South African Journal of Philosophy 2016, 35(3): 1–11
Printed in South Africa — All rights reserved

This is the final version of the article that is published ahead of the print and online issue

SOUTH AFRICAN JOURNAL OF PHILOSOPHY
ISSN 0258-0136 EISSN 2073-4867
http://dx.doi.org/10.1080/02580136.2016.1191853

How critical is "critical thinking"?[1]

Danie Strauss
School of Philosophy, North-West University, Potchefstroom Campus
dfms@cknet.co.za

Before criticism is justified, an account of the applicable criteria should be given. This task concerns first of all the well-known logical principles of identity, contradiction and the excluded middle. They connect critical thinking to the conceptual element of rationality and to the normed nature of logical thinking, manifest in logically sound (norm-conformative) thinking and antinormative thinking—briefly also accounting for the dialectical tradition. An analysis of these principles requires an understanding of the uniqueness of, and coherence between, the logical and non-logical aspects in the light of contraries like logical-illogical, polite-impolite and frugal-wasteful. It also questions the idea of autonomy and examines the switch from principles to values. When a school of thought does not accept all the logical principles, the criteria for scientific thinking are challenged, for example in intuitionistic logic which rejects the universal validity of the principle of the excluded middle. It is then argued that the principle of sufficient reason and that of the excluded antinomy points at a more than logical foundation for critical thinking and ultimately calls for a non-reductionist ontology.

Different kinds of reason

The roots of Western philosophy are found in ancient Greece with its peculiar appreciation of the *rational* capacities of human beings, closely related to the view that humans are rational-ethical beings. But rationality as characteristic soon received a number of different qualifications, assuming many shapes and forms in which Western philosophy knows "reason". Merely consider the "world reason" (*logos*) of Heraclitus; thought identified with being (Parmenides); the autocratic *nous* (reason) of Anaxagoras; the *intuitive* reason of Plato; the *self-contemplating* reason of Aristotle; the *negating* reason of neo-Platonism; the *self-assured* reason of Descartes; the *constructing* reason of Hobbes; Kant's *pure* reason; the *dialectical* reason of Hegel; the *historical* reason of Dilthey; the *pragmatic* reason of James and Dewey; the "sense-data" reason of positivism; the *liberating* reason of neo-Marxism; the *tradition-sensitive* reason of Gadamer; the *foolish* reason of Thevenaz; the *instrumental* and *communicative* reason of Habermas; the *existential* reason of Heidegger and Sartre, and the *uprooted* reason of postmodernism. The aim of this article is to advance the idea of a *non-reductionist reason*.

Are the criteria for critical thinking rational?

How do these diverse forms of human reason relate to the ideal of critical thinking? Would there be an agreement regarding the *criteria* for critical thinking? Are these criteria themselves *rational* in nature? Is it the case, as Paul Bernays claims, that the core meaning of rationality relates to the nature of the acquisition of concepts? He believes the "proper characteristic of rationality" is "to be found in the conceptual element" (Bernays 1974, 601).

1 Paper presented at the Annual Conference of the PSSA of South Africa, 18–20 January 2016, East London (Chintsa-East), South Africa.

Conceptual thinking (and language)

This view directs our reflection to the nature of concepts and their place within rational endeavours. Surely "critical thinking" requires conceptual clarity. But how can this be achieved if we are bound to express our thoughts lingually? Are words concepts or are concepts words—or do we have to distinguish between *concept* and *word*? Just consider the development of children: their logical sense appears to unfold *before* their linguistic competence develops. When a little girl for the first time learns the name of a pigeon and then afterwards refers to a shrike as a pigeon, it is clear that the child actually designates the *concept* "bird" with the *name* "pigeon". This is made possible by the fact that, from what has been perceived, particular bird characteristics have been lifted out, such as having a beak, wings, feathers and so on—and at the same time whatever is distinctly different is disregarded. In the intellectual development of human beings their acquisition of logical concepts therefore *precedes* matching lingual abilities. Language use is built upon the basis of logical skills—for the little child acquired a proper logical concept, but at that stage was not yet capable of designating it lingually in an appropriate way.

At the same time it is worth noting that "forming" a concept is a metaphor, for strictly speaking, concepts are *acquired* or *obtained*. Primarily concepts are not *lingually* structured. This explains why concepts cannot be *translated*. Of course it is possible to translate the words employed in designating a concept into a different language (such as *triangle*, *Dreieck*, *driehoek*). For this reason a concept (or argument) (inference) is "comprehended", "grasped", or "understood"—made possible by immediate intuitive *insight*. The fact that language is *formed* shows that it is founded in the cultural-historical aspect of *formative control*. Concepts, in contrast, are acquired on the basis of intuitive insight, for one either obtains this insight or one does not. But what are the key features of concepts?

