Constellation, Uncertainty, and Incompleteness: Towards a Human(e) Science

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Abstract

This paper argues there are significant "postmodern" responses to Enlightenment science's three primary characteristics of simplicity, generalizability, and verifiability. Specifically, Walter Benjamin's response to simplicity is constellation; Werner Heisenberg's response to generalizability is uncertainty, and Kurt Godel's response to verifiability is incompleteness. In each instance, three factors characterize the response: a determination of the epistemological inadequacy of the specific scientific characteristic, a reintroduction of the human into the equation for reality, and an expansion, not displacement, of the epistemological frame. By reframing each characteristic and its response as a type of Bohrian conceptual complement, this paper maintains both a humane science and science of the human is possible, a science that simultaneously invites a more exhaustive description of the human as well as provides a context for developing an ethical "techne of the self." Further, such a proposed human(e) science provides new directions for research in psychology, as well as suggests a therapeutic stance characterized by holistic understanding and client-based agency.

My focus in this article, is on examining potential limits in that powerful system for representing things-in-themselves known as modern or Newtonian science. By modern science, I mean that system of knowledge determination characterized by three primary principles: simplicity, generalizability, and verifiability, as outlined in Newton's (1999) *Principia* as the "Rules of Reasoning." Specifically, there corresponds to each of the "modern" characteristics of Newton's science a "postmodern response," one that in each instance reflects a limit in that characteristic's ability to accurately "re-present" the reality of the physical world. At the crux of each of the post-modern responses is the issue of variable human in the equation of truth. Niels Bohr's (1987a) "complementarity," when applied as a way to resolve seeming oppositions between these "modern" and "postmodern" concepts, offers up a redefinition of the basic structure of scientific epistemology. This redefinition shifts the underlying mode of truth-validation from "either-or" to "not only-but also," simultaneously retaining the power of "scientific" representations while also exposing certain limits in those systems of representation. Additionally, a Bohrian reframing of this set of seeming oppositions offers up interesting possibilities for both a human and humane science. By "human," I mean one that *accounts for* the participation of the human, that collection of tiny fragile bodies, in any representation of reality, from the human's "co-creation" of the particle in the collapse of the wave packet, to human's creative acts that make sense of observations with the stories of theory. By humane, I mean a science that is *accountable to* us human folk, one that will use all means in order to invite a just "mode of subjectification." The exploration of limits is crucial to this enterprise. As Foucault (1994) says in "What is Enlightenment?", the primary task is to "characterize the philosophical ethos appropriate to the critical ontology of ourselves as a historico-practical test of the limits we may go beyond, and thus as work carried out by ourselves upon ourselves as free beings" (p. 316).

That such an effort to get at an acceptable mode of subjectification will involve addressing "objectification," or more critically, Latour's (1993) "quasi-objectification," is a given: Newton's system(s) of representation in its various manifested appropriations has been revolutionary in consequence, both in technological developments interpenetrating cultural, social, and psychological spheres, and in the technologizing of the human (Latour). Shapin's (1996) four aspects characterizing the general change in knowledge following the "scientific revolution" highlight the true extent of objective science's permeation into the human world: the mechanization of nature, the depersonalization of natural knowledge, the attempted mechanization of knowledge, and the use of "reformed natural knowledge to achieve moral, social, and political ends"(p. 13). Donna Haraway's (1991) trope of the cyborg may, in fact, be more than metaphoric. From genetic advances that have left humanfolk at the threshold of recoding the body, to physical advances that allow for a sundering of the atom, "science," that is, Newton's intertwining of mathematical, theoretical, and observational systems of representation, is arguably the grandest of the conceptual actions-at-a-distance. That Newtonian science's epistemological power over the physical would be extended to other realms, areas such as the psychological, the social, and the cultural, seems inevitable, in retrospect, especially in light of Foucault's understanding of the history of this "modern" epistemology, more as an "attitude" than as a "period."

Similarly, Foucault (1994) repositions the postmodern period as a set of "countermodern attitudes." According to Kern (1983), in *The Culture of Time and Space*, the late nineteenth and early twentieth centuries' unprecedented eruption of technological innovations suggested a "cultural revolution of the broadest scope was taking place, one that involved essential structures of human experience and basic forms of human expression"(p. 6-7). As part of that "revolution," Walter Benjamin, Werner Heisenberg, and Kurt Gödel expose in their respective fields of study, limits inherent in objective science. By exposing limits, I mean each theorist responds to a critical inadequacy of science's characteristics to re-present the world, especially a world that necessarily includes the human. Further, each of these characteristics also roughly matches one of the three systems Newton brought together—simplicity empowers theory, generalizability empowers observation, and verification empowers mathematics. These three "postmodernists" question, at different levels, the representational powers of their respective characteristics. Walter Benjamin, working in literary, political, and theological studies, offers a response to simplicity: constellation, a manner of representation that redefines conceptual rigor as that which liberates historical "facts" from their oppressive context. Similarly, Heisenberg, working in quantum physics, offers a response to the characteristic of generalizability: the uncertainty principle, a manner of representation that underscores both the probabilistic nature of the physical world and its ontological coupling with the human, the observer. Finally, Gödel, working in metamathematics, offers a response to verification: the incompleteness theorem, a kind of rule of representation that substantiates the fundamental inability of any mathematical system to prove all statements. With each of these thinker's systems, the move is three-fold: an exposure of epistemological inadequacy, a re-introduction of the human into the system, and an expansion, rather than a displacement, of what could be called the epistemological frame.

Why Bohr?

It is that last move, what I am calling expansion of the epistemological frame, that seemed to demand an even larger frame—one that, perhaps ironically, "accounts for" the various responses' seeming oppositions to fundamental characteristics of Enlightenment science. To provide that frame-of-frames, I employ Bohr's (1987a) concept of complementarity.

Bohr (1987a), also an early twentieth century figure, could have functioned as a stand-in for Heisenberg, especially in his early work. Complementarity, Bohr initially used as a concept to describe the deterministic effects of experimental observation on the behavior of subatomic particles. At the base level of experimental manipulation of particle physics, complementarity frames the two competing theories of light—particulate versus wave function—as complementary modes of the same physical phenomenon. Crudely, the observer completes the phenomenon by the chosen arrangement of the experimental apparatus. Bohr's complementarity works also at a larger level, one that accounts for its application at the lower level of experimentation. To clarify: in Bohr's early work, especially those pieces written in the late 1920's and early 1930's, his concept of complementarity is directed primarily at reframing the results of specific experiments, with their corresponding mathematical representations, involving the activity of quanta. He writes in his 1927 essay *Atomic Theory and Mechanics:*

> …it seems to follow that, in the general problem of quantum theory, one is forced with not a modification of the mechanical and electrodynamical theories describable in terms of the usual concepts, but with an essential failure of the pictures in space and time on which the description of natural phenomena has been hitherto been based. This failure appears also in a closer consideration of impact phenomena. In particular, for impacts in which the time of collision is short compared to the natural periods of the atom and for the very simple results are to be expected according to the usual mechanical ideas, the postulate of stationary states would seem irreconcilable with any description of the collision in space and time based on accepted ideas of atomic structure. (p. 34-35)

Note Bohr's strong language—the "general problem," "essential failure," and "irreconcilable with any description." What Bohr is attempting to make sense of, specifically, are the anomalous wave-particle findings that led Heisenberg to develop his famous "uncertainty principle" to describe the experimenter's inability to measure both co-ordinate (position) and momentum of "wavicles." Bohr's complementarity, at this point in his application, is applied at the "lowest" level: accounting for "special" circumstances set up by the experimenter, requiring also "special" mathematics such as Hamiltonian matrix algebra. However, Bohr suggests the second level of application in the above quote – the potential general failure of classical mechanics to account for all observations.

