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Warranting evidence in diverse evidentiary settings

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Abstract: Informal logic, is faced with the problematic of persuasive arguments in contexts where evidence is rich, diverse and preferentially selected on the basis of pre-established attitudes. This requires that the standard view of challenge by presenting inconsistent evidence be rethought. In this paper, I will argue that the solution is to focus less on evidence that contradicts claims and to confront the network of warrants that support the selecting and evaluating of evidentiary moves.

Keywords: bias, chemistry, cognitive science, emotions, evidence, meaning, neuroscience, warrants

1: Introduction

Informal logic, is faced with the increasing problematic of persuasive arguments in contexts where evidence is rich, diverse, inconsistent and preferentially selected on the basis of pre-established attitudes. This requires that the standard view of challenge by presenting inconsistent evidence be rethought. In this paper, I will argue that the solution is to focus less on evidence that contradicts claims and to confront the network of warrants that support the selecting and evaluating of evidentiary moves. This requires a closer look at networks of commitments and how we might evaluate them in terms of their increasing adequacy over time. I will indicate the contour of such a framework and support its plausibility by indicating its relations to recent attempts to offer neurologic models of belief maintenance as well as to successful scientific practice.

My account offers a relatively straight-forward set of criteria for the acceptance of warrants within a network of commitments: increasing adequacy over time in terms of practical applications; increasing applicability to a growing body of successful applications; and increasing theoretic adequacy in terms of the connectedness of warrants through deep explanations. The model is based on physical chemistry, a paradigm rarely employed in discussions within informal logic, and which, perhaps surprisingly, resonates with recent speculative accounts of cognitive functioning at the neural level, construed in terms of neuro-physiology, and within formal models and computer simulations of cognitive processes.

2. Setting the problem

Before I can begin, however, I have to face the fact that I have been arguing substantially for this position for decades with little apparent success (Weinstein, 1990). And so, I will attempt to offer a few hopefully persuasive remarks to induce interest in what follows. Perusing the *New York Times* over the space of a few days yields a variety of examples the illustrate the problem of evidence. Paul Krugman, Noble Prize-winning economist in an op ed rails against the economic positons of some presidential candidates, calling them “zombie idea- ideas that should have been killed by evidence, but just keep lurching along" (Krugman, 2020, p. 22). As an example, he cites that financial crisis of 2008, claiming that 'the erosion of effective financial regulation' was the clear cause of the crisis rather than the view of some candidates for president that the crisis was caused by "forcing innocent bankers to lend money to people of color" (ibid.). Clearly, both of these claims may be considered reasonably appropriate evidence supporting claims about the cause of the financial crisis, and equally clearly the evidence does not in any way resolve the dispute as to which point of view is a 'zombie.'

An equally fraught debate, resurfacing after many years, is the debate over phonics as the basis for reading instruction in schools. Another *New York Times* feature article discusses the "debate between proponents of the 'science of reading,' which emphasizes phonics, and traditional educators who prefer to instill a love of literature" (Goldstein, 2020, section A, p. 1). This recent discussion contrasts the "eye-tracking studies and brain scans now show that … Learning to read, they say, is the work of deliberately practicing how to quickly connect the letters on the page to the sounds we hear each day" with the view that "blame low student performance on such factors as inexperienced teachers, school funding inequities and homes that lack books or time for parents to read to their children… (opting for) assigning more challenging literature … early-morning, after-school and Saturday tutoring sessions for students at risk of failing state tests… The guardians of balanced literacy acknowledge that phonics has a place. But they trust their own classroom experience over brain scans or laboratory experiments, and say they have seen many children overcome reading problems without sound-it-out drills. They value children picking books that interest them and worry that pushing students into harder texts could turn them off reading entirely." (ibid.) This debate, continuing for decades, seems impervious to the growing body of evidence from cognitive science, in the face of deep conviction about the ethical and cultural value of reading instruction that reflect the differing social, cultural, racial and economic perspectives of the interlocutors.

