What did not disappear, despite the vastly premature celebration of a new consensus by many commentators, was the enduring necessity of making a choice. For the new terms in which 'structure and agency' were re-conceptualized and linked together were again represented by *two*

standpoints, thus opening up a new debate beginning in the seventies or early eighties. These I have termed 'Elisionism' (because transcending the dualism between individual and society consisted in replacing it by an insistence upon their mutual constitution), and 'Emergentism' (because structure and agency are both regarded as emergent strata of social reality and linkage consists in examining their interplay).

The first manifestations of Elisionism in social theory were distinctly idealist. Neo-phenomenological forms of theorizing construed the social context as 'facticity' rather than fact and insisted upon its 'externalization' and 'objectification' rather than allowing it externality and objectivity. However, in viewing entities such as social institutions as purely dramatic conventions which depended upon co-operative acts of agents in sustaining a particular definition of the situation, Symbolic Interactionists in particular elided 'structure' and 'agency' in three key ways which have increasingly come to characterize Elisionism as a distinctive theoretical orientation: (i) a denial of their separability, because, (ii) every aspect of

'structure' is held to be activity-dependent in the present tense and equally open to transformation, and (iii) the conviction that any causal efficacy of structure is dependent upon its evocation by agency.

Because of the centrality of 'inseparability', such premisses are neither reductionist (*contra* Individualism), nor anti-reductionist (*contra* Collectivism). Whilst the untrammelled idealism, characteristic of interpretative sociology in the seventies, is no longer the hallmark of those viewing structure and agency as mutually constitutive, the fundamental inseparability of the two is what constitutes Elisionism as a distinctive approach. Those now endorsing the 'duality of structure' as the medium and outcome of social practices, under the rubric of Structuration theory, have reconstituted Elisionism on a more acceptable basis (which incorporates material resources and power rather than dealing with networks of meanings alone), whilst continuing to endorse *inseparability* and its associated premisses. In contradistinction, the very notion of 'emergent properties' which are generated within socio-cultural systems is necessarily antithetic to the tenet of inseparability because such structural and cultural features have autonomy from, are pre-existent to, and are causally efficacious *vis-à-vis* agents – their existence, influence and analysis therefore being incompatible with the central premises of Elisionism.

Consequently choice is inescapable because 'Elision' (the term used for those grouping themselves around Structuration theory) and 'Emergence' (those exploring the interface between transcendental realism and social theory) are based upon different ontological conceptions, related to disparate methodological injunctions and thus have quite distinct impli-

cations for practical social theorizing. To celebrate the development of a new consensus is to concentrate upon their common rejection of the terms of the old debate whilst ignoring the different bases upon which the two re-set the terms. The unpopular message of this book is that the burden of choosing has not been removed – and we can only make a sensible choice by closely scrutinizing the nature of and connections between ontology – methodology – practical social theory which Elisionists and Emergentists respectively endorse. This is exactly what will be done: it is undoubtedly more burdensome than the conclusion that we can have the best of both worlds, but it is preferable to recognize in advance that again there can be no *via media* than to find it collapsing under us later on.

From Margaret Scotford Archer, *Realist Social Theory: The Morphogenetic Approach*. Cambridge, UK: Cambridge University Press. 1995. Pages 59-61.

Elisionism

Margaret Archer

Contents

Articles

References

Article Licenses

Margaret Archer

Margaret Scotford Archer (born 20 January 1943) spent most of her academic career at the University of Warwick, UK, where she was for many years Professor of Sociology. She is now a professor at l'Ecole Polytechnique Fédérale de Lausanne, Switzerland. She is best known for coining the term elisionism in her 1995 book *Realist Social Theory: The Morphogenetic Approach*.

She studied at the University of London, graduating B.Sc. in 1964 and Ph.D. in 1967 with a thesis on *The Educational Aspirations of English Working Class Parents*. She was a lecturer at the University of Reading from 1966 to 1973.

She is one of the most influential theorists in the critical realist tradition. At the 12th World Congress of Sociology, she was elected as the first woman President of the International Sociological Association, is a founder member of both the Pontifical Academy of Social Sciences and the Academy of Learned Societies in the Social Sciences. She is a Trustee of the Centre for Critical Realism.

She has supervised many PhD students, many of whom have gone on to contribute towards the substantive development of critical realism in the social sciences. Notably, Dr Robert Willmott, author of *Education Policy and Realist Social Theory* and Dr Justin Cruickshank, senior lecturer at the University of Birmingham.

Analytical dualism

Archer argues that much social theory suffers from the generic defect of conflation where, due to a reluctance or inability to theorize emergent relationships between social phenomena, causal autonomy is denied to one side of the relation. This can take the form of autonomy being denied to agency with causal efficacy only granted to structure (*downwards conflation*). Alternatively it can take the form of autonomy being denied to structure with causal efficacy only granted to agency (*upwards conflation*). Finally it may take the form of *central conflation* where structure and agency are seen as being co-constitutive i.e. structure is reproduced through agency which is simultaneously constrained and enabled by structure. The most prominent example of central conflation is the structuration theory of Anthony Giddens. While not objecting to this approach on *philosophical* grounds, Archer does object to it on *analytical* grounds: by conflating structure and agency into unspecified movements of co-constitution, central conflationary approaches preclude the possibility of sociological exploration of the relative influence of each aspect.

In contradistinction Archer offers the approach of analytical dualism.[1] While recognizing the interdependence of structure and agency (i.e. without people there would be no structures) she argues that they operate on different timescales. At any particular moment, antecedently existing structures constrain and enable agents, whose interactions produce intended and unintended consequences, which leads to structural elaboration and the reproduction or transformation of the initial structure. The resulting structure then provides a similar context of action for future agents. Likewise the initial antecedently existing structure was itself the outcome of structural elaboration resulting from the action of prior agents. So while structure and agency are interdependent, Archer argues that it is possible to unpick them analytically. By isolating structural and/or cultural factors which provide a context of action for agents, it is possible to investigate how those factors shape the subsequent interactions of agents and how those interactions in turn reproduce or transform the initial context. Archer calls this a morphogenetic sequence. Social processes are constituted through an endless array of such sequences but, as a consequence of their temporal ordering, it is possible to disengage any such sequence in order to investigate its internal causal dynamics. Through doing so, argues Archer, it's possible to give empirical accounts of how structural and agential phenomena interlink *over time* rather than merely stating their theoretical interdependence.

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[1] M.S. Archer (1995) Realist Social Theory ch 3 to 6

External links

- Margaret Archer's page at the Pontifical Academy of Social Sciences (http://www.vatican.va/roman_curia/pontifical_academies/acdscien/own/documents/archer.html)

Elisionism

Elisionism is a philosophical standpoint encompassing various social theories. Elisionist theories are diverse; however, they are unified in their adherence to process philosophy as well as their assumption that the social and the individual cannot be separated. The term *elisionism* was coined by Margaret Archer in 1995 in the book *Realist Social Theory: The Morphogenetic Approach*. Elisionism is often contrasted with holism, atomism, and emergentism.

References

Holism

For the suffix, see holism.

Holism is the idea that natural systems (physical, biological, chemical, social, economic, mental, linguistic, etc.) and their properties should be viewed as wholes, not as collections of parts. This often includes the view that systems function as wholes and that their functioning cannot be fully understood solely in terms of their component parts. The term *holism* is derived from Ancient Greek *holos* ὅλος, meaning "all, whole, entire, total."

Reductionism is often viewed as the opposite of holism. Reductionism in science says that a complex system can be explained by *reduction* to its fundamental parts. For example, the processes of biology are reducible to chemistry and the laws of chemistry are explained by physics.

Social scientist and physician Nicholas A. Christakis explains that "for the last few centuries, the Cartesian project in science has been to break matter down into ever smaller bits, in the pursuit of understanding. And this works, to some extent... but putting things back together in order to understand them is harder, and typically comes later in the development of a scientist or in the development of science."

In science

General scientific status

In the latter half of the 20th century, holism led to systems thinking and its derivatives, like the sciences of chaos and complexity. Systems in biology, psychology, or sociology are frequently so complex that their behavior is, or appears, "new" or "emergent": it cannot be deduced from the properties of the elements alone.[1]

Holism has thus been used as a catchword. This contributed to the resistance encountered by the scientific interpretation of holism, which insists that there are ontological reasons that prevent reductive models in principle from providing efficient algorithms for prediction of system behavior in certain classes of systems.[*citation needed*]

Scientific holism holds that the behavior of a system cannot be perfectly predicted, no matter how much data is available. Natural systems can produce surprisingly unexpected behavior, and it is suspected that behavior of such systems might be computationally irreducible, which means it would not be possible to even approximate the system state without a full simulation of all the events occurring in the system. Key properties of the higher level behavior of certain classes of systems may be mediated by rare "surprises" in the behavior of their elements due to the principle of interconnectivity, thus evading predictions except by brute force simulation. Stephen Wolfram has provided such examples with simple cellular automata, whose behavior is in most cases equally simple, but on rare occasions highly unpredictable.

Complexity theory (also called "science of complexity"), is a contemporary heir of systems thinking. It comprises both computational and holistic, relational approaches towards understanding complex adaptive systems and, especially in the latter, its methods can be seen as the polar opposite to reductive methods. General theories of complexity have been proposed, and numerous complexity institutes and departments have sprung up around the world. The Santa Fe Institute is arguably the most famous of them.