To borrow from the language of cognitive psychology, Bohr (1987a) realizes that the dramatic findings of quantum physics can't be logically assimilated into the Newtonian schema of a purely objective science. Therefore, the bulk of his work following his earliest work in the laboratory was a sustained attempt to accommodate the schema of science itself so that it can account for all observations—including those special cases of an observer's act of observation apparently functioning as a demonstrable determinant of the phenomenon examined. Bohr's second level extension of complementarity from the special case of "complementary" quantum action of waves and particles to the "complementary" nature of classical and quantum mechanics, characterizes his writing almost immediately after he uses the concept to argue for a revised accounting of quantum physical experiments. In his 1929 essay *The Atomic Theory and the Fundamental Principles Underlying the Description of Nature*, he writes,

> The invocation of classical ideas, necessitated by the very nature of measurement, is, beforehand, tantamount to a renunciation of a strictly causal description. Such considerations lead immediately to the reciprocal uncertainty relations set up by Heisenberg and applied by him as the basis of a thorough investigation of the logical consistency of quantum mechanics. The fundamental indeterminacy, which we meet here, may… be considered as a direct expression of the absolute limitations of the applicability of visualizable phenomena, a limitation that appears in the apparent dilemma which presents itself in the question of the nature of light and matter. (p.114)

Bohr's "renunciation" of classical ideas is more than a simple rejection of Newtonian laws. Rather, he is arguing for an enlargement of the system in which classical physics and quantum physics are "complementary," both needed for an "exhaustive description" of nature, and both described relationally, with the same concepts used to make sense of wavicles--subject-object split, mutual exclusivity and interdependency-- now extended to not only the "experimental behavior" of particles but also to the systems of understanding themselves. This move is radical:

> Niels Bohr's approach implied the abandonment of *determinism*; in absolute contrast to Newtonian physics, complete knowledge of the present may provide only statistical information about the future. Also abandoned would be *realism*, at least in the form of *naïve realism*, according to which any physical quality—position, speed, and so on—had a precise value at all times. (Whittaker, 1996, "Preface" xiii)

At the lowest level, complementarity functions exactly as Whittaker describes a frame for understanding observations involving a seeming abandonment of both determinism and naïve realism. At the level of questioning assumptions underlying theory construction itself, complementarity explains the relational nature of physic(s) themselves, at this level Newtonian and Einsteinian determinism and realism are part of the frame of description of phenomena, such as astrophysical, and are *complemented* by the nondeterministic and "informed" materialism of quantum physics. What complementarity does as a construct is resolve irreconcilable descriptions and systems of description by reframing seeming oppositions as necessary but insufficient in and of themselves of a larger whole. (See figure one).

Level	Opposition	Epistemological Process
Third	**Science-Humanities**	**Metanarrative**
Second	**Newtonian-Quantum**	**Conceptual**
First	**Wave-particle**	**Observational duality resolution**

Figure 1: Levels of Bohrian Complementarity

What distinguishes Bohr's approach from other physicists such as Einstein's, Heisenberg's, Schrödinger's, Bell's and others, is that he doesn't stop with applications and articulations of what I am referring to as first and second level forms of Bohrian complementarity. Bohr not only infers a third, what I am calling a metanarrative level, almost from the outside. That third level becomes the primary focus of Bohr's (1987e) mature philosophical work, written primarily in the late 1940's and throughout the 1950's. In his 1958 essay, *The Unity of Knowledge*, Bohr underscores the critical need for reasoning at this level, as the aims of knowledge itself require a communicable integration of diverse experience and phenomena.

> The aim of all our argumentation is to emphasize that all experience, whether in science, philosophy or art, which may be

> helpful to mankind, must be capable of being communicated by human expression, and it is on this basis that we shall approach the question of the unity of knowledge. Confronted with the great diversity of cultural developments, we may therefore search for those features in "multifarious, often mutually exclusive, aspects. (p. 14-15)

This quote addresses what I have been treating as Bohr's third level application of complementarity, where the principle is extended to "account for" all areas of inquiry, that is, account for all systems of accounting. Of central importance to Bohr, the two standards of "communicable by human expression" and "helpful to mankind" characterize his grand epistemological metanarrative, with features, originally derived from quantum physics, such as mutual exclusivity and interdependency, employed on a continuum from algorithmic application to heuristic exploration, critical concepts redefined and becoming more analogical as the level increases.

Also highlighted at the third level are the three criteria I mention earlier, characteristic of Benjamin's, Heisenberg's, and Gödel's respective responses to modern science: (1) exposure of epistemological inadequacy, (2) re-introduction of the human, and (3) an expansion, rather than a displacement, of what could be called the epistemological frame. However, Bohr doesn't just account for these characteristics. Instead, he makes them central to his scheme of unity. Much of Bohr's philosophy is driven by his desire to include an "element of wholeness… foreign to classical physics" (p. 60). Life itself, he maintains, that is, "the place of living organisms within general physical experience," also can be framed as a set of complementarities (1987c, p. 23). That element of wholeness, significantly, *may* be a description of a nexus between things-in-themselves, consciousness, sensation, and even "peoples," not only subsuming without violation the laws at every level, but ultimately defined by a nearly Gorgian sense of logos: "truth" is ever bound by what could be called Bohr's Law of "common language," that is, a language understandable to the extent that we are able to share the experience. As Bohr notes in "Quantum Physics and Philosophy, "The integrity of living organisms and the characteristics of conscious individual and human cultures present features of wholeness, the account of which implies a typically complementary mode of description" (p. 7).

I say Bohr's (1987a) complementarity *may* be a description of a kind of epistemological nexus. Bohr's own writing, though clear at the sentence level, reflects more an effort after a language to account for a unity of knowledge than a clearly articulated model of such a "nexus." Plotnitsky's (1994) *tour de force* analysis of Bohr's approach as a complex intertwining of Bataille's General Economic model with Derrida's poststructural destabilization of language, though provocative in itself, also suggests an inherent problem with what Plotnitsky calls Bohr's "anti-epistemology." Though Bohr is committed to employing multiple "epistemologies" to capture not just an element of wholeness but what he perceives as an *elemental* wholeness characterizing all complex systems, he falls short of the mark. A "common language," one would assume, would not require the strenuous application of two particularly abstruse theories in order to decode it.

