

Addressing the Quantitative and Qualitative: A View to Complementarity—From the Synaptic to the Social

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History and anthropology reveal the perdurable human characteristic of attempting to create and employ some form of quantifiable representation of the qualitative aspects of life and the natural world. The recent revolution in the ability to quantify neurobiological processes through advanced neurotechnologies, and the announcement of comprehensive mapping of neuronal pathways as priorities both within the United States (e.g. the Brain Research through Advancing Innovative Neurotechnology, *BRAIN*, Initiative), and internationally (e.g. the European Union's Human Brain Project) call forth questions about how data, both quantitative and qualitative, can and should be leveraged to sustain neuroscientific research and related applications that are ethically sound, technically viable, and socially relevant. As neuroscience evermore gains influence in medical, public, economic and political spheres, it will be important to ask (early and iteratively) what such science—as a human endeavor—seeks to achieve, and how the methods selected (whether quantitative, qualitative, or some combination thereof) may help to realize such goals. In this paper we explore potential sources of tension, alignment, and integration with respect to the quantitative and qualitative domains of neuroscientific research, its influence upon society, and the role that the field of neuroethics can—and arguably should—play in rendering balance to the use of neuroscientific knowledge as both lens into the brain, and mirror upon human thought and action. Ultimately, we propose a stance of complementarity with a view toward maximizing the benefits of both the quantitative and qualitative domains.

Keywords: Quantification; Quality; Neuroscience; Technology; Neuroethics; Cognition; Society; Culture

Introduction

History and anthropology reveal the perdurable human characteristic of attempting to create and employ some form of quantifiable representation of the qualitative aspects of life and the natural world (Deacon, 1997; Keijzer, 2001). As Mac Kinnon notes (in this issue) that the formalization of quantification metrics has been both instrumental to, and reflective of increasing tendencies and trends toward the use of tools (e.g. knowledge, implements and technics) to define and shape the ecological parameters of human existence. The periodic expansion of technical and epistemological capability under the rubric of science (as defined and enacted at various points in history) is testimonial to an ever increasing focus and reliance upon systems and approaches aimed at objectively quantifying the qualitatively subjective dimensions of human experience.

In looking to older cultures of the East and classical Greece, and more recently as a consequence of discoveries and socio-cultural attitudes of the seventeenth through nineteenth centuries in the West (i.e. Europe and the then nascent United States), we observe an iteratively greater emphasis upon the

relative importance, meaning, validity and value of quantifiable objectivity (Ronan, 1982). To paraphrase Pythagoras, all things can be seen as numbers, and the scientific and industrial revolutions of the eighteenth and nineteenth centuries, and resultant technologic turn of the 1900s bear witness to this trend (Bernal, 1965; Caldwell, 1995). Indeed, the twentieth century has been termed as “The Epoch of Technology”, and quantification has been—and remains—paramount in the application of science and technology to social issues, and is often regarded as means to ascribe metrics to enhance the quality of life (Borgmann, 1984).

This prompts the question of how subjectivity and objectivity, quality and quantity, and explanandum, experience and explanation, are each and all engaged, related and valued (Wurzman & Giordano, 2009). One apparent view is that quantification measures variables, relationships, and facts upon which the quality of life depends. A seemingly reasonable enough claim, yet it opens a proverbial Pandora's Box of debatable issues, questions and problems, as any such trajectories are implicitly or explicitly based upon assumptions that 1) such qualities are, in fact quantifiable; 2) there is consensus upon the qualities to

measure the methods and units of measurement to be employed, and 3) quantification can directly or indirectly enhance the quality of life. However these waters are muddied: “indirectly”, “enhance”, and “quality” are all ambiguous terms, and quantification is objective, while quality remains largely subjective. As noted here too, the value of what is to be quantified, and how such quantities are leveraged to effect qualitative ends are often subjectively based, if not biased (Naugle, 2013). Can we, in fact, objectively measure flourishing, happiness, pleasure, sadness, suffering, love, hate, beauty, and/or success?

