Meth8-VŁ4: A LOGICAL JOURNEY TO THE END OF THE HUMAN BRAIN

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ABSTRACT

Logic has been, throughout themillennia, the most important tool for ancient philosophers/scientists in order to cope with scientific issues, in particular the study of the human brain and mind. However, the growing attention in the very last centuryon novel counterintiutiveconcepts such as quantum dynamics, have made logic incapable of describing scientific truths, so that it has been dismissed in the investigation of physical and biological issues. Here we introduce a novel logic model checker, called Meth8-VŁ4, that implements a variant of Łukasiewicz' four valued logic system. Meth8-VŁ4, overcomingmany limitations of the classical and non-classical logics, is able to assess the validity of scientific propositions related to neuroscientific frameworks,techniques andprocedures. We provide examples of the use of Meth8-VŁ4 in current nervous system's approaches, in order to prove or disprove their validity. In particular, we show that topology-based and informationentropy-based approaches to brain activity are logically validated, while set theory issues are not.

INTRODUCTION

The issues of the mind and brain activity were tackled from different point of views, from philosophy (Descartes, 1637; Avenarius, 1907; Dennett, 1991) to psychology (Ibáñez et al., 2016) and neuroscience (Başar, 2010). For example, in cognitive neuroscience, the term "mind" refers to a set of "cognitive" faculties (Bosse et al., 2008; Gazzaniga, 2009; Vandekerckhove and Panksepp, 2011). "Cognition" stands here for the mental functions that give rise to information processing: they embrace consciousness, perception, attention, different types of memory, language, learning, thinking, judgement, action, attitudes and interaction in the physical, material, social and cultural world (George, 2003; Almada et al., 2013).Here we use the powerful tool of the logic in order to investigate brain and mental functions. Despite scattered skeptical claims (Thagard, 2014), a logical approach has been proved useful in the assessment of mental issues, through modal logic (Hintikka, 1969), partial modal logic (Jaspars and Thijsse, 1996) and epistemic logic (Pietarinen, 2003). Further extensions were used in neuroscience and phenomenology (Pietarinen, 2004). This paper overcomes uncertaintiesin order to clarify the application of mathematical logic to neuroscience, by using the logic model checker named Meth8. It is based on a variant of Łukasiewicz's four valued logic system, recently corrected and named VŁ4 (James, 2015; James, 2016a and b). With the help of this simple, lower-order predicate logic, our aim is to evaluate (and validate) recently-described neuroscientific issues, procedures and approaches to the brain activity, in order to logically prove or refute them.

In particular, we evaluated the recently proposed role for the Borsuk-Ulam theorem as a general framework in order to analyze brain features and functions (Borsuk, 1933; Tozzi and Peters, 2017; Tozzi et al., 2017). Further, we assessed the claim that a four-dimensional Clifford tori, i.e., a multidimensional hypersphere, could describe the functional trajectoriestaking place on the neural connectome's phase space (Tozzi and Peters, 2016). We also analyzed the recent claim that fMRI images can be assessed through tessellations standing for different cortical values of Rényi entropy (Peters et al., 2017).

Neuroscientists commonly split the brain activity into different subsets of mental faculties, so that far apart specific observational mental domains interact with each other (Gazzaniga, 2013; Dricu and Frühholz, 2016). Indeed, in the framework of Zermelo-Fraenkel set theory, many Authors describe the mind as a set of functions carried out by the brain, and the specific observational domains of every mental function as subsets (Kandel et al., 2012). We evaluated whether such tenescan be logically validated. Last, but not least, we assessed the claims suggesting that the knowledge achieved by our brain cannot be exhaustive, because any measurement of a system from within itself yields incomplete knowledge of itself: this would imply that observable states of the nervous system are epistemic and not ontologic, that is, only relate to the study of knowledge.

MATERIALS AND METHODS

What is logic?*Logic* is a form of reasoning that is guided by a strict set of rules. In practice, the heartbeat of logic is the analysis of assertions or propositions and the proof of the correctness of the propositions (Church, 1970). In addition to proof, other matters of great concern in logic are disproof and compatibility of a given proposition with others (Hempel, 1943). Compatibility issues arise in connection with the notation, symbols, constants, variables, mathematical formulas in propositional functions (i.e., propositions dependent on the values of free variables and constants for their correctness) and the form of provable propositions. The term free variable was introduced by G. Peano in 1897, founder of mathematical logic and set theory and adopted by Russell (1903). A free variable x in a proposition P(x) provides with propositions with varying generality, depending on the range of possible values of x. In addition, thanks to the work of Russell and Whitehead, propositional functions defined in terms of free variables has led to a rigorous foundation of mathematics and a thorough-going mathematical logic, which Meth8-VŁ4 represents. Formal logicassesses the correctness conditions of reasonings (Kalish, 1980).A reasoning (called also argument) is a structured group of propositions, formed in such a way, so that conclusion follows from the premises:

1) All men are mortal. (First premise)
2) Socrates is a man. (Second premise)
3) Therefore, (conclusion indicator)
4) Socrates is mortal. (Conclusion)

The aim of logic is to assess, through a process called inference, either reasonings' correctness (validity) or incorrectness (invalidity). Concerning the propositions, theyhave to be declarative, i.e., must have the property to be true or false. Formal logiccopes just with deductive inferences, i.e., starts from universals (*all men are mortal)* to reach the particulars *(Socrates is mortal).* Among formal logics, the oldest is the Aristotelian one, based on syllogisms and on three laws: the principles of identity (P is P), of non-contradiction (P is not non-P) and of the excluded middle (either P or non-P) (Łukasiewicz, 1951; 1957). In propositional logic, introduced by Peirce and Frege, a system of formal proof rules establishes certain formulae as "theorems". In this successful logic, formulae (representing propositions) can be formed by combining atomic propositions through logical connectives: it makes use in the premises of five connectives (and; or; not; if…, then; if, and just if) and of quantifiers, either universal (for all) or existential (for at least one). Such logic is able to decide mechanically the validity or invalidity of logical expressions, by using the truth tables introduced by Wittgenstein. Predicate logic is a generic term for symbolic formal systems such as: first-order logic, second-order logic, many-sorted logic, infinitary logic. It provides an account of quantifiers general enough to express a wide set of arguments occurring in natural language. To male an example, first order logic is based on predicative (elementary) languages, i.e., universal or particular propositions that, not being decidable through simple truth tables, require calculations other than purely mechanical ones(Peters, 1997). Semantic logic uses instead a predicative elementary language plus sets, in order to clearly bound the universe of the discourse. In such logics, the concept of truth is controversial: to make a few examples, Wittgenstein states that truth stands for meaning, Tarskifor satisfaction (i.e., one must limit himself to define the truth of a single language every time). On the other side, Gödel, in his metalogic, prefers to use the demonstrability (discrepancies between propositions) instead of truth (Gödel, 1932). Among the formal logics, symbolic logic is the study of abstractions that capture the formal features of logical inference, while computational logic is used in computer science, mathematics and engineering.
All the classical logics discussed above are "bivalent" or "two-valued"; that is, they are most naturally understood as dividing propositions into true and false ones. Non-classical logics are systems that discard various rules of classical logic. For example, fuzzy logic encompasses an infinite number of "degrees of truth", represented by a number between 0 and 1. Intuitionistic logic, proposed by L.E.J. Brouwer, rejects the principle of the excluded middle. Jan Łukasiewicz extended the traditional values for truth and falsity, in order to include a third value, "possible", in a so-called ternary logic (Łukasiewicz, 1920). Modal logic is an extension of propositional logic, in which sub-parts of a sentence may encompass special verbs or modal particles. Because modal logic is not truth conditional, it has often

been proposed as non-classical. However, modal logic is formalized with the principle of the excluded middle and its relational semantics is bivalent, so that such inclusion is debated.

Currently, almost all the logical frameworks are largely in disuse wheninvestigating scientific issues, because they lack the tools to assess some counter intuitive experimental findings that underlie our world. For an example, Jan Łukasiewicz originally combined modal operators with the binary system B4 and developed a four-valued modal logic system named Ł4 (Łukasiewicz, 1953). It fell into disuse because it was unable to solve the contradiction raided by the experimentally well-validated issue of the Schrödinger's cat: "If possibly the Cat is alive and possibly the Cat is dead, then possibly both the Cat is alive and the Cat is dead" (Rescher, 1964; Béziau, 2011).

In the following, we discuss another type of proof assistant tool, standing for a new way to automate logical proofs for neuro-scientists. Furthermore, we provide practical examples from neuroscience.

IntroducingMeth8-VŁ4. Logic is a way to do abstract arithmetic on formulas, where simple true or false builds into proofs or contradictions. The goal is to disprove or prove equations with logic values, and the result is atruth table of outcome values, such as T in Tautology for validating proof. When the designated truth value is specified such as Tautology, then that is the cue for what value the practitioner seeks to constitute as a proof.