In anthropology

There is an ongoing dispute as to whether anthropology is intrinsically holistic. Supporters of this concept consider anthropology holistic in two senses. First, it is concerned with all human beings across times and places, and with all dimensions of humanity (evolutionary, biophysical, sociopolitical, economic, cultural, psychological, etc.) Further, many academic programs following this approach take a "four-field" approach to anthropology that encompasses physical anthropology, archeology, linguistics, and cultural anthropology or social anthropology.

Some leading anthropologists disagree, and consider anthropological holism to be an artifact from 19th century social evolutionary thought that inappropriately imposes scientific positivism upon cultural anthropology.

The term "holism" is additionally used within social and cultural anthropology to refer to an analysis of a society as a whole which refuses to break society into component parts. One definition says: "as a methodological ideal, holism implies ... that one does not permit oneself to believe that our own established institutional boundaries (e.g. between politics, sexuality, religion, economics) necessarily may be found also in foreign societies."[2]

In branding

A holistic brand (also holistic branding) is considering the entire brand or image of the company. For example a universal brand image across all countries, including everything from advertising styles to the stationery the company has made, to the company colours.

In ecology

Ecology is one of the most important applications of holism, as it tries to include biological, chemical, physical and economic views in a given area. The complexity grows with the area, so that it is necessary to reduce the characteristic of the view in other ways, for example to a specific time of duration.

John Muir, Scots born early conservationist,[3] wrote "When we try to pick out anything by itself we find it hitched to everything else in the Universe".

More information is to be found in the field of systems ecology, a cross-disciplinary field influenced by general systems theory.

The Earth seen from Apollo 17.

In economics

With roots in Schumpeter, the evolutionary approach might be considered the holist theory in economics. They share certain language from the biological evolutionary approach. They take into account how the innovation system evolves over time. Knowledge and know-how, know-who, know-what and know-why are part of the whole business economics. Knowledge can also be tacit, as described by Michael Polanyi. These models are open, and consider that it is hard to predict exactly the impact of a policy measure. They are also less mathematical.

In philosophy

In philosophy, any doctrine that emphasizes the priority of a whole over its parts is holism. Some suggest that such a definition owes its origins to a non-holistic view of language and places it in the reductivist camp. Alternately, a 'holistic' definition of holism denies the necessity of a division between the function of separate parts and the workings of the 'whole'. It suggests that the key recognizable characteristic of a concept of holism is a sense of the fundamental truth of any particular experience. This exists in contradistinction to what is perceived as the reductivist reliance on inductive method as the key to verification of its concept of how the parts function within the whole.

In the philosophy of language this becomes the claim, called semantic holism, that the meaning of an individual word or sentence can only be understood in terms of its relations to a larger body of language, even a whole theory or a whole language. In the philosophy of mind, a mental state may be identified only in terms of its relations with others. This is often referred to as "content holism" or "holism of the mental". This notion involves the philosophies

of such figures as Frege, Wittgenstein, and Quine.[4]

Epistemological and confirmation holism are mainstream ideas in contemporary philosophy. Ontological holism was espoused by David Bohm in his theory[5] on The Implicate Order.

Applications

Agriculture

There are several newer methods in agricultural science such as permaculture and holistic planned grazing that integrate ecology and social sciences with food production. Organic farming is sometimes considered a holistic approach. According to the USDA, "Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony"..."The primary goal of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people."

Architecture

Architecture is often argued by design academics and those practicing in design to be a holistic enterprise.[6] Used in this context, holism tends to imply an all-inclusive design perspective. This trait is considered exclusive to architecture, distinct from other professions involved in design projects.

Education reform

The Taxonomy of Educational Objectives identifies many levels of cognitive functioning, which can be used to create a more holistic education. In authentic assessment, rather than using computers to score multiple choice tests, a standards based assessment uses trained scorers to score open-response items using holistic scoring methods.[7] In projects such as the North Carolina Writing Project, scorers are instructed not to count errors, or count numbers of points or supporting statements. The scorer is instead instructed to judge holistically whether "as a whole" is it more a "2" or a "3". Critics question whether such a process can be as objective as computer scoring, and the degree to which such scoring methods can result in different scores from different scorers.

Medicine

In primary care the term "holistic," has been used to describe approaches that take into account social considerations and other intuitive judgements.[8] The term holism, and so called approaches, appear in psychosomatic medicine in the 1970s, when they were considered one possible way to conceptualize psychosomatic phenomena. Instead of charting one-way causal links from psyche to soma, or vice-versa, it aimed at a systemic model, where multiple biological, psychological and social factors were seen as interlinked.

Other, alternative approaches in the 1970s were psychosomatic and somatopsychic approaches, which concentrated on causal links only from psyche to soma, or from soma to psyche, respectively.[] At present it is commonplace in psychosomatic medicine to state that psyche and soma cannot really be separated for practical or theoretical purposes.[*citation needed*] A disturbance on any level - somatic, psychic, or social - will radiate to all the other levels, too. In this sense, psychosomatic thinking is similar to the biopsychosocial model of medicine.[*citation needed*]

Many alternative medicine practitioners adopt a holistic approach to healing.

History

The term 'holism' was coined in 1926 by Jan Smuts, a South African statesman, in his book, Holism and Evolution.[9] Smuts defined holism as "The tendency in nature to form wholes that are greater than the sum of the parts through creative evolution."[10]

The idea has ancient roots. Examples of holism can be found throughout human history and in the most diverse socio-cultural contexts, as has been confirmed by many ethnological studies. The French Protestant missionary, Maurice Leenhardt coined the term cosmomorphism to indicate the state of perfect symbiosis with the surrounding environment which characterized the culture of the Melanesians of New Caledonia. For these people, an isolated individual is totally indeterminate, indistinct and featureless until he can find his position within the natural and social world in which he is inserted. The confines between the self and the world are annulled to the point that the material body itself is no guarantee of the sort of recognition of identity which is typical of our own culture.[11][12]

However, the concept of holism also played a pivotal role in Spinoza's philosophy[13][14] and more recently in that of Hegel[15][16] and Husserl.[17][18]

Religion

Judaism

> *Prior to Creation, there was only the infinite Or Ein Sof filling all existence...He contracted (in Hebrew "tzimtzum") Himself in the point at the center, in the very center of His light... After this tzimtzum.... In the space of that void He emanated, created, formed and made all the worlds. (Etz Chaim, Arizal, Heichal A"K, anaf 2)*
>
> —Rabbi Moshe Miller, Safed, Kosher Kabbala Online.[19]

"The Kabbalah Tree" (1985); oil on canvas by the Italian artist Davide Tonato

Jewish Halacha

Judaism classically has no distinction in its *halakha* (the collective body of religious laws for Jews) between religious and ostensibly non-religious life. Holistically, Jewish religious tradition does not differentiate to a larger extend between religious, national, racial, or ethnic identities.[20] Jewish tradition guides religious practices and ascends all aspects of day-to-day life towards an ethical way of living.

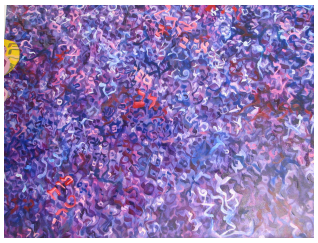
Kosher Kabbalah

Kosher Jewish Kabbalah, especially the Zohar and the Kabbalah of the Arizal, teaches *Tzimtzum*: inside the endless, omnipotent existence beyond space and time of the holistic oneness of God, He created our world and existence, He emanated the emanated ..

> In the beginning of God's creation of the heavens and the earth
>
> — Gen 1:1-20 [21]

In the holistic sense this means, that there would be nothing outside of God Ha-Makom (המקום lit. "the place", "the omnipresent"), in which our finite and seemingly independent world exists. In a holistic unity of opposites, God in Judaism is both immanent and transcendent.

Hegel's holism



"Otot" (literally signs letters), kabbalistic painting of the supernal illumination of Hebrew letters in Creation; oil on canvas by David Rakia.

Hegel rejected "the fundamentally atomistic conception of the object," (Stern, 38) arguing that "individual objects exist as manifestations of indivisible substance-universals, which cannot be reduced to a set of properties or attributes; he therefore holds that the object should be treated as an ontologically primary whole." (Stern, 40) In direct opposition to Kant, therefore, "Hegel insists that the unity we find in our experience of the world is not constructed by us out of a plurality of intuitions." (Stern, 40) In "his ontological scheme a concrete individual is not reducible to a plurality of sensible properties, but rather exemplifies a substance universal." (Stern, 41) His point is that it is "a mistake to treat an organic substance like blood as nothing more than a compound of unchanging chemical elements, that can be separated and united without being fundamentally altered." (Stern, 103) In Hegel's view, a substance like blood is thus "more of an organic unity and cannot be understood as just an external composition of the sort of distinct substances that were discussed at the level of chemistry." (Stern, 103) Thus in Hegel's view, blood is blood and cannot be successfully reduced to what we consider are its component parts; we must view it as a whole substance entire unto itself. This is most certainly a fundamentally holistic view.[22]

In sociology

Émile Durkheim developed a concept of holism which he set as opposite to the notion that a society was nothing more than a simple collection of individuals. In more recent times, Louis Dumont [23] has contrasted "holism" to "individualism" as two different forms of societies. According to him, modern humans live in an individualist society, whereas ancient Greek society, for example, could be qualified as "holistic", because the individual found identity in the whole society. Thus, the individual was ready to sacrifice himself or herself for his or her community, as his or her life without the *polis* had no sense whatsoever.