Thus, if and how the objective can enhance the subjective becomes a question, if not problem of increasing importance, as society moves toward an ever more ingrained reliance upon science, technology and the metrics of objectivity to gauge individual, community, economic and political accomplishment. While the adage asserting that “money doesn’t buy happiness”, may bear considerable truth, it begs the question “what does?” Money—as a concept and device—was developed as a token to tangibly reflect and allow purchase of quantifiable assets and goods that influenced and were attributable to an individual’s station in the ecological niches of a society (Jones, 1969). The marriage of the metrics of science to the market instantiated widespread and increasingly homogeneous quantification of the qualitative aspects of life that could now be formally categorized and compared; not just in nominal terms, or even cardinally, but ordinally as a source and representation of valuation, position and power. Larrivee and Gini (this issue) reveal that such quantification of the qualitative aspects and relative “goods” of life remain the regnant—although nonetheless contestable—posture in today’s economically-driven society (if not much of human culture). To wit the adage, “the one with the *most* (not necessarily the best) stuff wins”, was often waved as a banner slogan of the socio-economic immodesty of the late twentieth century. What will the momentum of quantification portend for the century to come?

On Quantifying the Qualitative: From “It” to “Bits”

Qualitative data are derived from some assessment of subjectively perceived experience (e.g. pleasure, pain, happiness, sadness). Quantitative data, on the other hand, are obtained from objective measurement of discrete phenomena. The durable, frequent, and perhaps fundamental tendency to attributively impose quantitative dimensions upon qualitative states is not trivial, convenient or serendipitous. Rather, it appears to reflect the hierarchical operations of increasingly complex nervous systems, including the human brain.

The world is comprised of physical entities and spaces that exhibit definable properties that exist as, and manifest quantitative energetic perturbations of the natural environment (e.g. fluctuations of photic frequencies; rarefactions and condensations of molecules of air, etc.). The world as it is can therefore be regarded as both analog and digital in its existence: It is an analog entity that is expressed through digital features. Energetic properties and perturbations of the environment are received by sensory organs that may be peculiar to various species, including humans. Environmental energies such as quanta of photons, types and numbers of molecules, and/or extent of physical activity (e.g. molecular movement viz. heat; mass and force, viz. tactile pressure, etc.) induce changes to the mem-

brane dynamics of sensory nerves that transduce and transmit impulses to central registration, assimilation and synthetic networks of the nervous system (Sporns, 2011). In short, (quantities of) physical forces from the environment evoke (quantifiable) responses from organisms’ nervous systems, and so objects and events of world (i.e. “it”) are encoded as spatio-temporal responses within the nervous system (i.e. “bits”) so as to create a representational construct of the exterior and interior dimensions of an embodied organism that is nested within its environment (Edelman, 2008). Let’s call this step one.

From “Bits to Wits”: Computation, Comparison, Decision and Action

Step two involves the iterative abstraction of quantities and patterns of neural responses within the hierarchically networked tiers of the nervous system. Projecting and mapping the output of these levels of neural networks enable multi-dimensional representations and abstractions to be assimilated, and allows a form of statistical computation that affords both comparative and predictive (i.e. decisional) capability (Glimcher, Dorris, & Bayer, 2005). The patterns of quantitative neural responses establish a “frequentist” probability that fortifies or diminishes the likelihood that a given neural response pattern will be yoked or associated with others. Let’s call this step three, as it builds upon a process of synaptic weighting (i.e. Hebbian dynamics) in networked connectivities to establish the functional and structural components of the types of non-linear Bayesian computational operations that neural networks (and the brain, writ large) engage to represent probabilities, relationships, and expectations of environmental events (Cooper, Intrator, Blais, & Shouval, 2004; Körding & Wolpert, 2007). This establishes a neural basis for cognition, emotion, learning, memory, and decisional action, and we go from “bits” to “wits”.

We do not sense the world as fields of uniformity; it is represented to us (through the nervous system) as myriad sensations and perceptions—each and all related to a prior experience (and emotion) and having some relative valuation, even if seemingly inconsequential. A bouquet of roses is not merely red, but a palette of reds, from which we select the one that most appeals. We do not merely feel “happy” but experience gradations of visceral responses when we are presented with objects and subjects of reinforcement and reward. The qualities of the world are represented with quantitative dimensionality, and this is preserved on a phenomenological level in our daily experience (Gallese, 2005). This analog-to-digital-to-analog conversion may undergird tendencies to quantitatively express and value qualitative aspects of the life-world and experience(s) of the lived body.