This paper is about a new logic named VŁ4 and its proof assistant Meth8. The latter is an automated tool to check the logic on input and produce truth tables onoutput at each step. Propositions in words (or formulas in symbols) are mapped into logic scripts of one-character symbols. VŁ4 is based on the 2-tuple, i.e., a bivalent object in bits: {11,01,10,00}. The 2-tuple is a ring, module and group, but it is *not* a vector space. The logical values are assigned as based on the left- or right-side of the pair of bits. The atomic values are: Zero 0 as False, One 1 as True. The bits are in pairs, so we chose a Left- or Sinister-side and Right- or Dexter-side for each of the four logical values. We also assign the Sinister-side as False, and the Dexter-side as True (**Figure A**). This binary logic system is B4.

Our logic system rehabilitates the modal logic system Ł4. VŁ4 does this by specifying five models to describe the combinations of logical results. VŁ4 is also based on a simplified truth and proof definition: tautology is proof; contradiction is not proof; truth is non-contingency; falsity is contingency. When applied to the Square of Opposition, that is the assumed basis of all logic, VŁ4 found that updates were required for the Square to be modernized (Westerstahl, 2012). Indeed, the vertices of the Square have been slightly redefined: this causes the edges of the Square to have definitions as logical equations. Those, in turn, were applied to the syllogisms of the Square, so that a correction to two of them was found. While standard logic provers subsequently validated these updates to the Square, it was VŁ4 which found them first. What followed from correcting the assumptions in the Square proved that the modal operators are logically equivalent to the quantified operators. This simplifies the theory of proofs, to the extent that VŁ4 can evaluate equations in any of the major high-order logic systems. This means that VŁ4 can compare and contrast results from other systems (such as: Belnap, 1977; Dugundji, 1940: Halldén, 1949; Kleene, 1938; 1950; Lewis, Landford, 1959).

In greater details, the basis of mathematical logic is the Square of Opposition, with four sides and four vertices. VŁ4 updates the formulas of vertices to be exact. Consequently, the four sides obtain unique descriptive equations. The Square also produces combinations for 256-syllogisms. From those, 24-syllogisms were adopted historically as valid modes of argument. VŁ4 have found and corrected two of the syllogisms, named Modus Camestros and Modus Cesare. Indeed, exact formulas for the vertices of the Square enable correct definitions for the modal operators of necessity [] and possibility <> and for the quantified operators of the universal quantifier ∀and existential quantifier ∃. Therefore, VŁ4 provesthat the respective operators are interchangeable and equivalent: necessity means "for all" and possibility means "for one". Because of this unique quality, VŁ4 is capable to describe other logic systems, and to validate them at tautologous. VŁ4 has two sets of logical values: FNCTand UIPE. The letters mean: contradiction, non-contingency, contingency, tautology; and unevaluated, improper, proper, evaluated. The designated proof values are tautology (T) and evaluated (E). The truth tables for Model 1 and Model 2 groups are described in **Figures B** and **C**, with ~ not, # necessity, and % possibility.

A

Left-false	Right-true	Meaning for each side	Reduction	Value names
1	1	True it is false, *or* True it is true.	False, *or* True	tautology (proof)
1	0	True it is false, *and* False it is true.	False, *and* False	contingent (falsity)
0	1	False it is false, *and* True it is true.	True, *and* True	non-contingent (truth)
0	0	False it is false, *and* False it is true.	True, *and* False	absurdum (contradiction)

B

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   VŁ4       ~VŁ4            1          21    22    231   232
 M1  M2    ~M1 ~M2          # %         # %   # %   # %   # %
  F   U      T   E       F. F C   U.  U U   U E   U P   U I
  C   I      N   P       C. F C   I.  I I   U E   I E   U I
  N   P      C   I       N. N T   P.  P P   U E   U P   P E
  T   E      F   U       T. N T   E.  E E   U E   I E   P E
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C

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1 & . F,F,F,F . F,C,F,C . F,F,N,N . F,C,N,T
1 \ . T,T,T,T . T,N,T,N . T,T,C,C . T,N,C,F
1 + . F,C,N,T . C,C,T,T . N,T,N,T . T,T,T,T
1 - . T,N,C,F . N,N,F,F . C,F,C,F . F,F,F,F
1 < . F,F,F,F . C,F,C,F . N,N,F,F . T,N,C,F
1 = . T,N,C,F . N,T,F,C . C,F,T,N . F,C,N,T
1 > . T,T,T,T . N,T,N,T . C,C,T,T . F,C,N,T
1 @ . F,C,N,T . C,F,T,N . N,T,F,C . T,N,C,F

