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Stenius on Logical Constants[*]

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1. Introduction

Philosophers have had very different opinions about the question whether the concept of "logical constant" can be defined at all. According to some philosophers, Quine being the most prominent example, the term "logical constant" refers to an arbitrary selection of expressions of a given language. Thus it has been thought that the so-called essential usage of logical constants defines the set of logical truths. Because there has been a strong tendency to think that logical truths are also such a selection of truths of a given language, all this has seemed to be very unproblematic.[1]

However, if we think that the terms "logical truth" and "logical consequence" have any content which is independent of our arbitrary stipulations, the question which terms actually are logical constants is a genuine philosophical problem. One possible approach is to reduce the question which sentences of a given language are logical truths, to the question which symbols of a given language are logical constants.[2] But one can proceed in reverse, too. In this case it is required that the concept of logical truth should have a definition which is independent of the concept of logical constant.

Stenius has chosen the latter alternative. By defining the concept of analyticity he tries to clarify both this concept and that of logical truth. After that he attempts to define the concept of logical constant using the clarified concept of analyticity. Although there are some severe problems with the details of Stenius' definition of analyticity, it succeeds, in our opinion, to clarify this concept considerably. Therefore the task of this exposition will not be to discuss the details of this definition, but we will reconstruct Stenius' attempts to define the concept of logical constant using the concept of analyticity or logical truth.

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[*] We are indebted to S. Albert Kivinen, J. Hiipakka, and A. Korhonen for useful comments on earlier drafts of this paper.

[1] See e.g., Quine (1976), p.110 and p.128.

[2] See e.g., Tarski (1956), pp.417-420.

2. The Stenian definition of analyticity

One of the most popular ways of defining the concept of analyticity is to say that analytic statements are "truths" which can be reduced to logical truths by using some special condition.[3] Although this way of constructing the definition of analyticity has its roots in Kant's own statements, it characterises quite poorly the classical concept of analyticity, analyzed by Kant himself. Analytic statements are normally considered true in virtue of the meaning of the symbols they contain. So, if a by-product of the concept of analyticity has to be an explanation of why analytic statements are factually empty, reducing analytical statements to logical truths does not yet yield such an explanation, for we would still have to explain why logical truths are factually empty. Stenius' point is that the latter are factually empty just because they are analytic, and hence the strategy considered at the beginning of this section begs the whole question.[4] For this reason Stenius decides to start from the Kantian characteristics 1 and 2, instead of characteristic 3:

(1) *The factual content of analytic statements is empty.*

(2) *An analytic statement is seen to be true on the basis of the analysis of the concepts it contains—we could say a semantic analysis of the symbols it contains.*

(3) *All logical truths are analytic.*

The characteristics 1 and 2 are, according to Kant, general properties of analytic statements which separate them from all the synthetic statements: If a statement has the one of the characteristics, it has the other one, too. So a statement is synthetic if it does not fulfil either one of conditions 1 and 2.[5] Consequently characteristics 1 and 2 divide all statements into analytic and synthetic. As regards condition 3, Stenius shows that e.g. all the logical truths of predicate logic fulfil both conditions 1 and 2 and thus condition 3 is satisfied too.

[3] See e.g., Quine (1976), pp.128-129.

[4] Though logical truths are normally considered true in virtue of the meaning of the symbols they contain, Stenius rightly observes that even this does not necessarily function as a basis of the Quinean conception of analyticity; cf. Stenius (1965), pp.106-107, Stenius (1972), p.60, and Quine (1976), p.108 and pp.112-115.

[5] Stenius (1965), pp.99-102, and Kant (1989), pp.18-21 [24-29].

Stenius starts from the Kantian conditions 1 and 2 and tentatively defines the concept of analyticity in the following way:[6]

Definition I. *A statement is said to be analytic if and only if it follows from the definitions of certain of the symbols (words) it contains that it is true independently of what states of affairs obtain.*

However, Stenius notices that Definition I is not a sufficient definition of analyticity as characterised by conditions 1 and 2. It works only with statements such as *Iron is a metal* which may be written symbolically as

(4) $(\forall x)(Ix \rightarrow Mx)$.