A concept unites a multiplicity of logically identified (and distinguished) features or hall-marks, where these characteristics are *universal*. For this reason, that which is individual escapes the grasp of a concept.[2] These universal features are intimately related to the universality of logical norms or principles. Because principles guide our logical activities in a norming way, it is possible to obtain proper concepts (such as the concept of a square or a circle) as well as improper (illogical) concepts (such as a square circle—this example is already found in Kant's *Prolegomena zu einer jeden künftigen Metaphysik die als Wissenschaft wird auftreten können*, [1783] 1969, 341; §52b). Cassirer explained an illogical concept with reference to a "round square" ("rundes Viereck"—Cassirer [1910] 1969, 16).

The norming nature of logical principles

Without norming standards or principles, it would be impossible to distinguish what is logical from what is illogical. Throughout the history of logic, the principles of identity and (non-) contradiction played a dominant role. The former entails that, within the analysable, A is always A (A is identical to itself—a square is a square and a circle is a circle), while the latter implies that A is never non-A (A is different from what it is not—a circle is not a square). Plato already knew the meaning of these two logical principles (of identity and contradiction). The following phrase highlights both principles: "No objection of that sort, then, will disconcert us or make us believe that the same thing can ever act or be acted upon in two opposite ways, or be two opposite things, at the same time, in respect of the same part of itself, and in relation to the same object" (*Politeia*, Book IV, Ch. XIII, 436, in Cornford (trans.) 1966, 130). Aristotle, in addition, had already understood the principle of the excluded middle (see *Metaph*. 1057a).

This underlying structure of logic allows us to make sense of the questioning of the principle of non-contradiction in the dialectical tradition.

The dialectical tradition: Questioning the principle of non-contradiction

During the middle ages, alongside the continuation of Aristotle's predicate logic, a notable dialectical

2 Janich mentions the slogan of the scholastics, "Individuum ineffabile" (the individual is inexpressible, ineffable)—to which they added: "de singularibus non est scientia " (there is no science about what is singular) (Janich 2009, 110).

tradition proceeding from Heraclitus and the dialectical logic of Plato (developed in his Dialogue *Permanides*), remained in force. Through the *via negativa* of neo-Platonism (Pseudo-Dionysius, Plotinus), Nicholas of Cusa eventually articulated this legacy in his notion of the coincidence of opposites (*coincidentia oppositorum*)—thus preparing a platform for the dialectical tradition which affirms and denies the logical principle of non-contradiction, as it is found in the thought of Hegel, Marx and those sociologists of the 20th century who are known as conflict theorists (e.g. Simmel, Rex and Dahrendorf) on the one hand, and the philosophy of "As If" of Vaihinger on the other.

The significance of Vaihinger follows from his claim that the use of inherently contradictory constructions (designated as *fictions*) may serve human (scientific) thought in unexpectedly efficient ways. In general he is interested in "the riddle that by means of such illogical, indeed senseless concepts, correct results are obtained" (Vaihinger 1949, 240). Examples of such "fictional constructs" are negative numbers, fractions, irrational numbers and imaginary numbers (Vaihinger 1949, 57). He pursues "the general law of fictions" aiming at correcting "the errors that have been committed". Alternatively he advances a procedure labelled as "the method of antithetic error" (Vaihinger 1949, 109).

Uniqueness and coherence: An account of logical principles

Clearly, calling a fiction *illogical* implicitly assumes the existence of logical principles such as the principle of identity and the principle of non-contradiction, for illogical thinking does not conform to the mentioned logical principles, it is antinormative. Yet illogical thinking is still a form of thinking—it does turn into something *non-logical*. Is it possible to understand the logical-analytical aspect by *disregarding* the non-logical aspects of reality? The logicism of Frege and Russell aims at deriving the basic notions of arithmetic from logic. But David Hilbert highlights the circularity in this *logicistic* attempt where he states:

> Only when we analyze attentively do we realize that in presenting the laws of logic we already have had to employ certain arithmetical basic concepts, for example the concept of a set and partially also the concept of number, particularly as cardinal number [*Anzahl*]. Here we end up in a vicious circle and in order to avoid paradoxes it is therefore necessary to come to a partially simultaneous development of the laws of logic and arithmetic (Hilbert 1970, 199; see also Quine 1970, 88).

At the end of his well-known article *On the Infinite* (1925), Hilbert therefore had to oppose "the earlier efforts of Frege and Dedekind" by expressing the conviction "that certain intuitive concepts and insights are necessary conditions of scientific knowledge, but that logic alone is not sufficient" (Hilbert 1925, 190).