2 & . U,U,U,U . U,I,U,I . U,U,P,P . U,I,P,E
2 \ . E,E,E,E . E,P,E,P . E,E,I,I . E,P,I,U
2 + . U,I,P,E . I,I,E,E . P,E,P,E . E,E,E,E
2 - . E,P,I,U . P,P,U,U . I,U,I,U . U,U,U,U
2 < . U,U,U,U . I,U,I,U . P,P,U,U . E,P,I,U
2 = . E,P,I,U . P,E,U,I . I,U,E,P . U,I,P,E
2 > . E,E,E,E . P,E,P,E . I,I,E,E . U,I,P,E
2 @ . U,I,P,E . I,U,E,P . P,E,U,I . E,P,I,U
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Figure. Details of VŁ4. **A**: The binary logic system used in VŁ4. **B**: Truth tables for Model 1 and Model 2 groups, with ~ not, # necessity, and % possibility. **C:** The connectives by Model types 1 and 2 are: & And, \ Not and, + Or, **-** Not or, < Not imply, = Equivalent, > Imply, @ Not equivalent. The look up truth tables for connectives by Model types 1 and 2 are presented horizontally as row major.

The virtues of Meth8- VŁ4. In this novel logic, the operators of arithmetic map directly into the connectives of logic, such as Multiply * into And&. To make this logic more expressive, modal operators are used: for example, the words “possible” or “necessary” also come to mean “one_event” or “all_events”. This means that the modal operators are fully interchangeable with the quantified operators, so that the universal and existential quantifiers are mapped respectively as necessity and possibility.VŁ4 has logic values for tautology, contradiction, truth, and falsity. Tautology is the designated proof value on the truth table. The standard logical operators are symbols in one character for easy input.

The Meth8 tool supports variables in one-letter for propositions or theorems. Equations to test are read from an input text file as updated by the user. The operators for <not, possibility, necessity> are <~, %, #>. Some expressions are adopted for clarity such as: (p=p) for true; (p@p) for false; (p\p) for one 1; (p\p) - (p\p) for zero 0; and (x<y) for x∈y. The expression "x less than or equal to y" is rendered in the negative as ~(x>y).In Meth8-VL4 logic, the only two ordinals are 0 and 1 (bi-valency): 0 = zero is false = (p@p) = p XOR p; and 1 = one is true = (p=p) = p EQV p.
VŁ4 is unique in support for propositional and quantified modal logic, and with truth table results available in five models. Because VŁ4 maps both first- and second-order logics, it stands for a novel system able to evaluate the known logics. Generic logics evaluated include: alethic; constructivist; deonitic; descriptive; doxastic; epistemic; intuitionist; modalistic; paraconsistic; positivistic;sequentic; set-theoretic; temporal. The Meth8 parser has extensive anomaly detection and notification for easier correction of user input. At each step of the logical evaluation, full truth tables are stored in the session transcript with a unique file name. Final results are reported onto the user monitor and clearly readable. The logic engine is driven in computer memory by look up tables. For more variables, the look up tables are accessed from external device.Laptop performance is less than one second of time for 250-steps of logic lookup. Exception handling covers all cases. Meth8 is metered by pay-to-play lookup table access. The installation and operation use a security wrapper to enforce one user license per CPU per session. The source code is industrial grade with embedded test cases and program documentation. Meth8 development and life-cycle management is fully compliant with Mil-STD-498. There are no ITARS restrictions on export.
Meth8-VŁ4 is not a higher-order logic at all, but a lower-order one, and is therefore much less complicated. One may think of Peano arithmetic as a specific numerical logic within an abstract propositional logic. In that regard, Meth8-VŁ4 is abstract arithmetic, while Peano is numerical. This is why Godel had to resort to endless numbering variables, and why set theory is not tautologous using the corrected Square of Opposition definitions as a basis. We will demonstrate later the last proposition.
The program also simplifies and solves the well-known distinction between logically equivalent (A => B and B => A tells us A and B are equivalent, written A ⇔ B) and mathematically equivalent.Members of a set X are mathematically equivalent, provided there is a relation R on X that is reflexive, symmetric and transitive. This means that the members of X are pigeonholed -partitioned-by R into equivalence classes. Meth8-VŁ4 views mathematical and logical equivalence as exactly the same and interchangeable:the equal “=” in arithmetic is the same as “==” in logic. In that regard, Meth8-VŁ4 makes no distinction between “==” and “<==>”. The proof of equality is (p>q)&(p<q), TTTT; in other words, the same as (p)+(~p) as (p>q)+~(p>q).
Similarly, the Imply >, Not Imply < are viewed as relational operators. For x to be an element in S and possibly equal to the limit as S, in FORTRAN-ese x lt.et S, is produced in Meth8-VL4 as ~(x>S), that is Not(x g.t. S).In logic, the Pi-product of 2*2*2 = 8 for p = 2 is p&p&p = p. Similarly, the Sigma-sum of 2+2+2 = 6 for p = 2 is p+p+p = p. Hence the theorem (p&p)=(p+p) ; TTTT.
In sum, the whole point of Meth8-VŁ4 is to show any terms out of logical sequence and not logically compliant, hence causing a contradiction in reasoning. The tool is characterizedby several virtues: it is fast and simple like lower-order logics; is equipped with simplified proofs; is able to compare results from other logical systems. Furthermore, the modal operators are mathematically equivalent to the quantified operators: this feature makes Meth8-VŁ4 able to solve the Schrödinger’s catparadox from quantum dynamics.

