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REGULAR ARTICLE

Agency, Chance, and the Scientific Status of Psychology

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Abstract Psychologists generally reject the reductionist, physicalist, "nothing but" stance of the natural sciences. At the same time they consider their discipline a science and wonder why it does not enjoy the status (and funding) of the natural sciences. Ferguson *American Psychologist, 70*, 527-542 (2015), Lilienfeld *American Psychologist, 67*, 111-129 (2012), and Schwartz et al. *American Psychologist*, *71*, 52-70 (2016) are among those who adopt a soft naturalism of nonreductive physicalism which declares, or implies, that when it comes to humans, there is more than what the natural sciences can unravel. They envision psychology as scientific in the epistemological sense of generating reproducible results, but reject the reductive ontology of science which currently points to the undeterminable chance of quantum theory as the closest physics has come to the beginnings and what might loosely be called the foundation of the universe (e.g., Bridgman *Harper's, 158*, 443-451 1929; Eddington 1948). The case made here is that any science, including a psychological one, must be based on a naturalist ontology. This implies restricting the term *science* to disciplines which not only meet epistemological criteria like reproducibility, but which also adopt—on the ontological level—the parsimonious assumption that at present it makes sense to think that "there is nothing but time and chance" (e.g., Cox and Forshaw 2011; Crease and Goldhaber 2014; Rorty 1989). From this perspective, psychology emerges as two distinct disciplines, one a natural science, the other a human science in the broad sense of science as *scientia*.

Keywords Agency · Chance · Quantum theory · Human sciences · Natural science · Naturalism · Physicalism

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Agency and Chance

The very title of this paper and section raises the question which construct, agency or chance, should have priority. Traditionally it has been agency, religious thinking appears to have preceded developed notions of chance. But, for better or worse, chance has become dominant and agency has waned, at least in secular and scientific discourse.

Much has been written on both of these constructs. For the moment, and to avoid drowning in the philosophical literature, let etymological considerations provide some indication of how they may have evolved. Both are abstract notions, but abstract concepts have evolved from sounds referring to the concrete activity and concerns of early gatherers, hunters, herders, and agriculturalists (e.g., Skinner 1989).

The question "what is an agent?" can be approached by looking at the verbs *to act* and *to agitate*. Both imply movement and historical linguists have traced them back to a hypothetical Indo-European root **ac-* (Claiborne 1989) or ****ag̑-*** **(**Buck 1949) on the basis of modern words like Greek *agein* and Latin *agere* which may once have referred to the concrete and specific activities of "driving," as in driving sheep or cattle, and of "moving to and fro," as in shaking a container to agitate its contents. Buck (1949, pp. 712–714) describes **ag̑-* as a "widespread root in words with primary meaning 'drive'" and suggests that several such words "were clearly first used for driving cattle." *Chambers Dictionary of Etymology* (1988, p. 19), relying on a different source, also refers to **ag̑-* as referring to "drive." An interesting difference between the two sources is that the first emphasizes drive in the sense of *push*, the second in the sense of *lead*. Today an agent is someone (or something) who (or which) acts. It could be a person, a supernatural entity, or a chemical compound. To judge from linguistic history, early Pre-Indo-European herders may have been the first *agents* discernible in the European past, i.e., the first movers, initiators, or actors as opposed to organisms perceived to go with the flow, to respond, to re-act.

Chance is in many ways the opposite of agency. The word has been traced to the root **kad-* in the time, some say 4000 years ago, of the proto-Indo-European language (e.g., Claiborne 1989, p. 123; *Chambers* 1988, p. 133). It evolved into Latin *cadere*, "to fall"; in Old French it appeared as *cheoir*, then *cheance*. Thence our *chance* as well as the German *Zufall* ("fall toward"). The dice are thrown, may they fall propitiously.

Agency has helped humans to cope as far back as anthropologists and historians can trace it. Hands (2017), for example, lists animism, totemism, shamanism all the way to deistic monism as forms of "primeval reflective consciousness" dominated by the idea that undetermined agents rather than determined natural phenomena, let alone chance, account for observed events. Agency continued to dominate, Hands argued, even after primeval reflective consciousness began to make way for what he calls "philosophical thinking." Hands's third stage of reflective consciousness is scientific thinking which dispenses with the concept of undetermined, spontaneous agency.

The categories agency and chance are not always mutually exclusive. Faith in agency often goes hand in hand with fatalism, something ordained by higher powers. In the West, fate has been embodied by three female figures ranging from the Greek *moirae* to the Germanic *Nornen* to the three witches of Shakespeare's *Macbeth*. But fate and chance overlap. If fatalism is" the belief that all events are predetermined and therefore inevitable," as the Oxford Dictionaries define it, then it is *determined* by definition. On the other hand, fickle fate is usually treated as delivering *unpredictable* blows or boons, such outcomes thus reflect chance.

