revision logic based on *epistemic entrenchment* is best suited to give a formal account of holistic empiricism.[9] We argue that this particular belief-revision logic captures some central aspects of Quine's holistic empiricism and sheds new light on others.

Gärdenfors and Makinson develop their belief-revision logic based on epistemic entrenchment along the following lines. They start from a regimented language L and a consequence relation Cn on L.[10] In most (but not all) logics of belief revision it is assumed that this consequence relation is classical.[11] For our present purpose of giving a formal account of holistic empiricism and with an eye to Quine's [1970, Ch. 6] staunch defense of classical first-order logic, we can take L to be the language of first-order logic and the consequence relation Cn to be classical. Throughout the paper, the phrase 'underlying logic' refers to the consequence relation Cn that defines the object-language logic regulating the logical closure of our beliefs.

In the logic of belief revision based on epistemic entrenchment, a *belief set* is a subset K of L that is closed under the consequence relation, that is, $K = Cn(K)$. Such a belief set may be regarded as the set containing exactly all sentences in L to which the 'totality of our so-called knowledge or beliefs' [Quine 1951a: 42] commits us.[12] It is a formal representation of all of our currently accepted beliefs and their logical consequences. The use of classical first-order logic implies that there is only one *in*consistent belief set: the set L itself.[13]

> Any conjunction of the form '$p \wedge \neg p$' logically implies every sentence whatever; therefore acceptance of one sentence and its negation as true would commit us to

[8] For a review of logics of belief revision, see [Hansson 1999; Fermé and Hansson 2011]. An epistemological underpinning of belief-revision theory is provided by [Levi 1980; Levi 1991]. Tennant [2006] shows that the standard approach in belief-revision theory relies on postulates that, although intuitively plausible, are too weak to rule out bizarre revision operations. It is an open question how to strengthen these standard postulates.

[9] The classic account of a logic of belief revision based on epistemic entrenchment is developed in [Gärdenfors 1984; Gärdenfors 1988; Gärdenfors and Makinson 1988]. See [Rott 2003] for more recent developments.

[10] A consequence relation on L is a function Cn from subsets of L to subsets of L such that for all subsets K and K' of L it holds that (1) $K \subseteq Cn(K)$ (*Inclusion*), (2) if $K \subseteq K'$, then $Cn(K) \subseteq Cn(K')$ (*Monotony*), and (3) $Cn(K) = Cn(Cn(K))$ (*Iteration*).

[11] For an account of revision of any system of beliefs governed by a weaker-than-classical logic, see [Restall and Slaney 1995; Priest 2001; Tamminga 2004; Tennant 2005]. A review is given in [Wassermann 2011].

[12] For a discussion of the meaning of 'our' in this key Quinean phrase, see [Hylton 2007: 24-5].

[13] The same holds for any logic in which a contradiction implies any sentence. This includes intuitionistic logic.

> accepting every sentence as true, and thus forfeiting all distinction between true and false. [Quine 1970: 81]

Acceptance of a sentence and its negation, Quine argues, does not make sense. In our formal reconstruction of Quine's holistic empiricism we may therefore follow common practice in belief-revision theory and require that belief sets be consistent [Gärdenfors 1988: 22]. This, of course, is completely in line with the first constitutive principle of holistic empiricism: *noncontradiction*.

Gärdenfors and Makinson's belief-revision logic based on epistemic entrenchment can also account for *pragmatic ordering*, the third constitutive principle of holistic empiricism. As we saw above, it is convenient to think of Quine's pragmatic maxims for belief revision as constituting a pragmatic ordering of the statements in our current world-theory. In the logic of belief revision based on epistemic entrenchment, the notion of an *epistemic entrenchment relation* (to be characterized below) enables us to formally represent a given pragmatic ordering: an epistemic entrenchment relation over the sentences in our current belief set K 'can be used to determine which sentences to retract by requiring that the epistemologically least entrenched sentences be given up first' [Gärdenfors 1988: 89]. Note that with the introduction of an epistemic entrenchment relation over the sentences in K, we introduce an extra-logical element into the formalism. It is extra-logical because there is no logical procedure to determine whether a belief A is epistemically less entrenched than a belief B. It is here that Quine's pragmatic maxims such as simplicity and conservatism might come into play.[14]

In summary, the logic of belief revision based on epistemic entrenchment provides a formal interpretation of two constitutive principles of Quinean holism: *noncontradiction* and *pragmatic ordering*.