This sort of examples have been analysed by von Wright (1943) who pointed out that, if we take the definition of iron to be *a metal which...*, or symbolically

(5) $Ix =_{\mathrm{Df}} Mx \wedge Sx$

where 'Sx' abbreviates all the other conditions in the definition of iron, and substitute (5) for Ix in (4), we get

(6) $(\forall x)(Mx \wedge Sx \rightarrow Mx)$.

(6), according to von Wright, may be considered a conjunction of sentences of the form

(7) $Ma \wedge Sa \rightarrow Ma$

which is a tautology of propositional logic, and thus factually empty.

Stenius rejects this analysis because there are statements which are true purely by virtue of the meanings of the symbols they contain, although they are not reducible to tautologies with the help of any definitions. Sentences involving color predicates form a typical example:

(8) *No (completely) red object is green.*

Stenius points out that many philosophers would consider (8) analytic, but its analyticity cannot be shown on the basis of the definitions of e.g. *red* and

[6] Stenius (1965), p.110.

green, but rather on the basis of the mutual semantic relations existing between these two terms.[7] More generally, what is essential to the analyticity of a given sentence, be it a logical truth of the propositional logic or a sentence in an ordinary language, is not that the symbols the sentence contains are introduced via some explicit definitions. Even when such definitions can be provided, the only essential thing for analyticity are the semantic conventions lying behind them. This brings Stenius to the following generalization of Definition I:[8]

Definition II. *A statement is said to be analytic if and only if, according to the semantic conventions for the use of certain of the symbols it contains, it is true whatever be the case.*

Let us show, following Stenius, that both the tautologies of propositional logic and the logical truths of predicate logic are analytic in the sense of Definition II.

It is very natural to think that the truth-tables define the meanings of the logical connectives. If there were no truth tables or a logical method of a similar kind, there would certainly not be any exactly defined logical connectives which are different from the connectives of natural language. Although the truth tables are not eliminative (or explicit) definitions of the logical connectives, we could say that they are explicit conventions which define them. In this sense they are also definitions of logical connectives, though not explicit definitions.[9] Now, the tautologies of propositional logic are analytic in the sense of Definition II-they are true on the basis of the definitions of the propositional connectives they contain, and their factual content is empty, because they are true whatever be the case i.e. independent of which states of affairs do obtain.

As we all know, first-order predicate logic is a generalization of propositional logic. From the present point of view, it is quite reasonable to think that the logical truths of predicate logic express the semantic conventions governing the use of quantifiers and identity-symbol, in addition to the semantic conventions which regulate the use of logical connectives.[10] It is these semantic conventions which become explicit in the formalized axioms and rules of inference of predicate logic. But then, these logical truths are also analytic in the sense of Definition II. For instance, that the logical truth of

[7] Stenius (1965), pp.110-111, and Stenius (1972), p.59.
[8] Stenius (1965), p.111, and Stenius (1972), p.62.
[9] Stenius (1965), pp.108-109, p.111, and Stenius (1972), pp.60-62.
[10] Stenius (1965), pp.111-114.

(9) $(\forall x)(Rx \wedge Sx \rightarrow Sx)$

is analytic can be seen from the fact that the formula $(Rx \wedge Sx \rightarrow Sx)$ is analytic, i.e., true whatever is the case on the basis of the semantic conventions governing the use of conjunction and implication, plus the fact that, if a formula Fx is analytic, then also $(\forall x)Fx$ is analytic, and this can be seen from the semantic conventions underlying the definition of the universal quantifier. Thus the logical truths of predicate logic are those statements which are true whatever is the case according to the semantic conventions for certain symbols they contain, i.e. the connectives, the quantifiers and the identity-symbol. If these sentences are considered as the logical truths proper, the Kantian characteristic 3 of analyticity is fulfilled, too.[11]

A question which naturally arises at this stage is whether all analytic statements (in the sense of Definition II) are logical truths in some relevant sense of the word. We shall answer this question later on.

Just as it is natural to think that the truth-tables define the meaning of the propositional connectives, and the axioms and natural deduction rules define the meanings of the quantifiers in predicate logic, in the same way the semantical properties of colour terms make (8) true, whatever is the case, i.e., (8) is an analytic statement in the sense of Definition II. Actually, following Stenius, we can show by a truth-table argument that every instance of the formal counterpart of (8), that is,

(10) $(Ra \rightarrow \neg Ga)$

is true whatever be the case. We have:

Ra	Ga	$Ra \rightarrow \neg Ga$
T	T	F
T	F	T
F	T	T
F	F	T

According to this truth-table, there seems to be a state of affairs, i.e. the one in which Ra is true and Ga is true which makes $Ra \rightarrow \neg Ga$ false. However, according to Stenius the "state of affairs" in question is not really a state of affairs, because the colours red and green are logically incompatible.