In psychology of perception

A major holist movement in the early twentieth century was gestalt psychology. The claim was that perception is not an aggregation of atomic sense data but a field, in which there is a figure and a ground. Background has holistic effects on the perceived figure. Gestalt psychologists included Wolfgang Koehler, Max Wertheimer, Kurt Koffka. Koehler claimed the perceptual fields corresponded to electrical fields in the brain. Karl Lashley did experiments with gold foil pieces inserted in monkey brains purporting to show that such fields did not exist. However, many of the perceptual illusions and visual phenomena exhibited by the gestaltists were taken over (often without credit) by later perceptual psychologists. Gestalt psychology had influence on Fritz Perls' gestalt therapy, although some old-line gestaltists opposed the association with counter-cultural and New Age trends later associated with gestalt therapy. Gestalt theory was also influential on phenomenology. Aron Gurwitsch wrote on the role of the field of consciousness in gestalt theory in relation to phenomenology. Maurice Merleau-Ponty made much use of holistic psychologists such as work of Kurt Goldstein in his "Phenomenology of Perception."

In teleological psychology

Alfred Adler believed that the individual (an integrated whole expressed through a self-consistent unity of thinking, feeling, and action, moving toward an unconscious, fictional final goal), must be understood within the larger wholes of society, from the groups to which he belongs (starting with his face-to-face relationships), to the larger whole of mankind. The recognition of our social embeddedness and the need for developing an interest in the welfare of others, as well as a respect for nature, is at the heart of Adler's philosophy of living and principles of psychotherapy.

Edgar Morin, the French philosopher and sociobiologist, can be considered a holist based on the transdisciplinary nature of his work.

Mel Levine, M.D., author of *A Mind at a Time*,[24] and co-founder (with Charles R. Schwab) of the not-for-profit organization All Kinds of Minds, can be considered a holist based on his view of the 'whole child' as a product of many systems and his work supporting the educational needs of children through the management of a child's educational profile as a whole rather than isolated weaknesses in that profile.

In theological anthropology

In theological anthropology, which belongs to theology and not to anthropology, holism is the belief that the nature of humans consists of an ultimately divisible[*citation needed*] union of components such as body, soul and spirit.

In theology

Holistic concepts are strongly represented within the thoughts expressed within Logos (per Heraclitus), Panentheism and Pantheism.

In neurology

A lively debate has run since the end of the 19th century regarding the functional organization of the brain. The holistic tradition (e.g., Pierre Marie) maintained that the brain was a homogeneous organ with no specific subparts whereas the localizationists (e.g., Paul Broca) argued that the brain was organized in functionally distinct cortical areas which were each specialized to process a given type of information or implement specific mental operations. The controversy was epitomized with the existence of a language area in the brain, nowadays known as the Broca's area.[25]

Notes

[1] von Bertalanffy 1971, p. 54.

[2] anthrobase definition of holism (http://www.anthrobase.com/Dic/eng/def/holism.htm)

[3] Reconnecting with John Muir By Terry Gifford, University of Georgia, 2006

[4] *Holism,* The Basics of Philosophy (http://www.philosophybasics.com/branch_holism.html)

[5] Bohm, D. (1980). *Wholeness and the Implicate Order*. London: Routledge. ISBN 0-7100-0971-2

[6] Holm, Ivar (2006). *Ideas and Beliefs in Architecture: How attitudes, orientations, and underlying assumptions shape the built environment*. Oslo School of Architecture and Design. ISBN 82-547-0174-1.

[7] Rubrics (Authentic Assessment Toolbox) "So, when might you use a holistic rubric? Holistic rubrics tend to be used when a quick or gross judgment needs to be made" (http://jonathan.mueller.faculty.noctrl.edu/toolbox/rubrics.htm)

[8] Julian Tudor Hart (2010) *The Political Economy of Health Care* (http://books.google.com/books?id=h5_6-NeAqcsC&pg=PA258) pp.106, 258

[9] Jan Smuts (1927). Holism and Evolution. London: McMillan and Co Limited. p. 88.

[10] Oxford English Dictionary (3rd ed.). Oxford University Press. September 2005.

[11] Anne Bihan, *The Writer, a Man Without Qualities,* Literature and Identity in New Caledonia (http://www.lehman.cuny.edu/ile.en.ile/paroles/bihan_writer.html)

[12] Susan Rasmussen, *Personahood, Self, Difference, and Dialogue (Commentary on Chaudhary),* International Journal for Dialogical Science, Fall, 2008, Vol. 3, No. 1, 31-54 (http://ijds.lemoyne.edu/journal/3_1/pdf/IJDS.3.1.03.Rasmussen.pdf)

[13] Charles Huenemann, *Interpreting Spinoza: Critical Essays,* Cambridge: Cambridge University Press, 2008, p.41

[14] Eccy De Jonge, *Spinoza and Deep Ecology: Challenging Traditional Approaches to Environmentalism,* UK: Ashgate Publishing, 2003, p.65

[15] Robert Stern, *Hegel, Kant and the Structure of the Object,* London: Routledge, 1990, p.6 & p.135

[16] Merold Westphal, *Hegel, Freedom, and Modernity,* New York: SUNY, 1992, pp.79-81, & p.86

[17] Michael Esfield, *Holism in Philosophy of Mind and Philosophy of Physics,* Springer, 2001, p.7

[18] Johanna Maria Tito, *Logic in the Husserlian Context,* Northwestern University Press, 1990, p.245

[19] *The Great Constriction* (http://www.kabbalaonline.org/Safedteachings/sfari/Ari_Basics_2_1st_Constriction.asp)

[20] Hershel Edelheit, Abraham J. Edelheit, History of Zionism: A Handbook and Dictionary (http://www.questia.com/library/book/history-of-zionism-a-handbook-and-dictionary-by-abfaham-j-edelheit-hershel-edelheit.jsp), p.3, citing Solomon Zeitlin, *The Jews. Race, Nation, or Religion?* (Philadelphia: Dropsie College Press, 1936).

[21] http://tools.wmflabs.org/bibleversefinder/?book=Gen&verse=1:1-20&src=JPR

[22] Robert Stern, *Hegel, Kant and the Structure of the Object,* London: Routledge Chapman Hall, 1990 (full text download) (http://www.mediafire.com/?rxmn2t1votf)

[23] Louis Dumont, 1984

[24] (Simon & Schuster, 2002)

[25] 'Does Broca's area exist?': Christofredo Jakob's 1906 response to Pierre Marie's holistic stance. Kyrana Tsapkini, Ana B. Vivas, Lazaros C. Triarhou. *Brain and Language*, Volume 105, Issue 3, June 2008, Pages 211-219, http://dx.doi.org/10.1016/j.bandl.2007.07.124

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External links

- Brief explanation of Koestler's derivation of "holon" (http://www.mech.kuleuven.be/pma/project/goa/hms-int/history.html)
- Holism in nature (http://www.ecotao.com/holism/) – and coevolution in ecosystems
- Stanford Encyclopedia of Philosophy article: "Holism and Nonseparability in Physics" (http://plato.stanford.edu/entries/physics-holism/)
- James Schombert of University of Oregon Physics Dept on quantum holism (http://abyss.uoregon.edu/~js/glossary/holism.html)
- Theory of sociological holism (http://www.twow.net/ObjText/OtkCcCE.htm) from "World of Wholeness"

Atomism

Atomism (from Greek ἄτομον, *atomon*, i.e. "uncuttable", "indivisible"[1]) is a natural philosophy that developed in several ancient traditions. The atomists theorized that nature consists of two fundamental principles: *atom* and *void*. Unlike their modern scientific namesake in atomic theory, philosophical atoms come in an infinite variety of shapes and sizes, each indestructible, immutable and surrounded by a void where they collide with the others or hook together forming a cluster. Clusters of different shapes, arrangements, and positions give rise to the various macroscopic substances in the world.[2][3]

References to the concept of atomism and its atoms are found in ancient India and ancient Greece. In India the Jain, Ajivika and Carvaka schools of atomism may date back to the 6th century BCE.[4] The Nyaya and Vaisheshika schools later developed theories on how atoms combined into more complex objects.[5] In the West, atomism emerged in the 5th century BCE with Leucippus and Democritus.[6] Whether Indian culture influenced Greek or vice versa or whether both evolved independently is a matter of dispute.

The particles of chemical matter for which chemists and other natural philosophers of the early 19th century found experimental evidence were thought to be indivisible, and therefore were given the name "atom", long used by the atomist philosophy.

However, in the 20th century, the "atoms" of the chemists were found to be composed of even smaller entities: electrons, neutrons, and protons, and further experiments showed that protons and neutrons are made of quarks. Although the connection to historical atomism is at best tenuous, elementary particles have thus become a modern analog of philosophical atoms, despite the misnomer in chemistry.

Reductionism

Philosophical atomism is a reductive argument: not only that everything is composed of atoms and void, but that nothing they compose really exists: the only things that really exist are atoms ricocheting off each other mechanistically in an otherwise empty void. Atomism stands in contrast to a substance theory wherein a prime material continuum remains qualitatively invariant under division (for example, the ratio of the four classical elements would be the same in any portion of a homogeneous material).