This leaves us with the second constitutive principle, *universal revisability*. In Gärdenfors and Makinson's belief-revision logic based on epistemic entrenchment this principle is *not* satisfied. Although in their logic of belief revision any nontautological belief can be removed from any belief set,[15] this does not hold for the laws of classical first-order logic because the underlying logic of the formalism is classical and because belief sets are closed under logical consequence.

There are at least two Quinean ways to deal with this supposed incompatibility between *universal revisability* and the logic of belief revision based on epistemic entrenchment: (1) restrict the applicability of *universal revisability* to nontautologous beliefs and stress Quine's unflinching endorsement of classical first-order logic, or (2) accept the possibility of changing the underlying logic of our belief revision system and refer to Quine's contention that '[r]evision even of the logical law of the excluded middle has been proposed as a means of simplifying quantum mechanics' [Quine 1951a: 43].[16] In Section 4, where we discuss Quine's view of constitutive principles, we argue that the second option

[14] Quine repeatedly recognizes the extra-logical character of his pragmatic maxims. In his *From Stimulus to Science*, for example, he claims that '[n]o general calibration of either conservatism or simplicity is known, much less any comparative scale of the one against the other. For this reason – and it is not alone – there is no hope of a mechanical procedure for optimum hypothesizing' [Quine 1995: 49].

[15] See footnote 19.

[16] Likewise, Arnold and Shapiro [2007] make a distinction between a 'logic-friendly' Quine who 'holds that logical truths and, presumably, logical inferences are analytic in the traditional sense: they are true solely in virtue of the meaning of the logical terminology. Consequently, logical truths are knowable a priori, and, importantly, they are incorrigible, and so immune from revision' and a 'radical' Quine who 'does not exempt logic from the attack on analyticity and a priority. Logical truths and inferences are themselves part of the web of belief, and the same global methodology applies to logic as to any other part of the web […] Everything, including logic, is up for grabs in our struggle for holistic confirmation' [Arnold and Shapiro 2007: 276-7].

does better justice to the role of logic in Quine's holistic empiricism. But let us not get ahead of ourselves.

We first give an outline of Gärdenfors and Makinson's belief-revision logic based on epistemic entrenchment. Given the language and the consequence relation of classical first-order logic and given the notion of a belief set as a set of formulas closed under logical consequence, we order the sentences in our current belief set by way of an epistemic entrenchment relation over the sentences in the language of first-order logic. Let K be a belief set. Then a relation $\leq$ over L is an *epistemic entrenchment relation with respect to* K, if for all sentences A, B, and C in L it satisfies the following five conditions:

If $A \leq B$ and $B \leq C$, then $A \leq C$	(Transitivity)
If $B \in Cn(A)$, then $A \leq B$	(Dominance)
$A \leq A \wedge B$ or $B \leq A \wedge B$	(Conjunctiveness)
If $K \neq L$, then $A \leq B$ for all B iff $A \notin K$	(Minimality)
If $B \leq A$ for all B, then $A \in Cn(\emptyset)$	(Maximality)

Informally, '$A \leq B$' means that giving up A is weakly preferred over giving up B. $A < B$ abbreviates the conjunction of $A \leq B$ and *not* $B \leq A$ Hence, '$A < B$' means that giving up A is strictly preferred over giving up B.[17]

The five conditions define the requirements a binary relation on L must meet to be an epistemic entrenchment relation. These requirements do not amount to a logical procedure for determining, for any given belief set K, a particular epistemic entrenchment relation that tells us for all sentences A and B in L whether or not $A \leq B$. In most cases different epistemic entrenchment relations with respect to a given belief set K are possible. A deliberate choice of one of these possible epistemic entrenchment relations can only be made on the basis of extra-logical, pragmatic considerations.