Is Psychology a Science?

Psychologies and Sciences

The constructs *agency* and *chance* are highly relevant to the question of the scientific status of psychology. The former is more associated with religion, ethics, and phenomenological and humanistic psychology, the latter—in the age of quantum theory—is more associated with the natural sciences in general and physics in particular. But before this question can be considered, both science and psychology need to be defined at least cursorily because, as Henriques (2016) pointed out, the question of whether psychology is a science makes no sense because the terms *psychology* and *science* both have multiple meanings.

***Scientia* and the Natural Sciences** *Science* has at least two distinct meanings. There is *scientia* which includes both the Geistes- and Naturwissenschaften of Wilhelm Dilthey, the human and the natural sciences. Dilthey's work is Germanic in scope and complexity, but it appears to be in Dilthey (1883/1966) that he most carefully develops the notion of Geisteswissenschaft in detail and contrasts it with Naturwissenschaft. This broad distinction characterizes most of his work. It appears, for example, in Dilthey (1894/1964) in an *Abhandlung* or treatise titled *Ideen über eine beschreibende und zergliedernde Psychologie* ["Ideas about a descriptive and analytical psychology"]. In it, Dilthey contrasts a descriptive psychology which focuses on human experience (essentially *Geist*) with what has been translated as "explanative psychology." Both psychologies seek to explain, but the first also and primarily seeks to describe human experience and resists pressure to exclude anything but reason and causal explanation. It is in this work that Dilthey makes the famous remark "*Die Natur erklären wir, das Seelenleben verstehen wir* ["Nature we explain, the life of the soul we understand"] (p. 144).

Scientia is also science as Koch (1959–1963) understood it when he edited his monumental *Psychology: A Study of a Science*. Koch's contributors ranged from B. F. Skinner to Carl Rogers. Between Dilthey and Koch is a time gap of more than half a century and the geographical gap between Europe and America. In Koch's time, American psychology dominated the discipline worldwide to a greater extent than it does today. The *Study of a Science* was largely the study of an American science. Where Dilthey's one-person effort penetrated deeply into philosophical depths, Koch's many collaborators offered diverse but circumscribed theoretical frameworks (behaviorist, biological, phenomenological, and others) and put them to empirical test. In a later summary statement, Koch (1993) concluded that psychology cannot be a coherent discipline, that the term *psychology* should be replaced by *psychological studies*. But he also contended that these studies share a common aim: to elucidate the human condition. Somewhat more specifically, a widely shared aim of psychological studies is seen here as dealing, jointly with philosophy, with the great divide between things subjective and objective, the agency versus chance variant of which is particularly relevant to psychology.

So much for inclusive *scientia*. There is also *science* defined to include only the natural sciences which purport to explain how our world and we came to be, beginning as the forces, particles, and atoms of physics (e.g., Harari 2016; Hawking and Mlodinow 2012). Science in this sense is both less and more comprehensive than scientia. It excludes *Geist*, but it also extends the scope of *Natur* to encompass the universe and do without Geist. Both the ways of thinking about humans and the physical world and of

depicting them have evolved. Paradigm shifts have opened new cognitive perspectives. Planck discovered the fundamental, challenging, and puzzling discreteness of nature. Einstein (reluctantly) "wrote probability into the fundaments of nature for the first time" (Crease and Goldhaber 2014, p. 76; Einstein 1917). Bohr, Heisenberg, Born, and others formulated the Copenhagen interpretation of the mathematical formalism of quantum theory. Current depictions of Dilthey's Geist have been greatly influenced by advances in areas like artificial intelligence and the neurosciences.

Phenomenological and "Scientific" Psychologies The term *psychology* also refers to two distinct things. The first is more "human science" and "descriptive"; the second is more "hard science" and "explanative." The first is rooted in phenomenology, the description of human experience is considered primary; the second reflects human constructions, what Nietzsche disparagingly referred to as *Trübungen durch Intellekt*, the muddling produced by intellect (Nietzsche 1956, p. 962). The clinical psychologist interpreting a client's art work is likely to lean toward the former, the neuropsychologist looking at MRI scans is likely to lean toward the latter. It is not surprising that the scientific status of psychology—treated as a single field of study and especially as it applies to North American "mainstream" psychology—has been, and is currently, the subject of controversy.

The Status of Psychology

Currently, in the arena of public opinion and in the offices of funding agencies and politicians, psychology is said to punch below the weight class of physics, mathematics, chemistry, and biology (Ferguson 2015; Lilienfeld 2012). Some psychologists vigorously claim the cachet of being scientific (e.g., Tannenbaum 2013) while practitioners of the natural sciences emphatically deny the discipline that status (e.g., Berezov 2012).

