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Simultaneity and Originality in Human Thought - Paper Presented at the Fifty-Fifth Annual Meeting

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SIMULTANEITY AND ORIGINALITY IN HUMAN THOUGHT

Geo. Glockler

All of us have observed in our scientific work that many discoveries have been made by different investigators at widely scattered places, but at the same time. Some of these instances are so striking that it becomes of interest to consider the matter and make an attempt to explain the condition in the hope that we may understand the phenomenon. The particular cases chosen for illustration are all from the fields of chemistry, physics, and mathematics. Furthermore, they are scattered examples which have happened to come to our attention over a number of years. The same observation can undoubtedly be made in other fields of science, and in fact, in any region of human endeavor. Why is it that hundreds of illustrations can be given, showing the simultaneity of discovery and invention? Is it only a matter of chance that produces these coincidences? Are there so many new ideas that we may expect a very definite fraction of the whole to be happening at the same time? To be sure, if we are satisfied with this answer, we refer the question to the realm of probability, thus admitting our inability to assign a satisfactory reason for this simultaneous appearance of new ideas. We are unwilling to make such an admission, or at least will only consent to it if all our efforts at explanation fail. There is however what appears to be a logical interpretation of this interesting phenomenon.

If we consider the progress of a field of science, we find the first phase concerns itself with the collection of facts, followed by later stages of systematization and theoretical elucidatton. If we now suppose that different workers, as human beings independent of race and nationality, use thought processes which are alike in fundamental approach, we can readily understand that they would force their way into the unknown at a very similar rate and thereby advance their scientific field along an identical pattern. This assumes of course that the different workers know the past in their fields and are cognizant of the forefront of thought in their subjects. This explanation of the occurrence of simultaneity of scientific discovery and advance appears satisfactory, for we must believe that our increased knowledge of the world about us depends on the processes of our minds. That is, since we are equipped with a mental apparatus of a definite type, we may expect to reason in one definite way.

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If we had minds constructed on an opposite plan, no doubt our varying thought processes would then form different sets of concepts concerning the physical world. The further assumption that different nationalities and racial groups have the same thought habits strongly appeals to us even though it may run counter to some racial theories rampant these days in Europe. That this assumption is reasonable can be seen when we recall the many important discoveries along similar lines made by different peoples and races of the world. It might be impossible to prove this assertion on a definite psychological basis, however.

It should be of interest to review a few cases of simultaneous discovery taken entirely at random. Naturally as chemists we think of the appearance of the periodic system of the elements in our science of chemistry. The Russian, Mendeljeff, and the German, Lothar Meyer, both announced the periodic law in 1869; namely, that the properties of the elements are periodic functions of their atomic weights. We all know the fundamental importance of this pronouncement. When we now consider the period just preceding the advent of the periodic law, we realize that it was an age of the discovery of many of the elements with the concomitant study of their physical and chemical properties. Surely we can see that this background must have led inexorably to a recognition of the interrelationships of the chemical elements. Evidently, the time was ripe for the appearance of the periodic table. We may go as far as to say that someone else would surely have made the discovery of Mendeljeff and Meyer and very shortly after 1869!

Turning now to the discovery of the chemical elements we can only mention a few examples. Even though the Chinese knew for many centuries that air was a mixture; still, as we know chemistry today, we hardly need give them credit for the discovery of the element, oxygen. But in the last part of the eighteenth century we find that three investigators were concerned in the recognition of this substance. Bayen (1774), Scheele (1771-3), and Priestley (1775) all had their interest in chemical analysis which flourished at that time. We will leave the question of priority to the historian and turn our attention to another period of discovery of elements.

After Bequerel had shown in 1896 that uranium salts emit rays which could penetrate paper and thin aluminum foil, the same property was demonstrated for thorium and its activity was discovered by Madame Curie on April 12, 1898, and by G. C.

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Schmidt on April 4 of the same year. During the next year, 1899, A. Debierne and F. Giesel reported in the French journal, Comptes rendus and Wiener Annalen respectively, the discovery of the element, actinium. The scintillations produced by alpha particles on a zinc sulphide screen were found by both Crookes, an Englishman, and Elster and Geitel, two Austrians, in the same year, 1903. Similarly, Hahn and Meitner on the one hand and Soddy and Cranston on the other discovered protoactinium in the year, 1918. In this instance, two German and two English investigators competed for the honor of discovery of this radioactive element. We can readily understand that the epoch making discovery of Bequerel should initiate a whole train of scientific endeavor and obviously, we have mentioned only a few cases at random as they occurred to us.