It should be noted that the notion of an epistemic entrenchment relation is an idealization of the Quinean notion it is supposed to cover. Quine's 'loose association reflecting the relative likelihood, in practice, of our choosing one statement rather than another for revision in the event of recalcitrant experience' [Quine 1951a: 43] helps us at best to partially determine an epistemic entrenchment relation. In general, there are many ways to turn such a partial entrenchment relation into an entrenchment relation of the sort that Gärdenfors and Makinson require.

Once we have settled on a particular epistemic entrenchment relation, it can be used to define, in Katz's words, (1) revisions that 'consist in a statement's changing from being marked true to disappearing from the system' and (2) revisions that 'consist in a statement's changing from being marked true to being marked false' [Katz 1998: 74]. In belief-revision theory, the first type of operation is called a *belief contraction*, the second type a *belief revision*.[18] In belief contraction, a belief set K is contracted with respect to a sentence A. We denote the belief set that results from the contraction by K_A^-. In belief revision, a belief set K is revised with respect to a sentence A. We denote the belief set that results from the revision by K_A^*. We first give a formal definition of belief contraction in terms of epistemic entrenchment and then a formal definition of belief revision in terms of belief contraction.

An epistemic entrenchment relation $\leq$ with respect to a belief set K can be used to determine, for any sentence A, a new belief set K_A^- that results from K if we give up our belief in A. Gärdenfors and Makinson propose the following construction: if A is *not* a

[17] Gärdenfors [1988: 86–91] argues for the plausibility of the five conditions.

[18] Chase [2012] uses the term *weak revisability* to refer to the first type of operation and *strong revisability* to refer to the second type.

logical law, then the new belief set K_A^- consists of exactly all sentences B in K for which it holds that giving up A is strictly preferred over giving up $A \vee B$. If A *is* a logical law, it cannot be removed from our belief set and hence K_A^- equals K. Formally,

$$K_A^- = \begin{cases} \{B \in K : A < A \vee B\}, & \text{if A} \notin Cn(\emptyset) \\ K, & \text{otherwise.} \end{cases}$$

This definition implies that for any sentence A it holds that if A is not a logical law, then the belief set K_A^- does not include A.[19]

A contraction operator not only tells us how to change our current belief set to give up a particular belief, it can also be used to define the revision K_A^* of a belief set K with respect to a sentence A. In the definition of revision in terms of contraction, to make room for the consistent addition of A the belief set K is first contracted with respect to the negation of A, then the sentence A is added set-theoretically to $K_{\neg A}^-$, and finally the union of $K_{\neg A}^-$ and $\{A\}$ is closed under logical consequence:[20]

$$K_A^* = Cn(K_{\neg A}^- \cup \{A\}).$$

All in all, the logic of belief revision based on epistemic entrenchment provides us with a formal perspective on Quine's holistic empiricism. Two of holistic empiricism's constitutive principles, *noncontradiction* and *pragmatic ordering*, are easily implemented by Gärdenfors and Makinson's formalism. In belief-revision theory, holistic empiricism's second constitutive principle, *universal revisability*, can only be accounted for by changing the underlying logic (that is, the consequence relation Cn). These observations are of fundamental importance for a proper understanding of Katz's Revisability Paradox. Let us therefore now return to Katz's claims and see what they look like through the prism of the logic of belief revision.

3. Katz's Revisability Paradox Revisited

So far we have argued that Gärdenfors and Makinson's belief-revision logic based on epistemic entrenchment captures some of the key characteristics of holistic empiricism. What does their logic of belief revision teach us about Katz's Revisability Paradox? As we have seen in the introduction, Katz's claim that every argument for the revision of one of holistic empiricism's three constitutive principles is of necessity unsound, rests on the assumption that these principles are premises of any holistic empiricist's argument for the conclusion that one of these principles is to be dropped from the system or to be marked false. The three constitutive principles can only be premises of an holistic empiricist's argument, however, if they are *truth-valued statements* in her web of belief, that is, if they are just three among the many statements that make up her current theory of the world. This is a crucial assumption of Katz's two-step argument for the incoherence of holistic empiricism. Without it, his argument falls to pieces.