The Meth8 procedure. We used Meth8 in order to evaluate (deny or affirm) neuroscientific assertions andvalidate them as tautology,or as not. For Meth8, an immediate application to “validate as tautologous” is mapping sentences of natural language into logical formulas. The approach identifies parts of speech as nouns, verbs, and modifiers. These translate into logical symbols for literals, connectives, and operators. For example: the conjunction “and” becomes the connective “&”; and the modifier articles “the” and “a” become the modal box # and lozenge %. Expressions for consecutive sentences are linked by the imply connective to build paragraphs and form requirements documents. Note that the semantic content or predicate basis of some expressions does not disqualify them from evaluation by Meth8 in classical modal logic. Indeed, the rules of classical logic, as based on the corrected Square of Opposition by Meth8, apply to virtually any logic system. Consequently, some numerical equations are mapped to classical logic as Meth8 scripts.
The rationale for mapping quantifiers as modal operators is based on satisfiability and reproducibility of syllogismsvalidation. Test results are Invalidated as Not Validated Tautology (*nvt*), or Validated as Validated Tautology (*vt*). For a paradox, invalidated means that it is not validated as true: that is, it is not a paradox or contradiction. The experimental tests used variables for 4 propositions, 4 theorems and 11 propositions. The sizes of truth tables are respectively for 16-, 256- and 2048- truth values.
The Meth8 modal theorem prover implements the logic system variant VŁ4, which corrects the quaternary Ł4 of Łukasiewicz. There are two sets of truth values on the 2-tuple {00, 10, 01, 11} as respectively <False for contradiction, Contingent for not true, Non contingent for true, Tautology for proof> and <Unevaluated, Improper, Proper, Evaluated>.
The mapping of formulas into Meth8 script was performed by hand, checked, and tested for accuracy of intent. (A

semi-automation of that process is underway). The Meth8 script uses literals and connectives in one-character. Propositions are p-z, and theorems are A-B. The connectives for <and, or, imply, equivalent> are <&, +, >, =). The negated connectives for <nand, nor, not imply, exclusive-or> are <\, -, <, @>. The operators for <not, possibility, necessity> are <~, %, #>. Some formulas tested are first- or second-order logic. The universal and existential quantifiers are mapped as necessity and possibility. Some expressions are adopted for clarity such as: (p=p) for True; (p@p) for False; (p\p) for one 1; (p\p) **-** (p\p) for zero 0; and (x<y) for x∈y.

RESULTS

We evaluated several neuroscientific issues, in order to logically validate or invalidate them. The **Table** displays the examined objects and our results. Some of the procedures and issues are validated as tautologous, others are not. Our results show that an approach to the brain activity based on the topological framework of the Borsuk-Ulam theorem and a functional hypersphere is feasible. The approach with Rènyi entropy remains controversial, while the use of set theory in order to describe mental functions in not tenable.

In order to elucidate ourprocedure, we provide an example. Meth8-VŁ4 automatically validates the logic scripts of arithmetic in equations and words in propositions as to status of proof.Here is a proposition example for the Borsuk-Ulam theorem, proposed as a new foundation of neuroscience.The word proposition is: “A point mapping to both antipodal points implies that point implies either of the antipodal points”;
The logical mapping input is: (p=(q&r)) > (p>(q+r)) ; andthe truth table output is:TTTT TTTTTTTTTTTT.
[Note that the presence of all T stands for tautology. i.e., it is logically validated.]