Indian Buddhists, such as Dharmakirti and others, also developed distinctive theories of atomism, for example, involving momentary (instantaneous) atoms, that flash in and out of existence (Kalapas).

Greek atomism

In the 5th century BC, Leucippus and his pupil Democritus proposed that everything is composed of fundamental and invariant atoms, in order to reconcile two conflicting schools of thought on the nature of reality. On one side was Heraclitus, who believed that the nature of all existence is change. On the other side was Parmenides, who believed instead that all change is illusion.

Parmenides denied the existence of motion, change and void. He believed all existence to be a single, all-encompassing and unchanging monism, and that change and motion were mere illusions. Parmenides explicitly rejected sensory experience as a path to understanding the world, favoring pure reason. He argued against the existence of void, equating it with non-being (i.e. nothing).

In response, Democritus provides a reductive account of changeable *figure, order and position* as the aggregates of *irreducible* unchanging atoms.

The work of Democritus only survives in secondhand reports, some of which are unreliable or conflicting. Much of the best evidence of Democritus' theory of atomism is reported by Aristotle in his discussions of Democritus' and Plato's contrasting views on the types of indivisibles composing the natural world.[7]

Geometry and atoms

Element	Polyhedron		Number of Faces	Number of Triangles
Fire	Tetrahedron (Animation)		4	24
Air	Octahedron (Animation)		8	48
Water	Icosahedron (Animation)		20	120
Earth	Cube (Animation)		6	24
Geometrical Simple Bodies According to Plato				

Plato (c. 427 — c. 347 BC), were he familiar with the atomism of Democritus, would have objected to its mechanistic materialism. He argued that atoms just crashing into other atoms could never produce the beauty and form of the world. In Plato's *Timaeus*, (28B – 29A) the character of Timeaus insisted that the cosmos was not eternal but was created, although its creator framed it after an eternal, unchanging model.

One part of that creation were the four simple bodies of fire, air, water, and earth. But Plato did not consider these corpuscles to be the most basic level of reality, for in his view they were made up of an unchanging level of reality, which was mathematical. These simple bodies were geometric solids, the faces of which were, in turn, made up of triangles. The square faces of the cube were each made up of four isosceles right-angled triangles and the triangular faces of the tetrahedron, octahedron, and icosahedron were each made up of six right-angled triangles.

He postulated the geometric structure of the simple bodies of the four elements as summarized in the table to the right. The cube, with its flat base and stability, was assigned to earth; the tetrahedron was assigned to fire because its penetrating points and sharp edges made it mobile. The points and edges of the octahedron and icosahedron were blunter and so these less mobile bodies were assigned to air and water. Since the simple bodies could be decomposed into triangles, and the triangles reassembled into atoms of different elements, Plato's model offered a plausible account of changes among the primary substances.

The rejection of atoms

Sometime before 330 BC Aristotle asserted that the elements of fire, air, earth, and water were not made of atoms, but were continuous. Aristotle considered the existence of a void, which was required by atomic theories, to violate physical principles. Change took place not by the rearrangement of atoms to make new structures, but by transformation of matter from what it was in potential to a new actuality. (This theory is called hylomorphism.) A piece of wet clay, when acted upon by a potter, takes on its potential to be an actual drinking mug. Aristotle has often been criticized for rejecting atomism, but in ancient Greece the atomic theories of Democritus remained "pure speculations, incapable of being put to any experimental test. Granted that atomism was, in the long run, to prove far more fruitful than any qualitative theory of matter, in the short run the theory that Aristotle proposed must have seemed in some respects more promising".WP:POV

Later ancient atomism

Epicurus (341–270) studied atomism with Nausiphanes who had been a student of Democritus. Although Epicurus was certain of the existence of atoms and the void, he was less sure we could adequately explain specific natural phenomena such as earthquakes, lightning, comets, or the phases of the Moon (Lloyd 1973, 25–6). Few of Epicurus's writings survive and those that do reflect his interest in applying Democritus's theories to assist people in taking responsibility for themselves and for their own happiness—since he held there are no gods around that can help

them. He understood gods' role as moral ideals.

His ideas are also represented in the works of his follower Lucretius, who wrote *On the Nature of Things*. This scientific work in poetic form illustrates several segments of Epicurean theory on how the universe came into its current stage and it shows that the phenomena we perceive are actually composite forms. The atoms and the void are eternal and in constant motion. Atomic collisions create objects, which are still composed of the same eternal atoms whose motion for a while is incorporated into the created entity. Human sensations and meteorological phenomena are also explained by Lucretius in terms of atomic motion.

Atomism and ethics

Some later philosophers attributed the idea that man created gods; the gods did not create man to Democritus. For example, Sextus Empiricus noted:

> Some people think that we arrived at the idea of gods from the remarkable things that happen in the world. Democritus ... says that the people of ancient times were frightened by happenings in the heavens such as thunder, lightning, ..., and thought that they were caused by gods.

Three hundred years after Epicurus, Lucretius in his epic poem *On the Nature of Things* would depict him as the hero who crushed the monster Religion through educating the people in what was possible in the atoms and what was *not* possible in the atoms. However, Epicurus expressed a non-aggressive attitude characterized by his statement: "The man who best knows how to meet external threats makes into one family all the creatures he can; and those he can not, he at any rate does not treat as aliens; and where he finds even this impossible, he avoids all dealings, and, so far as is advantageous, excludes them from his life." [8]

The exile of atomism

While Aristotelian philosophy eclipsed the importance of the atomists, their work was still preserved and exposited through commentaries on the works of Aristotle. In the 2nd century, Galen (AD 129–216) presented extensive discussions of the Greek atomists, especially Epicurus, in his Aristotle commentaries. According to historian of atomism Joshua Gregory, there was no serious work done with atomism from the time of Galen until Gassendi and Descartes resurrected it in the 17th century; "the gap between these two 'modern naturalists' and the ancient Atomists marked "the exile of the atom" and "it is universally admitted that the Middle Ages had abandoned Atomism, and virtually lost it." However, scholars still had Aristotle's critiques of atomism, and it seems unlikely that all ideas of atomism could have been lost in the West. In the Medieval universities there were rare expressions of atomistic philosophy. For example, in the 14th century Nicholas of Autrecourt considered that matter, space, and time were all made up of indivisible atoms, points, and instants and that all generation and corruption took place by the rearrangement of material atoms. The similarities of his ideas with those of al-Ghazali suggest that Nicholas may have been familiar with Ghazali's work, perhaps through Averroes' refutation of it (Marmara, 1973–74).

Still, "the exile of the atom" is an appropriate description of the interim between the ancient Greeks and the revival of Western atomism in the 16th century, in view of atomism's success elsewhere during that time. If the atom was in exile from the west, it was in India and Islam that atomistic traditions continued.

Indian atomism

The Indian atomistic position, like many movements in Indian Philosophy and Mathematics, starts with an argument from Linguistics. The Vedic etymologist and grammarian Yaska (c. 7th century BC) in his Nirukta, in dealing with models for how linguistic structures get to have their meanings, takes the atomistic position that words are the "primary" carrier of meaning – i.e. words have a preferred ontological status in defining meaning. This position was to be the subject of a fierce debate in the Indian tradition from the early Christian era till the 18th century, involving different philosophers from the Nyaya, Mimamsa and Buddhist schools.

In the pratishakhya text (c. 2nd century BCE), the gist of the controversy was stated cryptically in the sutra form as "saMhitA pada-prakr^tiH". According to the atomist view, the words (*pada*) would be the primary elements (*prakrti*) out of which the sentence is constructed, while the holistic view considers the sentence as the primary entity, originally "given" in its context of utterance, and the words are arrived at only through analysis and abstraction.[9]

These two positions came to be called *a-kShaNDa-pakSha* (indivisibility or sentence-holism), a position developed later by Bhartrihari (c. 500 AD), vs. *kShaNDa-pakSha* (atomism), a position adopted by the Mimamsa and Nyaya schools (Note: *kShanDa* = fragmented; "a-kShanDa" = whole).

Between the 5th and 3rd centuries BC, the atom (anu or aṇor) is mentioned in the Bhagavad Gita (Chapter 8, Verse 9):

kaviṁ purāṇam anuśāsitāram ***aṇor*** *aṇīyāṁsam anusmared yaḥ sarvasya dhātāram acintya-rūpam āditya-varṇaṁ tamasaḥ parastāt*
One meditates on the omniscient, primordial, the controller, smaller than the atom, yet the maintainer of everything; whose form is inconceivable, resplendent like the sun and totally transcendental to material nature

The ancient "shAshvata-vAda" doctrine of eternalism, which held that elements are eternal, is also suggestive of a possible starting point for atomism (Gangopadhyaya 1981).

There has been some debate among scholars as to the origin of Indian atomism; the general consensus is that the Indian and Greek versions of atomism developed independently. However, there is some doubt on this, given the similarities between Indian atomism and Greek atomism and the proximity of India to scholastic Europe, as well as the account, related by Diogenes Laertius, of Democritus "making acquaintance with the Gymnosophists in India".[10] The atomist position had transcended language into epistemology by the time that Nyaya–Vaisesika, Buddhist and Jaina theology were developing mature philosophical positions.