Our formal reconstruction of holistic empiricism in terms of a belief-revision logic based on epistemic entrenchment makes it clear that Katz's crucial assumption is false: an

[19] The proof is straightforward: suppose that A is not a logical law and suppose that A is in K_A^-. Then A is in $\{B \in K : A < A \vee B\}$. Then it must be that $A < A \vee A$, which is equivalent to $A < A$. Since $A < A$ abbreviates $A \leq A$ and *not* $A \leq A$, we have a contradiction. Therefore, if A is not a logical law, then A is not in K_A^-. Among other things, Gärdenfors and Makinson [1988: Theorem 4] show that K_A^- closed under logical consequence and that K_A^- is a subset of K.

[20] Obviously, K_A^* is closed under logical consequence and includes A. For other properties, see [Gärdenfors and Makinson 1988: Theorem 1].

holistic empiricist is in no way committed to treating the three constitutive principles as statements in her current theory of the world. In Gärdenfors and Makinson's formalism the inclusion of translations of the three constitutive principles into our current belief set K is neither *necessary* nor *sufficient* for the definition of their belief-revision logic based on epistemic entrenchment.

The inclusion is not *necessary*, simply because it is possible to define a belief-revision logic based on epistemic entrenchment without requiring that the translations of holistic empiricism's three constitutive principles be elements of any conceivable belief set. The formalism defined above is a case in point. The construction of Gärdenfors and Makinson's belief-revision logic shows that if we wish to formalize some key characteristics of holistic empiricism, we do not need to translate its three constitutive principles into our regimented language L so as to obtain three statements A, B, and C that are necessary ingredients of every belief set that an holistic empiricist can dream of.

The inclusion is not *sufficient*, because including a translation of a constitutive principle into a belief set does not ensure that the statements in the resulting belief set satisfy the constitutive principle. Let us, for the sake of the argument, drop the initial requirement that belief sets be consistent. Now suppose that instead we want to implement the constitutive principle of *noncontradiction* by including the statement $\forall K \forall A(A \notin K \vee \neg A \notin K)$ in every belief set. Even apart from the fact that this is not a first-order statement, its inclusion into every belief set does not ensure that all belief sets are free of contradiction. By itself, the presence of this statement in a belief set K does not prohibit us from also including a contradictory pair of statements A and $\neg A$ into that belief set. The inclusion of a translation of the constitutive principle of *noncontradiction* into every conceivable world-theory therefore does nothing to guarantee that every conceivable world-theory is consistent.

Something similar holds true for the constitutive principle of *universal revisability*. Suppose that we are building a belief-revision system and that the question of universal revisability has not yet been settled. (To ensure this, we also drop the initial requirement that belief sets be closed under the consequence relation.) Now suppose that we want to implement the principle of universal revisability by including a translation of it in every belief set. We could translate the principle, for example, as the statement $\forall K \forall A(A \in K \rightarrow \exists B(A \notin K_B^-))$: for every belief set K that contains a statement A there is a statement B such that A is not in the contraction of K with respect to B.[21] Including this statement in every belief set does not ensure that every statement in a belief set is revisable in principle. Even apart from the obvious fact that the statement $\forall K \forall A(A \in K \rightarrow \exists B(A \notin K_B^-))$ itself is not revisable in principle (because it is in every belief set by stipulation), its inclusion into every conceivable belief set K does not prohibit us from also including some other statement A into every belief set. The inclusion of a translation of the constitutive principle of *universal revisability* into every conceivable world-theory does not therefore guarantee that every statement is revisable in principle. By analogy, the same holds true for the constitutive principle of *pragmatic ordering*.