It is not only complex economic and educational issues that resist a simple appeal to evidence. In yet another recent op ed a mathematics professor discusses the difficulties of calculate the death rate of coronavirus, despite the apparent hard data available in both the test for the disease and the apparent indisputable facts of mortality and the clarity of the math (number of deaths over the number of cases). He indicates that "the corona virus might be blamed for the deaths of vulnerable people especially seniors already suffering from other diseases" and so the numerator (the number of deaths) is harder to determine than counting dead people with the virus. The denominator (the number of people with the virus) is also difficult to ascertain since "those being treated without being formally tested" might alter the total number of the people infected with the disease" (Paulus, 2020, p. 23). And, additional evidence will not settle the issue, since until the pandemic is over (if then), all extrapolations from available data are based on models, and models are only as good as their warranting assumptions.

It seems obvious to me that in these debates, as in debates about gun-control, abortion, affirmative action and many other significant issues that reflect crucial social concerns, it is not the evidence *per se* that is the issue, but the underlying commitments that determine which bodies of evidence to develop, to rely on and to prioritize. So why does so much of the inquiry within the informal logic community persist in using models of argument analysis that fail to capture the complex informational commitments of advocates in opposing sides? That is, why is the focus on relatively abstract structures (e.g. argument diagrams) rather than the adequacy of the elements that the structures expose? My guess is that it is the influence of formal logic (argument diagrams often reflect propositional logic functions, conjunction, disjunction and contradiction) and the need to have something relatively clear and simple to teach.

My suggestion over many years and many papers is that the analysis and evaluation of arguments requires a focus on warrants. But the adequacy of warrants, whether construed as generalizations or inference tickets, shifts the focus from evidence to the commitments through which evidence is selected, organized and applied. Concern with warrants moves the analysis of argument into a subject-matter dependent stance that is uncomfortable for theorists still committed to following the paradigm drawn from formal logic, which looks to subject neutral and information free tools of argument analysis; tools that privilege logicians rather than subject matter specialists in evaluating argument (Weinstein, 2003).

Surprisingly, my inability to convince others of my point of view is to be expected given my perspective. Informal logicians are deeply committed to a theoretic and educational project that relies on clear and simple analyses of all sorts of argument, and so, it should be of no surprise to someone holding my perspective that they would be resistant to any approach that calls into the question the roots of their endeavor. And so, I need to go into the logical roots, the theory of the logical basis of argument in the structure of the two sorts of propositions that are the root metaphor for the logical process of evidence in its dialectical role.

The basic form of a proposition can be characterized as **Fa**, where **a** is an individual expression and **F** indicates a property. The simplest relevant form of a proposition that functions dialectically in relation to **Fa** is **(x)Fx** normally translated as: **All x are F**. The dialectical function of the pair is seen as the contradictory expression **not-Fa** normally construed as contradicting **(x)FX.** The form of a correlative generalization is, e.g. **(x) (FX ⊃ GX)** and the correlative contradictory evidence is **(Fa & not-Ga)**. That much is so obvious that it hardly bares mentioning, but yet, if I am correct it is at the heart to the issue. For the obvious construction masks two deep and perplexing problems when we move from, for example, arithmetic, which was at the heart of formal logic as it was developed in the first decades of the 20^{th} century, to the concerns of informal logicians. For in ordinary contexts both the extension of the predicate **F**, and the domain of the universal quantifier are neither clear nor obvious. This first thing to realize is that except for bounded predicates, such as the coins in my pocket, extensional definitions of common terms and noun phrases are not available, since common nouns apply to all instances, past, present and future. But, although people have enough sense of the meaning of terms in use, it has hard to defend the view that intensional definitions of predicates are available, if by that we mean giving clear necessary and sufficient conditions for the use of common terms. Starting with Quine's seminal insights (Quine, 1953) and reflected in the work of more recent theorists who struggle with the problem of semantic meaning as readily available from practice (Alexander & Weinberg, 2007) the availability of adequate accounts of meaning in use seems questionable. This is, perhaps, controversial within informal logic since the availability of definition and their use in distinguishing analytic and synthetic generalizations is generally accepted in the informal logic literature (e.g. Freeman, 2005, pp. 97ff.). But surprisingly, if we look beyond mathematics, where meaning is clear, to a near relative, the disciplined use of generalizations in physical science, the situation is much more complex than it might first seem to informal logicians who think that meanings are both obvious and available. This requires a detour into an area that has been the focus of my recent work, the history of physical chemistry and its contrast with both mathematics and the ordinary sense of predicates, the latter best exemplified by the Aristotelian notion of natural kinds (Weinstein, 1999).