Will Durant wrote in *Our Oriental Heritage*:

> "Two systems of Indian thought propound physical theories suggestively similar to those of Greece. Kanada, founder of the Vaisheshika philosophy, held that the world was composed of atoms as many in kind as the various elements. The Jains more nearly approximated to Democritus by teaching that all atoms were of the same kind, producing different effects by diverse modes of combinations. Kanada believed light and heat to be varieties of the same substance; Udayana taught that all heat comes from the sun; and Vachaspati, like Newton, interpreted light as composed of minute particles emitted by substances and striking the eye."

Indian atomism in the Middle Ages was still mostly philosophical and/or religious in intent, though it was also scientific. Because the "infallible Vedas", the oldest Hindu texts, do not mention atoms (though they do mention elements), atomism was not orthodox in many schools of Hindu philosophy, although accommodationist interpretations or assumptions of lost text justified the use of atomism for non-orthodox schools of Hindu thought. The Buddhist and Jaina schools of atomism however, were more willing to accept the ideas of atomism.

Nyaya–Vaisesika school

The Nyaya–Vaisesika school developed one of the earliest forms of atomism; scholars date the Nyaya and Vaisesika texts from the 6th to 1st centuries BC. Like the Buddhist atomists, the Vaisesika had a pseudo-Aristotelian theory of atomism. They posited the four elemental atom types, but in Vaisesika physics atoms had 24 different possible qualities, divided between general extensive properties and specific (intensive) properties. Like the Jaina school, the Nyaya–Vaisesika atomists had elaborate theories of how atoms combine. In both Jaina and Vaisesika atomism, atoms first combine in pairs (dyads), and then group into trios of pairs (triads), which are the smallest visible units of matter.

Buddhist school

The Buddhist atomists had very qualitative, Aristotelian-style atomic theory. According to ancient Buddhist atomism, which probably began developing before the 4th century BC, there are four kinds of atoms, corresponding to the standard elements. Each of these elements has a specific property, such as solidity or motion, and performs a specific function in mixtures, such as providing support or causing growth. Like the Hindu Jains, the Buddhists were able to integrate a theory of atomism with their theological presuppositions. Later Indian Buddhist philosophers, such as Dharmakirti and Dignāga, considered atoms to be point-sized, durationless, and made of energy.

Jaina school

The most elaborate and well-preserved Indian theory of atomism comes from the philosophy of the Jaina school, dating back to at least the 6th century BC. Some of the Jain texts that refer to matter and atoms are Pancastikayasara, Kalpasutra, Tattvarthasutra and Pannavana Suttam. The Jains envisioned the world as consisting wholly of atoms, except for souls. Paramāṇus or atoms were considered as the basic building blocks of all matter. Their concept of atoms was very similar to classical atomism, differing primarily in the specific properties of atoms. Each atom, according to Jain philosophy, has one kind of taste, one smell, one color, and two kinds of touch, though it is unclear what was meant by "kind of touch". Atoms can exist in one of two states: subtle, in which case they can fit in infinitesimally small spaces, and gross, in which case they have extension and occupy a finite space. Certain characteristics of Paramāṇu correspond with that sub-atomic particles. For example Paramāṇu is characterized by continuous motion either in a straight line or in case of attractions from other Paramāṇus, it follows a curved path. This corresponds with the description of orbit of electrons across the Nucleus. Ultimate particles are also described as particles with positive (Snigdha i.e. smooth charge) and negative (Rūksa – rough) charges that provide them the binding force. Although atoms are made of the same basic substance, they can combine based on their eternal properties to produce any of six "aggregates", which seem to correspond with the Greek concept of "elements": earth, water, shadow, sense objects, karmic matter, and unfit matter. To the Jains, karma was real, but was a naturalistic, mechanistic phenomenon caused by buildups of subtle karmic matter within the soul. They also had detailed theories of how atoms could combine, react, vibrate, move, and perform other actions, all of which were thoroughly deterministic.

Calculation of Time, from parama-aṇuh (atom) explained in Srimad-Bhagavatam

The material manifestation's ultimate particle, which is indivisible and not formed into a body, is called the atom. It exists always as an invisible identity, even after the dissolution of all forms. The material body is but a combination of such atoms, but it is misunderstood by the common man.

Atoms are the ultimate state of the manifest universe. When they stay in their own forms without forming different bodies, they are called the unlimited oneness. There are certainly different bodies in physical forms, but the atoms themselves form the complete manifestation.

One can estimate time by measuring the movement of the atomic combination of bodies. Time is the potency of the almighty Personality of Godhead, Hari, who controls all physical movement although He is not visible in the physical world.

The division of gross time is calculated as follows: two atoms make one double atom, and three double atoms make one hexatom. This hexatom is visible in the sunshine which enters through the holes of a window screen. One can clearly see that the hexatom goes up towards the sky.

The atom is described as an invisible particle, but when six such atoms combine together, they are called a trasarenu, and this is visible in the sunshine pouring through the holes of a window screen.

“Excerpted from “Srimad-Bhagavatam” by A.C. Bhaktivedanta Swami Prabhupada, courtesy of the Bhaktivedanta Book Trust International, www.Krishna.com.”

prabhupadabooks.com [11]

Islamic atomism

Atomistic philosophies are found very early in Islamic philosophy and was influenced by earlier Greek and to some extent Indian philosophy. Like both the Greek and Indian versions, Islamic atomism was a charged topic that had the potential for conflict with the prevalent religious orthodoxy, but it was instead more often favoured by orthodox Islamic theologians. It was such a fertile and flexible idea that, as in Greece and India, it flourished in some leading schools of Islamic thought.

Asharite atomism

The most successful form of Islamic atomism was in the Asharite school of Islamic theology, most notably in the work of the theologian al-Ghazali (1058–1111). In Asharite atomism, atoms are the only perpetual, material things in existence, and all else in the world is "accidental" meaning something that lasts for only an instant. Nothing accidental can be the cause of anything else, except perception, as it exists for a moment. Contingent events are not subject to natural physical causes, but are the direct result of God's constant intervention, without which nothing could happen. Thus nature is completely dependent on God, which meshes with other Asharite Islamic ideas on causation, or the lack thereof (Gardet 2001). Al-Ghazali also used the theory to support his theory of occasionalism. In a sense, the Asharite theory of atomism has far more in common with Indian atomism than it does with Greek atomism.

Averroism

Other traditions in Islam rejected the atomism of the Asharites and expounded on many Greek texts, especially those of Aristotle. An active school of philosophers in Spain, including the noted commentator Averroes (AD 1126–1198) explicitly rejected the thought of al-Ghazali and turned to an extensive evaluation of the thought of Aristotle. Averroes commented in detail on most of the works of Aristotle and his commentaries did much to guide the interpretation of Aristotle in later Jewish and Christian scholastic thought.

Atomic renaissance

With few exceptions, much of the curriculum in the universities of Europe was based on Aristotle for most of the Middle Ages (Kargon 1966). Scholasticism was standard science in the time of Isaac Newton, but in the 17th century, a renewed interest in Epicurian atomism and Corpuscularianism as a hybrid or an alternative to Aristotelian physics had begun to mount outside the classroom. The main figures in the rebirth of atomism were René Descartes, Pierre Gassendi, and Robert Boyle, as well as other notable figures.

One of the first groups of atomists in England was a cadre of amateur scientists known as the Northumberland circle, led by Henry Percy (1585–1632), the 9th Earl of Northumberland. Although they published little of account, they helped to disseminate atomistic ideas among the burgeoning scientific culture of England, and may have been particularly influential to Francis Bacon, who became an atomist around 1605, though he later rejected some of the claims of atomism. Though they revived the classical form of atomism, this group was among the scientific avant-garde: the Northumberland circle contained nearly half of the confirmed Copernicans prior to 1610 (the year of Galileo's The Starry Messenger). Other influential atomists of late 16th and early 17th centuries include Giordano Bruno, Thomas Hobbes (who also changed his stance on atomism late in his career), and Thomas Hariot. A number of different atomistic theories were blossoming in France at this time, as well (Clericuzio 2000).

Galileo Galilei (1564–1642) was an advocate of atomism in his 1612, *Discourse on Floating Bodies* (Redondi 1969). In The Assayer, Galileo offered a more complete physical system based on a corpuscular theory of matter, in which all phenomena—with the exception of sound—are produced by "matter in motion". Galileo identified some basic

problems with Aristotelian physics through his experiments. He utilized a theory of atomism as a partial replacement, but he was never unequivocally committed to it. For example, his experiments with falling bodies and inclined planes led him to the concepts of circular inertial motion and accelerating free-fall. The current Aristotelian theories of impetus and terrestrial motion were inadequate to explain these. While atomism did not explain the law of fall either, it was a more promising framework in which to develop an explanation because motion was conserved in ancient atomism (unlike Aristotelian physics).

René Descartes' (1596–1650) "mechanical" philosophy of corpuscularism had much in common with atomism, and is considered, in some senses, to be a different version of it. Descartes thought everything physical in the universe to be made of tiny *vortices* of matter. Like the ancient atomists, Descartes claimed that sensations, such as taste or temperature, are caused by the shape and size of tiny pieces of matter. The main difference between atomism and Descartes' concept was the existence of the void. For him, there could be no vacuum, and all matter was constantly swirling to prevent a void as corpuscles moved through other matter. Another key distinction between Descartes' view and classical atomism is the mind/body duality of Descartes, which allowed for an independent realm of existence for thought, soul, and most importantly, God. Gassendi's concept was closer to classical atomism, but with no atheistic overtone.