Perhaps, I intend to complement Plotnitsky's (1994) effort. As he used two complex theorists to explain Bohr, I am using Bohr to explain three arguably complex theorists, treating Bohr's complementarity more as a way to ask questions than as a broad answer. Bohr's (1987a) foregrounding of the human in the highest sense, the ethical that characterizes much of his later writing, is not trivial. For Bohr, science is a means to an end, and that end is an improvement to the human condition. More broadly, he not only recognizes but also actively seeks diversity—of epistemologies, of nation-states, and of culture itself.

Therefore, I have chosen Bohr's (1987a) complementarity as a way to both decrypt and combine the following "post Enlightenment" thinkers' respective responses to Enlightenment science, that enterprise emerging fitfully in the 16 and 17^{th} centuries. By the early twentieth century, that science, having permeated the very consciousness of Western culture, approached what could be called of crisis of knowing. Across a continuum of fields, that which had come to be known as "science" seemed to have reached a critical mass of inadequacy of representation. From the extremes of its extension (as in literature and politics), to its narrowest application in the so-called "hard sciences" (as in physics and mathematics), the epistemological frame, brought together and articulated in Newton's *Principia*, seemed to demand new forms of response-ability.

Walter Benjamin: Ad Astra Per Aspera; Ad Aspera Per Astra

Sometime between 1924 and 1928, Walter Benjamin (1969b) writes:

> Kepler, Copernicus, and Tacho Brahe were certainly not driven by scientific impulses alone. All the same, the exclusive emphasis on an optical connection to the universe, to which astronomy quickly led, contained a portent of what was to come. The ancients' intercourse with the cosmos had been different: the ecstatic trance. For it is in this experience alone that we gain certain knowledge of what is nearest to us, and

> never of one without the other. This means, however, that man can be in ecstatic trance with the cosmos only communally. It is the dangerous error of modern man to consign it to the individual as the poetic rapture of starry nights. It is not; its hour strikes again and again, and then neither nations nor generations can escape it, as was made terribly clear by the last war, which was an attempt at a new and unprecedented commingling with the cosmic powers. (p. 92-93)

This is a curious passage. Benjamin (1969b) — literary critic, Marxist theorist, and Judaic theologian — combines in it an implied history of science, a relational definition of the human and the cosmos, and a critique of modernity's emphasis on the individual. And "combines" is a tragically inadequate verb to describe his method. His history of science, aphorized in this passage but elaborated elsewhere, is a history of loss of experience. In the above passage, not only the ancients, those certainly premodern, but even the earliest modernists—"Kepler, Copernicus, and Tacho Brahe"—are motivated by a desire for not just an individual human but a collective coupling with the physical world. Important here is "ocularity:" the reduction of experience, formerly grasped as a sensory whole, now becomes a single sense—vision, that which is most distancing. The move in part is from an experience of deep metaphor—a whole-for-whole substitution of things-in-themselves as a gestalt of perception—to the superficial report of metonymy, where the part, that which can be seen, re-presents the whole. Note Benjamin's language to describe the relationship between the cosmos and the human—"intercourse," and "commingling," the first term organic, intimate, sexual, noetic, the second term distancing in its hint of chemical reaction, less a fulfillment of than a subverted desire for a kind of completeness, a drawing to an isolate analog of a communal experience in which we once gained "certain knowledge of what is nearest to us, and never of one without the other" (p. 92-93).

Benjamin's (1969b) phrase "never the one without the other" could be used to describe his critique of modernity's valorization of the individual as well as his overall "critical" approach. In the case of his critique on the Enlightenment's focus on the individual, Benjamin consistently argues for recognition of both the general phenomena of increasing isolation of the person and the material consequences of such isolation: the unspeakable horror of the modern at its most material, the machined nightmare of World War One. "Never the one without the other," applied to Benjamin's overall approach underscores his more-than-dialectical stance towards ostensibly competing systems of knowing, such as radical Judaic mysticism and equally as radical Marxist materialism. Like Bohr, Benjamin is both exposing and responding to modernity's epistemological inadequacy, seeing in "progress" not a process to be celebrated but one to be lamented. Progress, Benjamin (1969a) maintains in Thesis IX of *Theses on a Philosophy of History*, is a storm that "irresistibly propels" the angel of history into the future while his back is turned, while the pile of debris before him grow skywards" (p. 258).

However one describes Benjamin's response to the limits of modernity, it is not "simple," either in method or in revelation. Consider the following from Benjamin's (1969a) Thesis XVIII from *Theses on the Philosophy of History*:

> Historicism concerns itself with establishing a causal connection between various moments in history. But no fact that is a cause is for that reason historical. It becomes historical posthumously, by events that may be separated from it by thousands of years. A historian who takes this as a point of departure stops telling the sequence of events like the beads on a rosary. Instead, he grasps the constellation, which his own era has formed with a definite earlier one. Thus, he establishes a conception of the present as the "time of the now" which is shot through with chips of Messianic time. (p. 263)

In this short, maddening paragraph, Benjamin asserts the totality of his system—the inadequacy of efforts to simplify understanding by an application of linear causality to "account for" human history, and the response-ability of reframing understanding as a constellation of forces, factors, and influences. In part, the conceptual error of "homogenous time" contributes to this mistaken approach to history (Thesis XVII, p. 262), the very concept of time upon which Newtonian science is based. Benjamin's "constellation" goes beyond providing a kind of collage of determinants: the historian engages in an active creation, an ongoing collective salvation, "conceiving"-- engendering-- a present characterized by moments of opportunity to recover interconnections, in which "homogenous time" is disrupted. For Benjamin, this experience of linear time stoppage is a requisite stance in order to invite a "messianic moment" in which, in the case of history, one recognizes the fact outside the oppression of its interpretive frames. Critically, one captures, in that moment, a recognition of the interpretive frames themselves:

> Thinking involves not only the flow of thoughts but their arrest as well. Where thinking suddenly stops in a configuration pregnant with tension, it gives that

> configuration a shock, by which it crystallizes into a monad. A historical materialist approaches a historical subject only when he encounters it as a monad. In this structure he recognizes the sign of a messianic cessation of happening, or, put differently, a revolutionary stance in the fight for the oppressed past. He takes cognizance of it in order to blast a specific era out of the homogenous course of history. (Thesis XVII, p. 262-263)

Benjamin's (1978a) Leibnitzian monad is not as much a simplification as it is a disruption: the monad, taken to be a unit of consciousness, glitters into awareness through the historian's thwarting of its flow in time. In Benjamin's frame, "Progress" and "homogenous time" are more than erroneous concepts: they are conceptual shackles that enslave the masses of moments. The complex constellatory relationships of the monad to other factors are not dispelled. Instead the monad, Benjamin seems to be saying, is conscious to the extent its formerly hidden-in-the-time-stream meanings are allowed to break free of the illusion of linear progress. One "saves" the moment, rescuing it, raising it from the death of assimilation into a context that enslaves. Assimilation, in a Piagetian sense, is an apt interpretative frame: the fact is not just denied its alternative description; it is distorted to the end of reaffirming its oppressive context—which for Benjamin is also a context of oppression. Additionally, this epistemological effort breaks with a simple sense of time itself, creating time instead that is full, heterogeneous, and complex with meaning. The past itself is humanized via materialization—seen as even "oppressed." Yet, alternatively, the human is saved as well, collectively raised from the dead, as the messianic act allows a "revolutionary" re-cognition of the fact. Historical "truth", in this method, is neither deterministic nor teleological. Instead, it—pardon the expression—involves a complex determination of the teleology of the now.