In academic circles, a major study in *Science* (Open Science Collaboration 2015) has cast doubt on the replicability of the results of psychological research. Smedslund (2016) argued that psychological processes are not amenable to research that meets scientific criteria. Lilienfeld (2012), Ferguson (2015), Schwartz et al. (2016) explicitly rejected the hard naturalism of (natural) science and endorsed a weak naturalism marked by "non-reductive physicalism" rather than reductive physicalism, token identity rather than type identity, constitutive materialism rather than exhaustive materialism. Schwartz et al. (2016) cautiously pleaded the case for an open mind toward neuroscience, psychology's "materialist" and rambunctious cousin. They worried that neuroscience is pushing psychology toward "greedy" (Dennett 1995) eliminative reductionism. They were apprehensive lest the attention to neuroscience they reluctantly endorsed could lead to misunderstandings, that adopting neuroscientific approaches could be like adopting in the nest of gentle reed warblers the suspiciously large egg of an unruly cuckoo. This possibility caused them to issue an array of cautions. These are thoughtfully worded, but their cumulative effect is not that of a welcome mat.

Enter Quantum Theory.

New things have been happening outside of psychology pertaining to the construct of chance. These new developments have been happening mainly on the micro-level of

molecules, atoms, and subatomic particles and they have implications for how we see the universe and everything in it, including agency.

Essentially, the quantum physicists have shown that it makes sense to think of the outcomes of events occurring on the most basic level of particles not only as random or chance outcomes but also as outcomes which are, *in principle*, undeterminable. They showed that there is a fundamental difference between the outcome of the roll of a die, which is random in the sense of "unpredictable in practice," and the outcomes "decay" or "not decay" of a uranium-238 atom, which we cannot predict in principle because they are deemed "really," intrinsically, ontologically, in nature undeterminable.

A regular flock of terms comes to mind in connection with the word *undeterminable.* There are its synonyms: *undetermined* ("uncaused," "without (known) cause," "acausal"), *indeterminate*, *indeterminateness*, and *in-* or *undeterminability.* There is the antonym *determinable* and the many words related to it: *determined* ("caused"), *determinate* ("fixed, defined, definite"), *determinateness*, and *determinability.* In what follows *determined* and *undetermined* are defined broadly in both the epistemological sense of "known/knowable" or "not knowable," respectively, and in the ontological sense of "caused" or "uncaused." In the epistemological sense they do not necessarily imply anything about the nature of reality. *Undetermined*, for example, may mean that something has not been determined, perhaps because no one has tried, perhaps because it is in principle undeterminable, perhaps because it is a part of the real world that is undetermined in the strong ontological sense of the term. These inclusive definitions of *determined* and *undetermined* permit use of the terms *determined chance* and *undetermined chance* to refer to the two kinds of events, and their outcomes, exemplified by the roll of a die and the emission of an alpha particle by a decaying uranium atom.

Quantum mechanics has been introduced to mainstream awareness by means of videos on the internet, educational TV programs, and a profusion of books aimed at the general reader (e.g. Al-Khalili 2003). This popularizes the notion of ultimate and ontological undeterminedness which is suggested by undeterminability. It is also causing some psychologists to look at the world in a new frame of mind which goes beyond what have become strawmen—Newtonian mechanism, Laplacian determinism, and even materialism—which their colleagues (e.g., Gantt and Williams 2014; Rychlak 1993) attacked as inadequate to deal with the complexity of human beings. Bickhard (2003), for example, boldly examined the process of evolution based on variation and selection from the world of small particles up.

Scientific Epistemology and Scientific Ontology

Most recent contributors to the debate have not explicitly made the distinction between epistemological and ontological issues. Those which did so tended to argue that psychology can and must be more scientific epistemologically, i.e., in the methods it deploys to accumulate knowledge, but that it cannot ontologically, *ever* or *in principle*, be scientific like the natural sciences because its subject matter beyond behaviour—*psyche*, human nature, the mental—is simply beyond the scope of the natural sciences (e.g., Ferguson 2015, Lilienfeld 2012; Rychlak 1993; Sperry 1993, and many more).

There is thus a gap between the ontological stance of most psychologists who think of themselves as scientists and the ontology underlying science in the natural science sense most people seem to have in mind when they utter the words *science* and

scientific. This gap manifests itself sometimes as "physics envy," a condition arising from the ambivalent relationship between psychology and the quintessentially natural science of physics. The condition is sometimes attributed by psychological practitioners to researchers and other more scientifically oriented colleagues, especially if they show more interest in the brain or behaviour than in the mind. But "physics envy" also describes the entirely justified envy on the part of psychologists who compare their discipline to the natural sciences. It is, or should be, fed by the visible achievements of the natural sciences, ranging from the Boeing 747 and the Airbus 380—the ships that fly—to the latest cancer treatments custom-made for individual patients and based on their genomes. It should also be elicited by acknowledgement that the physicists have paradigm shifters like Isaac Newton, Niels Bohr, and Albert Einstein, that the chemists have Mendeleev, and that the biologists have Darwin. The natural sciences have advanced convergent and consilient explanatory networks and achieved breakthroughs which propelled *Homo sapiens* out of caves into space, while psychologists debate how, or even if, specific psychotherapies work and sharply disagree on the merits of Sigmund Freud and B. F. Skinner.