The various aspects making possible our experience of the world are not unique only because they are fitted into an inter-aspectual (inter-modal) coherence. This entails that the meaning of any one of them will come to expression in, and through this coherence with, the other aspects. The core meaning of an aspect would have to be indefinable while at the same time expressing itself in its inter-modal coherence. In almost the same terms, Yourgrau explains that Gödel "insisted that to know the primitive concepts, one must not only understand their relationships to the other primitives but must grasp them on their own, by a kind of 'intuition'" (Yourgrau 2005, 169) Consider the primitive *quantitative* meaning of the one and the many and compare it with a *logical* unity and multiplicity.

A given unity and diversity is presupposed in every human act of identification and distinguishing. But Kant already realised that logical addition (a merely logical synthesis) cannot generate new numbers (cf. Kant [1787] 1956, 15 where he considers the proposition that 7+5=12). According to Frege, the logical addition of *ones* or *twos* will always terminate in the identification of what is the same: a "one" and another "one" or a "two" and another "two" will merely result in the general notion of "oneness" or "twoness." Frege therefore understood something of the difference between *arithmetical addition* and *logical addition*. He states:

> When the things to be counted are called units, then the unconditional assertion that these units are similar is false. That they are similar in certain respects is correct but worthless. The things to be counted necessarily have to be different if their number is to be greater than 1 (Frege [1884] 1934, 58, §45; Frege 2001, 80).

What is implicit in this account is the nature of an *analogy*. Whenever two entities or aspects are similar in that respect in which they differ, we meet an analogy. The President and his bodyguard are close to each other in a spatial sense, but far apart in terms of the respective positions they occupy within society. The similarity here is "distance"—but in this similarity the difference is shown: spatial distance is "close-by", whereas social distance is "far-apart". The phrase *social distance* therefore reveals an analogy of space within the structure of the social aspect, just like logical addition analogically reflects the meaning of number within the logical aspect: in the case of numerical addition 1+1=2, while in the case of logical addition 1+1=1. Spatial addition is found in a vector sum, where 3+4 may be equal to 5 (a vector has distance and direction—moving 3 km north and 4 km east will position you 5 km away from your point of departure).

The challenge of Gödel mentioned above, namely that one has to "know the primitive concepts" in their uniqueness and coherence, will form the leitmotif of our argumentation below. The acknowledgement of logical normativity proceeds from another important distinction, namely that between the norm side of the logical and post-logical aspects[3] and the factual side where humans act in norm-conformative or antinormative ways.

The original arithmetical meaning of unity and multiplicity appears analogically within the structure of the logical-analytical aspect, particularly evinced in the unity and multiplicity of a logical concept. This numerical analogy constitutes the ultimate (modal-analogical) foundation for the logical principles of identity and contradiction. The analytical acts of human beings actively functioning within the logical-analytical aspect are subject to the applicable logical principles on the norm side of this aspect.

In other words, the numerical analogy on the norm side of the analytical aspect explores the two sides of unity and multiplicity, and thus serves as the basis for the two most basic logical principles underlying every analytical act of identification and distinguishing. The freedom of choice in the human ability to identify and distinguish can pursue the option to identify and distinguish properly (correctly) or improperly (incorrectly). The former occurs when acts of identification and distinguishing conform to the logical principles of identity and non-contradiction, while the latter is seen when these principles are disobeyed.

Contraries and the normed freedom of humans

This normed freedom of choice surfacing in conforming or non-conforming to logical principles ultimately underlies the normative contrary logical-illogical. Within all the post-logical aspects, analogies of this basic logical contrary are found—just consider contraries like historical-unhistorical, clear-obscure, polite-impolite, frugal-wasteful, beautiful-ugly, legal-illegal, love-hate and certain-confused. Although we may differ about what is frugal or wasteful, beautiful or ugly and so on, we cannot deny that contraries like these presuppose norming standards.

Suppose now that the criteria for rational conduct are derived from the rational agent itself, will they also hold for other rational agents? Affirming this would entail that in his or her rationality, the human being is a *law-unto-itself*. But how do we then have to understand rational interaction between different individuals? If individuals produce their own norms for rationality, will they ever be able to agree or reach consensus? Does the affirmation of rational insights not rather require or presuppose universal normative standards that are not reducible to the subjectivity of one single rational agent only?

3 The expression "post-logical" has a structural and not a genetic-historical meaning—it refers to those aspects of our experiential horizon succeeding the logical-analytical aspect, namely the cultural-historical aspect, the sign mode, the social facet, the economic dimension, as well as the aesthetic, jural, ethical and certitudinal sides of reality.

These questions require an account of the status of logical principles. Are they mental constructs or are they rather supra-individual and non-arbitrary in nature, displaying ontic normativity? Reflecting on these questions will challenge the norm-free understanding of human autonomy.