[11] Stenius (1965), pp.111-113, Stenius (1972), pp.60-61, and pp.64-65.

Consequently the first row of the above truth-table has to be omitted. Accordingly the semantic conventions of the colour predicates make the sentence $Ra \rightarrow \neg Ga$ true whatever be the case.[12]

As this example shows, the analyticity of (8) is closely connected to the incompatibility of the colors red and green, which is a basic fact about the structure of any possible world. It is expressed by the sentence

(11) *The colors red and green are incompatible*

which, unlike (8), is not analytic but states, as pointed out, a precondition of the structure of any world. Needless to say, according to Stenius (8) and (11) say different things, but we are not going to discuss this matter in detail here.

Just as predicate logic is the logic of connectives, quantifiers and the identity-symbol, sentence (8) can be said to belong to the logic of colour predicates: The truth of (8) does not qualitatively differ from the truth of the logical truths of predicate logic—all these sentences are true according to the semantic conventions for certain of the symbols they contain, and they are true whatever be the case. But here "whatever be the case" should be interpreted as "whatever state of affairs obtains". With this interpretation, certain alleged states of affairs which block the logical validity of sentences like (8), do not block their analyticity, because they do not count, after all, as states of affairs.

3. Are all analytic statements logical truths?

Stenius is quite unequivocal about the answer to the question addressed here:

> Not only are all logical truths analytic....., the converse is also true. And it is clarifying to look at things in this way.[13]

He identifies analytic and logical truths in order to make it clear that the logical truths are in no way more analytic than the so-called non-logical analytic truths: If an analytic statement is one which is true whatever be the case on the basis of the semantic conventions of some of the symbols occurring in it, and if a logical truth is one which is true whatever be the case on the basis of the very same semantic conventions, then all analytic statements are logical truths.

Although Stenius does not explicitly state it, it is obvious that a logical truth is not to be identified with its model-theoretical definition *truth in all models*.

[12] Stenius (1974).
[13] Stenius (1972), p.66.

If we identify in the customary way the class of logical truths of predicate logic with the class of sentences true in all models (possible worlds, situations), then there will be analytic sentences (e.g. 8) which are not logical truths in this standard (model-theoretical) sense. However, the model theoretical definition is obviously only one way to give the extension of the concept of logical truth. Stenius does not accept such an identification to be a definition of the *general* notion of analyticity or logical truth.

Instead, Stenius equates the concept of logical truth with the concept of analyticity. Then, on the basis of different extensional identifications of analytic truths, he himself proposes a following hierarchy of logics:

(a) *The logic of connectives*
(b) *The logic of quantifiers*
(c) *The logic of special predicates*.

Each of these logics is an extension of the previous one.[14] However, the way in which the logic of special predicates is defined depends on the "special predicates" introduced.

Thus one can consider the logic of special predicates as an enrichment of first-order logic with adequate non-logical axioms for the new predicates. Then, in model-theoretical terms, from the class of models which may be admitted as interpretations for these axioms we exclude the non-standard ones, and this for the reason that the excluded models do not count as states of affairs at all. In other words, only the intended models will count as interpretations for these non-logical axioms.

4. Analytic statements and two notions of truth

According to Definition II, we can speak of the analyticity of a statement only relatively to some semantic conventions. Of course, no sentence can be true whatever is the case, if the semantic conventions of the language are to play any role in determining what is the case. Thus we have to make Definition II more explicit.

