

Linguistic Society of America

Review

Author(s): Yuen Ren Chao

Review by: Yuen Ren Chao

Source: *Language*, Vol. 26, No. 3 (Jul. - Sep., 1950), pp. 394-401

Published by: [Linguistic Society of America](#)

Stable URL: <http://www.jstor.org/stable/409735>

Accessed: 26-01-2016 18:20 UTC

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at <http://www.jstor.org/page/info/about/policies/terms.jsp>

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.



Linguistic Society of America is collaborating with JSTOR to digitize, preserve and extend access to *Language*.

<http://www.jstor.org>

REVIEWS

Human behavior and the principle of least effort: An introduction to human ecology. By GEORGE KINGSLEY ZIPF. Pp. xi, 573. Cambridge, Mass.: Addison-Wesley Press, 1949.

This is a brilliant book. As the author says, apropos of studying Shakespeare under G. L. Kittredge, 'As one of Kittredge's former students, I believe that both Mr. Kittredge and Mr. Shakespeare did their respective jobs brilliantly' (330 fn.). This is also a large book, not only in number and size (16 cm × 24 cm) of pages, but also in that it studies life from many sides, from language to all of culture, from individual to national and international behavior, from physiological to economic dynamics, from man to all life. It is a comprehensive book in that it attempts, with success here and failure there, to systematize and explain all the great wealth of collected and quoted data under one all-inclusive Principle of Least Effort.

The phrase 'The Principle of Least Effort', as the author acknowledges (12-6), is not new, nor is the systematic study of the economy of work of groups and individuals. The two new essential points advanced by the author are (1) that it is effort, or RATE of work, rather than AMOUNT of work, that is to be minimized, and (2) that, since it is impossible to foresee the future work entailed by present action, it is the estimated or probable average rate of work that is involved in the application of the principle. It is however a little surprising that the author did not relate his work to classical theories of economics and utilitarianism, either to agree or to disagree with them.

The book is divided into two parts. Part One deals with language and the structure of the personality. To paraphrase the table of contents slightly, the topics of Part One, after the first introductory chapter, are in the following groups of chapters:

Speech from the point of view of the speaker: Chap. 2, Economy of words and meanings; 3, Semantic balance between 'tool' and 'job'; 4, Children's speech.

Speech as heard: Chap. 5, Language as sensation and mentation; 5, Definition of organism, the Ego as the 'origin' of a frame of reference.

Dynamics of symbolic process, extending speech to all modes of social communication: Chap. 7, Mind, sex, and schizophrenia; 8, The economy of the language of dreams and art.

Part Two deals with the economy of human social behavior, also divided into three groups. Chaps. 9 and 10 deal with stable and unstable equilibrium in nations and between nations; Chap. 11, with the distribution of economic power and social status; and Chap. 12, with prestige symbols and cultural vogues.

While the reviewer, and probably most of the readers of this journal, will be more concerned with the earlier parts of the book, dealing more directly with language, 'the underlying aim of this book is not to present speech data. Instead, our primary aim is to demonstrate the universal validity of the Principle of Least Effort in all living process' (343).

The material of the book begins with Chapter 2, On the Economy of Words.

The book soon goes far beyond the study of words, and is thus of less direct interest to linguists than the content of the author's earlier book, *The Psycho-biology of Language*,¹ beyond which the present book has added relatively few linguistic data. In this chapter the empirical regularities are presented in slightly more systematic form than in the previous book. Here the author makes more use of the frequency-rank of a variable, whereas in the *The Psycho-biology of Language* it was mostly the NUMBER of cases of a frequency range that was made the independent variable. The first batch of equations are the following:

$$r \times f = C \quad (1)$$

that is, the rank, r , of frequency of a word is inversely proportional to its frequency (24).

$$m_r = \sqrt{F_r} \quad (2)$$

that is, the number of meanings of a word of frequency-rank r is equal to the square root of its frequency (28).

$$N(f^2 - 1/4) = C \quad (3)$$

that is, the number of different words of the same frequency, under conditions of equation (1), is approximately proportionate to the square of their frequency (32). This was the 'inverse square law' of *The Psycho-biology of Language* and earlier works, but is not independent of equation (1).

$$F \cdot Sn = \frac{F}{1} + \frac{F}{2} + \frac{F}{3} + \dots + \frac{F}{n} \quad (4)$$

As it stands, this equation says nothing. It is a tautology rather than the formula for a law, since ' Sn ' is simply an abbreviation of the sum $\sum_1^n \frac{1}{r}$. What the author really means to say here is that the total number of words in a speech sample (of the 'balanced' sort) is the product of the highest-rank frequency F times the sum of the harmonic series, whether the sum is written like the left side or the right side of the equation (36).

$$N^p \times I_f = \text{a constant (approximate)} \quad (5)$$

that is, the number of intervals, of like size I , between occurrences of words of like frequency f is inversely related (to a certain exponent p) to the size I . It means, in effect, a somewhat even distribution of work over time (41).