Consider in contrast to Benjamin's complex manner of configuring truth the following, Newton's (1999) first rule of consequence from the *Principia:*

> Rule one: *No more causes of natural things shall be admitted than are both true and sufficient to explain their phenomena* (italics Newton's). As the philosophers say: Nature does nothing in vain. And more causes are in vain when fewer suffice. For nature is simple and does not indulge in the luxury of superfluous causes. (p. 794)

In the above, Newton is asserting formally Enlightenment science's characteristic of simplicity, or parsimony, a concept generally credited to William of Occam, who developed his now famous "Razor" to describe his commitment to the belief that the simplest explanation is always the best. Certainly, Newton's deployment of the idea in the *Principia* is overtly limited to conducting science on the "natural" world, or at least he is not explicitly extending it to the "social," as in a "science" of history for example. Yet simplicity, Benjamin (1978a) seems to assume from the outset, is not only a primary characteristic of "modern" historicism but also that historicism's fatal flaw—the assumption of a "simple" progression of historical facts, counted "like beads on a rosary." "Beads on a rosary," as well, is no innocent image: Modernism is akin to the mother church, its ostensible "historians" priests droning a mindless prayer, sanctifying linear progress.

Like Bohr (1987c), Benjamin (1978a) expands, rather than just displaces, what could be called the epistemological frame. Simplicity, Benjamin seems to be saying, is not only limited as a representational rule: it is the very crucial limiting factor, preventing adequate representation. Both homogenous time and linear causality reflect simplicity's limitations. Benjamin's "constellation," as response to simplicity itself as a rule of epistemology, is an attempt to complicate the representation, to recapture a lost wholeness that is at the root of "experience" versus "information." In *Storyteller*, Benjamin (1969a) elaborates:

> Villemessant …characterized the nature of information in a famous formulation: "To my readers," he used to say, "An attic fire in the Latin Quarter is more important than a revolution in Madrid." This makes it strikingly clear that it is not longer intelligence coming from afar, but the information, which provides a handle for what, is nearest that gets the readiest hearing. The intelligence that came from afar—whether the spatial kind of foreign countries or the temporal kind of tradition—possessed an authority which gave it validity, even when it was not subject to verification. Information, however, lays claim to prompt verifiability. The prime requirement is that it appears "understandable in itself." Often it is no more exact than the intelligence of earlier centuries was. But while the latter was inclined to borrow from the miraculous, it is indispensable for information to sound plausible. (p. 88-89)

In a manner, the shift Benjamin is describing is in verbs for not just presenting the relationship between human and language but also between the human, language, and things-in-themselves. Simply, the shift

Benjamin is tracking in the cultural consciousness of the modern period is from language that is driven by a need to "re-late" to a language driven by a need to "in-form." Relatedly, shift in valorized genre he tracks is from the complex and multilayered "story" to the simple and transparent "report." For Benjamin (1969a), to tell a story is to provide a moment of participation, where "facts" are less "truths" than means to an ongoing act of collective "truthing." At its best, experience *of and as* storytelling invites Wisdom—the "epic side of truth" (p. 87). No facts are simple in this premodern system Benjamin outlines. The human valued determined by the ends to which they are put, facts are just part of a larger effort to make intelligible – and oddly co-create—the "web" that binds us together. Information, in contrast, is simple, but that simplicity comes at the cost of descriptions of inter-relations: one doesn't "listen" to information, as in Benjamin's description of the story, but rather one is merely—even simply—filled with information, so wrenched from experience that meaningfulness is reduced to that which is merely closest materially.

Significantly, Benjamin's (1978a) expansion of the epistemological frame involves the most intriguing—and perplexing—aspects of his "theory." Unlike so many associated with the Frankfurt School, from Adorno, to Marcuse, to Habermas, Benjamin is both—simultaneously, alternatively, and coin-spinningly—a theologian and historical materialist. The first of his "Theses" on a philosophy of history cleverly makes the point. In it, Benjamin (1969a) describes a legendary automaton, dressed as a hookah-puffing Turk, capable of beating all chess players. However, the real power behind the automaton is hidden under the table by a system of mirrors:

> A little hunchback who was an expert chess player sat inside and guided the puppet's hands by means of strings. One can imagine a philosophical counterpart to this device. The puppet called "historical materialism" is to win all the time. It can easily be a match for anyone if it enlists the services of theology, which today, as we know, is wizened and has to keep at of sight. (p. 253)

Unlike Bohr's (1987a) complementarity, where systems of representation are arranged horizontally, Benjamin is describing a peculiar vertical system of systems, in which materialism hides the intelligence behind its hand: the "wizened" theology, the "little hunchback." This double move of hiding from sight while affirming theology's critical role in providing the "intelligence" behind historical materialism may account for many past and current appropriations of Benjamin's work, which tend to highlight the Marxist aspects. Benjamin, it could be said, hid his wizened metaphysics under the table too well, providing ready—and so frequently lyrical—quotes to shore up a weary Marxism while failing to provide a manner in which to engage, as Benjamin himself had done, with ideas: artfully juxtaposing the systems of mysticism and materialism in productive denial of contradiction.

Benjamin, it should be reiterated, is not offering a traditional "physical" description and explanation of the world but rather a "constellation" of possibilities for understanding the world. That world from the outset is a human world, where the role of the "tiny fragile human body" is not just noted as a "fact" but is reinscribed as the focus of inquiry—and, interestingly, as the mystical and material "source" of all knowing. In contrast, Werner Heisenberg was a physicist, working directly and indirectly with Bohr, addressing one of Newton's central concerns: the nature of light in order to shed light on "nature."

Werner Heisenberg: Uncertainty of Generalization and the Generalization of Uncertainty

Newton's (1999) second and third Rules of Consequence stress Enlightenment science's principle of generalization. Newton writes in the *Principia*:

> Rule 2 Therefore the causes assigned to natural effects of the same kind must be, so far as possible, the same.
>
> Rule 3 Those qualities of bodies that cannot be intended and remitted [i.e. qualities that cannot be increased or diminished] and that belong to all bodies on which experiments can be made should be taken as qualities of all bodies universally. (p. 795)

These two rules offer a purity of explanation, a clear causality applicable across circumstances. What generalizability allows for is a global understanding of localized phenomena. To effect such a conceptualization, generalizability requires a systematic exclusion of the human as determinant in the reality equation. The experiment is a very special means to the end of deriving generalizable laws of causality. In a manner, the experiment as a method of observation could be described as an activity in which a scientist carefully maintains a sharp split between subject and object via experimental "control," and then manipulates potentially universal causal elements to both test and generate laws. Significantly, the experiment is the purest method of science, mainly because it objectifies, literally dehumanizes, a "fact," thereby reaching the apex of C. S. Peirce's "method of science:" "It is necessary that a method should be found by which our beliefs are determined by nothing human, but by some external permanency, something upon which our thinking has no effect" (Buschler, 1955, p. 18). Frank Kerlinger (1986), in *Foundations of Behavioral*

Research, says this stance of "self-correction" for determining a "reality outside the scientist's personal beliefs, perceptions, biases, values, attitudes, and emotions" is perhaps best expressed by the word "objectivity" (p. 7).

