ploration and the insatiable intellectual curiosity which is the mark of civilized man. The most powerful cyclotrons now in existence produce particles whose speeds, when fired at atoms, enable them to knock off only the external and more loosely bound features of the atoms under attack. It is at this point that the new giant cyclotron, now under construction, is of critical importance, for it is designed to produce projectiles so powerful that they can penetrate and explore the nucleus itself.

It is essential to realize the significance of this point. During the last forty years, science has learned much about atomic structure. One outstanding mystery, however, remains, and in many senses it is the major mystery. Relatively little is known about the nucleus, the central core of the atom. There is evidence that this nucleus possesses a discoverable structure, that it is formed of certain elementary units in accordance with laws with which we are not familiar; and physicists to-day consider its investigation the most important present problem in physical science. Here in the interior of the nucleus is the one essentially unexplored part of our universe. It is a world into which we have hitherto been powerless to enter; and the urge to penetrate, to explore and to analyze is irresistible.

This urge, moreover, is heightened and justified by the conviction that this virgin territory will prove to be rich. Practically all the energy of the atom, for instance, is stored within the nucleus; and it is the nucleus which really determines the character of an atom and is hence ultimately responsible for all the properties of matter. Furthermore, there is evidence that the essential forces which bind the nucleus together are due to an elementary particle called a "mesotron." These same mesotrons play an important rôle in cosmic rays; and if more could be learned about mesotrons it would immediately throw light not only on this other perplexing problem, but on still further riddles with which science is now grappling on the frontiers of knowledge.

The real case for building a great cyclotron rests upon its ability to make accessible a new infinitesimal world—the interior of atomic nuclei, with all the possibilities of fresh knowledge that may there reside. It is an adventure in pure discovery, motivated by the unconquerable exploring urge within the mind of man.

In this sense, therefore, the new cyclotron is more than an instrument of research. Like the 200-inch telescope it is a mighty symbol, a token of man's hunger for knowledge, an emblem of the undiscourageable search for truth which is the noblest expression of the human spirit.

SCIENTIFIC BOOKS

HUMAN NATURE

Human Nature and the Social Order. By E. L. THORNDIKE. xx + 1019. Macmillan. 1940.

THIS book is of monumental proportions with its half million words and weight of nearly 3½ pounds. Because of its forbidding size it lay on my desk for weeks before I could muster courage to tackle it. Once started, however, I read the book from cover to cover with unflagging interest in the contents and with many chuckles over the author's way of putting things. My chief complaint is that it was not published as two volumes instead of one, so that it could be read by the nearsighted with less fatigue of the arms and shoulders.

The material is divided into 38 chapters and 6 appendices. Part I (400 pages) deals with such topics as the ABC of behavior, human abilities, wants and their measurement, mental dynamics, individual differences, the roles of nature and nurture, conflicts of wants and the evaluation of satisfactions. Among the leading problems treated in Part II are the science of philanthrophy, the welfare of future men (eugenics), the welfare of the present, utility and disutility, natural resources and capital, labor and management, buying and selling, payment for human factors, money and credit, ownership, the psychology of capitalism, political science, human relations, criteria of a good government, rulers and methods of ruling, the aims of government, human nature and the law, the improvement of law, human nature and reform.

A statement in the preface says that the book is intended not only for college students of the social sciences but also for thinking men and women generally. In my judgment it will be useful and stimulating to both groups despite the fact that it is neither a systematic treatise on social psychology nor an all-round introduction to the social sciences. Part I is an exposition of the facts and principles of psychology which the author considers most important for the social science student. Here 75 pages are devoted to abilities, 55 to individual differences, 125 to wants and mental dynamics, 57 to heredity and environment and 50 to evaluation of satisfactions. In these sections the author draws extensively upon his earlier books, but there is much new material and the old is effectively reorganized and freshly stated. Part I presents a large amount of psychological information of the kind social scientists most need but get little of from the average text-book in social psychology. The

emphasis upon abilities, wants, individual differences and genetic factors sets the tone for the entire volume. The treatment is factual and realistic with a profusion of concrete illustrations expressed in striking (sometimes bizarre) word pictures. In places, however, it is not easy reading. Many of the concepts and distinctions that probably seem to the author quite elementary will present difficulties even for the superior student who has not had considerable course work in psychology and statistical methods. There are occasional passages that would have benefited from greater attention to clarity of statement. Outstanding qualities of the author's style are vigor, originality and pungency.