But perhaps the gap between the ontological stances of most psychologists and of the natural sciences is not unbridgeable. There is the move to make quantum theory accessible mentioned above. More important, psychologists like Donald Hebb and B. F. Skinner thought in terms of naturalistic ontologies. For Hebb *reality* spelled "brain," for Skinner it spelled "behaviour." Bickhard (e.g., Bickhard 2003; Bickhard 2011), as noted, accounts for human cognition and complex systems in general in terms of variation and selection, from the ground up, i.e., beginning with the physicist's particles, or at least with the processes associated with them.

The Ontological *Gretchenfrage*: Agency or Chance?

Bluntly put, the question of interest here is whether psychology can be a science if it rejects the ontology of science as generally defined—both by the majority of scientists and by the informed public—as naturalist, reductionist, and as converging on the view that ultimately things boil down to chance operating over eons of time (e.g., Atkins 2011; Dawkins 1988; Hawking and Mlodinow 2012; Krauss 2012; Mukherjee 2016). This is the question psychologists must ask themselves and it propels one to the edge of the Great Divide recognized by Dilthey (e.g., 1883/1985), the Grand Canyon which runs through both psychology and philosophy. The most extreme exponents of this divide are religion and physics, the former typically pointing to strong internal and external agents able to freely, wilfully, and intentionally initiate novel causal sequences, the latter suggesting that mind and first cause are best approached as outcomes which ultimately do not have discernible causes.

The Great Divide appears in many variants—religion and science, supernaturalism and naturalism (Morf In press), agency and chance, phenomenological psychology and neuropsychology, subjective and objective things, belief and knowledge. These variants will look more similar to Darwinian lumpers than to Darwinian splitters. They certainly do not always overlap greatly. In fact, certain pairs of variants may not overlap at all. Their relation is that of family resemblances (Wittgenstein 1953), or of populations considered part of the same species although some pairs of these populations do not interbreed (Ruse 2006, p. 121).

In psychology the Great Divide manifests itself typically in its agency versus chance variant. It raises a fundamental question in the manner of Goethe's famous *Gretchenfrage* put to Faust: *Wie hast du's mit der Religion?* ["What do you make of religion?"]. It is also, in our time of quantum physics, the question *Gott oder Zufall?* ["God or Chance?"] constituting the title of the German translation of the more circumspectly titled original English *Lion Handbook of Science & Christianity* (Berry 2012). On a secular level, it pits the phenomenologist's claim that ultimately it is all human experience against most physicists' claim, when speaking as physicists, that "ultimately it all reduces to particles in motion."

These claims must be equally persuasive since neither has managed to refute the other. Besides, it seems to make as much sense to say "ultimate reality is human consciousness since that is all we can possibly know" as it does to say "there is only one world and it is not that of human consciousness since human consciousness clearly emerged from something other than itself." It seems that the best we can do is adopt the first stance in the context of being in awe of the unknown, the *mysterium tremendum*, including our scientifically unfounded but overwhelmingly experienced sense of being free, responsible, and good or evil agents; and the second when trying to make sense of the world.

Determined and Undetermined Events and Outcomes

Overview: Event Types

The quantum theoretical demonstration of the difference between determined and undetermined chance suggests a similar distinction between determined and undetermined agency, one that may overlap with an agent's actions which are self-determined, *sui generis*, and others deemed undetermined, *ex nihilo.* That gives us a 2×2 contingency table of chance versus agency and determinedness versus undeterminedness. This is the core of Table 1 to which the event type *reflecting neither chance nor agency* and, in the present context, the mostly quantum theoretical category *micro-level* need to be added.

Table 1 is meant to be suggestive, not final in any sense. It represents event types. An event is typically defined as something that happens or takes place, where *happens* points to chance and *takes place* may or may not refer to determined outcomes. Table 1 thus represents the various event types under the main rubrics chance, agency, and *neither* as they appear determined or undetermined, and as they occur on the macro-level of Newton and human experience and the micro-level usually defined as that of atoms and subatomic particles on which quantum theory typically applies.