Ancient and modern ideas of autonomy

Is the idea of rational autonomy already known in Greek philosophy? Just consider what Protagoras defends in his *homo mensura* rule: "Of all things the measure is the human being, of [things] that are, how they are, of those that are not, how they are not" (Protagoras, B. Fragm. 1, in Diels and Kranz 1959/1960, Vol. II, 263). That this view is actually in the grip of the Greek form-matter motive is shown by Dooyeweerd:

> Human nature acquires real form only through the civilizing influence of the polis, through the free, formative control that it exercises through its legal order and its public moral and religious precepts.
>
> Protagoras no doubt recognized that this communal opinion of the Greek city-state is also susceptible to change and varies from polis to polis; nevertheless, it constitutes a formal limit for the fluid nature of human beings (Dooyeweerd 2012, 115).

The *homo mensura* rule should therefore not be confused with modern (post-Renaissance) conceptions of rational autonomy.

The developments from Descartes to Kant generated a different perspective. Descartes considers number and all universals as mere modes of thought (*Principles of Philosophy*, Part I, LVII). Kant added the next step: in the *Preface* of the first edition of his *Critique of Pure Reason* ([1781] 1956, 12), he explains what the age of criticism entails for him:

> Our age is, in every sense of the word, the age of criticism and everything must submit to it. Religion, on the strength of its sanctity, and law on the strength of its majesty, try to withdraw themselves from it; but by doing so they arouse just suspicions, and cannot claim that sincere respect which reason pays to those only who have been able to stand its free and open examination.

He explains that the order and law-conformity of nature is brought into it by human understanding, for whatever we discern in it had to be put there by ourselves (Kant [1781] 1956, 125). This view is in line with his rationalistic conviction that human understanding is the *formal law-giver of nature*. In his *Prolegomena* we read:

> (i) the categories are conditions of the possibility of experience, and are therefore valid a priori for all objects of experience (Kant [1787] 1956, 161); (ii) Categories are concepts which prescribe laws a priori to appearances, and therefore to nature, the sum of all appearances (Kant [1787] 1956, 163); (iii) Understanding creates its laws (a priori) not out of nature, but prescribes them to nature (Kant [1783] 1969, II, 320, §36).

This idea of a norm-free autonomy is continued in contemporary thought, for example by the philosopher Richard Rorty. In spite of switching from a rationalist to an irrationalistic position, Rorty maintains the underlying modern idea of *autonomy*. He holds that "there is nothing deep down inside us except what we have put there ourselves, no criterion that we have not created in the course of creating a practice, no standard of rationality that is not an appeal to such a criterion, no rigorous argumentation that is not obedience to our own conventions" (Rorty 1982, xlii).

A further dimension was added in the switch of focus from norms to values. This switch can be seen in Kuhn's philosophy of science.

The switch from norming principles to values

When the Baden School of neo-Kantianism emerged at the beginning of the 20th century, the focus switched from principles and norms to the idea of *values* (*Werten*). Particularly Windelband and Rickert contributed to this philosophical legacy. Initially, Rickert envisaged eternal values with an

ideal validity. However, the all-permeating effect of historicism soon relativised and subjectivised this view—eventually leading to the view that we as human subjects have to construct our own values. The so-called fact-value split (*Sein* and *Sollen* in the thought of Kant) had to face the developments within the philosophy of science of the 20th century with its emphasis on the value-ladenness of facts.

Thomas Kuhn considers the application of rules to be different from the act of evaluating (see Kuhn 1977, 331; 1984, 379). He introduces five (epistemic) values affecting the choice of a theory, namely "accuracy, consistency, scope, simplicity, and fruitfulness" (Kuhn 1984, 373). McMullin pursues a similar approach in discussing theory-choices in terms of "value-judgements" (McMullin 1983, 11). His preference is to speak of "epistemic values", but he transforms the values of Kuhn by designating them as *predictive accuracy*, *internal coherence*, *external consistency*, *unifying power* and *epistemic fertility*. To this list epistemic simplicity is added (McMullin 1983, 15–16).

The articulation of *epistemic values* actually reveals underlying coherences between the logical-analytical aspect of theoretical endeavours and the non-analytical aspects of the world. As will be argued below, the expression "epistemic fertility" analogically reflects the coherence between the logical-analytical aspect and the biotical aspect, for theories may be fertile and bear fruit. Just like the logical principles of identity and non-contradiction represent numerical analogies on the norm side of the logical-analytical aspect, the cognitive value of epistemic fertility represents a biotical analogy on the law-side of the logical-analytical aspect. The inevitable intersubjectivity present in scholarly endeavours illustrates the social analogy within the logical aspect explaining why the dominant intellectual traditions are met in diverging *schools of thought* found in the history of all the academic disciplines. Merely consider the schools of thought within some of the allegedly most "exact" natural sciences, such as mathematics, physics and biology.