Name of object	Type of object	Results with instances
Borsuk-Ulam	Theorem	Validated
Borsuk-Ulam extensible, non-invertive	Theorem	Validated
Clifford tori 2D / Kanban cell neuron	Definition	Validated
Rényientropy (H.1.2), H1.1, H2.	Formula	Validated
Bell /CHSH/ Spekken toy model	Inequalities	Invalidated
Zermelo-Fraenkel (ZFC):	(Axioms)	Invalidated (10) Validated (1)
ZFC Choice	Axiom	Invalidated
ZFC Empty set	Axiom	Invalidated
ZFC Extensionality	Axiom	Invalidated
ZFC Infinity	Axiom	Invalidated
ZFC Pairing	Axiom	Invalidated
ZFC Power set	Axiom	Invalidated
ZFC Regularity or foundation	Axiom	Invalidated
ZFC Schema of replacement	Axiom	Invalidated
ZFC Specification	Axiom	Validated
ZFC Union	Axiom	Invalidated
ZFC Well ordering	Axiom	Invalidated

Table. List of the tested conjectures.Concerning the "The Bell /CHSH inequalities and Spekken toy model", we used this object in order to assess the claim suggesting that the theknowledge achievable by our brain cannot be exhaustive. Indeed, the knowledge balance principle of the Spekken toy model ensures that any measurement of a system from within itself yields incomplete knowledge of itself. This implies that observable states of a system are epistemic, that is, only relate to the study of knowledge. The Spekken toy model implicitly assumes that there is an ontic state of a system at any instant, but which is unobserved. The model contains local and noncontextual variables, so that, based on Bell's theorem,it is unable to replicate predictions made by quantum mechanics. The toy model produces strange quantum effects, interpreted in support of the epistemic view.

CONCLUSIONS

We showed that some recently-proposed approaches assessing brain function and activities can be logically validated as tautologous, while others cannot.Summarizing our results, the use of the topological apparatus of the Borsuk-Ulam theorem and the hypersphere (Clifford tori 2D / Kanban cell neuron) in the assessment of brain functions was validated. Furthermore, the use of the Rényi informational entropy in the assessment of fMRI neuroimages is allowed. On the contrary, the description of the mind as a set of functions carried out by the brain (Zermelo-Fraenkel set theory) is not valid. Also, the claim that any measurement of the brain system from within itself yields incomplete knowledge of itself is invalid: this means that, from the brain observer's standpoint, it is possible to achieve a full knowledge of his own nervous functions.

The main question here is: what does it mean that a neuroscientific issue is validated or invalidated? The truth values in VL4 are T tautology (affirmed as in a state of proof), C contingency (denied proof and in some state of falsity), N non-contingency (denied proof, but affirmed as in as state of some truth), and F contradiction (denied as in a state of non-proof).When a conjecture is validated as tautologous, this means it is proved and affirmed. Otherwise, the conjecture is in some state of non-tautology and effectively refuted. We might also ask: how is this important, for experimental neuroscientists, the fact that a procedure has been validated by Meth8-VŁ4? If Meth8-VŁ4 validates as tautologous any tool used by scientists, then that adds a level of confidence as to fidelity of the methodology. Scientists should care about such logical results, because it is in keeping with their due diligence to follow the highest level of accountability for the scientific method of hypothesis, theory and conclusion.

We stated that logical operations in Meth8 may prove that a sentence concerning a neuroscientific issue is logically true or false. But how can Meth8 know whether a true sentence is meaningful or not?It might be objected that p, q, r, s could stand for any set of words, so that we could get any logical conclusions. Of course, Meth8-VŁ4 cannot impart meaning to propositions, but can show if those concepts are used in a logical discourse as a reproducible proof. The correct argument could be that the proposition:"given p as nervous activity, then that implies mental faculties of q, r, s"is proved as a correct line of reasoning. Concerning the invalidated neuroscientific issues, our data show two things. First, the way an issue is currently framed or expressed is not tautologous, and cannot be resuscitated and reapetedly replicatedby manipulation. Therefore, its textbook definiton should not be used. Second, because Meth8-VŁ4 is robust, even as a seemingly lower-level logic, it is able to fix up a rule to make the issue work at least logically, and prove itspossible tautologies.

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