Determined and Undetermined Agency: Agency 1 and Agency 2

Agency Type 1 Agents are not only determined or undetermined, the undetermined kind also calls for a distinction between internal and external agency. True, the determinants propelling determined agents can also be internal (a conviction, an intention, a desire or motive), but ultimately determined agents, think of them as agents type 1, are propelled by resultants of the interaction between their genomes and their environments, and even genomes have ultimately external origins. Determined agents

Table 1 Event types reflecting chance, agency, and neither chance nor agency

Event type	Outcomes	Macro-level	Micro-level
Events reflecting chance	Determined, Unpredictable in practice. Chance 1	The roll of a die results in a 6.	
	Undetermined. unpredictable in principle. Chance 2		A uranium-238 atom emits an alpha particle
Events reflecting agency	Determined, predictable in practice Agency 1.	A billiard player strikes the cue ball	
	Undetermined, unpredictable in principle Agency 2	Internal agency: An addict declines the offer of an opioid. External agency: A higher power answers a prayer.	
Events reflecting neither chance nor agency	Determined, predictable in practice	The cue ball collides with an object ball on the billiard table	The "color" of an electron is measured, the outcomes are "black" and "white" with probabilities of 1 and 0 (Albert 1992)[a]

The boundary between macro-level and micro-level is not clear cut (e.g., Knapp 2016, p. 123). The two examples of micro-level events here involve an atom and two particles, and they are explained in quantum theoretical terms

[a] Albert uses the familiar properties of hardness and color in place of the electron's spin properties less familiar to his intended readers

range from chemical agents whose effects are easily attributed to discernible chemical properties to human agents like the billiard player whose effects may be determined by skills, impulses, motives, and more. These determinants may not be fully discernible in practice, but the outcomes of the skilled player's action tend to be predictable.

External and Internal Agency Type 2 Undetermined agents, think of them as agents in the strong sense of agent type 2, include the self said to be endowed with free will, and external agents most relied on and evident to adherents of religions. They include the examples in Table 1: an addict said to have exercised free will declining the offer of an opioid, and a higher power said to have answered a prayer.

Philosophers have focused on internal agency. It famously pitted Kant's endorsement of undetermined agency against Hume's rejection of it. Kant (1781/1998, pp. 535–537), for example, distinguished act (*Handlung*), the movements involved in striking a match, and effect (*Wirkung*), the burning match. He concluded that "one can say of the acting subject" that it initiates its effects but that the act does not begin in it. The point that seems to emerge from at least this one of his many related formulations is that Kant conceived the act of the human agent, the "acting subject," as undetermined. Hume offered a simpler analysis of the human actor whose freedom may be the freedom from given constraints (the "liberty of spontaneity"), like those of incarceration, but not the freedom to do anything undetermined by the usual and ultimately genetic and environmental factors. Hume's blunt and not always fully acknowledged view that the latter (the "liberty of indifference") has "no existence" (Hume 1988, p. 132) seems to imply that reliance on the notion of undetermined agency is incompatible with claims to scientific status.

Determined and Undetermined Chance: Chance 1 and Chance 2

Determined Chance 1 The outcomes of a roll of a die illustrates the familiar determined kind of chance, i.e., the classical, determinist, epistemological chance of ignorance also involved in the toss of a coin and the break shot in billiards. The outcomes are determined, although we cannot specify *in practice* all initial conditions and all forces interacting as the die pursues its trajectory through the air and bounces off the table. This is the chance which produces outcomes whose determinants we can never unravel in practice; the chance playing its important role in human existence and the material world which must have impressed, to judge from its ancient linguistic roots, even our earliest ancestors long before the naturalist point of view arose. It is the chance Richard Dawkins and Richard Rorty have in mind when they argue that there is nothing but time and chance. Dawkins (e.g., Dawkins 1988) argued that while the results of evolution are highly improbable, given enough time, the improbable may happen, indeed keeps happening time after time. Hence nature—the blind watchmaker—achieved the miracle of sight not once, but multiple times and in separate lineages. Rorty (1989) saw contingency rather than design at work in the formation of language, the self, and the "liberal community," endorsing a "line of thought..[which] suggests that we try to get to the point where...we treat everything—our language, our conscience, our community—as a product of time and chance" (p. 22).

Undetermined Chance 2 Then there is undetermined chance. Probably the best known example is one mentioned earlier, involving the decay of a uranium-238 atom. We have no way of knowing when or even if the atom will emit an alpha particle.

As noted, outcomes may just be undeterminable, or they may be undeterminable because nature or reality is intrinsically undetermined. Either way, undetermined chance is a concept not easily grasped. *H sapiens* has adapted to its everyday world, not to the micro-world of particles of which the universe ultimately appears to consist. The human world is that of waves beating the ocean's shore, particles of sand getting in between toes, apples falling from trees. But humans now have tools like the Large Hadron Collider (LHC) of the European Organization for Nucelear Research (CERN) to smash particles and measure their energies and like the Hubble Space Telescope (HST) to observe distant galaxies. Devices like the LHC open the micro-world of undetermined chance.