3. **Meaning in science:**

We begin with an example: Prout's hypothesis, a corner stone of the periodic table and, in 1817, and a bold and ultimately fruitful conjecture. Expressed in its simple propositional form: All elements are composed of hydrogen atoms. The vicissitudes of just what we might mean by 'element' and by 'hydrogen atom' was reflected in the complex status of the available evidence and underlying theories through which the conjecture was to be verified. The evidence that prompted the conjecture was an outgrowth of a deep explanatory principle in early atomic theory, that is, that atoms of elements could be described in terms of whole number multiples of a primordial atom. This was itself based on both the underlying intuition of atomic theory in its original form (that atoms, being indivisible, would only enter into combination as discrete individuals) and a growing body of evidence showing whole number ratios among the experimentally ascertained weights of naturally occurring substances after chemical decomposition. This led to the correlative theoretic notion of atomic weight as an overlay of the empirical results of measuring weights on increasingly sensitive balances. Unfortunately, in 1825, the noted chemist Jacob Berzelius "compiled a set of improved atomic weights the disproved Prout's hypothesis" (Scerri, 2007, p. 40). Prout's hypothesis remained inconsistent with the evidence for at least a century. Nevertheless, Prout was correct in seeing hydrogen as the basis of the elements, since hydrogen with one proton serves as the basis as we move across the periodic table, each element adding protons in whole number ratios based on hydrogen with one proton. The core insight remained at the center of later work that strove to develop coherent chemical models based on multiples of fundamental elements. Problems with anomalies persisted despite the fact that the number of protons yielded the final organizing principle of the table. These were finally resolved, once atomic number, distinguished from atomic weight, which includes the contribution from neutrons unknown until the mid-20th century, finally vindicated Prout's bold conjecture. All of this was based on warrants that supported inferences, and appear to function inferentially as universal generalizations. Generalizations sustained in the face of counter-evidence, forming the basis for a sustained and successful research program (Weinstein, 2011). In other words, the definition of the relative terms evolved as the evidence prompted reconsideration of development of underlying theories. That is say, meaning was not *a priori*, but rather the result of the development of a network of concepts and generalization. in terms of which meaning was refined. This raises another foundational concern. What is the meaning of the universal quantifier in such a context of inquiry?

In the traditional logic of categorical propositions the meaning of 'all' is seemingly non-controversial, tied to the underlying ontology. Given Aristotle's views that essential definitions of natural kinds were there to be found, there was some sense of defining 'all' in relation to the philosophical ideal (Weinstein, 2002). 'All men are mortal' takes 'men' to be definable in principle, so it is not much of a stretch to think that 'all' can be sensibly seen to range over the class. In recent times the centrality of arithmetic in the foundational work in logic, and eventually the Skolem-Lowenheim theory (every consistent model had a model in the natural numbers) offered an even firmer basis for universal quantification. The definition of the natural numbers was clear in terms of Peano's axioms and the definition precisely characterized the domain. Quantifying over all of the numbers was both intuitive and furnished powerful logical tools e.g. mathematical induction. But whether we focus on predicates, as is natural in the syllogism, or focus on the domain, as in first–order logic, what it means to universally quantify over expressions in even as stable an inquiry as physical chemistry is none to clear. At no stage in the inquiry can the range of concern be precisely stated, since the task of inquiry is to find out, among other things, what is there and how, and to what extent, the available theory comports with what is to be found. Since in physical chemistry there is no way to delimit the domain there is no extensional definition of the domain, so the arithmetic paradigm, as the guiding intuition on the semantics of first order languages, has no purchase what so ever.

