their morale and makes them hard to get. What goes with those birds?" Or consider another newspaper writer who opened one of his columns with the sentence, "We Americans have been confronted with an arrogant proposition that persons presuming to call themselves intellectuals, and particularly those who claim the title of scientist, are a superior cult entitled to deference or even homage from the common man." One of our greatest universities takes a sound and courageous stand, and a newspaper writer complains, "Harvard has a peculiar fondness nowadays for putting security and the safety of the nation second to their fancy ideas of importance." If some speak out against the climate of fear resulting from the stupidities and iniquities of what is misnamed as the security system—doubly misnamed since it is not a system and does not achieve security—then their protest is labeled, as it was by Eugene Lyons in the *Saturday Evening Post,* as "the mock-heroic posture of this close-knit band of Cassandras"; he insultingly adds that these protesters do not themselves seem to have suffered, for "not one of them has as yet been muzzled, lynched, or denied his due royalties."

Anti-intellectual views such as these are widely expressed in those newspapers that combine a wide circulation with a narrow intellectual viewpoint, in some very popular national magazines, and even, one reports with shame, by highly placed persons in Washington.

It is hardly necessary to argue, these days, that science is essential to the public. It is becoming equally true, as the support of science moves more and more to state and national sources, that the public is essential to science. The lack of general comprehension of science is thus dangerous both to science and to the public, these being interlocked aspects of the common danger that scientists will not be given the freedom, the understanding, and the support that are necessary for vigorous and imaginative development. It is, moreover, of equally grave importance that science understand itself.

There are persons who are pessimistic concerning the prospects of materially improving the public understanding of science, and even the understanding that one branch of science has of the other branches. If one subscribes to the falsities and exaggerations that I stated in the first part of this article, then he could properly be pessimistic. If, on the other hand, he accepts the broader, more liberal, more human and humane view that I have advanced here, then—or at least so it seems to me—he can be very optimistic.

When David Brewster, a century and a quarter ago, was one of the prime movers in founding the British Association for the Advancement of Science, he said, "The principal objects of the Society would be to make the cultivators of science acquainted with each other, to stimulate one another to new exertions—to bring the objects of science more before the public eye and to take measures for advancing its interests and accelerating its progress."

This is a challenge which our own Association has always sought to meet. It is a challenge which, at this moment in history, requires renewed zeal and ever-renewed patience. Speaking of the present-day scientist, J. Bronowski has said, "Outside his laboratory, his task is to educate us in what goes on inside it, and to give it a meaning for us. In a world in which statesmen as much as voters are ignorant of the simplest implications in science, this is a formidable responsibility . . . [the scientist] has no other choice today but patiently to become a teacher, in a world in which distrust and prejudice are free. . . . There is no alternative to an informed public opinion: and that can exist only where scientists speak to voters and voters accept their responsibility, which is to listen, to weigh, and then to make their own choice."

If, as I believe, the sciences and the arts are lively and noncompetitive partners in the business of life, it is appropriate that we close, not with a scientist, but with a great artist. "Our privacy," Faulkner says, "has been slowly and steadily and increasingly invaded until now our very dream of civilization is in danger. Who will save us but the scientist and the humanitarian. Yes, the humanitarian in science, and the scientist in the humanity of man."

L. L. Thurstone and the Science of Human Behavior

Louis Leon Thurstone was born in Chicago, Illinois, on 29 May 1887. He received his M.E. degree from Cornell University in 1912 and his Ph.D. from the University of Chicago in 1917. In 1912 he served as assistant to Thomas Edison. From 1912 to 1914 he was instructor in engineering at the University of Minnesota. From 1915 to 1920 he rose from assistant to professor and department head at Carnegie Institute of Technology. He remained as department head until 1923, when he accepted a position as psychologist with the Institute of Government Research in Washington, D.C. In 1924 he was appointed associate professor of psychology at the University of Chicago and in 1928 he was promoted to professor of psychology, a position that he held until his retirement in 1952. In 1938 he was awarded the Charles F. Grey distinguished service professorship at the University of Chicago. During this year he also founded the Psychometric Laboratory. He served as its director until his retirement. He has held visiting professorships in several European universities. After his retirement from the University of Chicago, he moved his Psychometric Laboratory to the University of North Carolina, where he continued his research and publication.

Thurstone was the leading figure in the organization of the Psychometric Society in 1935 and the establishment of *Psychometrika,* which was first published in 1936. He was a member of numerous scientific societies and held high offices in many of them, including the presidency of the American Psychological Association in 1933. His contributions to science are recorded in numerous published articles and in many monographs and books.

It is said that a scientist may count his life a success if he advances but a little the frontiers of knowledge in his own discipline. Louis Leon Thurstone did much more. He explored, charted, and cultivated vast new domains. Early in his career he recognized that there can be no true science without measurement. Beginning with the classical psychophysical methods, he developed psychological scaling techniques and applied them to

the measurement of attitudes. Among his contributions in this area are the law of comparative judgment and the successive intervals technique. His work on absolute scaling stands as a classic whose vast potentialities for the assessment of mental development still remain to be fully exploited.