Realism and antirepresentationalism. The notion of undetermined chance raises the question of realism: Is there a world independent of human minds? It is hard to imagine persons who are not realist in outlook, however qualified their notion of reality may be. But there are antirepresentationialists like Rorty who do not think it is useful to think of statements as referring to a real world. Rorty is inclined to agree with Nietzsche (1956, Vol. 3, p. 896) who regards atoms as "erdichtet," as created in the sense of poetic creation. Rorty (1991, p. 5ff) suggests that there are atoms because we say *atom*, not that we say *atom* because there are atoms.

Physicists are divided on whether what they are talking about is or may be real. The Copenhagen interpretation is usually interpreted as antirepresentationalist, i.e., non-realist, and Bohr is usually said to have argued that since you cannot specify, say, momentum and position of a particle, it is not real (e.g., Knapp 2016, p. 89). But he also left the door ajar, maintaining that "It is wrong to think that the task of physics is to find out how nature is…Physics concerns what we can say about nature" (Gleick 2018, p. 17).

Planck's quanta and the uncertainty relation. The notion of undetermined chance assumes form in the contexts of Max Planck's discovery that energy comes in quanta, i.e. in tiny but indivisible units, and that of the Heisenberg principle of uncertainty which states that in the case of certain pairs of variables, the more precisely one is measured or specified, the greater will be the uncertainty associated with the other. The uncertainty relation holds for pairs of variables called conjugate variables of which the pair *momentum* and *position* and the pair *time* and *energy* are probably the two best known examples.

Planck discovered that—in the context of blackbody heat radiation—electromagnetic energy acts as if it were transmitted discretely, not continuously. Al-Khalili (2003) described these discrete amounts of energy as "bundles of energy localized in space" (p. 43). Planck's "bundles" were later called "particles" and, eventually *photons*. Planck found that using a constant close to $h = 6.6 * 10^{-34}$ yielded precise predictions pertaining to heat radiation and he defined a quantum as the energy $E = hv$ transmitted by a photon whose frequency is v (where v is the Greek letter *nu*, easily mistaken for v representing velocity below).

Heisenberg's uncertainty relation is based on the Planck constant h. If the pair of conjugate variables of interest is momentum p and position q of an electron, the uncertainty relation is usually stated as (e.g., Crease and Goldhaber 2014, p.162):

$$\Delta p \Delta q \geq \frac{\hbar}{2},$$

where Δp ("increment p") is the uncertainty associated with momentum and Δq is the uncertainty associated with position, and where $\hbar$ ("h *bar*") is the reduced Planck constant h. The only thing we need to know about Planck's constant and its reduced variant is that they are minuscule but not zero. The uncertainty relation thus implies that if position q has been measured accurately, yielding Δq of near zero, Δp must be large since the product of the two, though still extremely small, can be greater than half of the nonzero reduced Planck constant. As Cox and Forshaw (2011, pp. 72–73) put it: "[T]he more precisely you know the position of a particle at some instant, the less well you know how fast it is moving." More generally: As Δq approaches 0, Δp may approach` infinity, and vice versa.

We would like to know both momentum and position exactly, because then we could think of the electron as a measurable and hence, in a sense, *real* entity. The broader implication of the uncertainty relation is that nature ultimately does not give us what we would like and that on the micro-level constituting its foundation, it does not fit our traditional, classical, Newtonian way of thinking.

Events Reflecting neither Chance nor Agency

Table 1 includes a famous example of a macro-level event reflecting neither chance nor agency: a billiard ball hitting another billiard ball (Bridgman 1929; Hume 1748/1988; Michotte 1946/1963). This is an event whose outcomes appear determined and it does not seem sensible to attribute agential power to the first ball causing the second to move. Of course, the entity causing the first ball to move, the human player, is said to be acting rather than merely reacting, i.e., to be an agent. In Table 1 this agent reflects determined agency.

Table 1 includes a second event in this category but on the micro-level on which undetermined chance usually prevails. The event illustrating a micro-level event whose outcome is not due to chance is taken from Albert (1992). It involves measuring a spin property, Albert calls it "color," of an electron. The probability of the possible outcomes, "black" and "white," is 1 and 0.

Macro-World and Micro-World

Up to this point the main issue addressed here has been to identify the two kinds of agency and of chance. Undetermined chance emerges as the novel notion that seems to rule on the level of elementary particles. This novel notion is important. Among other things undetermined chance makes the first cause, the prime mover problem, appear somewhat more tractable, chance being a more parsimonious concept than prime mover or intelligent designer (e.g., Atkins 2011; Krauss 2012, 2017).

However, there remains one large hurdle to convincing psychologists to consider chance rather than agency as fundamental. A glance at Table 1 reveals the problem: While the micro-world harbors at its root undetermined, causeless, spontaneous chance, the familiar macro-world obeys physical laws and is determinist. How can these two different worlds be related? If the behavior and properties of individual small particles are intrinsically unpredictable, how is it that the aggregate of trillions upon trillions of particles constituting a soccer ball will fly through the air on its apparently certain and determined path?