Pierre Gassendi (1592–1655) was a Catholic priest from France who was also an avid natural philosopher. He was particularly intrigued by the Greek atomists, so he set out to "purify" atomism from its heretical and atheistic philosophical conclusions (Dijksterhius 1969). Gassendi formulated his atomistic conception of mechanical philosophy partly in response to Descartes; he particularly opposed Descartes' reductionist view that only purely mechanical explanations of physics are valid, as well as the application of geometry to the whole of physics (Clericuzio 2000).

Corpuscularianism

Corpuscularianism is similar to atomism, except that where atoms were supposed to be indivisible, corpuscles could in principle be divided. In this manner, for example, it was theorized that mercury could penetrate into metals and modify their inner structure, a step on the way towards transmutative production of gold. Corpuscularianism was associated by its leading proponents with the idea that some of the properties that objects appear to have are artifacts of the perceiving mind: 'secondary' qualities as distinguished from 'primary' qualities.[12] Not all corpuscularianism made use of the primary-secondary quality distinction, however. An influential tradition in medieval and early modern alchemy argued that chemical analysis revealed the existence of robust corpuscles that retained their identity in chemical compounds (to use the modern term). William R. Newman has dubbed this approach to matter theory "chymical atomism," and has argued for its significance to both the mechanical philosophy and to the chemical atomism that emerged in the early 19th century.[13] Corpuscularianism stayed a dominant theory over the next several hundred years and retained its links with alchemy in the work of scientists such as Robert Boyle and Isaac Newton in the 17th century.[14] It was used by Newton, for instance, in his development of the corpuscular theory of light. The form that came to be accepted by most English scientists after Robert Boyle (1627–1692) was an amalgam of the systems of Descartes and Gassendi. In The Sceptical Chymist (1661), Boyle demonstrates problems that arise from chemistry, and offers up atomism as a possible explanation. The unifying principle that would eventually lead to the acceptance of a hybrid corpuscular–atomism was mechanical philosophy, which became widely accepted by physical sciences.

Atomic theory

By the late 18th century, the useful practices of engineering and technology began to influence philosophical explanations for the composition of matter. Those who speculated on the ultimate nature of matter began to verify their "thought experiments" with some repeatable demonstrations, when they could.

Roger Boscovich provided the first general mathematical theory of atomism, based on the ideas of Newton and Leibniz but transforming them so as to provide a programme for atomic physics.[15]

In 1808, John Dalton assimilated the known experimental work of many people to summarize the empirical evidence on the composition of matter. He noticed that distilled water everywhere analyzed to the same elements, hydrogen and oxygen. Similarly, other purified substances decomposed to the same elements in the same proportions by weight.

> Therefore we may conclude that the ultimate particles of all homogeneous bodies are perfectly alike in weight, figure, etc. In other words, every particle of water is like every other particle of water; every particle of hydrogen is like every other particle of hydrogen, etc.

Furthermore, he concluded that there was a unique atom for each element, using Lavoisier's definition of an element as a substance that could not be analyzed into something simpler. Thus, Dalton concluded the following.

> Chemical analysis and synthesis go no farther than to the separation of particles one from another, and to their reunion. No new creation or destruction of matter is within the reach of chemical agency. We might as well attempt to introduce a new planet into the solar system, or to annihilate one already in existence, as to create or destroy a particle of hydrogen. All the changes we can produce, consist in separating particles that are in a state of cohesion or combination, and joining those that were previously at a distance.

And then he proceeded to give a list of relative weights in the compositions of several common compounds, summarizing: [16]

> 1st. That water is a binary compound of hydrogen and oxygen, and the relative weights of the two elementary atoms are as 1:7, nearly;
>
> 2nd. That ammonia is a binary compound of hydrogen and azote nitrogen, and the relative weights of the two atoms are as 1:5, nearly...

Dalton concluded that the fixed proportions of elements by weight suggested that the atoms of one element combined with only a limited number of atoms of the other elements to form the substances that he listed.

Atomic theory controversy

Dalton's atomic theory remained controversial throughout the 19th century. Whilst the Law of definite proportion were accepted, the hypothesis that this was due to atoms was not so widely accepted. For example in 1826 when Sir Humphrey Davy presented Dalton the Royal Medal from the Royal Society, Davy said that the theory only became useful when the atomic conjecture was ignored. Sir Benjamin Collins Brodie in 1866 published the first part of his Calculus of Chemical Operations as a non atomic alternative to the Atomic Theory. He described atomic theory as a 'Thoroughly materialistic bit of joiners work'. Alexander Williamson used his Presidential Address to the London Chemical Society in 1869 to defend the Atomic Theory against its critics and doubters. This in turn led to further meetings at which the positivists again attacked the supposition that there were atoms. The matter was finally resolved in Dalton's favour in the early 20th century with the rise of atomic physics.

Notes

[1] The term 'atomism' is recorded in English since 1670–80 (*Random House Webster's Unabridged Dictionary*, 2001, "atomism").

[2] Aristotle, *Metaphysics* I, 4, 985^b 10–15.

[3] Berryman, Sylvia, "Ancient Atomism", *The Stanford Encyclopedia of Philosophy* (Fall 2008 Edition), Edward N. Zalta (ed.), http://plato.stanford.edu/archives/fall2008/entries/atomism-ancient/

[4] Thomas McEvilley, The Shape of Ancient Thought: Comparative Studies in Greek and Indian Philosophies ISBN 1-58115-203-5, Allwarth Press, 2002, p. 317-321.

[5] Richard King, Indian philosophy: an introduction to Hindu and Buddhist thought, , Edinburgh University Press, 1999, ISBN 0-7486-0954-7, pp. 105-107.

[6] The atomists, Leucippus and Democritus: fragments, a text and translation with a commentary by C.C.W. Taylor, University of Toronto Press Incorporated 1999, ISBN 0-8020-4390-9, pp. 157-158.

[7] Berryman, Sylvia, "Democritus", *The Stanford Encyclopedia of Philosophy* (Fall 2008 Edition), Edward N. Zalta (ed.), http://plato.stanford.edu/archives/fall2008/entries/democritus

[8] http://www.epicurus.net/en/principal.html

[9] McEvilley (2002), 317–320

[10] Diogenes Laertius, *Lives of the Philosophers*, ix, 35.

[11] http://"http://prabhupadabooks.com/sb/3/11/1?d=1

[12] The Mechanical Philosophy (http://www.vernonpratt.com/conceptualisations/d06bl2_1mechanical.htm) - Early modern 'atomism' ("corpuscularianism" as it was known)

[13] William R. Newman, "The Significance of 'Chymical Atomism'," in Edith Sylla and W. R. Newman, eds., *Evidence and Interpretation: Studies on Early Science and Medicine in Honor of John E. Murdoch* (Leiden: Brill, 2009), pp. 248-264 and Newman, *Atoms and Alchemy: Chymistry and the Experimental Origins of the Scientific Revolution* (Chicago: University of Chicago Press, 2006)

[14] Corpuscularianism (http://www.philosophypages.com/dy/c9.htm) - Philosophical Dictionary

[15] Lancelot Law Whyte Essay on Atomism, 1961, p 54.

[16] http://webserver.lemoyne.edu/faculty/giunta/dalton.html

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- *Dictionary of the History of Ideas*: (http://xtf.lib.virginia.edu/xtf/view?docId=DicHist/uvaBook/tei/DicHist1.xml;chunk.id=dv1-21) Atomism: Antiquity to the Seventeenth Century
- *Dictionary of the History of Ideas*: (http://xtf.lib.virginia.edu/xtf/view?docId=DicHist/uvaBook/tei/DicHist1.xml;chunk.id=dv1-22) Atomism in the Seventeenth Century
- Jonathan Schaffer, "Is There a Fundamental Level?" *Nous* 37 (2003): 498-517. (http://people.umass.edu/schaffer/papers/Fundamental.pdf) Article by a philosopher who opposes atomism
- Article on traditional Greek atomism (http://plato.stanford.edu/entries/democritus/)
- Atomism from the 17th to the 20th Century (http://plato.stanford.edu/entries/atomism-modern/) at Stanford Encyclopedia of Philosophy (http://plato.stanford.edu/)

Emergentism

In philosophy, **emergentism** is the belief in emergence, particularly as it involves consciousness and the philosophy of mind, and as it contrasts (or not) with reductionism. A property of a system is said to be emergent if it is in some sense more than the "sum" of the properties of the system's parts. An emergent property is said to be dependent on some more basic properties (and their relationships and configuration), so that it can have no separate existence. However, a degree of independence is also asserted of emergent properties, so that they are not identical to, or reducible to, or predictable from, or deducible from their bases. The different ways in which the independence requirement can be satisfied lead to variant types of emergence.

Forms of emergentism

All varieties of emergentism strive to be compatible with physicalism, the theory that the universe is composed exclusively of physical entities, and in particular with the evidence relating changes in the brain with changes in mental functioning. [Many forms of emergentism, including proponents of complex adaptive systems, do not hold a material but rather a relational or processural view of the universe. Furthermore, they view mind–body dualism as a conceptual error insofar as mind and body are merely different types of relationships.] As a theory of mind (which it is not always), emergentism differs from idealism, eliminative materialism, identity theories, neutral monism, panpsychism, and substance dualism, whilst being closely associated with property dualism. It is generally not obvious whether an emergent theory of mind embraces mental causation or must be considered epiphenomenal.