Until the early 20th century, most scientists in physics assumed such a strict objectivity, and a concomitant generalizability of laws derived from structured observations of the physical world. Responding to a set of findings in which the competing theories concerning light, wave and light-quanta, were both demonstrable experimentally, Werner Heisenberg developed what has come to be known as "the Uncertainty Principle," which in its simplest form asserts the unknowability of quantum reality before measurement. A number of figures were involved in setting the stage for Heisenberg's development of the uncertainty principle. Schrödinger's attempted resolution, for example, offered an explanation based upon equation of the wave function with the density of charge (Whitaker, 1996, p. 138-143). In response, Max Born demonstrated that Schrödinger's equation only worked if it were treated as calculating the probability of an electron's location. The replacement of "certainty" with "probability" was at the crux of the dilemma but in a maddening way: the observer herself realized the probability in the moment of observation. In 1929, Werner Heisenberg (1930) said the following at the first of his series of lectures at the University of Chicago on the *Physical Principles of Quantum Theory*:

> Although the theory of relativity makes the greatest demands on the ability for abstract thought, still it fulfills the traditional requirements of science in so far as it permits a division of the world into subject and object (observer and observed) and hence a clear formulation of the law of causality. This is the very point at which the difficulties of atomic theory begin…. in classical physical theories it has always been assumed that this interaction is negligibly small, or else that its effect can be eliminated from the result based on calculations from the "control" experiments. This assumption is not permissible in atomic physics: the interaction between observer and observed causes uncontrollable and large changes in the system being observed, because of the discontinuous changes characteristic of atomic processes. (p. 2-3)

In this statement, Heisenberg is directly acknowledging the epistemological inadequacy of classical physics. At issue, as he indicates, are both causality and the subject-object split underlying empirical science. What has not failed is the structured observation itself: the experiment. Experiments work, consistently showing what could be called a global law of localized causality. However, what constitutes "causality" itself, what can be expressed as simple laws generalizability to a host of phenomena, is in dispute. Classical physics not only maintains an observer is isolated from the phenomenon under investigation: it draws its authority from that principle of "rigorous" objectivity. The situation is beyond just a difficulty in controlling for the influence of the observer: the observer's relationship with the phenomena "causes uncontrollable and large changes in the system." Einstein, generally treated as a radical theorizer, comes off as the most resistant to questioning traditional science's epistemological inadequacy suggested by the quantum physical experiments, referring to the observer effect as "spooky action-at-a-distance" (Jammer, 1974, p. 181-189) and arguing repeatedly with physicists such as Bohr over the inappropriateness of replacing certainty with probability (Whittaker, 1996, p. 239-243).

What is most interesting about Heisenberg's (1959) and others' response to the epistemological inadequacy of Enlightenment science is that it is directly related to the reintroduction of the human into the system of knowledge. For Heisenberg, the human is reintroduced quite literally as the experimenter, and quasi-literally, as the "causative" factor extended by the experimental apparatus. To explain this seeming violation of classical objectivity, he developed the concept of the "uncertainty principle," which he also calls "indeterminacy." Simply, the physicist can either measure the position of a particle, or its momentum. Before measurement, the quantum exists in an indeterminate state—a "probability wave packet" that is "collapsed" into reality when measured, also known as the "Projection Postulate" (Whitaker, 1996, p. 195). The Uncertainty Principle's conceptual framework necessarily reintroduces the human into the scheme of things, but in a manner that less dispels objectivity and replaces it with subjectivity than one in which the very opposition "subjective-objective" no longer holds:

> In classical physics, science started from the belief - or should one say from the illusion? - that we could describe the world or at least parts of the world without any reference to ourselves. This is actually possible to a large extent. We know that the city of London exists whether we see it or not. It may be said that classical physics is just that idealisation in which we can speak about parts of the world without any reference to ourselves. Its success has led to the general ideal of an objective description of the world. Objectivity has become the first criterion for the value of any scientific

> result. … Certainly, quantum theory does not contain genuine subjective features; it does not introduce the mind of the physicist as a part of the atomic event. But it starts from the division of the world into the 'object' and the rest of the world, and from the fact that at least for the rest of the world we use the classical concepts in our description. This division is arbitrary and historically a direct consequence of our scientific method; the use of the classical concepts is finally a consequence of the general human way of thinking. But this is already a reference to ourselves and in so far our description is not completely objective (p. 195).

Note Heisenberg's seeming vacillation between objectivity and subjectivity. On the one hand, he asserts, objective reality exists—London is there, of course, that metaphoric tree continues to fall in the forest whether observed or not. Indeed, he admits objective reality has served us well, and has become "the first criterion for the value of any scientific result." On the other hand, he underscores that the separation of world into subject and object is "arbitrary, that is, strict scientific objectivity is an "historical" consequence of the success of representation of the scientific method, making it more a heuristic than an algorithm, and a heuristic that has worked again and again, not only at accurately representing the "lived in" level of the physical world but also as a kind of "test" of the fancy theorizing and experiments of the scientist. Objectivity, as in the radical separation of observers from observed, is the very starting point of experimentation, even in the quantum realm. But what classical objectivity isn't, Heisenberg maintains, and what is revealed by the findings contextualized under the term "uncertainty" is definitely not an *a priori*, Kantian rule.

With Heisenberg's (1959) uncertain response, Kant's entire system is undermined, with the worlds of the *noumenal* and the *phenomenal* convoluted, combined, and utterly complicated. Heisenberg maintains that after the uncertainty principle is incorporated into our understanding of the physical world, then:

> Kant's arguments for the a priori character of the law of causality no longer apply…. A similar discussion could be given on the a priori character of space and time as forms of intuition. The result would be the same. The a priori concepts, which Kant considered an undisputable truth are no longer contained in the scientific system of modern physics. (p. 88)

Significantly what Heisenberg implies with his rejection of a Kantian *a priori* frame, along with admission of the productivity of objective classical representations, is that extension of the complications of the objective –subjective opposition derived from quantum physics could also function as a heuristic for framing observations. That is, the implication left is that the nuanced reintroduction of the human into the equation for reality necessary for resolution of the quantum dilemma could offer possibilities for a larger reframing of scientific epistemology itself, if not for general epistemology.