There are at least two different questions which can be answered when we say that a given sentence is true. In most cases we assume that a given sentence has certain truth conditions and then assert it to be true. But on the other hand, we sometimes express both that a given sentence has certain truth conditions and that it is true. It is reasonable to suppose that we should know the *truth*

[14] Stenius (1972), p.66.

conditions of a sentence before we can even make the final investigation into the truth value of a sentence. Consequently, we can always distinguish two possible ways of speaking about the truth of a given sentence:[15]

A. (*Sentence S has certain truth conditions*) $\Rightarrow$ *Sentence S is true in the primary sense if and only if one of its truth-conditions obtains.*

B. *Sentence S is true in the secondary sense if and only if it is true in the primary sense and it has the correct truth-conditions.*

Now we can amend Definition II:[16]

Definition III. *A statement is said to be analytic if and only if, according to the semantic conventions for the use of certain of the symbols it contains, it is true in the primary sense whatever be the case.*

It follows from Definition III that a sentence S is analytic if and only if it is analytic according to Definition II, assuming it has certain truth conditions. Definition III is the final formulation of the Stenian definition of analyticity. It is not without its problems, but we shall accept it in the sequel.

5. Logical constants

We pointed out that among the logical constants of predicate logic there are the standard propositional connectives, the standard quantifiers and the identity symbol. In addition there may be some constants of higher-order logics.[17] However, we observed that even this kind of talk about "logical constants" is well-defined only in relation to the semantic conventions for the use of these very same symbols. The logical constants of predicate logic are those symbols which make certain sentences true whatever be the case in virtue of the semantic conventions governing their use.

Another important feature of these symbols is that the sentences mentioned above define their meaning. Thus according to Stenius, the concept of logical constant could be defined on the basis of this characteristic:[18]

[15] Stenius (1965), pp.117-119, Stenius (1972), pp.62-63, and note 22.

[16] Stenius (1965), p.119, and Stenius (1972), p.63. We have replaced Stenius' talk about 'truth in the intensional sense' with 'truth in the primary sense', and Stenius' 'truth in the semantic sense' with 'truth in the secondary sense'.

[17] For example, Tarski was eager to do that; see Tarski (1956), pp.416-420.

[18] Stenius (1965), pp.115-116.

Definition IV. *Logical constants are symbols which acquire their meaning from the fact that certain sentences of the language are true in the primary sense according to the semantic conventions for the use of these symbols, and are true whatever be the case.*

General talk about meaning is not, however, very clear. In spite of the fact that we loosely talk of the meanings of some symbols as entities to which these symbols refer, the meanings of the symbols characterized by Definition IV cannot be such entities. The symbols in question cannot refer to any objects in reality.

In order to define the notion of logical constant in a more adequate way, we should be more specific about the different sorts of semantic conventions. We propose, for a start, the following distinction:

(C) *Semantic conventions which specify the mutual semantic relations between terms of the language.*

(D) *Semantic conventions which specify the relations between linguistic symbols as constituents of sentences and reality.*

We may say that the semantic conventions (C) determine *relational* meaning, while the conventions (D) determine *referential* meaning. Obviously the latter is independent of the former.The relational meaning should not be thought of, in general, as something a particular term or expression has, but rather something that different expressions of the language mutually share. It arises when we coordinate the different (referential) meanings that words have. This coordination is not arbitrary: As we saw, e.g., the semantic conventions governing the use of colour predicates have to make just certain sentences analytic. On the other side, we claim that even logical constants have relational meaning of a particular sort to be made more precise in the final section of this paper.[19]

Since only part of the terms of a language have a referential function, and logical constants obviously do not refer, we expect the semantic conventions (C) to fix the "meanings" of those terms which are nonreferential. We are ready for the following improvement of Definition IV:

Definition V. *A term is a logical constant if and only if it fulfils the following conditions:*

[19] The question how the general concept of relational meaning can be clarified is an important matter of further investigation.

1. *It has relational meaning but not referential one.*
2. *The semantic conventions governing its use make a certain determinate class of sentences of the language analytic.*

Condition 1 is partly negative, but it seems to be impossible to avoid this kind of formulation, because this condition is important in clarifying what it means to say that a symbol acquires its meaning from its logic alone. Definition V is intended to capture both the Wittgensteinian and the Stenian conception of logical constants, according to which e.g. logical connectives are not in any reference-relation to reality, but get their meanings solely from the manner in which they are used to form molecular sentences from atomic ones.[20] Of course, we still have the task of giving a satisfactory explanation of how is possible for single terms to have relational meaning, but this will be taken up later. In addition, it is not enough for a term to lack referential meaning and to have relational meaning in order for it to be a logical constant. According to clause (2) of Definition V, what we still have to require is that the term in question has also a logic, that is, certain sentences of the language must turn out to be analytic on the basis of the semantic conventions regulating the use of this term (and some other terms of the language). *Thus a symbol can be a logical constant, only if the analyticity of certain sentences is partly determined by its relational meaning.*

Whether the converse holds or not is an interesting question. If a sentence is analytic, i.e., true on the basis of the semantic conventions regulating the use of certain symbols of the language, then these symbols have a relational meaning. Some of them may be logical constants, too. Whether there should always be some logical constants in the sentence is a question we leave open.

