parts by either space or hyphen, as in the Germanic languages. Perhaps it may be because of the present transitional state of the language that there seem to be no very definite rules as to when hyphens should be employed in such English compound nouns. Originally, perhaps hyphens were the general rule; but gradually usage has justified the omission of the hyphen in many cases. Then when two compound terms are compounded together, with the use of a single hyphen, the results are sometimes curious; *e.g.*, "the Great Northern-Northern Pacific railway system," a term which is clear enough to an American, but might puzzle a foreigner.

As editor of *Stain Technology*, the writer has to struggle again and again with the problem of hyphenation of compound names, trying to solve it in a way that is logical, consistent and at least fairly grammatical. Thus, although the term "spore former," as two words without a hyphen, is undoubtedly sanctioned by usage, the logic of "non-spore former" seems at least questionable; just what is a "non-spore"? This latter compound noun is quite simply improved by introducing a second hyphen; but when an author tries to describe some technic by the use of a compound term made up of all the principal ingredients used (themselves often compound nouns), the problem becomes more complicated. It is hard to justify such terms as "safranin-orange G-crystal violet technic" or "iron alum-hematoxylin phenol-Bismarck brown Y schedule." Such expressions as these are perhaps unambiguous to any one familiar with the names of dyes and the nature of staining solutions; but the layman, looking at the former, would never suspect that the "G" belongs with "orange" and "crystal" with "violet."

Does English have any rules for the hyphenation of such a compound term? The writer has been unable to find any, presumably because such compounding was originally foreign to the language. Granted that Weatherby is right in assuming that compound terms will some day be frankly recognized and written as one word, let us hope that some one will devise a system for use in doubly and triply compounded words to show which elements belong most closely together and which are related to the others more indirectly.

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USE OF PARENTHESES IN ZOOLOGICAL NOMENCLATURE

IN a recent communication, Dr. Osgood[1] ably argues for dropping the parentheses about authors' names when the specific designation of an animal has been changed. One of his arguments is that parentheses are unnecessary to the specialist and both unnecessary and confusing to the layman (such as, I suppose, a visitor to a museum).

Personally, I hold no thesis in this matter and am perfectly willing to follow any convention which seems to the majority wisest; but I wish to point out that not all who use zoological names are specialists in taxonomy nor, strictly speaking, laymen. General zoologists are often temporarily befuddled by the rapidity of changes in nomenclature, however wise and necessary these changes may be in themselves.

Recently, I have had occasion to make use of an extensive taxonomic literature upon a group whose members are not well known to me. In this task, I have found the conventional use of parentheses very helpful in tracing synonymy and I suspect that other non-taxonomic zoologists may have had similar experiences.

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[1] SCIENCE, 89: 9–11.

QUOTATIONS

DISTRIBUTION OF THE YOUNGER STARRED SCIENTISTS[1]

THE distribution of productive scientists is certainly of great significance in an age of science, and can advantageously be studied geographically. A summary of the findings is of special interest to the scientists themselves.

Cattell has published, in the appendices of "American Men of Science," 1906–1933, some data as to the places of birth, education and work of the scientists who were, between 1903 and 1932, starred, by vote of their fellow specialists, as especially distinguished in research.

In the following discussion the scientists first starred in the sixth edition of "American Men of Science," issued in August, 1938, receive especial attention; but the 1938 distribution of all the living scientists starred in 1921–1937 is discussed. Detailed attention is given to the starred astronomers, geologists, chemists, physicists and mathematicians. Some comparisons are made, also, with the older groups of scientists, those starred in 1903 or 1910, nearly all of whom are now dead or retired.

DISTRIBUTION BY OCCUPATION, AGE, SEX

The occupational distribution of those of the nearly 500 scientists starred in 1932 or 1937 who report their employment in the 1938 edition of "American Men of

[1] Extracts from an article in the issue of the *American Journal of Science* for January, 1939.

Science" is of interest. Seventy-six per cent. are connected with educational institutions and presumably are supported by their teaching. Only one twelfth are connected with research institutions and only one fifteenth are in government employ (aside from the state universities). Half of those employed by the Federal Government are in the Geological Survey. Less than one sixteenth are in applied or commercial science. Research institutions employ relatively many astronomers, chemists, pathologists and physicists. Comparison with the situation in 1906 and 1921–27, reported by Cattell, indicates that there has been a sharp decline in the number of anthropologists in federal employment; a sharp gain in the number of astronomers and botanists employed by research institutions; of geologists, the number in the U. S. Geological Survey has remained about stationary, the number in universities and state surveys has declined; in pathology there has been a shift to research institutions. Of the zoologists, there are far fewer in federal employment, more in research institutions and about the same proportion as formerly in universities.