Less obvious perhaps, is the fact that there are no clear intentional definitions. In the early stages of the history of chemistry, when the fundamental principles that were to permeate the developing science were laid down, the extent of the elements was unknown. The prevailing notion of decomposition into elements through chemical means was in its childhood, if not its infancy, and there was no reason to believe in the adequacy of any available conception of what the elements were. Progress was expected and changes in basic concepts welcomed in the face of empirical advance. Philosophical hand waving about all possible elements, or about where we would end up in the long run gives small comfort. And so, to put the point boldly, if the domain is not determinable, the universal quantifier is not logically defined. In such a situation, it seems reasonable to say that 'all' is a vague statement of hope and intention and leave it at that. But that leaves us nowhere, for without some idea as to how generalizations comport with their evidence, no logic of science is possible. And yet throughout the history of physical chemistry, generalizations were made and functioned logically in terms of confirmation and contrary evidence. To understand the logic of all of this is essential to understanding argumentation in inquiry, and perhaps this may offer some connection with the new possibilities that modern logic provides.

Science when sufficiently mature and theoretical, as in physical chemistry, requires clear and often mathematical theories. In such formal theoretic contexts, as in mature scientific theories, predicates often refer to an unbounded, yet definable domain as specified by the theory. That is to say that within a theory predicates are given clear and explicit definitions in respect of an equally explicit domain of theoretic entities, and so 'all' makes clear sense as applying to the entire unbounded range of possible instances. That is, science, like mathematics, takes 'all' seriously. But when the theory reaches out to reality, to the models of data, which stand as its confirmatory basis, such clarity is often obscured by the empirical facts. For although experimental data is interpretable in terms of the theory and its predicates, the world has something to say about the specifics. This is required for the theory to be empirical, that is, falsifiable.

The history of theoretic generalizations in relation to their empirical database, however, is not the simple one of refutation by experimental counter-example as in the classic view of Karl Popper (1963). Theories often resist anomalous data in light of the robustness of the theoretic contexts within which the interpretation of empirical data occurs. Theories are subject to modification or even disconfirmation in light of recalcitrant facts, interpreted within the domain and predicates of the theory, which fail to support its theoretic generalizations. But empirical data may also be resisted in the name of the power of the theory, measured by its over-all empirical basis, and as important, its place in a network of other theories, each of which is supported by its own empirical basis and its place in the network of related theories. It is this give and take between theoretic embeddedness on the one hand, and risk of modification or falsification in light of recalcitrant empirical data that the discussion of Prout's hypothesis was intended to illuminate. Such an account explains how counter examples are to be considered on their merit, rather than serving as automatic refutations as in standard logic or in the view of those who followed Popper in philosophy of science.

What I have to offer in place of the simple model of conjecture and refutation is three intuitive parameters, drawn from the history of physical science that enable a reasonable estimation of the strength of a generalization and its correlative ability to withstand counter-evidence (Weinstein, 2009). Physical chemistry exhibits an explanatory structure that includes three highly intuitive epistemological properties: consilience, breadth and depth, all viewed over time (Weinstein, 2011). These three are the core of the epistemological power of scientific theorizing seen as productive of emerging truth. The first, ***consilience,*** requires that theories are increasingly supported by a body of evidence that is improving in scope and detail. ***Breadth*** requires that a theory explains an increasing number of diverse phenomena, and ***depth*** requires that a theory is reinterpreted in terms of by higher-order explanatory frameworks that connect it to other theories of increasing breadth and increasing evidentiary adequacy. My contention is given concrete expression in my model of emerging truth (MET), where warrants are afforded weights in relation to the growth of consilience, breadth and depth over time (Weinstein, 2009). When combined with an intuitive analysis of how these weights function dialectical and within available modifications of adaptive logic (Weinstein, 2012), the MET offers a coherent account of dialectical advance in the face of changing evidence with clear consequences for understanding the logic of inquiry in science, for the theory of argument and for critical thinking (Weinstein, 2013).