Perhaps his outstanding contributions arose from his recognition that neither psychology nor any other science can advance very far if the primary variables of the discipline are not specified first. Beginning with the pioneer work of Charles Spearman, Thurstone made many important contributions to the theory and practice of multiple factor analysis, whose fundamental role in psychology, he emphasized repeatedly, is to define the variables of human behavior. The centroid method that he developed has been by far the most widely used computational technique in factor analysis. The concept of simple structure in factor analysis, as a basis for finding invariant solutions, was uniquely Thurstone's contribution. In spite of the early opposition to the concept by some of the more conventional mathematical statisticians, both theoretical and practical considerations through the years have demonstrated the fundamental importance of the concept. In recent years more rigorous analytic procedures have been developed for rotating an arbitrary factor matrix to simple structure. Indeed, one of Thurstone's most recent contributions is a technique of rotation that appears to be amenable to the more formal and analytic mathematical methods.

His notion of second order general factors permitted a *rapprochement* between his own emphasis on common factors and Spearman's concept of a general factor of intelligence. His preference for generalized oblique rotational procedures and his techniques for deriving first order general factors from second order general factors have far-reaching implications for the unification and generalization of major existing factor theories, which even today appear not to be fully appreciated.

To imply that Thurstone won all the engagements in the crucial issues of factor analysis theory and technique is not quite correct. The problem of communalities in factor analysis still remains a lively issue. But Thurstone kept the spotlight trained on this controversal problem and made major contributions toward its eventual solution. In any case, he was always generous to those who disagreed with him on the communality question provided that they were even moderately well-informed on the technical and theorectical issues involved.

Although the major part of Thurstone's efforts were concerned with the fundamental problems of measurement and identification of the variables in a discipline that was sadly lacking in both, he also made important contributions in more specialized areas. Among these were his efforts to quantify and rationalize theoretical and experimental approaches to the problems of learning and motivation.

Notwithstanding Thurstone's basic contributions to science in general and psychology in particular, he was in no sense an ivory-tower psychologist. In a very real sense, his major contributions consisted of bringing psychology out of the ivory tower. He often remarked that it was the sterility of classical psychophysics that led him to work on the measurement of attitudes of ordinary human beings in real-life situations. This, in turn, motivated the development of his measurement and scaling theories and techniques.

He demonstrated repeatedly throughout his scientific career that productive and useful basic research comes from attempts to solve the problems of real people in a real world. For him, the dichotomy of pure versus applied psychology did not exist. Once, in his presence, a well-known person was referred to as an industrial psychologist. He remarked, a little impatiently, "There is no such thing as 'industrial psychology.' " He had little respect for the conventional rubrics of psychology. For him, considerations of scientific rationale and methodology were of prime importance. It was also of prime importance that the problems come from life itself, but it was not scientifically relevant whether the problems came from industry, a military establishment, the clinic, the school room, or the college campus. The numerous psychological instruments that he developed for the evaluation of special aptitudes, primary mental abilities, and various aspects of temperament are merely the natural outgrowth of his basic research in measurement and in the identification of primary variables; they justify his unwillingness to dichotomize scientific activity into pure and applied.

Even though Thurstone had a great respect for the role of mathematics in scientific research, it was always clear that he regarded both mathematics and statistics as nothing more than useful and faithful servants. Under no circumstances would he tolerate the slightest evidence of insubordination on their part. Some have protested that his formulations might be modified to fit existing models. Thurstone entertained no compromise for such proposals. If the servant could not solve the problem, the master must improvise as best he could until such time as the servant could develop adequate proficiency for the task at hand. But Thurstone would not hesitate to oversimplify a problem for the sake of reaching a practical solution. He insisted that a major principle of scientific method not only permits but insists on the oversimplification of hypotheses as a basis for parsimonious description and prediction.

Although Thurstone was willing to go to considerable lengths to oversimplify his hypotheses, he was always scrupulous in avoiding falsification or unfair selection of the experimental data for testing the hypotheses. In fact, even though he was generous with those who disagreed with him on points of theory, methodology, and interpretation, he had no time whatever for those who were lax in their selection of data or for those who might suggest any laxness in this respect on his part.

Thurstone was consistently patient with and tolerant toward those who showed a genuine interest in the development of psychology as a quantitative rational science. He had a rare knack for putting at ease students who were shy or had difficulty in communicating their ideas. He would listen carefully in the hope of discovering students with ideas, and he was generous in his encouragement of anything that had the remotest resemblance to a novel or productive suggestion. His own style in lecture, discussion, and writing was clear, lucid, and unambiguous, but he made no pretense of being a flowery speaker or writer. In fact, he had a great facility for penetrating highly technical jargon or beautifully written prose to discover whether it covered up a dearth of ideas. For those who concealed a lack of ideas with an imposing verbal façade he had neither patience nor generosity.

When Louis Leon Thurstone died on 30 September 1955 at the age of 68, his contributions left psychology a far more respectable science than it was when he entered it; but equally important, he also left many well-marked signposts pointing out the directions of further research that will continue to advance the development of psychology as a quantitative rational science.

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Genius begins great works, labor alone finishes them.—JOUBERT.