Some varieties of emergentism are not specifically concerned with the mind-body problem, and instead suggest a hierarchical or layered view of the whole of nature, with the layers arranged in terms of increasing complexity with each requiring its own special science. Typically physics is basic, with chemistry built on top of it, then biology, psychology and social sciences. Reductionists respond that the arrangement of the sciences is a matter of convenience, and that chemistry is derivable from physics (and so forth) *in principle*, an argument which gained force after the establishment of a quantum-mechanical basis for chemistry.[1]

Other varieties see mind or consciousness as specifically and anomalously requiring emergentist explanation, and therefore constitute a family of positions in the philosophy of mind. Douglas Hofstadter summarises this view as *"the soul is more than the sum of its parts"*. A number of philosophers have offered the argument that qualia constitute the hard problem of consciousness, and resist reductive explanation in a way that all other phenomena do not. In contrast, reductionists generally see the task of accounting for the possibly atypical properties of mind and of living things as a matter of showing that, contrary to appearances, such properties are indeed fully accountable in terms of the properties of the basic constituents of nature and therefore in no way genuinely atypical.

Intermediate positions are possible: for instance, some emergentists hold that emergence is neither universal nor restricted to consciousness, but applies to (for instance) living creatures, or self organising systems, or complex

systems.

Some philosophers hold that emergent properties causally interact with more fundamental levels, an idea known as downward causation. Others maintain that higher-order properties simply supervene over lower levels without direct causal interaction.

All the cases so far discussed have been synchronic, i.e. the emergent property exists simultaneously with its basis. Yet another variation operates diachronically. Emergentists of this type believe that *genuinely novel properties* can come into being, without being accountable in terms of the preceding history of the universe. (Contrast with indeterminism where it is only the *arrangement or configuration* of matter that is unaccountable). These evolution-inspired theories often have a theological aspect, as in the process philosophy of Alfred North Whitehead and Charles Hartshorne.

The concept of emergence has been applied to the theory of literature and art, history, linguistics, cognitive sciences, etc. by the teachings of Jean-Marie Grassin at the University of Limoges (v. esp.: J. Fontanille, B. Westphal, J. Vion-Dury, éds. L'Émergenceh-- Poétique de l'Émergence, en réponse aux travaux de Jean-Marie Grassin, Bern, Berlin, etc., 2011; and: the article "Emergence" in the International Dictionary of Literary Terms (DITL).

Relationship to vitalism

A refinement of vitalism may be recognized in contemporary molecular histology in the proposal that some key organising and structuring features of organisms, perhaps including even life itself, are examples of emergent processes; those in which a complexity arises, out of interacting chemical processes forming interconnected feedback cycles, that cannot fully be described in terms of those processes since the system as a whole has properties that the constituent reactions lack.

Whether emergent system properties should be grouped with traditional vitalist concepts is a matter of semantic controversy.[2] In a light-hearted millennial vein, Kirshner and Michison call research into integrated cell and organismal physiology “molecular vitalism.”

According to Emmeche *et al.* (1997):

> "On the one hand, many scientists and philosophers regard emergence as having only a pseudo-scientific status. On the other hand, new developments in physics, biology, psychology, and crossdisciplinary fields such as cognitive science, artificial life, and the study of non-linear dynamical systems have focused strongly on the high level 'collective behaviour' of complex systems, which is often said to be truly emergent, and the term is increasingly used to characterize such systems."[3]

Emmeche *et al.* (1998) state that "there is a very important difference between the vitalists and the emergentists: the vitalist's creative forces were relevant only in organic substances, not in inorganic matter. Emergence hence is creation of new properties regardless of the substance involved." "The assumption of an extra-physical vitalis (vital force, entelechy, élan vital, etc.), as formulated in most forms (old or new) of vitalism, is usually without any genuine explanatory power. It has served altogether too often as an intellectual tranquilizer or verbal sedative—stifling scientific inquiry rather than encouraging it to proceed in new directions."[4]

Examples

The first emergentist theorists used the example of water having a new property when hydrogen, H, and oxygen, O, combine to form H_2O (water). In this example there emerge such new properties as liquidity under standard conditions. (Analogous hydrides of the oxygen family, such as hydrogen sulfide, are gases). However, a better and more recent example of an emergent phenomenon, one provided by physicist Erwin Schrödinger, is found in the case of families of molecules known as isomers, which are made up of precisely the same atoms, differently arranged, which nevertheless have different physical properties. Similarly, enantiomers are molecules made up of precisely the same atoms but in mirror image arrangement: they exist in "right-handed" and "left-handed" forms which have

different properties when interacting with other molecules.

Biologists Ursula Goodenough and Terrence Deacon in their 2006 essay *The Sacred Emergence of Nature* [5] have assembled a range of examples of physical and biological emergent properties that provide the evidential basis for **emergentism** as a philosophy that comports with a modern scientific understanding of how complexity arises in the natural world, and as a philosophy that supports religious naturalism. A longer compilation of emergent forms in nature is the 2004 book by biologist Harold J. Morowitz: *The Emergence of Everything* [6].

In the game of Go, the rules stipulate various constraints on the placement and removal of playing pieces. As a consequence of this, an "emergent" pattern is that groups of pieces with two eyes are "alive" and can never be removed. This is a vital part of the game, without which it cannot be played or understood; but is not part of the rules. Similarly, in John Conway's Game of Life, some patterns of cells have striking properties — such as the ability to move or reproduce — which are not explicitly coded into the rules.

Although examples of higher level properties which are not *identical* to lower order properties are easy to find, examples where they are not *reducible to* or *predicable from* their bases are more controversial.

History

John Stuart Mill

John Stuart Mill outlined his version of emergentism in *System of Logic* (1843). Mill argued that the properties of some physical systems, such as those in which dynamic forces combine to produce simple motions, are subject to a law of nature he called the "Composition of Causes". According to Mill, emergent properties are not subject to this law, but instead amount to more than the sums of the properties of their parts.

Mill believed that various chemical reactions (poorly understood in his time) could provide examples of emergent properties, although some critics believe that modern physical chemistry has shown that these reactions can be given satisfactory reductionist explanations. For instance, it has been claimed that the whole of chemistry is, in principle, contained in the Schrödinger equation.

C. D. Broad

British philosopher C. D. Broad defended a realistic epistemology in *The Mind and its Place in Nature* (1925) arguing that emergent materialism is the most likely solution to the mind-body problem.

Broad defined emergence as follows:

> Put in abstract terms the emergent theory asserts that there are certain wholes, composed (say) of constituents A, B, and C in a relation R to each other; that all wholes composed of constituents of the same kind as A, B, and C in relations of the same kind as R have certain characteristic properties; that A, B, and C are capable of occurring in other kinds of complex where the relation is not of the same kind as R; and that the characteristic properties of the whole R(A, B, C) cannot, even in theory, be deduced from the most complete knowledge of the properties of A, B, and C in isolation or in other wholes which are not of the form R(A, B, C).

This definition amounted to the claim that mental properties would count as emergent if and only if philosophical zombies were metaphysically possible[*citation needed*]. Many philosophers take this position to be inconsistent with some formulations of psychophysical supervenience.

C. Lloyd Morgan and Samuel Alexander

Samuel Alexander's views on emergentism, argued in *Space, Time, and Deity* (1920), were inspired in part by the ideas in psychologist C. Lloyd Morgan's *Emergent Evolution*. Alexander believed that emergence was fundamentally inexplicable, and that emergentism was simply a "brute empirical fact":

"The higher quality emerges from the lower level of existence and has its roots therein, but it emerges therefrom, and it does not belong to that level, but constitutes its possessor a new order of existent with its special laws of behaviour. The existence of emergent qualities thus described is something to be noted, as some would say, under the compulsion of brute empirical fact, or, as I should prefer to say in less harsh terms, to be accepted with the "natural piety" of the investigator. It admits no explanation." (Space, Time, and Deity)

Despite the causal and explanatory gap between the phenomena on different levels, Alexander held that emergent qualities were *not* epiphenomenal. His view can perhaps best be described as a form of nonreductive physicalism (NRP)[7] or supervenience theory.

Ludwig von Bertalanffy

Ludwig von Bertalanffy founded General System Theory (GST), which is a more contemporary approach to emergentism. A popularization of many of the elements of GST may be found in *The Web of Life* by Fritjof Capra.

Jaegwon Kim

Addressing emergentism (under the guise of non-reductive physicalism) as a solution to the mind-body problem Jaegwon Kim has raised an objection based on causal closure and overdetermination.

Emergentism strives to be compatible with physicalism, and physicalism, according to Kim, has a principle of causal closure according to which every physical event is fully accountable in terms of physical causes. This seems to leave no "room" for mental causation to operate. If our bodily movements were caused by the preceding state of our bodies *and* our decisions and intentions, they would be overdetermined. Mental causation in this sense is not the same as free will, but is only the claim that mental states are causally relevant. If emergentists respond by abandoning the idea of mental causation, their position becomes a form of epiphenomenalism.

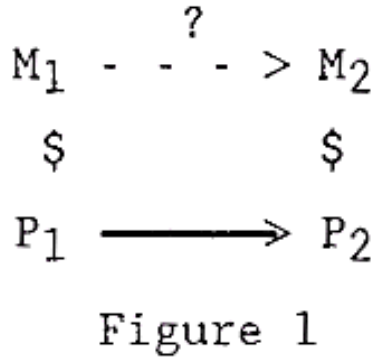

Figure demonstration how M1 and M2 are not reduced to P1 and P2.

