Techniques were required. It is equally absurd now, when peace is such a desperate necessity, to suggest, as men of intelligence are doing, that *the motivation provided by the fear of the atomic bomb will alone keep the peace* without the aid of techniques. It is quite within reasonable probability that social science can provide these techniques if it is given anything like the amount of support afforded to physical science in developing the atomic bomb.

The notable acceleration since 1930 in the gains made by social scientists, and the presence in the world of perhaps a few dozen of these men who are highly skilled in the techniques of their discipline, augurs well for a trial of the scientific method in discovering ways of maintaining peace. It is not as if a start had to be made from total ignorance. There is already at hand a very considerable body of knowledge as well as steadily increasing excellence in the means of enlarging it.

But while the social scientists seemingly must be responsible for discovering a means of preventing war, if it is to be discovered, the physical, biological, and medical scientists are at present possessed of nearly all the tremendous prestige that goes with the word *science*. Up to now no authoritative voice of any considerable group of physical, biological, or medical scientists has been raised in support of their co-workers in social science—of those who share their method of observing, classifying, and generalizing natural phenomena.

These more famed colleagues of the social scientist are probably not versed in his recent accomplishments; perhaps they are not fully aware that he uses the same method of science that they use; more than likely they have formed their opinions after listening to quacks posing as social scientists.

Is it not time for physical, biological, and medical scientists, whose prestige is so great, to investigate the work of social scientists thoroughly enough to ascertain whether it is, in truth, science? And if they find that it is, can they not do more toward keeping the peace than merely informing persons in authority, and others, of the terrible consequences of the atomic bomb in case of a war? Can they not unite and give their great influence to support the work of social scientists toward finding techniques by which the peace will be maintained?

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On Opening "Frozen" Vacuum Desiccators

I have read with interest the method for opening "frozen" desiccators described by J. D. Reid (*Science*, 1945, 102, 483), which consists of driving a single-edged razor blade between the top and body of the desiccator. I have used this method myself successfully, but have always felt lucky that I did not chip or crack the top of the desiccator, since desiccator waxes of thick consistency are sometimes so tenacious that removing the lid becomes a major operation.

The method I have come to adopt is absurdly simple but always effective, and in the event that someone may not yet have discovered the method for himself I shall describe it here. The desiccator is held under a hot-water faucet, the water being allowed to flow over the edge of the lid. As soon as it becomes warm, the wax softens, and the lid is removed with ease. Only a few seconds are required to perform the entire operation.

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Information Please

In the early 1890's a one-room country school in Indiana was attended by two boys—classmates, both of whom became starred scientists. They have often wondered whether any other one-room country school in the United States has ever numbered two starred scientists among its alumni. The authors of this note, who were the boys referred to above, hope that any reader of *Science* who knows of a parallel or similar case will present the facts in a communication to this magazine. The likelihood of an occurrence of this kind by pure chance is not known but must be very small. If, as might reasonably be estimated, there is not more than one chance in a thousand that such a school has enrolled even one starred scientist, the likelihood of its enrolling two would be only one in a million on the basis of chance alone. In the instance here reported the laws of chance may have been upset by the fact that the teacher of the boys was exceptionally capable and inspiring.

It is suggested that replies to this appeal include instances of other comparable recognition—membership in the National Academy of Sciences, listing in *Who's Who*, etc.—and that mention be made of extrachance factors that may have been involved.

B. and T.

The Rumbling of Thunder

Arthur Taber Jones (*Science*, 1945, 102, 407) calls attention to an especially continuous and pronounced case of the rumbling of thunder on the morning of 30 August 1945, at Northampton, Massachusetts, and cites W. J. Humphreys, who, in *Physics of the air*, lists four causes for the rumbling of thunder: (a) inequalities in the distance from the observer to various points of the path of the lightning; (b) crookedness of the path; (c) succession of discharges; and (d) reflection.