Provided that Gärdenfors and Makinson's logic of belief revision based on epistemic entrenchment is an adequate formal reconstruction of some of the key characteristics of holistic empiricism, we conclude that it does not make sense to think of holistic empiricism's constitutive principles as statements that are included in an holistic empiricist's theory of the world. In our view, it is better to think of the three constitutive principles as *properties* of an holistic empiricist theory of scientific inquiry. The constitutive principles are *true of* a particular belief-revision mechanism; this is not equivalent to saying that they are *true in* all belief sets that are revised according to that

[21] Those who prefer something stronger can choose the statement $\forall K \forall A(A \in K \rightarrow \exists B(\neg A \in K_B^*))$.

mechanism.[22] Hence, Katz's crucial assumption that an holistic empiricist is committed to treating the three constitutive principles as truth-valued statements that are included in her theory of the world is false. Katz's Revisability Paradox stands and falls with this assumption:

> Unrestricted universality sanctions the dangerous move of self-application, which is a familiar feature of paradox. From the application of the belief-revision epistemology to itself, it follows that a revisable principle is unrevisable. [Katz 1998: 74]

We conclude that an holistic empiricist can consistently argue that the three constitutive principles fall outside the scope of the things they regulate.[23] They are constitutive in the sense that, according to holistic empiricism, they formulate the requirements a belief-revision mechanism should meet. This does not imply, of course, that the three constitutive principles of holistic empiricism are immune to revision. It is possible to change them, but a change of the constitutive principles breaks the boundaries of holistic empiricism's theory of scientific inquiry.

4. Quine on the Status of Constitutive Principles

Our new solution to Katz's Revisability Paradox, inspired by Gärdenfors and Makinson's logic of belief revision, presupposes a distinction between the constitutive principles an holistic empiricist endorses and her theory of the world, between the *properties of* her preferred belief-revision mechanism and the *statements in* her current belief set. In this section we argue that this account of the status of constitutive principles in holistic empiricism is perfectly in line with Quinean orthodoxy. To do so, we discuss some central passages in Quine's work on the philosophy of logic.

In his 'Truth by Convention' [1936], Quine constructs an argument against logical conventionalism, the thesis that logical truths are only true relative to conventionally introduced linguistic frameworks. This argument of Quine's is the first in a series of attacks against the logical positivist's analytic-synthetic distinction. The argument runs as follows: there must be more to logical truth than convention alone because (1) there are infinitely many logical truths, (2) we humans can only stipulate a finite number of conventions, and (3) we need logic to infer all logical truths from any finite set of conventions. The important thing, Quine claims, is that the question of how to justify the logic used in (3) cannot be answered by a logical conventionalist without falling prey to vicious regress.

Quine's objection to logical conventionalism is based on a distinction between *statements* (the conventions that we humans stipulate) and the *rules of inference* that we need to infer all logical truths from these statements. In response, the conventionalist could claim that whenever our finite set of stipulated conventions contains at least some rules of inference, it is entirely possible to infer infinitely many logical truths from a finite set of conventions. Referring to Lewis Carroll's [1895] parable of Achilles and the Tortoise, Quine replies that the stipulation of a rule of inference is not enough to get the inferential engine going: '[T]he difficulty is that if logic is to proceed *mediately* from conventions, logic is needed for inferring logic from the conventions' [Quine 1936: 104]. This reply is

[22] In fact, there need not even be a single logic that rules these two domains: the underlying object-language logic that regulates the logical closure of our belief sets might differ from the metalanguage logic that regulates the reasoning about the properties of our belief-revision mechanism.

[23] A fortiori, this observation effectively blocks Colyvan's 'proof of the paradox' as well as Elstein's 'new revisability paradox'. See [Colyvan 2006: 7] and [Elstein 2007: 311–3]. It also shows that Chase's modal treatment of holistic empiricism does not touch the heart of the matter. See [Chase 2012].

similar in spirit to our claim that including translations of the three constitutive principles of holistic empiricism into our theory of the world does not ensure that the resulting world-theory conforms to these principles. The mere adoption of a rule of inference as a convention is not enough: a rule of inference must be *used* (and not only *stated*) to be a rule of inference.[24]

Now that we have seen that Quine's [1936] objection to logical conventionalism makes essential use of the fact that logic cannot be captured with statements alone, some of his later remarks on the status of logic in our theory of the world come as a complete surprise:

> [T]otal science is like a field of force whose boundary conditions are experience. A conflict with experience at the periphery occasions readjustments in the interior of the field. Truth values have to be redistributed over some of our statements. Reëvaluation of some statements entails reëvaluation of others, because of their logical interconnections – *the logical laws being in turn simply certain further statements of the system*, certain further elements of the field. Having reëvaluated one statement we must reëvaluate some others, which may be statements logically connected with the first or may be *the statements of logical connections themselves*. [Quine 1951a: 42, emphases added][25]

This is hard to square with Quine's [1936] philosophy of logic. In later works Quine sets things right. Thus, in 'Two Dogmas in Retrospect' [1991], we find him claiming that, after all, logic does have 'a special status: logical implication is the link between theory and experiment' [Quine 1991: 394]. Quine leaves no room for doubt as to what he means by this when he discusses holism in *Pursuit of Truth* [1990a]. Probing the status of logic in our web of belief, Quine now argues as follows: suppose that some (consistent) set S of beliefs implies a prediction that is false. Which beliefs in S do we have to give up in order to restore consistency? According to Quine, at least the logical truths in S are safe:

> [S]ome one or more of the sentences in S are going to have to be rescinded. We exempt some members of S from this threat on determining that the fateful implication still holds without their help. Any purely logical truth is thus exempted, since it adds nothing to what S would logically imply anyway. [Quine 1990a: 14]

By implication, for Quine [1990a], 'the statements of the logical connections themselves', which were assigned such an important role in [Quine 1951a], are no longer doing any work in our theory of the world. This observation is similar to Quine's [1936] view: logical truths are just epiphenomenal consequences of the underlying logic that guides our set of beliefs. As long as we do not change the underlying logic, we cannot remove the logical truths from our set of beliefs, because the truths of logic already follow from the empty set. Reevaluating 'the statements of the logical connections themselves' therefore amounts to revising the underlying logic of our belief-change mechanism.

This brings us back full circle to Section 2, where we acknowledged that the constitutive principle of *universal revisability* is not satisfied by Gärdenfors and Makinson's logic of belief revision based on epistemic entrenchment: the truths of classical first-order logic cannot be removed from any belief set, because the underlying logic of their belief-revision mechanism is classical and because belief sets are closed under logical consequence. As long as we hold fast to classical first-order logic as the underlying logic

[24] We cannot lay down the instructions for the use of a rule of inference in additional conventions, because the same problem reappears one level up: again we need to stipulate how these instructions themselves are to be used. The regress is evident.

[25] Around the same time, Quine claims that '[l]ogical laws are the most central and crucial statements of our conceptual scheme' [Quine 1950: xiv].

of our belief-revision mechanism (that is, the consequence relation Cn that regulates the logical closure of our beliefs), the truths of classical first-order logic will continue to pop up as statements in our theory of the world. To get rid of these logical truths, we will have to exchange our belief-revision mechanism for a system based on a weaker-than-classical logic. This can be done: the belief-revision literature provides several such systems to choose from.[26] The same holds true of Quinean holistic empiricism: even the truths of classical first-order logic are revisable in principle, but a revision of the logical truths in an holistic empiricist's scientific theory of the world requires that she exchange the logic that underlies her theory of scientific inquiry.[27]

5. Conclusion

What is the upshot of our investigations into the nature of holistic empiricism's constitutive principles and Quine's view of the status of the truths of classical first-order logic? What it all comes down to is this: neither classical first-order logic nor holistic empiricism's theory of scientific inquiry can be fully captured in terms of statements that are part of our set of accepted beliefs. The Tortoise (with regard to the truths of first-order logic) and Katz (with regard to holistic empiricism's constitutive principles) wrongly assume otherwise, and therefore get entangled in infinite regress or paradox.

If a belief-revision mechanism conforms to the canons of classical first-order logic, the truths of classical logic are elements of every belief set ruled by this mechanism, as long as belief sets are closed under logical consequence. Nevertheless, a belief-revision mechanism may conform to the constitutive principles of empiricism without the principles themselves being elements of every belief set ruled by this mechanism. Unlike the laws of logic, the principles clearly fall outside the scope of the things they regulate and therefore do not apply to themselves. Because his 'dangerous move of self-application' is thereby illegal, Katz stumbles as soon as he takes the first step in his argument. As a consequence, Katz's 'Revisability Paradox' dissolves.