In section 3 we equated the concept of logical truth with the concept of analyticity. With this equation in mind, it is easy to remark that Definition V characterizes the concept of logical constant with the help of the Stenian notion of analyticity. This is very close in spirit to the way Stenius conceived of the concept of logical constant.[21]

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[20] See Wittgenstein (1984), 4.03, 4.0312, and Stenius (1965), pp.107-109, remark 23. It should be noticed that this view does not imply the view that "logic has no ontology" (cf. Grossmann 1996). When the applicability of the colour predicates is connected to the incompatibility of certain states of affairs, the applicability of logical truths is closely connected to the question what do we mean when we say that a state of affairs (in general) obtains. However, because in the Wittgensteinian tradition one makes a sharp distinction between internal and external features of entities, one need not take the terms of language to indicate explicitly when a state of affairs obtains; see also note 23.

[22] Stenius (1965), pp.114-116.

Given the fact that colour predicates do not fulfil clause 1 of Definition V, i.e. they have referential meaning, we conclude that they are not logical constants.

6. Comparisons with other approaches

In order to be more specific about the notion of relational meaning, we will use some insights from the theory of generalized quantifiers. The prevalent view nowadays among logicians, linguists and philosophers is that a logical constant is a generalized quantifier, i.e. a class of structures closed under certain conditions. This view goes back to Frege for whom an existential quantifier occurring in a sentence like

(12) *Some man is smoking*

is a second-order relation, that is, a two-place relation having as arguments the property of being a man and the property of smoking. Extensionally speaking, the existential quantifier is thus a set of sets. This view of quantifiers have been exploited by Mostowski (1957), who generalized it to quantifiers others than the standard *some* and *every*.Thus in the sentences

(13) *Every philosopher goes to the library*
(14) *Most dogs bark*
(15) *Three cowboys arrived in town*

Every, *Most* and *Three* are all generalized quantifiers, i.e. second-order relations having two first-order properties as their arguments. Extensionally speaking, each of them is defined, respectively, by

$$\text{Every} = \{(X,Y): X \subseteq Y\}$$
$$\text{Most} = \{(X,Y): |X \cap Y| > 1/2\,|X|\}$$
$$\text{Three} = \{(X,Y): |X| \cap |Y| = 3\}.$$

The arity of the second-order relations need not be restricted to two. In the sentence

(16) *More pupils in my class than pupils in your class solved the exercises*

the quantifier *more...than...* denotes a three-place second-order relation, which in the present example has as arguments the *property of being a pupil in my* *class*, that of *being a pupil in your class* and the property of *solving the exercises*. In extensional terms:

More...than... = $\{(X,Y,Z): |X \cap Z| > |Y \cap Z|\}$.

There are two important things to be emphasized about the theory of generalized quantifiers. The first thing is that such a quantifier *expresses*, in this Fregean tradition, a (second-order) property, which in the model-theoretical implementation becomes a set of sets. Thus a logical constant like a quantifier receives a semantical value. The second thing is that this semantical value is subject to certain constraints which codify our intuitions about the quantifier in question being a logical constant. If the quantifier is a logical constant, then the relation corresponding to it has to be "logical", "structural", or "formal", which, in turn, is made more precise by requiring that the relation in question is closed under isomorphisms. In other words, if the pair (X,Y) belong to a second-order relation, and F(X) and F(Y) are the ranges of X and Y under the isomorphic function F which maps a model of the relevant language into another model, then the pair (F(X),F(Y)) belongs also to the second-order relation in question.

Closure under isomorphisms is supposed to reflect the structural properties of a quantifier, i.e. the fact that it does not distinguish between individuals, but is, indeed, logical.

All the logical constants of ordinary predicate logic can be construed as generalized quantifiers, i.e. second-order relations closed under isomorphisms; and so are (with the obvious extensions) the logical constants of higher-order logics. Actually, there are plenty of mathematical concepts which turn out to be generalized quantifiers.(Cf. Barwise, Feferman 1985.)