Part I and Part II are essentially quite different. Part I is psychological throughout and is concerned almost exclusively with fields in which the author himself has made research contributions of high merit. Part II (600 pages) is not to any great degree psychological but gives the author's personal reactions on a vast miscellanea of problems in economics, political science and social welfare. The discussion of these problems, which lie so largely outside the realm of present-day psychological science, is rightly intended to emphasize the extent to which their solutions must take account of psychological phenomena. On a good many of the issues discussed in Part II the psychologist, as psychologist, can at present make little or no contribution. Some of the discussions could as well have been written by a mathematician, chemist, biologist or lawyer. What Thorndike has to say is nearly always thought-provoking, whether he speaks primarily as psychologist or not, but it is probably these excursions into alien territory that will draw the most criticism.

I estimate that nearly 20 per cent. of Part II is taken up by quotations, often long ones, from many authors. The quotations are apropos and usually interesting but distract somewhat from the unity of treatment. Part II in general is likely to impress the reader as having less organization than would have been desirable.

I have stated above that this book "is neither a systematic treatise on social psychology nor an all-round introduction to the social sciences." Numerous topics which bulk large in the average text in social psychology are omitted or only casually mentioned. For information on relative emphasis it is instructive, even if sometimes perhaps misleading, to compare the index of a book with that of another in the same general field. I have made some comparisons of this kind between Thorndike's book and Kimball Young's "Social Psychology."[1] The figures that follow show for selected topics the number of references to each in the subject indexes. The first figure in each pair is for Thorndike, the second for Young.

More frequent mention by Thorndike:	
Abilities (or intelligence)	14–4
Capital (or capitalism)	10–1
Genes (or heredity)	25–3
Individual differences	21–10
Mastery	11–0
Measurement	12–0
Needs (or wants)	17–0
Prediction	7–0
Rewards	11–0
Rulers (or ruled)	4–0
Russia (or Soviet)	14–0
Satisfactions	12–0
Tests	8–0
Wealth	6–0
More frequent mention by Young:	
Attitudes	6–24
Censorship	1–37
Conditioning	2–9
Crowd	0–31
Cultures	0–30
Emotions	0–25
Fads (or fashions)	1–37
Gangs	0–4
Interaction	0–7
Language	0–30
Laughter	0–8
Leadership	0–37
Legends (or myths)	0–18
Newspapers	0–29
Personality	2–30
Play	1–13
Prejudice	0–35
Stereotypes	0–21
Propaganda	3–40
Public opinion	0–32

Examination of the name indexes discloses similarly striking contrasts even when the comparison is limited to names of writers who have dealt with social issues. The following figures (again in the T-Y order) are more or less typical:

F. Allport	2–15
Bentham	7–0
Burgess	0–7
Cooley	0–7
Dewey	1–11
Freud	3–11
Holmes (Justice)	7–0
McDougall	1–14
W. I. Thomas	2–16
E. A. Ross	0–9
Sumner	0–7
Veblen	14–9
G. Wallis	7–2
Webb (B. or S.)	12–0

The figures just given make it clear that this book

[1] Knopf, 1930, pp. 38 + 674.

is not just another text in social psychology. For the most part it leaves the concepts and problems of sociology to the sociologists, especially the problems of acculturation and human interaction. Its most distinctive contribution is in the emphasis placed upon the social significance of individual differences in abilities, character, wants and satisfactions, and upon the genetic causes of such differences. Thorndike does not deny the importance of good environment, but he never forgets that genes set the limits to its effects. With sly humor he notes that "the perfectibility of human nature is wisely put by religions in a heaven with not only optimal environment but also infinite time." Numerous passages could be cited in which he pays his respects to the biological ignorance that underlies egalitarian social philosophies. Certainly very few writers have so boldly expressed the implications (as he sees them) of the doctrine of individual differences for economic and political theory.

