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The grin without a cat

> "Did you say 'pig,' or 'fig'?" asked the Cat.
>
> "I said 'pig'," replied Alice; "and I wish you wouldn't keep appearing and vanishing so suddenly: you make one quite giddy!"
>
> "All right," said the Cat; and this time it vanished quite slowly, beginning with the end of its tail, and ending with the grin, which remained some time after the rest of it had gone.
>
> "Well! I've often seen a cat without a grin," thought Alice; "but a grin without a cat! It's the most curious thing I ever saw in all my life!"

Though actually everything works like that, like a Gestalt puzzle, the vase morphing into the face. The world is supposed to be *given* to us, as a complex of things, properties, and relations; but these things, properties, and relations are emergent, the products of a process of pattern recognition; and as the world *continues*, and inexorably changes and expands, they change with it.

Ontology is a process. It is not a matter of Being, but Becoming. — This is less a concern in everyday life[1] — grins usually appear upon faces, after all, and faces on persons, which may or may not be cats — than in the philosophy of Nature; where (as Russell would put it) we deal less with raw data than with a flux of logical constructions. Explanation requires taking things apart and putting them back together., and when you get done everything can get turned inside out.

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[1] Psychology, particularly the analysis of motives, excepted.

The canonical example is the luminiferous ether.[2] Maxwell explained light as a wave phenomenon; waves presuppose some medium in which to propagate; he devised models, assorted variations on the theme of infinite and all-pervasive box springs, but didn't didn't seem to take any one in particular seriously. Finally Hertz stated what now seems obvious — "Maxwell's *theory* is Maxwell's *equations*" — the Michelson-Morley experiment failed to detect an ether, and Einstein conjured it all away with the principle of relativity. — Mechanism, it turned out, is less fundamental than the formalism invented to describe it. Radiation has energy and momentum, but that just means the Lagrangian/Hamiltonian formalism can be extended to describe it, not that little springs are literally jiggling up and down.

So the universal jello is gone,[3] but its oscillations remain. — As Wittgenstein said, having climbed up our ladder we can kick it away.

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Einstein explains that what persuaded physicists Newtonian mechanics was not a unique foundation was "the electrodynamics of Faraday and Maxwell. For this theory and its confirmation by Hertz's experiments showed that there are electromagnetic phenomena which by their very nature are detached from ... ponderable matter — namely the waves in empty space... . If mechanics was to be maintained as the foundation of physics, Maxwell's equations had to be interpreted mechanically. This was zealously but fruitlessly attempted ... . One got used to operating with these fields as independent substances without finding it necessary to give an

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[2] E. T. Whittaker, *A History of the Theories of Aether and Electricity* [London: Longmans, Green, and Co. 1910] surveys the evolution of the mechanical-model picture of the electromagnetic medium.

[3] The Thing That Cannot Die, it returns later in the form of the elementary particle vacuum, but less as a substance than a form of quantum-mechanical potentiality.

account of their mechanical nature; thus mechanics as the basis of physics was being abandoned, almost unnoticeably... ."[4]

The giveaway here is "almost unnoticeably" — the cat fading out as the grin remains. — It is the conceptual equivalent of the lap dissolve.

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Another example is the spin of the electron. Angular momentum is an observable introduced, originally, as the dynamic equivalent of the lever arm in statics: a body moving at a distance from an axis of rotation has an angular momentum of magnitude the product of its speed around that axis[5] and its distance from it; an idea of extension is presupposed. But the concept has a logic and an algebra of its own, and in quantum mechanics these entail that even pointlike particles without internal structure must be regarded, in some sense, as *turning*, like spinning tops.

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In mathematics, famously, theorems turn into definitions. Here the canonical example is compactness, which is introduced as a property of a closed interval on the real line: any cover by open intervals (Heine-Borel) has a finite subcover. This provides an analysis of the idea of "finite extent" (or "finite volume") that makes no reference to metric concepts. — Thus when you kick away the ladder of the real numbers, it becomes an attribute of an abstract space.

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In epistemology individuals and predicates emerge from the blooming, buzzing confusion of the perceptual world: *ab initio* you might begin

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[4] "Autobiographical Notes", pp. 26-27, in Paul Arthur Schilpp, ed., *Albert Einstein Philosopher-Scientist*. [La Salle: Open Court Publishing, 1949.]

[5] I.e., perpendicular to a radial vector.

with shapes and colors, sounds and motions, but presently through pattern recognition these become things, persons, and activities — the stuff to which we assign nouns and verbs: a man mowing his lawn, a dog chasing a frisbee, the shot Marlowe pours himself from the office bottle — and those are what you perceive. Those are the facts. But the semantic apparatus of the language in which they are stated is almost unfathomably complex.

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When Dirac first wrote down his equation, he didn't understand what it meant. He thought that, like Schrödinger's, it described the motion of a particle. It does do that, but as it were at second order: the correct interpretation is that it describes the dynamical entity (the quantized field) that creates and annihilates electrons, not the electron directly.

The particle interpretation has strange consequences: the velocity of the electron measured in any direction is (*Zitterbewegung*) the speed of light; the reflected intensity of an electron beam impinging on a potential wall can be larger that the incident intensity (Klein paradox); and the bizarre hole theory, which is required to explain away the negative-energy solutions by claiming all those states are filled and that gaps in this vacuum state behave like (anti)particles. (Feynman's alternative, that positrons are negative-energy electrons running backwards in time, is technically also superfluous, though it still exerts an intuitive appeal.)

The solution is the so-called second quantization, which considers all electrons (and the Pauli exclusion principle) at once. This has (as Quine would say) very different ontological commitments: what were formerly the irreducible constituents, the particles, appear and disappear as needed — a happy coincidence with the requirement of the theory of relativity that energy and mass are interchangeable.

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Gell-Mann, trying to derive consequences from the theory f quarks without positing their existence, appeals to the example of French cuisine:

> We use the method of abstraction from a Lagrangian field theory model. In other words, we construct a mathematical theory of the strongly interacting particles, which may or may not have anything to do with reality, find suitable algebraic relations that hold in the model, postulate their validity, and then throw away the model. We compare this process to a method sometimes employed in French cuisine: a piece of pheasant meat is cooked between two slices of veal, which are then discarded.[6]

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The furniture of the world isn't fixed, there's a constant process of rearrangement and replacement. Every vessel is the ship of Theseus.

What logicians imagine to be a static equilibrium is actually dynamic. The logical structure of theory is constantly being redesigned. — It is something like walking: you are usually resting your weight on one foot or the other, but never both at once. And you are never standing still.

At any moment there's a foundation, but it is always shifting. — The fallacy is something like Wittgenstein's in assuming language could not make sense if there were not (immutable) simple objects to which everything ultimately referred.

The Earth must be supported by something. *Therefore*, it must rest upon the backs of elephants standing on a turtle.

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[6] M. Gell-Mann, "The Symmetry Group of Vector and Axial Vector Currents", *Physics*, 1, 63 (1964). In a footnote, with a straight face, he says "I am indebted to Professor V.L. Telegdi for a discussion of this point."

Eppur si muove.