These equations are not all independent, but have mostly been verified empirically, some already recorded in previous publications. But it is in this book

¹ G. K. Zipf, *The psycho-biology of language* (Boston, 1935), reviewed by Martin Joos in Lg. 12.196-210 (1936); Zipf's reply in Lg. 13.60-70 (1937). Instead of the Principle of Least Effort, the earlier book made the generalization that 'all speech-elements or language-patterns are impelled and directed in their behavior by a fundamental law of economy in which is the desire to maintain an equilibrium between form and behavior' (19). The saving of effort (38) and economy of effort (129) were mentioned incidentally, but were not developed there.

that the author attempts to rationalize the whole thing on the Principle of Least Effort.

The formulas are added to (e.g. 354-9, 366-71, and Chapter 11), and some of them receive wider applications as well as more generalized forms. The harmonic series, for example, is generalized as:

$$F \cdot S_n = \frac{F}{1^p} + \frac{F}{2^p} + \frac{F}{3^p} + \cdots + \frac{F}{n^p}$$

When $p = 1$, it is the formula for word frequency of normal speech. In the speech of schizophrenes (291, 294), $p > 1$, the series is convergent as n increases, and the interpretation is that 'the schizophrenic can continue forever to say the same things about an increasing diversity of things' (303).

In discussing the economy of phonetic systems the author sets up four fundamental principles: (1) The number of phonemes of a language is generally between 20 and 60 and not hundreds, thousands, or millions. (2) Certain sounds (a , n , m , s , etc.) occur in most languages, human speech apparently leaning heavily on these. (3) When different languages happen to have about the same sounds, they tend to have about the same frequencies. (4) The fourth principle states the usual phonetic law about the same change occurring under the same conditions, and cites Brugmann (99).

In rationalizing these principles, the comparability of the number of phonemes in different languages is argued from the identity of physiological apparatus for speech and the 'saturated' use of permutations for economy. It is not made clear however why, as a result of the operation of these factors, the order of magnitude of the number of phonemes should be 20 or 60 and not 2 (the number of elements involved in the all-or-nothing kind of action of nerve cells) or some function of the number of distinguishable or recognizable auditory qualities.

In using supporting materials for the thesis that difficult sounds are less frequent than easy sounds, some of the conditions do not seem to be very clearly defined. As Martin Joos has noted,² unaspirated lenis (voiceless) stops are by no means simpler than aspirated stops or than voiced stops. From the point of view of economy of effort, the kind of stops quoted from Peipingese (101) requires a very difficult coordination of timing. The fact that these same phonemes have voiced allophones in intervocalic positions also cuts across Zipf's category of voiced sounds, which he counts as more complex and therefore less frequent. It is symptomatic that Zipf has to mull over the voiced pronunciation of the middle consonant in American *latter*, and finally concludes that its phonemic status must be decided according to what will happen in the future.³

We might in fact ask, why are initial unaspirated stops comparatively rare in languages of the world? We might also ask, by the way, why are fronted palatal stops (like Tibetan t' , t'' , etc., spelt by -, py -, phy -, etc.) also comparatively rare? They are 'difficult', not because it takes more work or more effort (aspiration, voicing, etc.) to make them, but because they have to be formed just so. Unaspirated voiceless stops need critical timing in starting the vowel—too soon makes

² Lg. 12.207-8.