I see these epistemological characteristics to have been first exemplified by physical chemistry in the mid 1800's. And despite a history of false starts, misleading empirical data and over-stated arguments, with the elaboration of the periodic table of elements in the 20th century, physical chemists were able to offer a unified and highly coherent body of branching explanatory structures, that ranges from micro-physics to cosmology, from the basic properties of matter to the complexity of the living cell (Sceri, 2007). Surprisingly, perhaps, this model has a clear connection with recent work in cognitive neuro-science that accounts for the prevalence of commitments in the face of counter-evidence. For like physical chemistry, commitments are based, not merely on evidence, but the perspective that deep and connected generalizations of both fact and value play in determining which evidence to focus on, which evidence to remember, and which evidence to count as determinative of our beliefs and commitments.

4. Cognitive science:

Cognitive scientists, like early chemists had a basic theoretic perspective that permitted mathematical articulation (Weinstein, 2015). Rather than look at behavior alone, cognitive scientists built models that accounted for the behavior in terms of functional models based on theoretic constructs (Gardner, 1987). This placed cognitive science in a position of indefinite growth. And the promise of increasingly sophisticated computer simulations of mind offered possibilities for the description of the complex theoretic structures put forward. Complex descriptions that require computer modeling for their articulation offers a test of consilience unlike anything in the prior history of psychology. Computer simulations of interactions employed theoretic constructs based on a vastly increased knowledge of the structure of the brain, available through powerful advances in instrumentation, brain scans of various sorts. This enabled the analysis of the range of cognitive behaviors.

We do not know which theories in cognitive science are correct, but if they can be developed consistent with the available evidence they have the potential to grow in scope and detail as the theoretic predictions of ever-finer models of complex systems can be ascertained through computer simulations corresponding to the increasingly detailed experimental knowledge of the brain. That is, cognitive science shows potential for consilience. Like early physical chemistry, we don't know which theories in cognitive science are true, but if a theory continues to yield important explanations, the potential for a growing and all-encompassing theoretic structure of psychology becomes plausible.

In the history of physical chemistry, the increasing degree of articulation in the details that chemical theories explained, consilience, was combined with breadth, that is, with the scope of a theory. Cognitive science is, if nothing else, exceptionally broad in the scope of its concerns. The *Cambridge Handbook of Cognitive Science* (Frankish & Ramsey, 2012) lists eight related research areas that reflect different aspects of cognition, including perception, action, learning and memory, reasoning and decision making, concepts, language, emotion and consciousness. In addition, they list four broad area that extend the reach of cognitive science from human cognition standardly construed to include animal cognition, evolutionary psychology, the relation of cognition to social entities and artifacts and most essential, the bridge between cognitive science and the rest of physical science: cognitive neuroscience. Each of these is a going concern, and none of them is free of difficulties. Yet in all cases there is a sense of advance, of wider and more thoughtful articulation of theoretical perspectives that address a growing range of cognitive concerns. But as compelling as these characteristics are, it is depth that cognitive science shares with physical science, as both structures enable micro-explanation that can be seen to yield an over-arching ontology (Weinstein, 2002).

The key to the epistemological power of cognitive science is its foundation in neuro-science. Speculations of instantiated neural mechanisms have systemic power much greater than their evidentiary weights. Such speculations offer an image of enormous potential warrant. For their enterprise, bridging between fundamental pre-cognitive processes such as physiological control and emotions to build the functional potential for memory and cognition offers deep structural warrants supported by reliable evidence and accepted theories. Moreover, their materialist assumptions permit a deep reduction to physiology, neurobiology, biochemistry and electrochemistry that any adequate theory of brain function must depend on. The question for us is what cognitive science has to offer to informal logicians in understanding the role of evidence and underling belief commitments in explaining the strength of argument and especially their resistance to, what seems to be the heart of rationality, the willingness to change in the face of counter-evidence.