(a) Mathematics: axiomatic formalism (Zermelo, Hilbert, Ackermann and Fraenkel), logicism (Russell and Frege) and intuitionism (Brouwer, Heyting, Troelstra and Dummett).
(b) Physics: classical determinism (Einstein, Schrödinger, Bohm and the school of De Broglie) and the mechanistic main tendency of classical physics (last representative Heinrich Hertz) versus the Kopenhagen interpretation of quantum mechanics (Bohr and Heisenberg); the contemporary ideal to develop "a theory of everything" (Hawking and super string theory: Greene).
(c) Biology: the mechanistic orientation (Eisenstein), the physicalistic approach of neo-Darwinism, neo-vitalism (Driesch, Sinnott, Rainer-Schubert Soldern, Haas and Heitler), holism (Adolf Meyer-Abich), emergence evolutionism (Lloyd-Morgan, Woltereck, Bavinck, Polanyi) and pan-psychism (Teilhard de Chardin, Bernard Rensch); recent complexity theory (Behe's notion of "irreducibly complex systems") and the contemporary advocates of the idea of "intelligent design" (the most prominent one is Stephen Meyer).

In 1982, Ernan McMullin gave a lecture on epistemic values at the Randse Afrikaanse Universiteit. He consistently discussed epistemic values, but when the term "integrity" surfaced, he suddenly jumped to "moral values". In the discussion, I questioned this move by pointing out that *epistemic integrity* should be part and parcel of *epistemic values* and that for this reason it cannot be a *moral* value.[4] Interestingly, the published version of McMullin's lecture (1983) no longer called epistemic integrity a *moral* value.

The logical and number: An inter-modal account of the logical principles of identity and non-contradiction

Relativising logic as suggested above can help in tackling the problem of the supposed unquestionableness of mathematical logic.

The rise of axiomatic theories illustrates this point further because they reveal the dependence of such theories upon the primitive meaning of number and space. Axiomatic theories may employ first-order predicate calculus as a platform where primitive symbols are required—such as *connectives*, *quantifiers*, *variables* and *equality*. What is concealed here is a cognisance of

4 To reiterate, whereas the criterion of *epistemic fertility* highlights a biotical analogy within the cognitive sphere, the yardstick of *epistemic integrity* reveals an *ethical analogy* within the logical-analytical aspect. Epistemic values ought to be distinguished from moral values.

multiplicity and an intuition of *succession* within this underlying academic discipline (arithmetic). Accepting quantifiers and variables reveals an intuition of the *one and the many*. If there is a multiplicity (i.e. more than one member) in *Zermelo-Fraenkel Set Theory* (ZF[5]—where the general form is "*x* is a member of *y*"), then the notions of ordinality and cardinality are both implicitly assumed. They are subsequently explicated in the axioms of pairing, union and power-set present in ZF. In the power-set axiom, one observes the dependence of ZF on the primitive spatial meaning of wholeness (and the implied whole-parts relation), for it postulates for any given set *a*, a set whose members are all the subsets of *a* (Fraenkel et al. 1973, 35).[6]

The intuition of *multiplicity* is made possible by the unique quantitative meaning of the numerical aspect—first accounted for in the discreteness of the natural numbers and in their succession. The conclusion from *n* to *n + 1* is normally designated as "(complete) induction", apparently discovered by Francesco Maurolico (1494–1575) (according to Freudenthal 1940, 17). Induction therefore relates to the two just-mentioned key properties of the numerical aspect, namely *being a multiplicity* as well as the succession entailed in their being distinct, entailing that every number is *unique* (with *characteristic properties*—a point, line or surface do not have distinct properties—see Laugwitz 1986, 9). In 1922, Skolem noted that those involved in set theory are as a rule convinced that an integer must be defined and that complete induction has to be proved. Nonetheless, sooner or later one stumbles upon what is *indefinable* or *non-provable*. His assessment of axiomatic set theory demands that the basic starting points ought to be immediately clear, natural and beyond doubt:

> The concept of an integer and the inferences by induction meet this condition, but it is definitely not met by the set theoretic axioms such as those of Zermelo or similar ones. If one wishes to derive the former concepts from the latter, then the set theoretic concepts ought to be simpler and employing them then ought to be more certain than working with complete induction—but this contradicts the real state of affairs totally (Skolem [1922] 1979, 70).

Intuitionism questions the principle of the excluded middle

Indeed, the intuitionism of Brouwer (and his followers) questioned the universal validity of the classical logical principles ("laws of thought"). In the case of the infinite, the principle of the excluded middle (*tertium non datur*) is rejected.[7] This claim relativises an overestimation of the logical principles, for there clearly are differences of opinion regarding the "rules of the (scientific) game". Anyone holding the view that scholarly endeavours are supposed to be "objective" and "neutral" faces serious problems. I once had an argument with a colleague who made an appeal to the Wittgensteinian idea of "language games". This colleague advanced the view that anyone not accepting the "rules of the game" operates outside the realm of science. The crucial question, of course, is what the rules of the game are? The answer given in this incident mentioned the logical principles of identity, non-contradiction and the excluded middle. But since intuitionism rejects the logical principle of the excluded middle in the non-finite case, the question arises if the colleague would accept the logical conclusion, namely that in rejecting one of the universally accepted logical principles, intuitionism no longer meets the criteria for being a sound scholarly discipline.

