

## Resultants and Emergents (1875)

*George Henry Lewes*

65. Thus, although each effect is the resultant of its components, the product of its factors, we cannot always trace the steps of the process, so as to see in the product the mode of operation of each factor. In this latter case, I propose to call the effect an emergent. It arises out of the combined agencies, but in a form which does not display the agents in action. Galileo established the luminous principle of the independence of motions. This we may generalize as the independence of causal agents. Each agent, indestructible and independent, has its own individual value; and the effect or combination of agents has two modes: in the one case we have an addition or mixture; in the other a combination, with an emergent. Thus when we see one motion followed by another, or the depression of one scale followed by the elevation of the other (there is not really a succession, the two are simultaneous, but we consider them successively), we trace such parity in the two events, the one is seen to be so absolutely the equivalent of the other, that we seek for no outlying agency, no extra power; the one event is said to be dependent on the other. We call this a communication of motion; the effect is the motion communicated. Again, in the somewhat more complicated effect of compound motions, — say the orbit of a planet, the resultant of its tangential direction and its direction towards the sun, — every student learns that the resultant motion of two impressed forces is the diagonal of those directions which the body *would* take were each force separately applied. Every resultant is either a sum or a difference of the co-operant forces: their sum, when their directions are the same; their difference, when their directions are contrary. Further, every resultant is clearly traceable in its components, because these are homogeneous and commensurable.

66. It is otherwise with emergents, when, instead of adding measurable motion to measurable motion, or things of one kind to other individuals of their kind, there is a co-operation of things of unlike kinds. Add heat to heat, and there is a measurable resultant; but add heat to different substances, and you get various effects, qualitatively unlike: expansion of one, liquefaction of a second, crystallization of a third, decomposition of a fourth; and when the sensitive nerves of the skin are acted on, the effect is still more dissimilar. Here we have various emergents, simply because in each case there has been a different co-operant; and in most of these cases we are unable to trace the process of coalescence. The emergent is unlike its components in so far as these are incommensurable, and it cannot be reduced either to their sum or their difference. But, on the other hand, it is like its components, or, more strictly speaking, it *is* these: nothing can be more like the coalescence of the components than the emergent which is their coalescence. Unlike as water is to oxygen or hydrogen separately, or to both when uncombined, nothing can be more like water than their combination, which is water. We may be ignorant of the process which each passes through in quitting the gaseous to assume the watery state, but we know with absolute certainty that the water has emerged from this process. To fill up this gap in our knowledge by the word “power,” or “causal link,” is illusory. Some day, perhaps, we shall be able to express the unseen process in a mathematical formula; till then we must regard the water as an emergent.

67. Were all effects simple resultants, in the sense here specified, our deductive power would be almost absolute; a mathematical expression would include all phenomena. It is precisely because effects are mostly emergents that Deduction is insecure, and Experience is requisite to confirm even the most plausible deductions. Could we by the mere contemplation of phenomena discern the resultants of their changed positions, our deductive vision would be as far-reaching as our ideal construction. Unhappily this is not so.

Who, before experiment, could discern nitric acid in nitrogen and oxygen? Who could foresee that gold would be changed into a chloride if plunged into a mixture of two liquids (hydrochloric and nitric acid), in either of which separately it would remain unchanged? Yet it is no extravagant hope that the day will arrive when we shall not only know the separate operations of agents, but their mutual modification in the product which emerges from their union. When an agent, A, has the value  $x$ , and another agent, B, has the value  $y$ , the resultant of  $A + B$  must be  $x + y$ . But this is only true when no other factor interferes. In truth, some other factor almost always does interfere, though it is generally thrown out of the calculation, either because it is arbitrarily set aside, being irrelevant to the purpose in view, or too small in amount to disturb our “approximation.” So that, strictly speaking, the *real* effect is always an emergent, since we never know with absolute accuracy enough of all the factors to trace their operation. This, which is true of reals, is no longer true of ideal constructions, wherein the factors are accurately defined.

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