5: Cognition and Biasing Emotions:

The connection between reasoning and emotions was postulated as early as Freud and continues to be an active area of research (*academia.edu* indicates over 100,000 papers on affective neuro-science.) Research over decades indicates that our past associations affect our ability to alter our beliefs (Jacoby, et. al, 1989). A study of political beliefs showed resistance to argument that challenge our memories and commitments: "the persistence of misinformation might better be understood as characteristic of human thinking" (Lewandowsky et al., 2012, p. 114). Much of the available research relevant to the role of emotions in cognition focuses on bias and stereotyping. For example, the studies of unacknowledged bias indicate "influence of implicit stereotypes on judgment and behavior." (Blair, Ma, & Lenton 2001, p. 828).

Unacknowledged, such attitudes may remain disconnected from a person's avowed beliefs: “Dissociations [between implicit and explicit attitudes] are commonly observed in attitudes toward stigmatized groups, including groups defined by race, age, ethnicity, disability, and sexual orientation.” (Greenwald & Krieger 2006, p. 949). Such implicit biases create emotional disturbance when in the face of social pressure such views are put into question. “When one denies a personal prejudice (explicit bias) that co-exists with underlying unconscious negative feelings and beliefs (implicit bias] leading to diffuse negative feelings of anxiety and uneasiness.” (Dovidio and Gaertner 2005, p. 42).

There are neural mechanisms that account for such phenomena. The prefrontal cortex which processes conscious thought and the so-called “executive functions,” planning, goal setting, evaluation, and cognitive control is connected to other parts of the brain organizing input together into a coherent whole. Under the prefrontal cortex is the orbitofrontal cortex, which broadly supports self-regulation: physical, cognitive, emotional and social. These regions combine inputs to create the image of our physical body as well as perceptions of the external world and mental constructs (Dehaene, 2014). An interesting detail relevant for social cognition are so called “mirror neurons,” neurons that fire both when you act and when you perceive another performing the same action and which allow us to infer or predict others’ intentions (Iacoboni, et. al. 2005). Research indicates that mirroring of emotions, the degree of empathy we show others, is modifiable by real or perceived social relationships supporting ethnic or gender stereotypes (Amodio & Devine, 2006). There is evidence that biasing emotions reach deep into our biographies and are expressed in implicit biases. Evidence indicates that “early and affective experiences may influence automatic evaluations more than explicit attitudes. In addition, there is growing evidence that systemic, culturally held beliefs can bias people’s automatic evaluations” regardless of expressed personal opinions. (Rudman, 2004, p. 81). Childhood based biases cause strong reaction such as fear of unfamiliar others, which has been correlated with activation in the amygdala (Dunham, Baron, & Banaji 2008). Biases interfere, on a neural level, with the ability to experience others. When “European-American subjects looked at the face of another European-American, there was a larger neural response than when they looked at African-American faces (Lebrecht, et. al., 2009, p. 3). The result: “people do not mentally simulate the actions of [members of] outgroups. Their mirror-neuronsystems are less responsive to outgroup members than to ingroup members” (Gutsell and Inzlicht 2010, p. 844).

Such results have been generalized in a theory of the “automaticity” of higher mental functions, which sees ordinary cognition as dependent on environmental and social factors (Bargh & Ferguson, 2000). Evans (2008) in response to the then prevailing dual-processing model that distinguished between System 1 (unconscious/automatic/low effort) and System 2 (conscious/explicit/high effort) offers a complex image of the interaction between what he terms unconscious and conscious cognition, seeing a variety of distinct and possibly incompatible systems. The work continues with the development of neural models that indicate the integration of cognition and emotion through abstract structures based on the known physiology of the brain.