The year of birth is available for all but four of the group starred in 1937. Two were born before 1870, 11 in the 1870's, 61 in the 1880's, 108 in the 1890's and 64 since then, the youngest in 1911, the next youngest in 1908, and 9 since 1905. The median year of birth is 1895. Age at starring: eight in the 60's, 21 at ages 55 to 59, 27 in the early 50's, 100 in the 40's, 56 in the last half of the thirties, 21 in the early 30's, 2 at 28, one at 26. The average age at starring is almost 43 years. (For the 1932 group, Cattell found the average age at starring of mathematicians and physicists to be 36, chemists 41, psychologists 44, biologists 46, pathologists 48, geologists 49.) Although the average age at starring of the 1937 group is almost exactly the same as for the 1932 group, the distribution is somewhat less concentrated, a third more being over 55 or under 36 at starring; one quarter instead of one third being aged 40 to 46. The youngest man of the 1932 starring was 27, another was 28, four others were 29 and seven were 30. Four were in their 60's in contrast with eight of the 1937 group.

Nine women were starred in 1937, four of whom were married; three are zoologists, two geologists; one each, in anatomy, astronomy, botany and psychology. In 1932 three women were starred; two zoologists and one anthropologist.

Distribution by Institutions

Table I gives by leading institutions the 1938 distribution of the scientists first starred in 1921–1937, according to the sixth edition of "American Men of Science." This table shows that the leading universities in this respect are Harvard 69, Chicago 45½ (a part-time person is given a half-rating), Columbia 39½, California 39, Yale 35, Michigan 32, Princeton 31, Hopkins 30 and Minnesota 26. The leading institutions which are not universities are the Carnegie Institution of Washington (31½), the U. S. Geological Survey (23½) and the Rockefeller Institute and Foundation (24).

TABLE I

Starred Scientists at Leading Institutions in 1938
Number of Those Starred in the Year Indicated

	1921	1927	1932	1937	Total
Bell Tel. Lab.	2	6	2	3	13
Brown	6	1	1	0	8
California	8	7	14	10	39
Calif. Inst. Tech.	4	4	3	12½	23½
Carnegie Inst.	8	10	6	7½	31½
Chicago	9	14	11	11½	45½
Cincinnati	3	0	1	2	6
Columbia	13	9	10	7½	39½
Cornell	9	4½	7	5	25½
Duke	1	2	0	2	5
Harvard	17½	17½	17	17	69
Hopkins	10	4	7	9	30
Illinois	5	4	8	6	23
Iowa	1	0	4	3	8
Iowa State Col.	0	2	1	2	5
Kansas	2	2	1	0	5
Mass. Inst. Tech.	4	4	6	8	22
Michigan	8	4	11	9	32
Minnesota	8	4	9	5	26
N. Y. U.	1	2	1	3	7
North Carolina	1	2	1	2	6
Northwestern	5	1	2	4	12
Ohio	4	3	3	3	13
Pennsylvania	6	9	3	5	23
Princeton	6	4	10	11	31
Rockefeller	6	7	7	4	24
Rochester	2	1	4	3	10
Stanford	6	5	7	6	24
Swarthmore	2	1	0	2	5
Texas	2	3	1	½	6½
Thompson Inst.	1	1	1	2	5
United States					
Bureau of Standards	6	4	1	3	14
Dept. of Agriculture	2	3	2	5	12
Geol. Survey	4	7	5	7½	23½
National Museum	4	4	2	2	12
Virginia	1	1	3	1	6
Wash. (St. Louis)	3	2	3	1½	9½
Wisconsin	5	6	5	3	19
Yale	8	8	13	6	35

Schools with 4 each are: George Washington, Rutgers, St. Louis, Wesleyan. Schools with 3 each are: Indiana, Mt. Holyoke, Nebraska, Oberlin, Penn State, Pittsburgh, Tulane, Western Reserve. Schools with 2 each are: Arizona, College of the City of New York, Colorado Col., Conn. State, Rice, Trinity and Vanderbilt.

The totals given in Table I may be compared with corresponding data for 1906 given by Cattell. Universities which have about the same number of starred scientists on their faculty in 1938 as in 1906 are: Harvard with 66 in 1906 and 69 in 1938; Hopkins with 30, 30; Mass. Inst. Tech., 20, 22; Wisconsin 18, 19; Iowa 7, 8; Cincinnati 6, 6; North Carolina 5, 6; Kansas 5, 5; Western Reserve 4, 3; Texas, 5, 6½; Vassar 3, 3; Virginia, 7, 6.

Universities which have gained notably between 1906 and 1938 are: California 27 to 39; Yale 26 to 35; Michigan 20 to 32; Illinois 6 to 23; Princeton 15 to 31; Chicago 39 to 45½; Pennsylvania 17 to 23; Stanford 16 to 24; Washington (St. Louis) 5 to 9½; Ohio 10 to 13; Brown 5 to 8; and Northwestern 9 to 12; California Institute of Technology, not in existence in 1906, had only 7 starred men in 1927, but 23½ in 1938; Minnesota 10 to 26.