Let us finally compare our findings with van Fraassen's proposals for formulating a coherent empiricism. We submit that our findings not only provide independent and additional support for van Fraassen's position, but also extend its reach and help to explicate his notion of a stance. We noted in the introduction that van Fraassen's argument only applies to those types of empiricism that are strongly anti-metaphysical, because it draws heavily upon his assessment that empiricism stands and falls with the rejection of metaphysics. This assessment did not play a role in our argument that empiricism cannot be characterized by statements that are on the same footing as the factual claims of science. Hence, our argument also addresses those empiricists who do not join van Fraassen's rebellion against metaphysics.

Lastly, our contention that the constitutive principles of holistic empiricism are best seen as properties of an holistic empiricist's preferred belief-revision mechanism can help explicate van Fraassen's account of the empirical stance as a cluster of epistemic and evaluative attitudes.[28] Our findings on the status of holistic empiricism's constitutive principles suggest that we can make the notion of the empirical stance more precise by

[26] See footnote 11.

[27] And hence we agree with Arnold and Shapiro's contention that 'the radical Quine is the real Quine' [Arnold and Shapiro 2007: 278]. See footnote 16.

[28] For a discussion of the proper interpretation of the notion of the empirical stance, see [Teller 2004; van Fraassen 2004; Rowbottom and Bueno 2011; van Fraassen 2011].

explicating its role in guiding our choices in the continuous revision of our current theory of the world.[29]

Universities of Groningen and Oldenburg

References

Adler, J. 2003. The Revisability Paradox, *Philosophical Forum* 34/3&4: 383-9.

Alchourrón, C.E., P. Gärdenfors, and D. Makinson 1985. On the Logic of Theory Change: Partial Meet Functions for Contraction and Revision, *Journal of Symbolic Logic* 50/2: 510-30.

Arnold, J. and S. Shapiro 2007. Where in the (World Wide) Web of Belief is the Law of Non-Contradiction?, *Noûs* 41/2: 276-97.

Carroll, L. 1895. What the Tortoise Said to Achilles, *Mind* 4/14: 278-80.

Chase, J.K. 2012. The Logic of Quinean Revisability, *Synthese* 184/3: 357-73.

Colyvan, M. 2006. Naturalism and the Paradox of Revisability, *Pacific Philosophical Quarterly* 87/1: 1-11.

Elstein, D.Y. 2007. A New Revisability Paradox, *Pacific Philosophical Quarterly* 88/3: 308-18.

Fermé, E. and S.O. Hansson 2011. AGM 25 Years: Twenty-Five Years of Research in Belief Change, *Journal of Philosophical Logic* 40/2, 295-331.

Gärdenfors, P. 1984. Epistemic Importance and Minimal Changes of Belief, *Australasian Journal of Philosophy* 62/2, 136-57.

Gärdenfors, P. 1988. *Knowledge in Flux*, Cambridge, MA: The MIT Press.

Gärdenfors, P. and D. Makinson 1988. Revisions of Knowledge Systems Using Epistemic Entrenchment, in *Proceedings of the Second Conference on Theoretical Aspects of Reasoning about Knowledge*, ed. M.Y. Vardi, Los Altos, CA: Morgan Kaufmann: 83-95.

Hansson, S.O. 1999. *A Textbook of Belief Dynamics*, Dordrecht: Kluwer Academic Publishers.

Hylton, P. 2007. *Quine*, London and New York: Routledge.

Katz, J.J. 1998. *Realistic Rationalism*, Cambridge, MA: The MIT Press.

Katz, J.J. 2002. Mathematics and Metaphilosophy, *Journal of Philosophy* 99/7: 362-90.

Levi, I. 1980. *The Enterprise of Knowledge*, Cambridge, MA: The MIT Press.