Considering the great importance that aluminum has attained in our civilization, it is quite natural that we should be reminded of its present mode of preparation, although not of the discovery made by Bunsen in 1854. It is an interesting fact that both in this country and in France in 1886, Héroult and Hall, respectively, made a most important discovery. They found that naturally occurring bauxite, which is aluminum oxide when dissolved in molten cryolite (sodium aluminum fluoride) can be deposited electrolytically, thus liberating the free metal. It need hardly be mentioned that the process is an all important one when one considers the value of the element, aluminum, in our daily lives and especially its paramount place in the defense of our country at the present time.

It is obvious, of course, that simultaneous invention and discovery can lead to friction and in the industrial field can produce lawsuits, where the contending parties aim to show priority in patent rights.

In the field of pure science, these struggles for precedence in time are perhaps not as frequent but nevertheless they do occur. However, rather than cite cases where such differences of opinion have led to bad feeling and argument, it is more pleasant to recall the cordial relations that existed between LeBel and Van't Hoff who simultaneously in 1879 announced the theory of the asymmetric carbon atom. While LeBel made his deduction on mathematical grounds, Van't Hoff arrived at his conclusion on a more chemical basis. To be sure, Pasteur already knew of the optical activity of crystals but the two scientists mentioned gave a more intimate theoretical picture of the phenomenon. The interesting feature is that LeBel always referred to Van't Hoff's elegant theory and Van't Hoff invariably discussed the problem on the basis of LeBel's magnificent notion. These men were true scientists and gentlemen, ready and willing to give the other credit for accomplishments and minimizing their own importance. It would be pleasant indeed could one give more instances of this kind.

Turning from the field of chemistry for the moment, we naturally enter the related fields of physics and mathematics in our search for examples of time-coincident developments. At once we are reminded of the famous topic of the calculus. We read in all beginning texts that both Sir Isaac Newton, the famous English scientist, and Leibnitz, the German mathematician, promulgated this remarkable mode of mathematical reasoning in or about 1670. For some time historians in the field wondered whether or not these men operated independently, but the latest consensus of opinion seems to be that they produced this addition to our mathematical knowledge independently. But more interesting from our present point of view, is the fact that recent historical investigation tends to show that the methods of the calculus were coinvented by two other philosophers at the same time, Barrow and Gregory! Is this coincidence merely an accident or may we suppose that at the end of the seventeenth century, mathematical science had reached a certain development wherein the next logical step was necessarily the invention of the calculus? The latter premise appeals to us to be more inherently plausible.

Another outstanding example of coincident development is the discovery of electromagnetic induction by Faraday in England and by J. Henry in this country. Faraday reported his findings before the Royal Society in November, 1831, and published the results of his researches in February, 1832; while Henry experimented during the summer of 1831 and his work appeared in published form in July, 1832. Again, we find one of the most important advances in electrical science made thousands of miles apart on two different continents, but practically at the same moment. Evidently, the development of this science had reached a stage where the tremendous advance inherent in this discovery was imminent.

Although the idea that the logical development of a science necessarily leads to the next advance in the field may not be very comforting to an individualist, it appears to be the true state of affairs. On this basis we may even suppose that in cases where no simultaneity of discovery is involved, some other investigator might have made the advance in question, had not a previous one already announced it. For example, Einstein discovered his famous principle embodied in the special theory of relativity in 1905. Had he never lived, would others have made the same advance in knowledge? We believe this would have been the case, and in this connection need only remind ourselves that the Dutch physicist, Lorentz, had carried on fundamental investigations leading to his well-known transformation equations. We cannot help but accept the surmise that he was on the very threshold of thought which would have resulted in his discernment of the system of ideas now known as the relativity theory. Moreover, others were at the same time groping in the dark, feeling their way and surely someone would have been led onto the pathway of advance.

Returning once more to our favorite subject, chemistry, we are bound to mention the modern development of the electron conception of valency. The advances made by the physicists in our views regarding the internal complexity of the atoms, almost forced the chemist to take cognizance of its internal architecture. The simple valency bond was speedily replaced by a more detailed picture of chemical combination. The electrical nature of the atom demanded an electrical basis for the valency bond. The transfer of electrons and the shared electron pair were adopted by chemists and again we find that G. N. Lewis in this country and W. Kossel in Germany both elaborated a system of chemical binding based on electrical concepts. In 1916 Lewis published his notions regarding valency in the Journal of the American Chemical Society and Kossel his ideas in the Annalen der Physik in Germany. With World War I raging, no connection existed between these countries and the chemist, Lewis, and the physicist, Kossel, arrived at their theories independently. With the exception of minor details the fundamental principle was the same.