³ Psycho-biology 109.

them voiced, too late makes them aspirated. Fronted palatal stops need critical pressure of air—enough for an explosion, but not enough to turn them into affricates. The Principle of Least Effort will probably have to be supplemented by a different principle, namely the principle of probability, to the effect that events corresponding to a greater range of combinations of factors are more likely to happen than those limited to a narrower combination of factors. If the Principle of Least Effort has to do with work or rate of work, this other principle has to do with configuration or entropy.⁴ It is not claimed that linguistic change is all 'down hill' in any higher-order sense than the usual downhill direction of physical process according to the second law of thermodynamics; but it seems that the factor of probability of configurations will have to enter into any complete account of human behavior. Furthermore, the emphasis on work and effort at the expense of other factors leads to overstatements such as this: 'Implicit therefore in the mass of this earth is an organization of the surface which involves conscious living phenomena. In the unity of nature with a continuity of natural law, life may then be rather a property of large masses of matter than a peculiarity of earth' (252). Now the very first author quoted in this book is L. J. Henderson (545). In 1913, Henderson published a book⁵ whose main thesis was that the earth is unique in having a highly improbable combination of chemical and physical circumstances which are singularly fit for the phenomenon of life. That theory does not seem so far to have been successfully challenged—all science fiction notwithstanding!

This leads us to the wider problem of the author's general outlook and his methodology. The implicit philosophical position of the author is more or less that of commonsense realism, which is also the position taken implicitly by the majority of behaviorists. The validity of scientific induction is assumed, as it is by all scientists. One needs only to determine sameness or difference of classification as a basis for the future (180). As he goes on, a more pragmatic philosophy becomes more evident (181).

There are a number of definitions or quasi-definitions of the mind throughout the book. (1) 'The matter-energy that is in transit through this system [of actions for the most economical survival], according to the laws of inanimate physics, constitutes the individual's *physical being*, or body. Yet the *kinds* of matter-energy and its *kinds* of action-reaction in transit through the system is the individual's *mind* (by present definition)' (192). (2) 'Consciousness ... seems to be nothing more than a secondary systematic reaction to the more primary stimulus response; ... consciousness is an awareness of an awareness; ... a sensation of a sensation' (196). (3) 'Mind as a unit prediction mechanism with a minimum of different classes (of sense data)' (196 fn.). (4) 'Mind as a unit

⁴ A book of such general scope as the present one will naturally touch upon many overlapping problems in another equally comprehensive study: Norbert Wiener, *Cybernetics or control and communication in the animal and the machine* (Paris and New York, 1948), which came out shortly after Zipf's book. It is disappointing that Zipf did not make more than two points of light contact with Wiener's ideas: a hint of feedback situations (199) and a mention of oscillating conditions (483), without, however, any discussion of conditions for stability and instability.

⁵ L. J. Henderson, *The fitness of the environment* (New York, 1913).

semantic system that tries to minimize its n different classes of action' (200). (5) '*Mind* is a word that we are using to designate an organism's selection of particular kinds of matter-energy in order to minimize the organism's own probable work' (253). (6) 'The tertiary reality, or *mind* [primary reality being what lies beyond sensation and secondary reality being sensory reality], is a system of classified and correlated physical sensations, etc.' (285). (7) 'The empiric law of speech refers to an individual's kinds, or manners, of behavior, whose sum total we shall define as his *mind*' (311). While it is quite legitimate to employ implicit forms of definitions, it is not quite clear that the seven definitions of *mind* are really equivalent.

Since the conception of *organism* plays an important part in the book, here is a definition of the term: '*An organism is a movable mathematical point in time-space, in reference to which matter-energy moves in such a way that a physical situation exists in which work is expended in order to preserve a physical system (continual as a whole but not continual as to its parts) from a final gravitational and electromagnetic equilibrium with the rest of the universe*' (212). This seems to fit the actual biological organisms of the earth, but it does not seem to exclude crude imitations of them like the mechanical tortoises 'Elmer' and 'Elsie' of W. Grey Walter.⁶

In striving not to overlook any relevant factors, the author often explicitly mentions reflexive applications of a principle to his problem. 'The work of calculating a path of least effort must be included in the total work of taking the path of least effort' (11). The work of improving the economy of tools must be included as part of the economy (58). The author's own researches of course form part of this research, as when he observes that the increasing intelligibility of children's speech 'will also be more economical of the efforts of the listeners (as well as for the student of biosocial dynamics who has to classify it)' (150-1), which, though whimsically mentioned, seems to be none the less true. However, logicians may wonder how those self-contradictory paradoxes (of the type 'All Cretans are liars') from reflexive application of a metalanguage to a lower-order language will fare under the present treatment. But that is an aspect of the problem not covered by the present book, nor apparently found troublesome so far. Perhaps the question does come up in those passages where the author departs from his usual style, as when he warms up to exhortations ('The greatest of all arts is the art of one's own living. ... So act that ye may so become' 335), or is wrought up over the 'Pied Piper Morality' and the foreign policy of the United States during and after the second world war (478-82, 525, 537). Here the reader finds unexpected 'agitato' passages in an otherwise deliberate book; the book seems to go suddenly off color. (Whether one agrees or disagrees with the author's political views is another matter.) Nevertheless, the writing of the book and the inclusion of such strenuous language must of necessity be instances of the principle of least effort, and that has to be that.