Is intuitionism a valid scientific standpoint in mathematics?

Clearly, in terms of the argument which bases the scholarly enterprise upon accepting all three principles, the intuitionistic approach in mathematics either is or is not a valid scientific position. There is no third option. However, as Kant has already highlighted, the principle of non-contradiction does not provide any grounds for deciding which one of two contradictory

5 In 1900 when Russsell and Zermelo independently discovered that the naïve set concept is "inconsistent" (as Cantor called it) by showing that the set *C* of all sets *A* not containing themselves as an element contains itself (namely *C*) as an element if and only if it does not contain itself as an element, the axiomatic set theory of Zermelo (1904) and Fraenkel (1922) was designed to avoid this set *C*.

6 For example, the finite set {1, 2, 3} has 8 subsets (i.e. two to the power three: 2^3), namely {1}, {2}, {3} {1,2}, {1,3}, {2,3}, {1,2,3} and the empty set {Ø}.

7 The ontological status of this principle is discussed in Strauss (1991).

statements is actually true (Kant [1787] 1956, 84).

The grounds needed immediately refer us beyond the boundaries of logic, which brings another logical principle to light (discovered by Leibniz), namely the *principle of sufficient reason* (grounds). Yet, if intuitionism is accepted as a valid scientific standpoint, in spite of partially truncating the principle of the excluded middle (and thus violating the principle of the excluded middle), we are in need of one or another extra-logical ground to uphold its scientific status. The next question is why intuitionism is not appreciated as the valid mathematical standpoint rather than the Cantorian (or axiomatic formalistic) orientation? One reason could be that it is unacceptable because the majority of mathematicians are not intuitionists. But the additional assumption here coming to light is that *truth* (a valid scientific standpoint) belongs to the *majority*. This raises a simple problem, for now a new principle is introduced, namely the *majority*. Unfortunately it is impossible to justify the majority principle, except if recourse is taken to a *regressus in infinitum*, rightly identified in logic textbooks as the *majority fallacy*.

Did the majority decide that what the majority hold is true?

and: Did the majority decide that the majority decide that what the majority believe is true?! …

and so on *ad infinitum*.[8]

The upshot is significant: the scientific enterprise does allow for disagreement regarding specific principles of reasoning. Our argumentation not only demonstrates that the claim concerning the objectivity and neutrality of scholarship is self-defeating, but at the same time it also opens up room for different schools of thought even within the so-called "exact sciences".

Critical thinking: The more-than-logical difference between the principle of non-contradiction and the principle of the excluded antinomy

This raises another question: how does one assess mutually exclusive views in academic disciplines? This question has to delve deeper than merely pinpointing contradictions, such as the mentioned example of an illogical concept (a "square circle").[9]

When the basic structure of a theoretical stance harbours inner tensions, coming to expression in multiple contradictions, then the situation is more serious. Negating the principle of non-contradiction is shattering. Hersh correctly remarks: "From any contradiction, all propositions (and their negations) follow! Everything's both true and false! The theory collapses in ruins" (Hersh 1997, 31).

While the *principium rationis sufficientis* (the principle of sufficient ground or reason) directs thinking beyond the limits of logic, the logical principle of non-contradiction is actually based upon an ontic principle—namely the principle prohibiting every reductionist approach, because reductionism always results in antinomies (see Dooyeweerd 1997, Vol. II, 36ff.). This ontic principle norms our systematic philosophical investigations and it is known as the principle of the excluded antinomy (*principium exclusae antinomiae*). Viewed from their law-sides, the various (unique and irreducible) aspects of reality are also designated as *law-spheres*. Trying to reduce irreducible law-spheres to each other leads to a *clash of laws*—captured in the term *antinomic* (anti = against, and *nomos* = law). A few examples will clarify this point.

In the well-known arguments of Zeno against multiplicity and movement, the attempt to reduce motion and number to space is antinomic. In his fourth Fragment, Zeno commences by first granting that something moves and then denies it: "Something moving neither moves in the space it occupies, nor in the space it does not occupy" (B Fragm. 4, in Diels and Kranz 1959/1960, Vol. II). The (il-) logical expression of this antinomy reads: Something moves if and only if it does not move. True antinomies confuse distinct and unique (irreducible) aspects of reality—in the example of Zeno, the aspects of space and movement are confused. Antinomies are therefore inter-aspectual (inter-modal) in nature. Confusing a square and a circle is restricted to the aspect of space and it is therefore

8 When they discuss "rhetorical ploys and fallacies", Bowell and Kemp also mention the "fallacy of majority belief" (Bowell and Kemp 2005, 131ff.).