From our sister science, physics, we can glean several remarkable examples of scientific advance made by different people at the same time. The so-called powder method of crystal analysis which permits us to locate the position of atoms within a solid, was independently perfected by Debye and Sherrer in Switzerland and by Hull of the General Electric Laboratories in this country. With the advent of the quantum theory of radiation, it was natural that the interaction of quanta and matter should be considered on an impact basis. Hence the Compton effect, which involves a change of frequency of X-rays on scattering and for

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which Compton received the Nobel prize, was discovered by both Compton and Debye. Compton, working in this country, not only made the theoretical studies but also showed the reality of the phenomenon by experiment and hence the effect is named after him; while Debye then in Switzerland only made the theoretical deductions from the quantum theory of radiation. The need for another property of the electron besides mass, charge and field was felt by two Dutch physicists, Uhlenbeck and Goudsmit. in 1925 in order to explain the well known fact that the famous D-lines of sodium are a doublet, about six angstroms apart. But in the same year Bichowsky and Urey in this country made the same suggestion; namely, that the electron has an intrinsic angular momentum or spin. As is well known, this idea is of the greatest importance in our present system of atomic and molecular structure. In 1925, the French physicist, de Broglie, conceived the brilliant idea that the dual nature of radiation, i. e. quantum and wave aspect, should be carried over to entities like the electron which heretofore had been considered as primary particles, without wavelike properties. It did not take a great deal of time to show that electrons can be diffracted just like X-rays. In 1927, Davisson and Germer, two physicists working at the Bell Telephone Research Laboratory, and G. P. Thomson, an English physicist, announced the experimental proof of the wave-nature of the electron. It certainly appears that the time was ripe for this advance in our knowledge of this property of matter. The fundamental notion of de Broglie that particles behave like waves led Schroedinger on the one hand and Heisenberg, Born and Jordan on the other to formulate independently the present basic theory of wave mechanics. They used an entirely different mathematical apparatus but the ultimate thought was the same. The famous Schroedinger differential equation, called the wave equation, and the matrix notation used by Heisenberg are simply two different mathematical statements that portray the same basic idea. A new system of thought called wave mechanics having arisen in 1925, what is more in order than for the physicists to review the whole field of physics with the thought that some heretofore unexplained phenomenon could be satisfactorily comprehended by the new theory? This development actually happened in the field of radioactivity where we had known certain laws, as, for example, the Geiger-Nuttall relation, which we could not understand at all. In the same year, 1928, Gurney and Condon in this country, and Gamov in Germany

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applied the fundamental ideas of wave mechanics to the problem and pronounced the modern theory of radioactivity. Gurney and Condon published their work in Nature on September 22 and Gamov presented his in the Zeitschrift für Physik on October 12, 1928. Another discovery of far reaching importance concerning our knowledge of molecular structure, the so-called Raman Effect, was discovered by Raman in 1928 and at the same time Landsberg and Mandelstamm made similar observations in Russia. Raman, a Hindu physicist, worked on liquids and showed that visible radiation can be scattered by molecules with a change in frequency. Such measurements allow us to determine the fundamental frequencies of vibration of molecules. Raman had a full understanding of the significance of his discovery and went much further to consolidate his findings than did the Russian workers, and received the Nobel prize for his research. To be sure Smekal predicted this molecular scattering in 1923 but he did nothing to show the effect experimentally. In the discovery of the neutron in 1932 two different investigators had important parts. Chadwick in England and Curie and Joliot in France contributed toward the solution of the problem and as a culmination of their efforts we know now of an apparently primary particle of unit mass and zero charge. Again, two earlier investigators, Bothe and Becker in Germany in 1930, evidently produced a type of radiation which we now know to have been neutrons, but they failed to recognize these new particles and identify them. Another newcomer among the particles of primary nature is the mesotron. It has the negative charge of the electron but about 200 times its mass. It was found in cosmic rays by two different sets of investigators, Anderson and Neddermeyer, at the California Institute of Technology and by Street and Stevenson, at Harvard in 1937.

The instances cited of simultaneous discovery should be sufficient to prove the assertion that a given field of science and technology is ready for the next advance at a certain time and the discovery will be made by a worker in some part of the world. We have mentioned only a few outstanding developments in the physical sciences but the same story could be told in any branch of human thought. Had we covered the field of patents we would have obtained the same picture; only in this case, it becomes of great practical importance indeed to decide priority and lawsuits concerned with patent infringement have frequently resulted from the question of simultaneity.

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We have explained the fact of coincident discovery on the basis of the essential similarity in logical processes possessed by different peoples, concluding that they go forward into the unknown regions of their sciences in much the same way, and it is to a certain degree accidental just who the investigator happens to be who makes the advance and thereby attains priority of discovery or invention.

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