Though not to the extent Bohr (1987c) extended his concept complementarity, Heisenberg does offer interesting ideas for expansion, and not displacement of, the epistemological frame of Enlightenment science. Just as with Bohr, Heisenberg (1930) sees that the expansion or modification of any epistemology is intimately related to the constraints of language:

> It is only after attempting to fit this fundamental complementarity of space-time description and causality into one's conceptual scheme that one is in the position to judge the degree of consistency of the methods of quantum theory (particularly of the transform theory). To mold our thoughts and language to agree with the observed facts of atomic physics is a very difficult task, as it was with the case of relativity theory. In the case of the former, it proved advantageous to return to the older philosophical discussions of the problems of space and time. In the same way, it is now profitable to review the fundamental discussions so important to epistemology, of the difficulty of separating the subjective and objective aspects of the world. Many of the abstractions that are characteristic of modern theoretical physics are to be found discussed in the philosophy of past centuries. At that time, these abstractions could be disregarded as mere mental exercises by those scientists whose only concern was with reality, but today we are compelled by the refinements of experimental art to consider them seriously. (p. 65)

Here, Heisenberg is suggesting, between long passages in which he traces the genealogy of the mathematics underlying the uncertainty relations, that a quasi-scholastic effort may be required to provide an effective manner of understanding "modern science." Specifically, he is brushing the modernists' "make it new!" commandment against the grain, noting almost as an aside that "the philosophy of past centuries" should be taken "seriously" as it hasn't been with "scientists whose only concern was with reality." One cannot but think of Newton's "hidden" work both in alchemy and theology, where the ideas of the ancients were valorized and where, in the case of alchemy, the rule of the "experimenter" was considered not as a potential site of "interference" with transmutation, but as a co-determinant, more aptly as part of "the interaction between observer and observed [that] causes uncontrollable and large changes in the system being observed." Perhaps most intriguing in the above quote is Heisenberg's use of the term "reality": usually, it's a mark of a good scientist to be concerned with reality.

However, it seems that in the above quote Heisenberg (1959) is trying to describe a better scientist—one concerned not with reality but with changing the definition of how we come to know reality. Perplexingly, Heisenberg's uncertainty relations seem more to describe reality than to explain it. Just as Benjamin's (1978a) "constellation" as response to simplicity could be framed as a Bohrian complementarity, so, too, can Heisenberg's "uncertainty" be framed as a complement to science's generalizability. As with Benjamin's, Heisenberg's response involves a recognition of modernity's limits in accurate representation, the need to reintroduce the human, and the expansion of the epistemological frame. Part of Heisenberg's studies, however, involved a specialized area of "knowing" called mathematics, specifically in his case, Hamiltonian matrix algebra. One of Newton's greatest accomplishments was his combining of structured observation, theory, and mathematics in order to provide a means to triangulate on reality. Quantum physics fits this triangulation as well—the structured observations of the experiments, the theories of uncertainty and complementarity, and a math that reflects the probabilistic nature of the quantum world.

Our final thinker, Kurt Gödel, looks neither to complicate the ideal of simplicity in science nor to demonstrate the inadequacy of traditional generalization. Instead, he is responding to Enlightenment science's third characteristic—verification—and he takes on the very language of truth, mathematics itself.

Kurt Gödel: Incomplete Math and the Math of (In)completion.

In 1931, Kurt Gödel wrote the following in his "*On Formally Undecidable Propositions of Principia Mathematica and Related Systems*":

> The development of mathematics towards greater precision has is well known, to the formalization of large tracts of it, so that one can prove any theorem using anything but a few mechanical rules. Then most comprehensive formal systems that have been set up hitherto are the system Principia mathematica on the one hand and the Zermelo-Frankl axiom system of set theory (further developed by J. von Neumann) on the other. These two systems are so comprehensive that in them all method of proof today used in mathematics are formalized, that is reduced, to a few axioms and rules of inference. One might therefore conjecture that these axioms and rules of inference are sufficient to decide *any* mathematical question that can at all be formally expressed in these systems. It will be shown below that this is not the case, that on the contrary there are in the two systems relatively simple problems in the theory of integers that cannot be decided on the basis of the axioms. The situation is not in anyway due to the special nature of the system that have been set up but holds for a wide class of formal systems. (1970, p.145)

In these few lines, written in a lucid and unostentatious prose, Kurt Gödel, metamathematician, theoretical physicist, and logician, managed to outline a discovery concerning the very heart of mathematical epistemology: the determination of the "truth" of a statement. As simply as can be stated, Gödel determines, using strict and rigorous application of the rules of formal logic, that there will always be a true but unprovable statement outside any system of logic. The two axiom systems to which Gödel refers—the *Principia Mathematica* system of Bertrand Russell and A. N. Whitehead and the Zermelo-Frankl/von Neumann system – form, at the time of Gödel's writing, the basis for all but the most experimental mathematical systems used by scientists in a variety of fields. Note, however, Gödel's extension of his findings: it will hold for a "wide class of formal systems." Gödel, so frequently careful in expression, is very conservative in that simple assertion: the implications of Gödel's incompleteness theorems, as his discovery has come to be called, is a dramatic expression of the epistemological inadequacy of modern science.

To trace the real epistemological consequence of his findings one need look no further than Boyer's (1991) popular *The History of Mathematics*:

> In its implications, the discovery by Gödel of undecidability as was disturbing as the disclosure by Hippasus of incommensurable magnitudes, for it appears to foredoom hope of mathematical certitude through the use of obvious methods. Perhaps doomed as a result, is the ideal of science—to devise a set of axioms from which all phenomena of the natural world can be deduced. Nevertheless,

> mathematician and scientists have taken the blow in stride. (p. 611)

Note Boyer's apocalyptic language—"disturbing," "foredoomed," "doomed as a result" "the blow--" it is as if it is the end of the mathematical world. Gödel has left a blasted heath of "certitude," it seems, and the very ideal of science, a rule set capable of universal verification, is fundamentally impossible. Just as Benjamin (1978a) "responded" to simplicity, and Heisenberg (1959) to generalization, Gödel is responding to the last, and perhaps most critical, characteristic of Enlightenment science: verification. Consider Newton's (1999) last Rule of Reasoning in the *Principia*:

> Rule 4—In experimental philosophy, propositions gathered from phenomena by induction should be considered nearly or exactly true notwithstanding any contrary hypotheses, until other phenomena make such propositions either more exact or liable to exceptions. (p. 796)

There it is—the rule governing the determination of the truth of "propositions gathered from phenomena." Newton is demanding verification, specifically here for the construction of propositions by induction—setting up structured observations of things-in-themselves to both determine and test "rules." However, things-in-themselves, even in terms of their empirical observations, are secondary to their inducted characteristics: Newton is describing only the base level of verification, that of proposition development. Gödel is responding to the next level of verification—the manipulation of those propositions within a formalized system of truth-value determination. In short, Gödel's studies involve attempts to develop an ideal mathematics, a symbolic logic capable of determining the truth of any statement. Gödel's study of the possibility of such an ideal math, using metamathematics, which "is not concerned with the symbolism and operations of arithmetic, but with the interpretation of these signs and rules," offers up both a qualified semiotic method to study math and what could be called a qualified semiotic interpretation: a re-introduction of the human into the mix (Boyer, 1991, p. 612).