6. Models of the knowing brain:

Speculations as to the neural mechanisms have systemic power much greater than their evidentiary weights. Although speculative and very likely inadequate, they offer an image of enormous potential warrant. For their enterprise, bridging between fundamental pre-cognitive processes such as physiological control and emotions to build the functional potential for memory and cognition, offers deep structural warrants supported by reliable evidence and accepted theories. Moreover, their materialist assumptions point to the deep reduction to physiology, neurobiology, biochemistry and electrochemistry that an adequate theory of brain function would depend on. This seems to me to parallel my account of the structure of scientific reasoning. As the models, indicated below, show, the brain coordinates functions across an array of inputs permitting an integrated response that enables perception, memory and purposes to bring together information necessary for coordinated action in the world. I see this as a clear parallel with consilience, the increasing systematic effectiveness across areas on concern as the sciences develop and new problems are confronted. Second the brain integrates the broad array of disparate information, proprioceptive, hormonal, electrical, and chemical, integrating new input with stored impute and modifying content in relation to newly acquired stimuli of many kinds. This seems to me parallel to breadth Most importantly, all of these functions are accounted for on increasingly defined more abstract levels, moving from gross physiological function to the operation at the cellular level, and if we accept materialism, to the molecular level, as we understand the functions of the neurological array on the deepest physiological levels. This has a clear parallel with depth, the reinterpretation of a theory in terms of a higher order, more abstract and more deeply ontological sense of the ultimate realties behind the phenomena. And this is despite the enormous gap between the simple models of neurological activity proffered and the brute facts of the living brain: 30 billion neurons making countless trillions of connections and sensitive to a wide array of known biochemical agents, with more perhaps to come. We turn to two such accounts, the ambitious attempts of Thagard and Aubie, (2008) and Damasio (2010) to bridge the gap between abstract structure and available physiological knowledge.

Thagard and Aubie draw upon both neurophysiology and computer modeling. This enables both theoretic depth and the possibility of increasing adequacy, even if the latter is no more that computer simulations of simplified cognitive tasks. They cite ANDREA, a model which "involves the interaction of at least seven major brain areas that contribute to evaluation of potential actions: the amygdala, orbitofrontal cortex, anterior cingulate cortex, dorsolateral pre-frontal cortex, the ventral striatum, midbrain dopaminergic neurons, and serotonergic neurons centered in the dorsal raphe nucleus of the brainstem" (Thagard and Aubie, 2008, p. 815). With ANDREA as the empirical basis, they construct EMOCON, which models emotional appraisals, based on a model of explanatory coherence, in terms of 5 key dimensions that determine responses: valance, intensity, change, integration and differentiation (pp. 816ff). EMOCON employs parallel constraint satisfaction based on a program, NECO, which provide elements needed to construct systems of artificial neural populations that can perform complex functions (p. 824ff. see pp. 831 ff. for the mathematical details). This points to the potential power of their approach. Computer models, even if gross simplifications, permit of ramping up. A logical basis with a clear mathematical articulation has enormous potential descriptive power as evidenced by the history of physical science.

Damasio (2010) has a similarly ambitious program. He begins with the brain's ability to monitor primordial states of the body, for example, the presence of chemical molecules (interoceptive), physiological awareness, such as the position of the limbs (proprioceptive), and the external world based on perceptual input (extroceptive). He construes this as the ability to construct maps and connects these functions with areas of the brain based on current research (pp. 74ff.). This becomes the basis for his association of maps with images defined in neural terms, which will ground his theory of the conscious brain.

Given that much he gives an account of emotions elaborating on his earlier work, but now connecting emotions with perceived feelings. As with the association of maps and images, Damasio associates emotions with feeling and offers the following account: "Feeling of emotions are composite perceptions of (1) a particular state of the body, during actual or simulated emotion, and (2) a state of altered cognitive resources and the deployment of certain mental scripts" (p. 124). As before he draws upon available knowledge of the physiology of emotional states but the purpose of the discussion is not an account of emotions *per se*, but rather to ground the discussion of memory, which becomes the core of his attempt at a cognitive architecture (pp. 339ff.). The main task is to construct a system of information transfer within the brain and from the body to the brain. The model is, again, mediated by available physiological fact and theory about brain function and structure. The main theoretic construct in his discussion of memory is the postulation of 'convergence-divergence zones' (CDZs), which store 'mental scripts' (pp. 151ff.). Mental scripts are the basis of the core notion of stored 'dispositions,' which he construes as 'know-how' that enables the 'reconstruction of explicit representation when they are needed" (p. 150). Like maps (images) and emotions (feelings) memory requires the ability of parts of the brain to store procedures that reactivate prior internal states when triggered by other parts of the brain or states of the body. Dispositions, unlike images and feelings are unconscious, 'abstract records of potentialities' (p. 154) that enable retrieval of prior images, feelings and words through a process of reconstruction based in CDZs, what he calls 'time-locked retroactivation' (p. 155). CDZs form feedforward loops with, e.g. sensory information and feedback to the place of origination in accordance with coordinated input from other CDZs via convergence-divergence regions (CDRegions) by analogy with airport hubs (pp. 154ff.). Damasio indicates empirical evidence in primate brains for such regions and zones (p. 155) and offers examples of how the architecture works in understanding visual imagery and recall (pp. 158ff.).