We parse multiple domains of information to a diminished field of comparison (that is frequently binary) so as to facilitate emotionality, relationality and decisions. We tend toward simplification so as to enable relative parsimony of choices and actions, and do so through a process of cognitive statistical probability (Chronicle, Mac Gregor, & Ormerod, 2004). Here we confront the apparent paradox of “leveling”. Our phenomenal reality and engagement of others are conducted on the “analog” level. That is, in social intercourse we use “folk” psychological terms to describe inner states and experiences (Churchland, 2002). Most of us do not look longingly upon an object of desire and relate our feeling in terms of synaptic

spikes or neurochemical flux¹. Implicitly, however, we apprehend the world in terms of its effect upon us, and seek to describe phenomenological experience in terms of not only “what” and “how”, but “*how much*”, and these estimations relate our feelings of reinforcement, reward, privation or pain. We may ask “*How do I love thee?*” but answer “let me *count the ways*”. Would ten “ways of love” be qualitatively “less” than five, six or nine? And what of beauty? Is this in some way quantifiable? Can understanding the neural responses to various visual, auditory and tactile stimuli be used (and of any utility) to describe the feelings evoked by a work of art, music, sculpture—or another being?² Can we employ mathematical, physical and neuroscientific methods to define and predict contentment and flourishing, happiness and sorrow, pain and pleasure and wellness, illness and health—and in so doing, develop some system of what might be considered *neuro-eudaimonia*? Moreover, given that humans exist as actors and agents in an economically structured socio-culture, what do such questions infer about the perceived—and pursued—relationship of the quantity of goods to the quality of life?³

The Neurocentric Trajectory

Much of science—both as intellectual endeavor and socially valuable tool—depends upon reducing complex natural phenomena to principles, models, and/or measurements (data) that are objectively assessable, accessible, and appreciable. This view was instrumental to developing the rational empirical approach of psychophysics, as championed by Fechner, and Wundt. Indeed, we can look to their work (as well as that of von Helmholtz, and William James) as attempts to establish an experimentally valid (and quantifiable) discipline—psychology—to bridge phenomenological philosophy, physics and physiology. This afforded not only an address of sensation, perception and cognition, but provided incipient steps toward insight to concepts of first person subjective understanding (*Verstehen*) and objective relation and explanation (*Erklären*), that sought to reconcile the human and natural sciences, and hermeneutic and scientific traditions⁴. As Kohls and Benedikter (2010) depict, this empirical approach may be seen as the seeds from which the field of contemporary neuroscience has grown. Since its titular establishment some forty years ago, neuroscience has undergone an evolution in the type(s) and amount of quantitative data that can be utilized to describe and define cognitive processes. Advances in neuroimaging and neurophysiological recording, coupled to genetic and computational technology, have substantially contributed to this trend, and the conjunction of nanoscale techniques and technologies within a paradigm of advanced integrative scientific convergence will only serve to generate additional and ever more *avant* discoveries and developments (Giordano, 2011a,b; Vaseashta, 2012;

¹For further discussion of the use and misuse of folk psychological and neuroscientific language, see Giordano J. “Neuroalolia—Can we talk our way through the forest and trees of neuroscience?” *NeuroBioethics Blog*, 1. August, 2011; available at www.neurobioethics.wordpress.com.

²See here the work of Samir Zeki (*ut infra*, Note 5), and Robert Solso. For counter point, see Roger Scruton.

³Questions such as these provide the rationale, if not impetus for the field of neuromarketing.

⁴A more detailed discussion of *Verstehen* and *Erklären* in the phenomenological and hermeneutic traditions can be found in Spiegelberg, H. *The Phenomenological Movement: A Historical Introduction*. Boston: MartinusNijhoff, 1984; and Ehrlich, L. H. *Karl Jaspers: Philosophy as Faith*. Amherst: University of Massachusetts Press, 1975.

Giordano, 2012a; for a recent overview, see the Nuffield Council on Bioethics Reporton *Novel Neurotechnologies*, 2013).

To be sure, an important goal of neuroscience is to advance an objective (and objectifiable) understanding of the structure and function of nervous systems. Essential to this point is that these functions are consciousness, cognition, emotion and behavior. The neuroscientific pursuit and utilization of quantitative data are especially challenging because the neural events that are the focus of investigation putatively influence or subserve those dimensions of cognition and emotions that form the subjective precepts of reality, and are operative in shaping intent and behavior. In this way, neuroscience has served as both a lens through which to examine the structure and function of neural systems, and a mirror with which to view and analyze human nature, the human condition, and human thoughts, emotions and actions within the socio-cultural, economic and political milieu (Giordano, 2011a; Giordano & Benedikter, 2012a; Benedikter & Giordano, 2011; Benedikter, Giordano, & Fitz-Gerald, 2010).