The question as to what extent Gödel's incompleteness directly indicates self referentiality, that is, provides proof of a human as co-determinant, hinges on the idea of a truth outside the system of logic. The "outsideness" of the unprovable but true statement suggests the statement is inside the human, which is trivial at one level, but not when the statement's truth and unprovability are "determined" by the human (Gödel, 1970). The human does more than contain the statement-- the human necessarily constructs the statement and somehow determines the statement's truth. In most cases, the self-referentiality argument is taken from what has become the almost clichéd non-mathematical demonstration of incompleteness: start with a Universal Truth Machine (UTM), which is capable of unerringly determining the truth of statements. Truth, with such a machine, then is that which can be proven, the basic equation.

Now, feed statement, call it G for Gödel, into the machine. We now have statement G (UTM). If G(UTM) is indicated true, then the machine is lying; that is, the machine—the internally consistent logic—is not a Universal truth machine, because truth and provability is the basic equation for UTM's functioning, and it therefore can't agree to the statement's truth because it overtly denies the basic equation. However, if G(UTM) is deemed false, then it violates the first part of its definition-- that it is true.

To be brief, what these truth-determination machinations mean are that formal logic's apex—math (this includes "maths" as it applies to all formalized systems for handling number sets) -- is incomplete in and of itself--but determination of truths outside the system(s) is still possible. Self-referentiality, as indicated in the above nonmathematical example, comes in part from the G—the deployment of Gödel as the statement. One could, in fact, replace G with "I" for "incomplete" and the example would still work. However, whatever symbol is used to refer to the statement, self-referentiality necessarily enters the system—as the generation of unprovable statements themselves requires not a formal mathematical system but an intuitionist one. Gödel's overall position, despite the unsettling nature of his incompleteness system, is decidedly realist, that is, Platonist. For the realists, mathematical objects' existence is as "real" as existence of physical objects. Other mathematicians, called variously "constructivist," "nominalist," and "predicativist," aimed at placing "mathematics in a conventionalist role as the 'syntax of language,' thus separating it from physical science, which itself was to rest finally on empirically findings" (Feferman, 1986, p. 29). The latter group, by approaching mathematics as one would a language, seems at first glance closer than Gödel to offering a point of conceptual insertion of the human into the reality equation.

Undeniably, Gödel's interpretation of his own theorem is that it supports his sense of the independence of mathematical objects from our ideas, constructions, and thoughts. Mathematical objects, such as his "true but unprovable" propositions, require "mathematical intuition" to find "the source of genuine mathematical knowledge. The intuition can be cultivated through a deep study of the subject" (Godel, 1986, p.32). That intuition, Gödel maintains, is in addition to formalized testing of propositions. However, what still remains in Gödel's system of systems is the human as an even more complex and active participant in knowledge perception, where a pure logic denied is also a chance for development of a cluster of logics. That those clusters are framed as systems to "sense" and not "construct" mathematical reality does not eliminate the human from the equation. Rather, Gödel highlights the role of the human as a higher-order perceiver of mathematical reality, where, almost in contrast to Heisenberg (1959), the very positivity of a mathematical object, its ability to have a reality imperceptible by a system of mathematical sensing such as Russell's and Whitehead's, increases the human's power. Choice of the real is a choice between either formally verifying or intuitionistically sensing the mathematical object. Intuitionist approaches to math are not simply feeling a proposition. Rather the term refers to an alternative approach to math that allows for presentation of propositions without, among other things, an initial demand for a strict formalist consistency. Prior to Gödel, such approaches were not uncommon, but the move had always been to treat those propositions as hypotheses and then test those intuitionist statements within a formal system. Gödel's incompleteness theorem puts the human in an interesting place in epistemology: the human actively chooses between hitherto hierarchically ranked systems of verification, with a Bohrian "exhaustive description' of the world of mathematical objects possible only through an interdependent yet mutually exclusive application of both formal mathematical approaches and intuitionistic approaches.

Although Gödel (1970) devoutly argues against the idea of mathematics as a constructive language, he does not address a possible implication of his incompleteness theorem for language itself as a means to knowledge. To the extent that the ideal of an argument is based upon modeling the "pure" truth validation of mathematics, what is suggested by a realization that that ideal is not just temporarily but definitively incapable of perfect knowing?

Certainly, the argument structure of analytic philosophy is mathematical in its basic parameters, whether math is viewed as the model or the apex. As varying shades of mathematically based logic systems, all systems of argument are necessarily, in light of Gödel's theorem, incapable of proving all statements. In fact, as with the math, a logic's very "truth-ability" may be well tested by its inability to prove true but unprovable statements. And if that is so, then the true but unprovable statement-- and its very outsideness of the logic-- is foundational for the logic to work. As Gödel notes in his "Postscript" to the notes of the Second Conference on Epistemology of the Exact Sciences in 1930:

> The assertion of the consistency of the system in question itself belongs to the propositions undecidable in that system. That is, a consistency proof for one of these systems can be carried out only by means of inferences that are not formalized in the system itself. For a system in which all finitary forms of proof are formalized, a finitary consistency proof, such as the formalists seek, would thus be altogether impossible. (1986, p. 205)

Gödel's (1986) Postscript was requested by the editors of *Erkenntnis,* the journal that had accepted Gödel's paper on undecidability but had not released publication before the conference. What the Postscript clarifies, in part, are comments Gödel made concerning both undecidability and formal consistency. What Gödel is asserting above is not just the impossibility of a system capable of proving all statements, but more critically, the very verifiability of a system's consistency is dependent upon such statements. Thus, a verification system can never verify itself, that is, use its own means to determine the truth-value determination power of those means. Instead, it must appeal to the authority not just of a different system but more specifically to a system that it cannot verify.

The key to Gödel, perhaps, is to note how the three characteristics of a post-modern response combine in his system. His recognition of formal systems' inadequacy also becomes the basis for his expansion, and not displacement, of the epistemological frame. Another way of saying this is that taken together—unprovable true statements and formal mathematical systems—provide in their inter-relationship an overarching possibility of sensing the "wholeness" of the world of mathematical objects. The critical term here is "inter-relationship," conceived as functioning as a form of Bohrian complementarity. The very consistency of the logic system is dependent upon the failure to prove the undecidable, and the truth of the undecidable statement is mutually exclusive of its proof from the formalized system.

That complementary relationship extends to the idea of "exhaustive description" of the world of mathematical objects, where the two means, formal and intuitionist, mutually exclusive yet interdependent, are both needed to provide a means of complete verification, of both objects and systems of object recognition. Critically, the role of the human in this expansion of the epistemological frame is that of completionist: the one system of truth-value determination in which the incompleteness theorem does not hold is the human herself.

Towards a human(e) science and a science of the human.

Almost tentatively, Foucault (1994) writes in "What is the Enlightenment?"