Not every one will agree with Thorndike on what the true implications are. Some who agree with him completely about the potency of genes will be unable to accept all the conclusions he deduces from that premise. For Thorndike the fact that the ability of the gifted far transcends that of the masses, together with the fact that there is a positive correlation between ability and character, calls for a political system in which power would be largely concentrated in the hands of a benevolent aristocracy composed of the able and the good and in which equal suffrage would be replaced by some scheme of weighted ballots. The author believes that our present "aversion to government by experts is on a level with aversion to medical treatment or sanitation by experts." One may question whether he has given due consideration to the dangers inherent in even the best aristocracies and whether he is not banking too heavily on the practical consequences of a slight positive correlation between intelligence and character. It may well be, however, that a vigorous presentation of this point of view will serve as a useful antidote to the sentimental political and social philosophies that ignore or deny heredity differences and attribute magic influences to factors of environment.

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SPECIAL ARTICLES

FAILURE OF BARLEY TO FIX MOLECULAR N^{15}

THE testimony of centuries of experience in practical agriculture has established the respective nitrogen depleting and nitrogen replenishing natures of non-leguminous and leguminous crops. Despite the weight of practical and experimental evidence against the conclusion, periodic reports reassert that non-leguminous plants can fix atmospheric nitrogen.

Results were presented in this journal by Ruben, Hassid and Kamen[1] indicating the fixation of radioactive N^{13} gas by the fresh tops of barley plants and the lack of fixation by tops boiled in water before exposure to N^{13}. As N^{13} has a half life of but 10.5 minutes, these experiments were necessarily of very short duration, the barley tops having been exposed to N^{13} for only 20 minutes.

The stable nitrogen isotope, N^{15}, offered us a means of tracing nitrogen fixation without the time limitation imposed by the radioactive isotope. Barley seeds were dehulled and then rendered bacteria-free by treatment with 70 per cent. ethyl alcohol followed by calcium hypochlorite solution carrying 3 per cent. available chlorine. The seeds were germinated aseptically and transferred to culture tubes containing thoroughly washed quartz sand to which a nitrogen-free nutrient salts solution had been added prior to sterilization. Tubes containing bacteria-free red clover plants and red clover plants with added root nodule bacteria (*Rhizobium trifolii*) were prepared in the same manner. Cresol red[2] in side bulbs on the tubes indicated when CO_2 was needed, and this gas was added to the atmosphere as required during the experiment. The plant culture tubes were sealed to a common manifold, evacuated and supplied with a gas mixture of 20 per cent. oxygen and 80 per cent. nitrogen. The nitrogen gas had 13.5 atom per cent. N^{15} excess (*i.e.*, 13.87 per cent. N^{15}, the normal abundance of N^{15} being 0.37 per cent.) and was freed of combined nitrogen compounds by passage through alkaline $KMnO_4$ and H_2SO_4.

Each group of plants, bacteria-free barley, bacteria-free clover and inoculated clover, received the same gas mixture, and the gas during the entire experiment was free to diffuse among the tubes through their cotton plugs. Air controls were grown in the same manner. The plants of experiment 1 were harvested after 42 days, subjected to Kjeldahl digestion, the NH_3 distilled and then converted to N_2 with alkaline hypobromite.[3] The N_2 was analyzed for the N^{15} isotope with a mass spectrometer.

In a second experiment, which did not include the bacteria-free clover culture, 8.1 atom per cent. excess

[1] S. Ruben, W. Z. Hassid and M. D. Kamen, SCIENCE, 91: 578, 1940.

[2] Elizabeth M. Smyth, SCIENCE, 80: 294, 1934.

[3] D. Rittenberg, A. S. Keston, F. Rosebury and R. Schoenheimer, *Jour. Biol. Chem.*, 127: 291, 1939.