Universities which had fewer starred men on their faculty in 1938 than in 1906 include Columbia, 60 in

1906, 39½ in 1938; Cornell 33, 25½; Dartmouth 6, 1; New York 9, 7; Clark 7, 1; Indiana 6, 3; Missouri 9, 1; and Wesleyan 7, 4.

Since the 1938 edition of "American Men of Science" was put into type, more than a dozen men starred in 1921–1937 have died and several have moved. Hence the data given above are only approximately correct. A recently issued federal report[2] gives the distribution of starred scientists who were not yet 66 early in 1938. According to that table, which counts equally all persons in any way connected with the institution (not giving half weight as was done in the above article), Harvard, in 1938, had 83 starred scientists under age 66, Chicago 54, Columbia 50, California 47, Yale 41, Hopkins 36, Princeton 34, Minnesota 29, Michigan 28, Stanford 28, Cornell 26, Pennsylvania 25, California Institute of Technology 25, Wisconsin 22, Massachusetts Institute of Technology 22, Illinois 21. In federal service: the Geological Survey had 20, Bureau of Standards 16, Smithsonian Institution 11, Department of Agriculture 10; all other bureaus a total of 14.

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[2] "Research—a National Resource," (1) "Relation of the Federal Government to Research," National Resources Committee, December, 1938.

SPECIAL ARTICLES

PRE-LINGUISTIC SIGN BEHAVIOR IN CHIMPANZEE

THE expression "symbolic behavior" has been used frequently for types of adaptation which resist explanation by accepted principles of "animal learning," or even as substitute for "insight" and "higher mental processes." It is true that some of the most impressive contrasts between the behavioral capacities of man and other primates may be attributed to linguistic process or neural mechanism which is present in the former and either absent or rudimentary in the latter. Thus the great difficulty of double alternation[1] and temporal maze[2] problems for animals other than man may be attributed to inability to count. Likewise, differences in ability to respond to complex, obscure or novel relations, as in multiple-choice problems,[3] in rate of acquiring simple discrimination habits and in various tests of "reasoning" and "insight," are subject to a similar anthropomorphic explanation.

Analysis reveals, however, that many of these manifestations of behavioral adaptivity can be accounted for, without the postulation of symbolic processes, in terms of innate and acquired perceptual organization, generalization, transfer, processes involved in delayed conditioning and other relatively simple and widely applicable determinants of animal behavior. For example, performance in double alternation and temporal maze experiments might be explained as differential conditioning to two stimuli in a series of intra-organic stimulus-responses initiated by the external situation. Logically viewed, adaptive response to relations of varying degrees of complexity and unusualness, as widely exhibited in the animal kingdom, should not require the appearance of an entirely new process at some point in the series of events. Indeed, few if any of the attempts to account for tool using or construction and for other presumptively "insightful" problem solutions, occasionally exhibited by animals, have excluded the possibility that perceptual organization and transfer may suffice as principles of explanation.

Considerations, elsewhere discussed,[4] which suggest the operation of symbolic processes in delayed response will be summarized briefly. In infrahuman animals the establishment of a discrimination habit *in the absence of spatial cues* commonly requires a large number of differential rewards and frustrations, whereas the establishment of a comparable habit in delayed response tests *when spatial cues are available* may occur in a single trial and with signified versus actual reenforcement.[5] This contrast may be accounted for by the relative obtrusiveness and prepotency of the two varieties of cue or by the diversity of mechanism operative in the two cases. Man adapts as promptly to the delayed response type of situation without spatial cues as with them. It seems probable that his success is due entirely to capacity for linguistic response —use of symbols for white-black or right-left, as the case may be. The diverse observations cited may be brought into relation by assuming (*a*) that delayed response requires the mediation of a symbolic process and (*b*) that some of the vertebrates are capable of symbolic response to spatial but not to non-spatial cues. The latter assumption is strongly supported by the relative frequency and evident significance of spatial factors in the lives of most animals.

For present purposes a symbolic process may be conceived of as a differential, and usually implicit,

[1] W. S. Hunter, *Jour. Genet. Psychol.*, 35: 380*ff.*, 1928.
[2] S. D. S. Spragg, *Comp. Psychol. Monog.*, 13: 2, 38*ff.*, 1936.
[3] R. M. Yerkes, *Comp. Psychol. Monog.*, 10: 1, 89*ff.*, 1934.
[4] H. W. Nissen, A. H. Riesen and V. Nowlis, *Jour. Comp. Psychol.*, 26: 361–386, 1938. See also W. S. Hunter, *Behav. Monog.*, 2: 1, 1913, and *Psychol. Rev.*, 31: 478–497, 1924.
[5] J. T. Cowles and H. W. Nissen, *Jour. Comp. Psychol.*, 24: 345–358, 1937.