Levi, I. 1991. *The Fixation of Belief and Its Undoing*, Cambridge: Cambridge University Press.

Priest, G. 2001. Paraconsistent Belief Revision, *Theoria* 67/3: 214-28.

Quine, W.V. 1936. Truth by Convention, in [Quine 1976: 77-106].

Quine, W.V. 1950. *Methods of Logic*, New York: Henry Holt & Company.

Quine, W.V. 1951a. Two Dogmas of Empiricism, in [Quine 1961: 20-46].

Quine, W.V. 1951b. On Carnap's Views on Ontology, in [Quine 1976: 203-11].

Quine, W.V. 1955. Posits and Reality, in [Quine 1976: 246-54].

Quine, W.V. 1961. *From a Logical Point of View*, 2nd and revised edition, Cambridge, MA: Harvard University Press.

Quine, W.V. 1970. *Philosophy of Logic*, Englewood Cliffs, NJ: Prentice-Hall.

Quine, W.V. 1976. *The Ways of Paradox and Other Essays*, Cambridge, MA: Harvard University Press.

Quine, W.V. 1990a. *Pursuit of Truth*, Cambridge, MA: Harvard University Press.

Quine, W.V. 1990b. Three Indeterminacies, in *Perspectives on Quine,* ed. R.B. Barrett and R.F. Gibson, Oxford: Blackwell: 1-16.

Quine, W.V. 1991. Two Dogmas in Retrospect, in *Confessions of a Confirmed Extensionalist and Other Essays,* ed. D. Føllesdal and D.B. Quine 2008, Cambridge, MA: Harvard University Press: 368-86.

Quine, W.V. 1995. *From Stimulus to Science*, Cambridge, MA: Harvard University Press.

Quine, W.V. and J.S. Ullian 1978. *The Web of Belief*, New York: Random House.

Resnik, M.D. and N. Orlandi 2003. Holistic Realism: a Response to Katz on Holism and Intuition, *Philosophical Forum* 34/3&4: 301-15.

Restall, G. and J. Slaney 1995. Realistic Belief Revision, *Technical Report TR-ARP-2-95, Research School of Information Sciences and Engineering and Centre for Information Science Research*, Canberra: Australian National University.

Rott, H. 2003. Basic Entrenchment, *Studia Logica* 73/2: 257-80.

[29] We thank Lieven Decock, Igor Douven, Jeanne Peijnenburg, the anonymous referees of this Journal, the members of the Groningen research colloquium in theoretical philosophy, and the people who attended our talks at the Universities of Bayreuth, Groningen, Konstanz, Oldenburg, and Stockholm for their suggestions and comments. Sander Verhaegh's research is funded by the Netherlands Organization for Scientific Research (NWO), Grant 322-20-001.

Rowbottom, D. and O. Bueno 2011. How to Change It: Modes of Engagement, Rationality, and Stance Voluntarism, *Synthese* 178/7: 7-17.
Tamminga, A. 2004. Expansion and Contraction of Finite States, *Studia Logica* 76/3: 427-42.
Teller, P. 2004. Discussion: What is a Stance?, *Philosophical Studies* 121/2: 159-70.
Tennant, N. 2005. Contracting Intuitionistic Theories, *Studia Logica* 80/2-3: 369-91.
Tennant, N. 2006. On the Degeneracy of the Full AGM-Theory of Theory-Revision, *Journal of Symbolic Logic* 71/2: 661-76.
van Fraassen, B.C. 1995. Against Naturalized Epistemology, in *On Quine: New Essays,* ed. P. Leonardi and M. Santambrogio, Cambridge: Cambridge University Press: 68-88.
van Fraassen, B.C. 2002. *The Empirical Stance*, New Haven, CN: Yale University Press.
van Fraassen, B.C. 2004. Replies to Discussion on *The Empirical Stance*, *Philosophical Studies* 121/2: 171-92.
van Fraassen, B.C. 2011. On Stance and Rationality, *Synthese* 178/7: 155-69.
Wassermann, R. 2011. On AGM for Non-Classical Logics, *Journal of Philosophical Logic* 40/2: 271-94.