Science as human endeavor may be considered to have two domains—the objective, quantitative domain, in which we measure, describe, and simplify the natural world; and the subjective, qualitative domain by which we assess the value of this knowledge and determine how it ought to be applied (Jaspers, 1963). In some ways, neuroscience blurs this distinction by implying that the phenomena constituent to the subjective domain (emotion, cognition, behavior, and consequently, values, culture, and ethics, etc.) can be (partially, if not wholly) objectively quantified and potentially, manipulated. This is evidenced by and in such nascent fields as neuroeconomics, neuromarketing, neuroaesthetics and neurospirituality⁵. In light of this, it becomes critical to question, and more accurately prescribe what the “neuro” prefix means in these contexts.

First and foremost, it does not ascribe an absolutist stance of reductive materialism. At very best, the most mature hypotheses of how consciousness occurs in brain are speculative, if not conjectural, albeit conjecture based upon the current fund of epistemological capital. So, while there is much that is known about the material structure and function of the brain, there is also much—even apart from the enigmatic efficient causality of phenomenal consciousness—that remains unknown. We have posited that it is this corpus of the known, unknown, questions unanswered and yet to be asked that defines the “neuro” prefix. In this way, it can be regarded as synecdoche: not merely to refer to “the neural mechanisms *X* that putatively are involved in or subserve *Y*”, but also to define the current state of the field of neural sciences and the reality that much of “neuro” information and knowledge is iterative and contingent (Giordano, 2011a,b). By assuming this stance, we open the door to possibility, assume a posture of humility, and thus avoid the pitfalls of false hubris about the actual maturity of the science, as well as society’s capabilities to exercise prudence in interpretation, value, and use (Giordano, 2012b).

Can neuroscience provide objective assessments of certain brain structures and functions? Surely. Are these measures of

⁵For overviews of these fields, see: Glimcher, P.W., Camerer, C.F., Fehr, E. and Poldrack, R.A. (eds.) *Neuroeconomics: Decision Making and the Brain*. NY: Academic Press, 2008; Zurawicki, L. *Neuromarketing: Exploring the Brain of the Consumer*. NY: Springer, 2007; Zeki, S. *Splendors and Miseries of the Brain: Love, Creativity and the Quest for Human Happiness*. Oxford: Blackwell 2008; Newberg A.B. *The Mystical Mind: Probing the Biology of Religious Experience*. Minneapolis: Fortress Press, 1999.

sufficient granularity and specificity so as to define—and perhaps obviate—subjectivity? Clearly not; at least as yet. We can view the brain-mind relationship most accurately as an expression of token physicalism. At present, many—if not most—complex mental phenomena cannot be directly or wholly explained or defined by underlying neurobiological processes. But current and near-future developments may soon enable an increasing level of objective accuracy. This does not, and need not infer that such trajectories of research are good, bad, right or wrong. There is defensible worth in being able to define “brain phenotypes” of particular subjective states. The prospect of quantifying such subjective phenomena has inherent value to medicine in evaluating non-communicative or pre-verbal patients, or perhaps even non-human organisms, and in developing interventions of a variety of kinds, not just of the high-tech, *Brave New World*, or *Clockwork Orange* sort. As Reiser has argued (2009), and Moskovitz advances in this issue, it will be vital to define the boundaries of science and technology, and quantification and quality in medicine. Despite the potential for great benefit, Huxleyan and Burgessian visions foster a creeping unease—if not frank fears—about the Foucauldian prospects of biopower and biopolitics such capability may evoke⁶. Might this render subjective discourse superfluous, and default personal, social, economic, legal and even political decisions and conduct to some bastardized construct of Wittgensteinian picture thinking, create widening schisms of status and regard within societies on the global stage?

Neuroethics—Balancing the Quantitative and Qualitative

The discipline of neuroethics is well-positioned to address the ways that neuroscience is articulated, and its outcomes and products engaged in both our understanding of what it means to have an embodied brain that evokes a mind (whether human or otherwise), in various fields of human endeavor. Inherently, a core question is: Given the scope and speed of neuroscientific progress, what do we do with the knowledge and capability available and what do we do about those that are lacking? Neuroethics’ so-called “first tradition” entails studies of the putative neural mechanisms involved in proto-moral cognition, emotions and actions (what we refer to as “neuroecology”; Giordano, 2011a,b; Giordano & Benedikter, 2012b; Giordano, Benedikter & Kohls, 2012). While it is popular to refer to this as “the neuroscience of ethics”, this is a misnomer, and miscommunicates the strengths and limits of the field. The path from brain functions to ethics involves many steps, but one important step is an understanding of how brains function in resource use and allocation and organismal relationships within the various niches occupied in an environment. For humans, this is a tall order. These studies must operate from the naturalistic epistemology of neuroscience to provide both a lens to view brain function, and a mirror to look upon humanity with newfound insight (*vide supra*).