There is no doubt that all these factors enter into the cause of the rumbling of thunder; but there occurs to the writer another cause which he believes to be even more potent than any of the four named above. As is well known, thunder is caused by the sudden change in temperature of the air through which electricity is passing during a lightning flash. In order to understand clearly the operations of the factor about to be described, let it be supposed that lightning flashes between two clouds so situated that the electric discharge comes directly toward the observer. When the discharge starts from the cloud of lower potential, we may assume the number of elec-

trons, N, per unit of time to be very great. These N electrons are accelerated by the difference of potential between the clouds and, after having been accelerated, meet with molecules of the air; and in thus colliding with the molecules generate light quanta—the light of lightning. Part of the light thus generated, however, is absorbed by electrons in other molecules, in their immediate neighborhood. These absorbing electrons are liberated as photoelectrons or beta electrons and become a part of the electron beam which constitutes the lightning discharge. The original electrons which started from the negative cloud and made collision with air molecules after the initial collision recoil and are free electrons in a potential field. There are now 2 N electrons in the discharge per unit of time. These 2 N electrons are now accelerated, make collisions with molecules, and generate light quanta. This process is repeated many times during the discharge of electricity from the negative cloud to the positive cloud. At each repetition of the process the number of electrons in the discharge is doubled, so that there occurs in the electric discharge N, $2N$, $4N$, $8N$. . . . It is the generation of the radiation—ultra violet, visible, infrared, and radiant energy radiation—which produces the heat, which causes the expansion, which, in turn, sets in motion the air waves we hear as thunder. The rate at which the lightning travels between the clouds is nearly, though not quite, that of light. The rate at which sound travels is only a small fraction of the velocity of light. If, now, the lightning is traveling toward the observer and the sound is traveling in the same direction, the sound produced by the lightning in the last part of the lightning flash will reach the observer first; and since the number of electrons in the discharge, having doubled at each collision with molecules, have increased possibly a hundred-thousandfold, the heat expansion would be comparable and the thunder would be heard as a loud crash, at first, followed by a gradually decreasing rumble, fading out to a very low rumbling sound coming from the beginning of the discharge.

If the lightning discharge takes place away from the observer, the sound of the first part of the discharge will be heard first, and the thunder will gradually increase in loudness, ending with a loud crash.

If the discharge is in any direction other than the two mentioned, the thunder will be heard as some variant of the two patterns described. The time of the lightning discharge is very brief, as the duration of the flash indicates. The reason why the thunder is prolonged is due to the difference in the distance of the different parts of the discharge from the observer.

In the case referred to by Professor Jones there must have been a very great number of lightning flashes passing in different directions between different clouds. The fact that there was no visible lightning was unusual but entirely understandable to the science of electrical discharge. When electrons collide with molecules of air they generate radiant energy quanta, but not necessarily of visible frequencies. The low-frequency radiation generated produces heat, and the consequent expansion of the air produces thunder. We may therefore have a thunderstorm without visible light.

The above cause of the rumbling of thunder has been deduced from a general theory, not yet published, of electric discharges through air. There is no doubt that the four causes mentioned by W. J. Humphreys will have their influence in causing rumbling, but I believe that the chief cause for rumbling is the one elaborated above.

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"Freezing" Behavior in Rats

Dr. Riess is properly conservative in the title of his recent article, "A possible explanation of 'freezing' behavior in rats," (*Science*, 1945, 102, 570), but the conclusions drawn in the report go somewhat beyond the data presented. It is stated that eighteen of the 124 rats raised in groups of six to a cage manifested the behavior in question, whereas only two of the "other group," raised in isolated, single cages, did so. The data are, of course, quite uninterpretable, statistically or otherwise, without a statement of the size of the "other group." Furthermore, the author evidently feels that his observations carry the implication of a connection between submissiveness, as developed in a social situation, and "freezing" behavior in the maze. Since three (of the eighteen) animals living in groups were "dominant and winners in fighting" (the other fifteen being submissive individuals), and since two animals who presumably had no opportunity for social interaction also showed "freezing," it would be more correct to say that the behavior may be related to social factors, or that social conditions seem to be *a* factor in producing the phenomenon, than to conclude that the behavior is "the result of the hitherto uncontrolled factor of social interaction in the living quarters of the experimental animals."

Prompt communication to fellow scientists of experimental results having wide current interest is certainly desirable and to be encouraged, but this desideratum is neither incompatible with, nor warrants the abandonment of, the usual standards of scientific reporting.

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A Correction

IN a recent note, "A possible explanation of 'freezing' behavior in rats" (Bernard F. Riess, *Science*, 1945, 102, 570), the author was guilty of a serious omission which completely vitiated the meaning of the article. A comparison was made between two groups of animals, one living in multiple-animal cages, the other in isolation. In giving a description of the groups, the population of the multiple-housed animals was given as 124 and that of the second group was inadvertently omitted. There were 84 animals in this second group. This makes it possible to evaluate the difference between the two groups. The author apologizes for the omission.

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