> I wonder whether we may not envisage modernity as an attitude rather than a period of history. And by attitude, I mean a mode of relating to contemporary reality; a voluntary choice made by certain people; in the end, a way of thinking and feeling; a way, too, of acting and behaving that at one and the same time marks a relation of belonging and presents itself as a task. No doubt, a bit like what the Greeks called an ethos. And consequently, rather than seeking to distinguish the "modern" era from the "premodern" or "postmodern," I think it would be more useful to try to find out the attitude of modernity, ever since its formation, as found itself struggling with attitudes of "countermodernity." (p. 309-310)

What interests me most about this quote is Foucault's definition of attitude: a "mode of relating to contemporary reality," involving thinking, feeling, and acting, and marking "a relation of belonging." Enlightenment's science's three characteristics—simplicity, generalizability, and verifiability—are, I have assumed from the outset, characteristics of the "attitude" of modernity. Relatedly, I have treated Benjamin, Heisenberg, and Gödel as early examples of what Foucault would call "attitudes of 'countermodernity'" However, what drives Foucault's analysis is also a limit: the ultimate reduction of human activity to expressions of "relations of power." Foucault himself is an example of an attitude of counter-modernity: truth-games, ostensibly unbiased epistemologies, are complicit with at the minimum and disguising at the maximum "power games" (Foucault, 1994, p. 294). Foucault's near equation of power games with truth games suggests he seems to neither replace or nor expand the epistemological frame but rather to displace the whole idea of epistemology. My sense is, despite Foucault's brilliance, his method is recognizably dialectical, even if forever holding in abeyance a "synthesis." In a larger sense, Foucault responds to Newton's and others' thesis of "unity of truth" with its antithesis--"will to power--" under the guise of "will to knowledge," problemitizing the Enlightenment's claim to truth while nevertheless offering little by way of functional response.

Benjamin, Heisenberg, and Gödel, in partial contrast, do offer at least intimations of a functionally humane response. In each of their systems, in different ways, the philosophic move is counter-reductive and more overtly aimed at re-covering "modern" epistemology. Bohr's meta-epistemological frame of complementary allows for not so much a synthesis as for a new—and I maintain— productive manner of configuring of knowledge that suggests the possibility of a human(e) science and a science of the human. Conceptually, Bohr's approach invites a description of horizontal levels of application. Benjamin's response to simplicity—constellation—can be framed not as antithetical to simplicity but as a complementarity ensemble, perhaps one that could be called "Holicity." Similarly, Heisenberg's response to generalization—uncertainty—can be framed as the complementarity ensemble "Glocalicity." Finally, Gödel's response to verification—incompleteness—can be framed as the complementarity ensemble "Veraticity." Approaching all phenomena, in this system, would require both "sides" of the complement, as well as the "sides'" interactivity in terms of mutual exclusivity and interdependency. Additionally, each complement calls into question the subject-object split, requiring more a continuum of separation rather than a binary opposition.

Each of the complementarities reflects not so much a description of wholeness but rather a new manner of attempting to capture features of wholeness, whether in the physical world, the social world, or the psychological world. All of these complementarities express the three characteristics of what Foucault (1994) calls the "attitude of post-modernity," which in my analysis includes recognition of inadequacy of modernity's epistemological frame to account for wholeness, a re-introduction of the human into the equation, and finally, an expansion, not a displacement, of modernity's epistemological frame. Importantly, these complementarities are not answers in themselves but rather conceptual sites for reframing the very questions we ask, along with set of ways to "verify" those answers. In short, these complementarities disrupt the frame of binary opposition, freeing knowledge from the demand for hierarchicalization.

The "importance" of these findings, though, is, like the evidence of the photographic plates that so perplexed twentieth century physicists, only determinable after the fact, the "fact" of their extension to the ethical. It is the ends to which epistemology (ies) is put that provides the final "completeness" theorem, and that end should be, could be, and already is the human. If a principle, a necessary precondition of argument as Aristotle says in the *Rhetorica*, is not just akin to, but a form of, a true but unprovable statement, then the full completion is a circle: the principle is the alpha and omega of logic, and its translation via argument into a course of action is the very root of ethics. The science Foucault (1994) tracks in his studies, that of the Greeks, was a *techne* of the self—an *ethos,* as he puts it. A problematic *techne*, certainly: though it offers a possibility of liberation, it also, and if one accepts the gist of Foucault's interpretation—more often—subjugates the human. Thus, we have the Scientific Management of the human, a *techne* of the self that is characterized by simplicity, generalizability, and verifiability. The human gains and loses in this method of systemizing the self and placement of self into a system: how powerful our factories and assembly lines, from our production of textiles to our minting of graduate students! Yet how horrifying the literal and figurative "objectifications" conjured by this modern epistemology. From the machining of warfare, to the production-consumption model of "knowledge," modernity, with "science" as my point of interrogation, must be held accountable for and to the human.

The theorists I selected are among those whom, I think, hold modernity accountable. All three move the "human subject" from the periphery of knowledge to the center of knowing: Benjamin's human seizes time itself and stops it; Heisenberg's human turns probability into reality; and Gödel's human completes the inherent—and inhuman—incompleteness of truth-language itself. Such approaches offer examples of a human science, but with the exception of Benjamin, an inherently "humane" science, one driven by its ethical ends, is still elusive.

The answer to the question of a human science, as well as a manner to approach the larger issue of Bohr's (1987c) desired *unity of knowledge,* may be in the extension of these developments to "retranslation" of "category human" itself. To approach and to offer as productive definition the human as a constellated subject rather than as only a simple object suggests a "liberating" *techne* for understanding and a *techne* for liberation from mechanical sense of being. Similarly, to view the human as an active participant in the realization of probabilities, from the most foundational level of "realizing" light, to the semiotic level of "realizing" political potentialities, provides a context for human as having inherent and multi-leveled agency. Finally, to see the human as the penultimate completionist of not just "truth," but of methods of knowledge themselves, suggests a stance neither person-to-object, nor self-to-other, nor even person-to-person.

Rather, it suggests a god-to-god rendezvous between people, where all communicative acts have the possibility of being "completions of creation." As Walter Benjamin (1978b) says, "All higher language is a translation of the lower, until in ultimately clarity the word of God unfolds, which is the unity of this movement made up of language" (p. 332). For Bohr (1987c), that "higher language" is always held to the standard of a "common language capable of communicating experience" (p. 81). However, he viewed that task of translation as an ongoing process, as:

> an endeavor to achieve harmonious comprehension of ever wider aspects of our situation, recognizing that no experience is definable without a logical frame and that any apparent disharmony can be removed only by an appropriate widening of the conceptual frame. (p. 82)

That comprehension, Bohr (1987c) writes at the height of the Cold War, always had implied an ethical responsibility. Given the human consequences of "modern" knowledge, that response-ability takes on a new urgency:

> When the fate of all peoples is inseparably connected, …collaboration in mutual confidence, based upon appreciation of every aspect of the common human position, is more necessary than ever before in the history of mankind. (p. 15-16)

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