Part of such insight must be to question how neuroscientific knowledge is obtained, its validity, and the ways that it might be employed. This is neuroethics’ “second tradition”—namely, the ethics of neuroscientific research and its applications. At

this point it is vital to recall that any meaningful ethical analysis begins with—and is predicated upon—fact. In this case, the facts upon which a pragmatic neuroethics is structured are that 1) any understanding of the brain remains tentative, 2) the power conferred by science and technology is enormous; and 3) there is strong lure of using our current toolkit to (a) quantify nature, life and experience, as well as (b) to quantify the ways that our tools and assets can confer relative power, and 4) this may be inherent to our nature. Jahr recognized almost ninety years ago that as we increase the font of scientific knowledge, we must accordingly adapt certain philosophical concepts of metaphysics, epistemology, anthropology and ethics (Jahr, 1927; Giordano, Benedikter, & Kohls, 2012a,b). Thus, perhaps most importantly, must we aptly engage the “neuro” prefix to address, direct and govern the ways that neuroscience should or should not be employed to effect conceptualizations and strivings for “the good” that we individually and communally hold to be valuable. In the Thomistic sense—a right measure of knowledge to guide the right measure of action.

Toward Complementarity

Perhaps then, a valuable first step of neuroscientific projects such as the newly proposed Brain Research through Advancing Innovative Neurotechnologies (*BRAIN*) initiative in the United States, and the Human Brain Project in the European Union might be a neuroethically sound appreciation of what can and cannot be done with the armamentarium of tools presently at hand (Giordano, 2011b; Giordano & Olds, 2010). This assuredly provides incentives to develop ever more sophisticated neurotechnologies and techniques. Yet, even if and when this occurs, we must still rely upon metrics and reports of qualitative experience that can be correlated to quantitative, objective depictions of various brain functions and states. Appropos, we must recognize the value of both qualitative and quantitative information—not as distinct, but as complementary, in epistemological, semiotic as well as personally and socially-relevant ways. The human being—and human action—is based and reliant upon the interaction of multiple dimensions of representation and signification (Parsons & Shils, 1951; Grinker, 1956; Morris, 1964; Engel, 1977). Thus, the qualitative and the quantitative provide two very useful sets of tools, means and styles of representing the world, life and experiences. We need not persevere upon the inherent weaknesses of either, but instead, in the strict definition and practical spirit of complementarity should look to the importance and merits of both.

Ad Rem...

The papers in this thematic issue of the *Open Journal of Philosophy* are committed to, and present this perspective. Herein, Edward MacKinnon provides a historicity of quantification as concept and practice, creating a temporal and cultural pediment to frame the discourse. Denis Larivee and Adriana Gini speak to biological, psychological and social aspects of the qualitative and quantitative, regarding recent trends in science and technology, and afford an interpretistic model of quantification that they offer as a viable epistemological and practical approach to assess and affect quality of life. Yet, as Peter Moskovitz details, attempts at and acts of quantification may be unviable as metrics for life quality within the context and practices of healthcare, and Moskovitz provides compelling argument for medicine to return to, and sustain a strongly qualita-

⁶For an in depth discussion of Michel Foucault’s work on scientific reason, quantitation and ordinal values, see Gutting, G. *Michel Foucault’s Archaeology of Scientific Reason*, Cambridge: Cambridge University Press, 1995, and Sheridan, A. *Michel Foucault: The Will to the Truth*. London: Routledge, 1997.

tive orientation to the needs and treatment of patients. If qualitative indices are to be maintained, then it will be important to advance such metrics so as to keep pace with the multi-dimensional and multi-disciplinary approaches aimed at improving the human condition. Rochelle Tractenberg, Futosh Yumoto and Paul Aisen examine currently used quality of life ratings, and pose potentially new methods—and vistas—for addressing, assessing and affecting qualitative domains of experience in a variety of medical and social settings. Ultimately, the outcomes and products of science and technology are manifest in the social milieu, and Francis Ambrosio and Elisabetta Lanzilao provide insights to the ways in which visions of objectivity/subjectivity, and quantification and qualification may be the well-spring of “cultural wars” that manifest claims of authenticity and trumping authority over each other, and purportedly competing worldviews. As Ambrosio and Lanzilao note, such competition is not only a source of discontent, but is also one of conflict on a variety of scales that range from the epistemological to the geo-political and religious. Taken together, these papers afford a view of the questions, potential, and problems incurred when addressing and approaching the quantitative and qualitative, and offer the reader a multi-faceted vista of the quantitative and qualitative that extends from the synaptic to the social.

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