Hawking and Mlodinow (2012, pp. 67–72) offer some hints using the soccer ball as an example and relying on simple mathematics, the reduced Planck constant $\hbar$, and the uncertainty relation. Hawking and Mlodinow's soccer ball weighs 0.333 kg. Its mass is 0.333 kg. Its momentum p is mass times velocity, $p = m * v$. The uncertainty relation is:

$$(m*\Delta v)*\Delta q \geq \frac{\hbar}{2}$$

On the macro-level we have, if we specify the soccer ball's position q to within 10^{-2} meters (1 mm):

$$(m*\Delta v)*\Delta q = (0.333\ kg*\Delta v\ m/s)*10^{-2}\ m \geq \frac{\hbar}{2}$$

Since $\hbar$ is minuscule (though not zero) and m is very large, both Δv and Δq can be minuscule. In other words, it is possible to measure both velocity and position with precision. We stipulated that position is specified accurately, now we see that Δv can also be minuscule and that speed can also be measured accurately because we are dealing with a macro-world object of great mass. In the macro-world, both position and velocity are determinable and deemed determinate and determined.

On the micro-level we have a minuscule mass: The weight of an electron is something like 10^{-29} kilograms. Specifying precisely its position q to within the diameter of a carbon atom, about $2.2 * 10^{-8}$ meters (0.22 nm), yields:

$$(m*\Delta v)*\Delta q = 10^{-29}\ kg*\Delta \mathrm{v}\ m/s*\left(2.2*10^{-8}\ m\right) \geq \frac{\hbar}{2}$$

Although $\hbar$ is minuscule, it is not zero, hence Δv can be very large. Velocity in this case is undeterminable.

So much for a sliver of a hint of some of the reasoning underlying Hawking and Mlodinow's explanation of the mysteries of their discipline to a general public. As far as the even more challenging physics underlying this issue is concerned, Hawking and Mlodinow (2012) note with disarming frankness: "Physicists are still working to figure out the details of how Newton's laws emerge from the quantum domain" (p. 68). Knowing the mathematics without fully knowing the physics may be a less than perfect situation, but it has not stopped physicists from calculating precise probabilities and making accurate predictions.

The Two Disciplines of Psychology

Psychology as a Janus-Faced Field of Inquiry.

One can think of psychology as a single field of inquiry which grapples with the Great Divide between subjective and objective things, the phenomenological and the physical, *erleben* (experiencing) and *erfahren* (come to know, acquire as knowledge), and, in the present context, between subjectively experienced agency and objectively observed chance. Psychology from this inclusive perspective is a single, though Janus-faced, field of study looking in the diametrically opposite directions of agency and chance. Since it looks in both directions, psychology construed in this manner may be uniquely qualified to address the deep issues of the Great Divide. Some critics of psychology think it is neither fish nor fowl, but perhaps it is both, perhaps not unlike particles which are also waves.

Psychologists grapple with the relationship between Dilthey's *Geist* and *Natur* more than do physicists and other practitioners of the natural sciences. Scientific researchers rarely concern themselves, in their professional roles, with ontological (i.e., metaphysical) issues pertaining to the nature of agency and chance. But physics and metaphysics differ in ways more fundamental than their relative positions in Aristotle's writings. Physics and that which is" beyond" or" after" it end up on separate sides of the Great Divide. To most physicists it looks like there are two worlds: the workday world of the laboratory and science, and the private and personal world in which many of them embrace religious beliefs implying direct and concrete external agency. As Krauss (2017, p. 22) points out, one must not confuse science with scientists. Where psychologists are likely to grapple with the Great Divide, physicists may be more likely to live in two worlds.

The downside of this dual natured psychology is that its scientific status is widely doubted and that the relationship between psychological practice and the science on which it is said to be based is tenuous. At least in theory, the science is considered the base providing knowledge and tools to be applied by psychological practitioners. In practice, the science seems to have played a secondary role and scientific education has been accepted grudgingly by many clinicians and the majority of Ph.D. students preparing for careers as professional psychologists.

Two Disciplines

An alternative to treating psychology as a single entity is the one alluded to earlier in the article: to bite the bullet and distinguish the two disciplines of psychology. There have been moves in that direction: The Association for Psychological Science (APS) separated from the American Psychological Association (APA), some programs award doctorates in psychology rather than Ph.Ds. A clear cut distinction between two disciplines would follow Cronbach's example (Cronbach 1957): He distinguished between "the two disciplines of *scientific* psychology," one experimental, the other correlational. The Janus faced field of study seems to divide quite naturally into two disciplines of psychology, one humanistic and the other scientific. It must be kept in mind, however, that Cronbach's scientific psychology was scientific epistemologically, i.e., in its methods of acquiring knowledge, not necessarily scientific in ontology. In the context of determined and undetermined agency and chance, the scientific psychology

would be a natural science and hence scientific not only on the epistemological level, but also on the ontological level of what is deemed to be, i.e., to be "real."