So much for the author's philosophical outlook. As to his method of procedure, he calls it 'inductive-deductive'. Preliminary examination of data results in certain empirical uniformities, for example the inverse proportion between fre-

⁶ W. Grey Walter, An imitation of life, Scientific American 182.5.42-5 (May 1950).

quency and frequency-rank of words. An explanation by a balance between forces of diversity and forces of uniformity is suggested, and further predictions are checked by further empirical investigations. Very often the students who helped gather the data did not know what the data were to prove (543).

Besides this usual alternation between induction and deduction, there is a related procedure in the abundant use of models, analogues, or illustrations, introduced by phrases like 'upon reflection', 'we assume', 'obviously'. The problem of least effort is illustrated by the choice of paths between places with intervening mountains, swamps, etc. (11), by the bell analogy, where a little demon is to plan a least-effort pattern for running back and forth between a scoring board and bells to ring at various distances from the board (48), and by the tool analogy, by which a workman has to plan, design, arrange, and, when necessary, improve his tools and permutations of tools so as to get the most out of them by the least effort (57-63). As often happens in other fields, a good analogy may turn out to be just a special case of a more generalized form of the concept illustrated by the analogy, thus making a figure of speech literally true.

A very interesting application of the tool analogy is that of senescent and nascent tools in connection with the Principle of Economical Specialization. Reasoning from tool efficiency yields the result that 'whenever we find a tool (or word) whose magnitude is smaller than that of its neighbors in the frequency range, we may conclude that the tool (or word) of below-average size is an older tool (or word) whose usage is on the decrease (hereinafter we shall call this a *senescent tool*)', and 'whenever we find a tool (or word) whose magnitude is above average for its frequency, we may conclude not only that it is a newer tool (or word), but that its usage may well be directed toward an increase (hereinafter we shall call this a *nascent tool*)' (72). The application to words is verified to a fair degree for English of various periods (111). By regarding all behavior as work and words as tools, the analogy becomes a case and the qualifier 'or word' can be omitted.

Now in the development of many branches of science, a broadening of a concept usually goes with a sharpening of definitions. Thus, the concept of 'energy' was defined with progressive precision as the law of conservation was extended. Is there a progressive sharpening of definitions of terms in this work, of whose breadth there is no question? Take the example of the Hanley-Joos statistical study of words in James Joyce's *Ulysses* (23-7), which 'provided the most clear-cut example of a harmonic distribution in speech of which I know' (546). Now in the data for correlation between rank and frequency of words, morphemes, varimorphs (or morphs), holophrases (or compounds), the relation is not always that of simple inverse proportion, not even always one of simple power relation (called by Zipf 'linear', from plotting on log-log graph). If now a word is already defined by minimum free utterability, or by some other formal feature or features, then a formula for inverse ratio or some other 'linear' relation will be a law, or a synthetic statement about facts. On the other hand, by taking the inverse proportion, or, more accurately, the harmonic relation (35-7) as the norm, and DEFINING words as units of such size as will satisfy that condition, the formula will fix the nature of the word. Thus, 'the negative slope [of the

rank-frequency graph on a log-log scale] for words in English ..., as well as for some other tongues, was 1, thereby indicating theoretically that words represent an equilibrium in class inclusiveness between the opposite economies of the generic and the specific in the particular case where the magnitudes of the two opposite economies are equal. Indeed a *word* might almost be thus defined' (187).