9 Remember that the contrary logical-illogical entails conforming to or disobeying logical principles.

intra-modal in nature. While antinomies always entail logical contradictions, logical contradictions do not necessarily presuppose antinomies.

This distinction between antinomy and contradiction not only depicts the limits of logic, but also calls attention to the importance of a non-reductionistic ontology. Ontological reductionism violates the *principium exclusae antinomiae* and it leads to disastrous consequences, entailing all kinds of logical contradictions.

Two implications for the theme of critical thinking should be mentioned:

(a) The ontic principle of the excluded antinomy exceeds the scope of the traditional logical principles.
(b) This principle entails the challenge to develop a non-reductionist ontology in which modal norms (principles) are elucidated, as well as the typical "totality laws" holding for the multi-aspectual nature of the various communal and coordinational forms of societal human interaction.

For example, without an articulated insight into the structural principle of the state as a public legal institution, no yardstick will be at hand to serve a critical assessment of political practices. So-called "critical thinking" will therefore always be dependent upon the implicit or explicit ontology of a thinker.

A non-reductionist ontology: The irony of reification

When such an ontology is developed in a non-reductionist fashion, it will avoid antinomies, as well as the irony of antinomous thinking, which always reaches the opposite of what is aimed at. In other words, the perennial philosophical quest for explaining the coherence of what is unique and irreducible opens the way to an appreciation of the foundational position of the *principium exclusae antinomiae* in respect of the logical principle of non-contradiction. Scholarship guided by the principle of the excluded antinomy should be rooted in the urge to avoid reifying or absolutising anything finite or limited or any one aspect.

The term *irony* is used to indicate the opposite outcome of the original intention of every attempted reductionism. In order to get rid of the irreducible meaning of space, arithmeticism, ironically enough, had to use the very meaning of this mode (by borrowing from space the notion of wholeness or totality in the idea of infinite totalities). This irony is a general feature of different forms of reductionism. The vitalism of Schweitzer, for example, claimed that the golden rule of life is: "live and let live". The irony is that a consistent obedience to this rule would exclude most heterotrophic living entities (i.e. entities not capable of producing chlorophyll by means of a process of photosynthesis) from the necessary means to stay alive. To achieve the desired aim, namely to live one has (in this case) to die. We mention another example—the historicist claim that everything (law, morality, art, faith, and so on) is taken up in the flow of historical change and is everywhere only understandable as elements of an on-going and ever-changing historical process (cf. Troeltsch [1922] 1961, 573). Contrary to this claim, we are used to speaking about legal history, art history, economic history, and so on. But if law, art and economics are nothing but history, we must in fact deal with the contradiction of a historical history. Whatever is history, cannot have a history; and whatever has a history, cannot itself be history. The irony, once again, is that historicism, attempting to reduce every facet of reality to the historical mode, has thus eliminated the very meaning of history—if everything is history, there is nothing left that can have a history (Change, also historical change, always presupposes something constant—in this case the underlying modal structures of the economic, aesthetic and legal aspects.).

Concluding remark

Before we terminate our analysis it should be noted that advancing the ideal of "critical thinking" presupposes showing a sense of solidarity. It is only when such a sense of solidarity has been presented, highlighting what is found useful and worthwhile in the view of your conversation partner, that critique is appropriate. Articulating critique on the basis of solidarity (critical solidarity), then ought to proceed by exercising immanent critique, factual critique and transcendental critique (the latter is meant to discern the philosophical paradigm of a thinker

as well as the ultimate commitments preceding and directing a theoretical frame of reference.). Critical solidarity concerns theoretical views and not one or another "solidarity group".

The preceding analysis is *critical* in the sense that it not only gives an account of logical and more-than-logical criteria, since it also explains how the coherence of what is unique provides a point of entry to account for the criteria involved in critical thinking.

References

Aristotle. (1941) 2001. *The Basic Works of Aristotle* (including: Metaphysics). Edited by R. McKeon. New York: The Modern Library.

Bernays, P. 1974. Concerning Rationality. In: *The Philosophy of Karl Popper, The Library of Living Philosophers*, Volume XIV, Book I, edited by P. A. Schilpp. La Salle: Open Court.

Bowell, T., and G. Kemp. 2005. *Critical Thinking, A Concise Guide*. London: Routledge & Kegan Paul.

Cassirer, E. (1910) 1969. *Substanzbegriff und Funktionsbegriff.* Darmstadt: Wissenschaftliche Buchgesellschaft.

Cornford, F.M. 1966. *The Republic of Plato*. Translated with Introduction and Notes. Oxford: Clarendon Press.