Damasio like Thagard and Aubie offer speculative models that reference current physiological knowledge, rely on concepts from computer science and information theory and bypass the deep philosophical issues that are seen by many to create an unbridgeable gap between the mental and the physical short of deep metaphysical reorientation (Chalmers, 1996). Yet, whatever the ultimate verdict on these two authors, the rich program in cognitive science persists and has a strong appeal. The reason is the potential strength of the warrants, that is to say, if such models prove to be correct, the epistemic force of the warrants that support them will be enormous, for they are presumptively warrants with increasing consilience and breadth, and most importantly warrants that have great ontologically depth. And thus, they are warrants that swamp the alternative approaches that rely on, for example, psychological generalizations alone.

6: Conclusion

If my analysis is at all correct, the consequences for informal logic in both theory and practice are significant. For, if as I maintain, arguments both in successful areas of inquiry like physical chemistry and on a neural level, have a similar functional structure, then informal logicians should alter their analysis of argument structure in relevant ways. Most obviously the model of argument as a structure whose form offers an indication of its adequacy must be expanded. Argument must move from structure to the functions the structures exemplify, and in particular, the function of warrants that reflect the underlying networks of commitments in directing and sustaining argument. This requires more than a complication of argument diagramming, but rather a movement into the detail of support. How commitments to warrants and the networks of beliefs that they represent alter the evaluation of evidence, both evidence sought and evidence already available. As important, the hard and fast distinction between fact and value needs to be overcome, especially in areas of social significance, for values affect the way we look at fact. The gloss of value as emotions, is not the main concern, it is rather the affect-laden nature of our values that must be taken into account, for the force of values in making determinations of fact used as evidence are all too often more powerful than the force of facts alone. How does the value of individual freedom as compared to the value of lives possibly at risk, determine the gun debate? How does the religious perspectives on the meaning of life affect views of a women's right to control her reproductive choices? How does a commitment to a political party affect our willingness to believe hyperbolic claims and promises? On and on! It is the network of commitments of all sorts that determine the force of arguments and if logicians want to get serious about evaluating arguments, it is these underlying networks that must be addressed.

As severe as my view is for theory, it is even more severe for practice. I have no doubt that an introductory course in informal logic or critical thinking has some effect on students' perspectives. Any new way of looking at the world can have a profound effect on college–age students. So, anecdotes about the effectiveness of such courses by their professors are quite beside the point. Rather, the introduction to argument and logic must point students towards critical attitudes in their other courses of studies and to the world that such studies reflect upon. What a doctoral student of mine, Daniel Fisherman, calls, 'perceived questionability,' the attitude that prompts a questioning perspective towards areas of concern (Fisherman, 2013). This is close to the much-maligned views of John McPeck, whose idea of reflective skepticism was all too readily disregarded in the heydays of the critical thinking movement (McPeck, 1981). McPeck, like myself, sees critical thinking to ultimately reside in the areas of human concern, what many have called the disciplines. And like McPeck, I see informal logicians to have to go into the 'weeds' of an argument, to look at the details of the supporting warrants that connect the concepts that are at issue. And that is not even to engage with the more difficult terrain of backing, in my gloss on Toulmin, the deep theoretic reinterpretation of warrants in terms of deeper and more theoretically laden perspectives: worldviews and standpoints (Weinstein, 2006).

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