Thinking in terms of two disciplines not only makes the issue of the scientific status of psychology moot, it also may make the relationship between them clearer. It would be less a matter of one being the ostensible basis of the other and more a relationship in which science unabashedly extends its domain at the expense of agency in the manner in which Newtonian thinking replaced medieval thinking and the manner in which quantum theory and relativity are in the process of replacing Newton's world (e.g., Knapp 2016).

Science where Possible

The general position defended here can be summed up as "science where possible." It reflects the success of the natural sciences. They have advanced in leaps and bounds both in theory and practical application, and they have opened entirely new and unexpected ways of looking at the world in which undetermined chance plays a central role. This implies that the epistemology and ontology implied by the natural sciences should be carried forward in psychology to the extent possible, that a world view based on undetermined chance should be allowed to encroach on the domain of undetermined agency. This may sound extremist, but in a sense, it is merely a recommendation that cultural changes evolving since the Middle Ages in the West be embraced.

A more specific position defended here has been that the case for the "nothing but chance" stance is not one that should be rejected automatically by psychologists. It is an ontological stance which, from the scientific perspective, sees undetermined chance as currently coming closer to a plausible origin of the universe or multiverse than any other readily available construct. It points to ultimate beginnings as humans can imagine them, and hence to the beginnings of the evolution of the atoms of physics, the molecules of chemistry, life and the organisms of biology in the manner recently and succinctly summarized by Harari (2016, p. 3) .

Not everybody, to say the least, enthusiastically adopts this stance. Even the man who put undetermined chance on the map, Albert Einstein, did not consider it to be the last word. Indeed, it would be presumptuous to think of anything generated by human minds as the last word. Even the most brilliant and confident sounding physicists acknowledge the limitations of their explanations when, for example, they allow that their "nothing" out of which the universe emerged is in fact something (Krauss 2012) or that their theory of everything will constitute the answer only "if [it] is confirmed by observation" (Hawking and Mlodinow 2012, p. 181). In the much quoted, and apparently seldom referenced, words of J. B. S Haldane: "things are not only queerer than we suppose, they are queerer than we can suppose" (e.g., Bryson 2004, p. 17).

Occasional doubts even among scientists themselves notwithstanding, the prospects of continued scientific advance look promising not only in science itself, but also on the cultural level. Knapp (2016) considers quantum theory the stimulus which could cause societies to embrace new "collective forms of thinking" replacing old dicta like "reality is a collection of objective facts," "matter is stable," and "science is neutral." She does not address the construct of agency central to psychology, her focus is on the natural sciences. But by making the case for quantum theory as a cultural force and for chance, she reduces the role of agency.

Among the things that quantum theory could do for psychology are three theoretical ones. First, it could clarify the notion of agency. It could do so by suggesting the distinction between agency 1 and 2 analogous to the distinction between determined and undetermined chance 1 and 2 as shown in Table 1. Second, it could make possible a more coherent worldview by linking, in time honored bottom-up fashion, the micro-world foundations with the macro-world in which humans operate. This is illustrated by the difference discussed between what we know on the macro-level as massive soccer balls and on the micro-level as minuscule electrons. Third, and extending the preceding point, quantum theory could possibly bring closer together the mental and physical, Dilthey's opposites. It could do so by showing how immaterial mathematics and waves on one hand, and particles which may or may not be "real" as we understand them, together generate the world.

On a more concrete level, movement along these lines might shift the focus of psychologists away not only from notions like agency, but from the language of blame, guilt, personal responsibility. This could affect verbal exchanges in therapy and counselling and the contents of assessments and recommendations. Quantum theory might also encourage psychologists to oppose, more strongly than they already do, old beliefs about punishment which among western democracies stubbornly remain at least in the U.S. a deeply rooted part of a system of "justice" resulting in executions and consecutive sentences amounting to multiple life times of incarceration.

Endorsing the "science where possible" and the "chance rather than agency" stances is not the same as rejecting the nonscientific discipline of psychology, the one encompassing *geisteswissenschaftliche* endeavors, the secular humanistic studies which focus on internal agency and the religious studies which postulate one or many external agents. Both chance- and agency-inclined psychology spring from the same source: The puzzling unknown of which humans try to make sense. The common origin of the two psychologies is this unknown which calls for elucidation by scientific means where possible, and assuaging and intelligent speculation and reasoning where experiment and systematic data collection fail.

Some, perhaps most, questions raised by the unknown at the root of human efforts to understand and explain can be answered by science. Many crucial ones have not been so answered and elicit non-scientific and supernaturalist modes of response. The universe is queerer than we can suppose. There are no atheists in foxholes. The best answer to the deepest mysteries may be, as Einstein (1950/2005) suggested, a smile.

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