Recall our earlier distinction between relational and referential meaning. There is a strong sense in which the second-order relations associated with logical constants in the theory of generalized quantifiers can be said to express relational meaning in our sense, that is, they express certain semantical relations holding between the predicates standing for properties instantiated by certain individuals instantiating in these second-order relations. We could even say that they offer explicit examples of the notion of relational meaning. But they do not exhaust relational meaning in that they express only mutual semantical relations which are formal or structural. In other words, a first proposal would be to define *logical constants as those terms of the language which have formal relational meaning*. That there is relational meaning which is not structural follows from examples in the theory of generalized quantifiers of second-order relations which are not closed under isomorphisms.

The above proposal cannot be accepted before we handle one more problem. The Fregean conception of a quantifier as expressing a second-order relation is clearly opposed to the Stenian one in that it makes a logical constant to denote a relation. What we have been after all the time was a definition of logical constants which does justice to the Wittgensteino-Stenian view that a logical constant has no referential meaning. Now one might say that, after all, the delimitation of logical constants via structural relational meaning requires these constants to denote (second-order) relations and thus to have referential meaning.

But let us look the matters more closely. We may say that the logical constants have a formal relational meaning but we shall not take logical constants to have such a meaning in the sense of *denoting* a (genuine) second-order relation. After all, in the sentence

(17) *Some man is sitting on a bench*

we can think of an individual to instantiate both the property of being a man, and the property of sitting on a bench. What the quantifier *some* does in the sentence is to express a structural fact about these two properties: they instantiate in one and the same individual. Thus, there is a relational meaning that the quantifier *some* captures which is structural but one could hardly say there is anything the quantifier refers to.Thus, we have reached a point at which the Stenian and the Frege-Mostowski conception of logical constants can be reconciled.

7. Conclusions

We took for granted the Stenian definition of analyticity and then formulated the definition of the concept of logical constant using the concept of analyticity (or logical truth) so defined. This was accomplished in Definition V. The only new element in this definition, new in the sense of not being recoverable from Stenius' writings, was the concept of relational meaning. The problem with Definition V was that it did not pick up only the terms we intuitively call logical constants. For this reason we distinguished, within the province of relational meaning, what we have called formal or structural meaning.

It should be emphasized that the Stenian definition of analyticity is wholly independent of the question which sentences actually are analytic. Similarly, the Stenian definition of the concept of logical constant we ended up with, if we may call it Stenian, is independent of the question which symbols of the language actually are logical constants.

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Solid Belief

To the memory of Richard Sylvan

ANDRÉ FUHRMANN

1. Introduction

There is a well-known distinction between a sentence or proposition being true and its being assertible in a given context. The distinction is most famously invoked as a means of saving a simple, i.e. truth-functional account of the truth conditions of indicative conditionals against evidence that suggests more complicated, usually highly intensional construals. The meaning of a sentence, so the defence goes, is a product both of its truth conditions and its assertibility conditions. Assertibility conditions serve as a padding around simple truth conditions: they bounce off all evidence against the truth-functional account of indicative conditionals. In particular it remains possible to maintain that the falsity of the antecedent is sufficient for the truth of a conditional and explain why it would be "funny" to assert a conditional on the basis of disbelieving the antecedent. I shall come back to that explanation in a moment.

The main purpose of this paper is, first, to generalise the framework in which the supplementing strategy is couched and, second, to extend the strategy to also cover inference, in particular the inference from inconsistent premisses to arbitrary conclusions. For this purpose the concept of solidity will be introduced. Solidity is a weaker property that assertibility: everything assertible must be solid but solidity may not suffice for assertibility. Very briefly, a test for solidity consists in asking whether something still follows from a set of beliefs after these beliefs have been reconsidered in a certain way.

Apart from serving as a face-saving exercise for the standard definition of logical consequence respectively validity, the concept of solidity has two further benefits. First, it gives rise to a subclassical inference relation that handles inconsistent premisses in a discriminating way. This kind of inference relation seems to accommodate all major items on the want lists of paraconsistent logicians without engaging in baroque deviance. The relation will be introduced and discussed in Section 5 below. Second, it does justice to and explains the very common and—despite best efforts—irrepressible view that nothing rather than everything follows from a contradiction, a topic discussed in the final section of this paper.