Diels, H. and W. Kranz. 1959-1960. *Die Fragmente der Vorsokratiker*. Vols. I-III. Berlin: Weidmannsche Verlagsbuchhandlung.

Descartes, R. 1965. *A Discourse on Method*, *Meditations and Principles*, trans. J. Veitch. London: Everyman's Library.

Dooyeweerd, H. 1997. "A New Critique of Theoretical Thought." *Collected Works of Herman Dooyeweerd, A Series Vols. I–IV*, edited by D. F. M. Strauss. Lewiston: Edwin Mellen.

Dooyeweerd, H. 2012. "Reformation and Scholasticism in Philosophy." *Collected Works of Herman Dooyeweerd, Series A, Volume 5/1*, edited by D. F. M. Strauss. Grand Rapids: Paideia Press.

Fraenkel, A. A. 1922. "Zu den Crundlagen der Cantor-Zermeloschen Mengenlehre." *Mathematische Annalen* 86: 230–237.

Fraenkel, A., Y. Bar-Hillel, A. Levy, and D. Van Dalen. 1973. *Foundations of Set Theory*, 2nd revised edition. Amsterdam: North Holland.

Frege, G. (1884) 1934. *Grundlagen der Arithmetik*. Breslau: Verlag M & H. Marcus.

Frege, G. 2001. *Grundlagen der Arithmetik*. Stuttgart: Reclam.

Freudenthal, H. 1940. "Zur Geschichte der vollständigen Induktion." *Archives Internationales d'Histoire des Science* 22: 17–37.

Hersh, R. 1997. *What is Mathematics Really?* Oxford: Oxford University Press.

Hilbert, D. 1925. "Über das Unendliche." *Mathematische Annalen* 95 (1): 161–190. doi:10.1007/BF01206605.

Hilbert, D. 1970. *Gesammelte Abhandlungen*. 2nd edn. Vol. 3. Berlin: Verlag Springer. doi:10.1007/978-3-662-25726-5.

Janich, P. 2009. *Kein neues Menschenbild. Zur Sprache der Hirnforschung*. Frankfurt am Main: Suhrkamp Verlag.

Kant, I. (1781) 1956. *Kritik der reinen Vernunft*, 1st edn. (references to CPR A). Hamburg: Felix Meiner edition.

Kant, I. (1787) 1956. *Kritik der reinen Vernunft*, 2nd edn. (references to CPR B). Hamburg: Felix Meiner edition.

Kant, I. (1783) 1969. *Prolegomena zu einer jeden künftigen Metaphysik die als Wissenschaft wird auftreten können*. Hamburg: Felix Meiner edition.

Kuhn, T. S. 1977. *The essential tension: selected studies in scientific tradition and change*. Chicago: University of Chicago Press.

Kuhn, T.S. 1984. "Objectivity, Value Judgments, and Theory Choice." In: *Reason at Work*, edited by S. M. Cahn, P. Kitcher, G. Sher, and R. J. Fogelin, 371–385. New York: Harcourt Brace Jovanovich.

Laugwitz, D. 1986. *Zahlen und Kontinuum*. *Eine Einführung in die Infinitesimalmathematik*. Mannheim: B.I.-Wissenschaftsverlag.
McMullin, E. 1983. "Values in Science." *Proceedings of the Philosophy of Science Association* 2: 3–28.
Quine, W. V. O. 1970. *Philosophy of Logic*. Englewood Cliffs: Prentice Hall.
Rorty, R. 1982. *Consequences of Pragmatism (Essays: 1972–1980)*. Minneapolis: University of Minnesota Press.
Skolem, T. (1922) 1979. "Einige Bemerkungen zur axiomatischen Begründung der Mengenlehre." In: *Mengenlehre*, edited by U. Felgner, 57–72. Darmstadt: Wissenschaftiche Buchgesellschaft.
Strauss, D. F. M. 1991. "The Ontological Status of the principle of the excluded middle." *Philosophia Mathematica II* 6(1): 73–90. doi: 10.1093/philmat/s2-6.1.73.
Troeltsch, E. 1922. Die Krisis des Historismus und seine Problemen. *Die neue Rundschau* 33: 572–590.
Troeltsch, E. 1961. Collected Works (*Gesammelte Schriften*), Volume 4. Tübingen: J.C.B. Mohr.
Vaihinger, H. 1949. *The Philosophy of "As If."*, trans. C. K. Ogden. London: Routledge & Kegan Paul.
Yourgrau, P. 2005. *A World Without Time*. *The forgotten Legacy of Gödel and Einstein.* London: Penguin Books.
Zermelo, E. 1904. "Beweis, dass jede Menge wohlgeordnet werden kann." *Mathematische Annalen* 59 (4): 514–516. doi:10.1007/BF01445300.