While this is no formal definition, it is an operational definition in that the graph can be tested (though it would be hard to apply to individual cases). However, the author only says that 'a *word* might almost be thus defined', and his official—since it is not 'formal'—definition says '*words are tools that are used to convey meanings in order to achieve objectives*' (20), which is even less workable than the descriptions, given in his earlier work: 'a word as a name of a frequently used category of experience' and 'Empirically a word is an event in the stream of speech somehow related to the data of experience.'⁷

While a looseness of concepts is to be expected in a pioneering work, where additional data and systematization will serve to tighten them up—just as momentum, force, energy, etc. were gradually defined and differentiated and definitions and laws are separated—there does not seem to be any notable progressive clarification and rigor as the book goes on. To be sure, the author is quite aware that some of the mathematical formulas are not to be taken literally. In his earlier work, he said 'yet the conclusions themselves can probably never be established numerically because of the nature of the phenomena involved',⁸ and again, in the present book, 'our alleged Forces of Diversity and Unification are by no means mathematical parameters Not until we have operational units of measurement of these theoretical Forces, such as we have for sheer physical force (e.g., a unit of horsepower), will the Forces in question be anything but theoretical [read figurative]' (360). Here, as in the case of the analytic-synthetic problem, or the definition-theorem problem, it is to be expected that the researcher should have the right to experiment around a bit. But in a systematic treatise one should expect the basic terms to be more consistently defined. The cumulative effect of a journey through these formulas and applications to ever widening fields is that there is more and more to it, and that there must be something in this Least Effort business. But for 'An Introduction to Human Ecology' as an established science, there is still not enough distinction between model and instance, between analogy and example. The majority of the figures of speech have not yet been assimilated into literal truths, as the author seems to have succeeded in doing done in some cases. This is not in disparagement of the book, but rather to indicate that the Science of Human Ecology studied from the Principle of Least Effort is still in a fluid stage, made extremely promising by Zipf's extensive and pioneering work. I am highly intrigued, even persuaded. But I am not fully enlightened, since I am not sure what exactly the dimensions of effort are, and I am not fully convinced, since I believe that in biological and social phenomena, other factors may be as important as that of effort. As Norbert Wiener says, 'In the nineteenth century, ... the fundamental notions are those associated with energy Today, we are coming to realize that the body is

⁷ Psycho-biology 267.

⁸ Psycho-biology 4.

very far from a conservative system, and that its component parts work in an environment where the available power is much less limited than we have taken it to be. The electronic tube has shown us that a system with an outside source of energy, almost all of which is wasted, may be a very effective agency for performing desired operations, especially if it is worked at a low energy level. We are beginning to see that such important elements as the neurons, the atoms of the nervous complex of our body, do their work under much the same conditions as vacuum tubes, with their relatively small power supplied from outside by the circulation; and that the bookkeeping which is most essential to describe their function is not one of energy.⁹

YUEN REN CHAO, *University of California*

Tone languages: A technique for determining the number and type of pitch contrasts in a language, with studies in tonemic substitution and fusion.

By KENNETH L. PIKE. (University of Michigan Publications: Linguistics, Vol. 4.) Pp. xii, 187, lithoprinted. Ann Arbor: University of Michigan Press, 1948.

Pike has made two important contributions to the study of pitch phenomena in language: *The Intonation of American English* (1946), which treats the special type of pitch phenomenon known as intonation, and the present volume, which is chiefly concerned with the analysis of tones. There are so few general treatises on the nature of tones in different languages that Pike's book is a welcome contribution to the field and an indispensable aid to students working on languages of this type. The purpose of this book, as stated by the author (vi), is '(1) the illustration of an analytical approach to tone languages, a methodology based upon recent linguistic advance, and (2) the presentation of firsthand data on Mixteco and Mazateco, languages which represent two very different structural arrangements of linguistic tone.' Accordingly, Part I of the book is devoted to the characteristics of tone languages, forming the general theoretical background of his study; Part II is concerned with the methods of analysis; and Part III is an analysis of the various tonal phenomena in Mixteco and Mazateco.

A tone language is defined by Pike (3) as 'a language having lexically significant, contrastive, but relative pitch on each syllable'. One may doubt, in the first place, the theoretical justification of such a classification of languages, although one can readily admit the practical convenience of such a label to designate the languages that come under discussion. H. Maspero, *L'Indochine* 63 ff. (Paris, 1929), divides the languages in French Indo-China into two groups, *langues monotoniques* and *langues variotoniques*. He does not consider his division a purely practical device, but intends to convey some implications of genetic relationship. His purpose is thus entirely different from Pike's, which is purely descriptive. One may also question the advisability of limiting tone language to a type in which each syllable has a lexically contrastive pitch, especially as Pike recognizes (25) what he calls nonlexical tonemes, non-lexical neutral tonemes (not contrastive), and rhythmically toneless syllables. But these are minor points, because Pike is primarily interested in describing tones, tone systems, and tone

⁹ *Cybernetics* 53-4.