In detail: he proposes (using the chart on the right) that *M1* causes *M2* (these are mental events) and *P1* causes *P2* (these are physical events). *P1* realises *M1* and *P2* realises *M2*. However *M1* does not causally effect *P1* (i.e., *M1* is a consequent event of *P1*). If *P1* causes *P2*, and *M1* is a result of *P1*, then *M2* is a result of *P2*. He says that the only alternatives to this problem is to accept dualism (where the mental events are independent of the physical events) or eliminativism (where the mental events do not exist).

Notes

[1] Crane, T. *The Significance of Emergence*

[2] see "Emergent Properties" in the *Stanford Encyclopedia of Philosophy*. online at Stanford University (http://plato.stanford.edu/entries/properties-emergent/) for explicit discussion; briefly, some philosophers see emergentism as midway between traditional spiritual vitalism and mechanistic reductionism; others argue that, structurally, emergentism is equivalent to vitalism. See also Emmeche C (2001) Does a robot have an Umwelt? *Semiotica* 134: 653-693 (http://www.nbi.dk/~emmeche/cePubl/2001d.robumwelt.pdf)

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[7] *Stanford Encyclopedia of Philosophy* (http://www.seop.leeds.ac.uk/archives/win2008/entries/properties-emergent/#SamAle)

Further reading

- Jones, Richard H. *Analysis & the Fullness of Reality: An Introduction to Reductionism and Emergence* (2013)
- Laughlin, Robert B. *A Different Universe* (2005)
- Ansgar Beckermann, Hans Flohr, Jaegwon Kim: *Emergence Or Reduction? Essays on the Prospects of Nonreductive Physicalism* (1992)

External links

- Emergentism (http://plato.stanford.edu/entries/properties-emergent/) in the Stanford Encyclopedia of Philosophy, 2007.
- Emergentism (http://philosophy.uwaterloo.ca/MindDict/emergence.html) in the Dictionary of Philosophy of Mind, 2007.

Morphogenesis

Morphogenesis (from the Greek *morphê* shape and *genesis* creation, literally, "beginning of the shape") is the biological process that causes an organism to develop its shape. It is one of three fundamental aspects of developmental biology along with the control of cell growth and cellular differentiation.

The process controls the organized spatial distribution of cells during the embryonic development of an organism. Morphogenesis can take place also in a mature organism, in cell culture or inside tumor cell masses. Morphogenesis also describes the development of unicellular life forms that do not have an embryonic stage in their life cycle, or describes the evolution of a body structure within a taxonomic group.

Morphogenetic responses may be induced in organisms by hormones, by environmental chemicals ranging from substances produced by other organisms to toxic chemicals or radionuclides released as pollutants, and other plants, or by mechanical stresses induced by spatial patterning of the cells.

History

Some of the earliest ideas and mathematical descriptions on how physical processes and constraints affect biological growth, and hence natural patterns such as the spirals of phyllotaxis, were written by D'Arcy Wentworth Thompson (1917)[a] and Alan Turing (1952). Where Thompson explained animal body shapes as being created by varying rates of growth in different directions, for instance to create the spiral shell of a snail, Turing correctly predicted the diffusion of two different chemical signals, one activating and one deactivating growth, to set up patterns of development. The fuller understanding of the mechanisms involved in actual organisms required the discovery of DNA and the development of molecular biology and biochemistry.

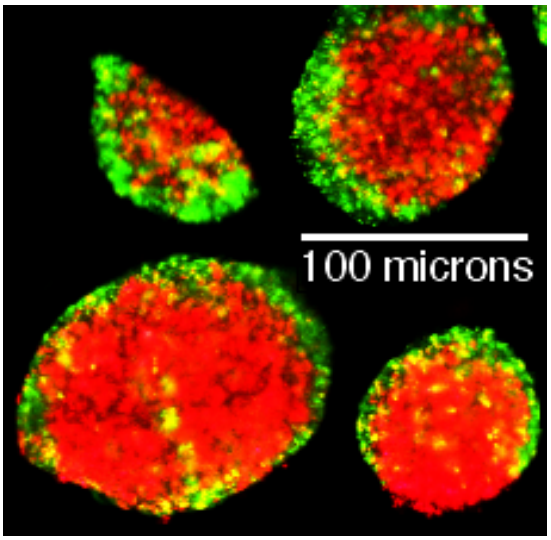
The term **histomorphogenesis** was coined by Ricqlès et al. (2001) for the same process in bone histology.

Molecular basis

Several types of molecules are particularly important during morphogenesis. Morphogens are soluble molecules that can diffuse and carry signals that control cell differentiation decisions in a concentration-dependent fashion. Morphogens typically act through binding to specific protein receptors. An important class of molecules involved in morphogenesis are transcription factor proteins that determine the fate of cells by interacting with DNA. These can be coded for by master regulatory genes and either activate or deactivate the transcription of other genes; in turn, these secondary gene products can regulate the expression of still other genes in a regulatory cascade. At the end of this cascade, another class of molecules involved in morphogenesis are molecules that control cellular behaviors (for example cell migration) or, more generally, their properties, such as cell adhesion or cell contractility. For example, during gastrulation, clumps of stem cells switch off their cell-to-cell adhesion, become migratory, and take up new positions within an embryo where they again activate specific cell adhesion proteins and form new tissues and organs. A number of developmental signaling pathways have been implicated in morphogenesis, including Wnt, Hedgehog, and ephrins. Several examples that illustrate the roles of morphogens, transcription factors and cell adhesion molecules in morphogenesis are discussed below.

Cellular basis

Morphogenesis arises because of changes in the cellular structure or how cells interact in tissues. These changes can result in tissue elongation, thinning, folding or separation of one tissue into distinct layers. The latter case is often referred as cell sorting. Cell "sorting out" consists of cells moving so as to sort into clusters that maximize contact between cells of the same type. The ability of cells to do this has been proposed to arise from differential cell adhesion by Malcolm Steinberg through his Differential Adhesion Hypothesis. Tissue separation can also occur via more dramatic cellular differentiation events during which epithelial cells become mesenchymal (see Epithelial-mesenchymal transition). Mesechymal cells typically leave the epithelial tissue as a consequence of changes in cell adhesive and contractile properties. Following epithelial-mesenchymal transition, cells can migrate away from an epithelium and then associate with other similar cells in a new location.



Example of cell sorting out with cultured P19 embryonal carcinoma cells. Live cells were stained with either DiI (red) or DiO (green). The red cells were genetically altered and express higher levels of E-cadherin than the green cells. After labeling, the two populations of cells were mixed and cultured together allowing the cells to form large multi-cellular mixed aggregates. Individual cells are less than 10 micrometres in diameter. The image was captured by scanning confocal microscopy.

Cell-cell adhesion

During embryonic development, cells are restricted to different layers due to differential affinities. One of the ways this can occur is when cells share the same cell-to-cell adhesion molecules. For instance, homotypic cell adhesion can maintain boundaries between groups of cells that have different adhesion molecules. Furthermore, cells can sort based upon differences in adhesion between the cells, so even two populations of cells with different levels of the same adhesion molecule can sort out. In cell culture cells that have the strongest adhesion move to the center of a mixed aggregates of cells. Moreover, cell-cell adhesion is often modulated by cell contractility, which can exert forces on the cell-cell contacts so that two cell populations with equal levels of the same adhesion molecule can sort out.

The molecules responsible for adhesion are called **cell adhesion molecules (CAMs)**. Several types of cell adhesion molecules are known and one major class of these molecules are cadherins. There are dozens of different cadherins that are expressed on different cell types. Cadherins bind to other cadherins in a like-to-like manner: E-cadherin (found on many epithelial cells) binds preferentially to other E-cadherin molecules. Mesenchymal cells usually express other cadherin types such as N-cadherin.

Extracellular matrix

The extracellular matrix (ECM) is involved in keeping tissues separated, providing structural support or providing a structure for cells to migrate on. Collagen, laminin, and fibronectin are major ECM molecules that are secreted and assembled into sheets, fibers, and gels. Multisubunit transmembrane receptors called integrins are used to bind to the ECM. Integrins bind extracellularly to fibronectin, laminin, or other ECM components, and intracellularly to microfilament-binding proteins α-actinin and talin to link the cytoskeleton with the outside. Integrins also serve as receptors to trigger signal transduction cascades when binding to the ECM. A well-studied example of morphogenesis that involves ECM is mammary gland ductal branching.

Cell contractility

Tissues can change their shape and separate into distinct layers via cell contractility. Just like in muscle cells, myosin can contract different parts of the tissue to change its shape or structure. Typical examples of myosin-driven contractility in tissue morphogenesis occur during the separation of Caenorhabditis elegans, drosophila and zebrafish germ layers. Often, during embryonic morphogenesis, cell contractility occurs via periodic pulses of contraction.

Notes

a. ^ Thompson's book is often cited. An abridged version, comprising 349 pages, remains in print and readily obtainable. An unabridged version, comprising 1116 pages, has also been published.

References

External links

- Artificial Life model of multicellular morphogenesis with autonomously generated gradients for positional information (http://panmental.de/ALifeXIflag)
- Turing's theory of morphogenesis validated (http://www.brandeis.edu/now/2014/march/turingpnas.html)

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