the observational range that defines the science. (See "A possible distinction between traditional scientific disciplines and the study of human behavior," in *Minnesota Studies in the Philosophy of Science*, vol. 1, *The Foundations of Science and the Concepts of Psychology and Psychoanalysis*, H. Feigl and M. Scriven, Eds. (Univ. of Minnesota Press, Minneapolis, 1956).

4. The best advanced discussion of "fitness" with which I am acquainted is J. M. Thoday, "Components of fitness," in "Evolution," *Symposia Soc. Exptl. Biol. No. 7 (1953)* (1954).
5. In quantum physics we envisage the further possibility that there are no such factors, only the irregularity in the individual events, but we have the partial compensation of some statistical regularities. These are in some respects more informative than the nonquantitative probability and tendency statements of psychotherapy, personality theory, psephology, and so on.
6. H. G. Cannon, *The Evolution of Living Things* (Manchester Univ. Press, Manchester, England, 1958).
7. But senile adults may have properties of evolutionary interest—for example, in a gregarious society, especially a gerontocracy. It might seem that we can then include them as environmental conditions for the prospective parents, but this is inadequate (an example is the well-known case of the worker bees). A case where senile maladaptiveness is irrelevant is that of the coiled oyster.
8. The problem of accounting for, for example, the departure of the dinosaurs did not in fact arise until 34 years after Linnaeus' death, with Cuvier's work; but it is too commonly assumed that nonevolutionists would have *had* to assert, as they usually did with the few fossils of extinct forms recognized in the 18th century, that the animals still existed in some as-yet-unexplored part of the globe. They could also have said that a catastrophe that indiscriminately annihilated the life forms in some area was responsible—that is, one of the catastrophes discussed in the second point above. This involves no commitment to evolution.
9. Darwin believed in unpredictable variation, of course, but the several genetic origins of this were not understood by him, nor for that matter were they clear to Mendel.
10. For example, "If there is a volcanic eruption which produces a vast lava stream, then organisms in its path will probably be destroyed."
11. People have sometimes argued that if *A really* is the cause of *X*, it must *always* be followed by *X*. This is to confuse causes with sufficient conditions, and practically to abolish them from the applied sciences, since there are almost no absolutely reliable statements of sufficient conditions available there. Causes are not necessary conditions either; their logical nature is complex, though there is relatively little difficulty in using the term "cause" correctly—a situation which characterizes other fundamental terms in science, such as "probability," "truth," "explanation," "observation," "science," and "simplicity."
12. J. Maynard Smith, *The Theory of Evolution* (Penguin, Baltimore, Md., 1958), p. 245.
13. C. D. Waddington, "Epigenetics and evolution," in "Evolution," *Symposia Soc. Exptl. Biol. No. 7 (1953)* (1954).
14. C. R. Darwin, *The Origin of Species*; these and the preceding passages are quoted by Flew in his illuminating essay "The Structure of Darwinism," in *New Biology* (Penguin, Baltimore, Md., 1959).

Further Reading

The outstanding work on the logical problems of biology, and, in my view, an extremely important book, is Morton Beckner's *The Biological Way of Thought* (Columbia Univ. Press, New York, 1959).

Russian-English Transliteration

An exchange of views on this problem shows that a universally accepted solution is not yet at hand.

Comment by Hamp

The article by Gregory Razran [*Science* 129, 1111 (1959)] on the transliteration of Russian draws welcome attention to our inconsistent practice in a matter where we could readily do better. I can only applaud Razran's sensible attitude and second his call for improvement. I think, however, that we can clarify the problem further, and understand in some measure the present confusion, by raising a point of principle which Razran does not touch.

It has taken a fair part of the last half century for workers in linguistics to appreciate clearly the fundamental distinction that must be drawn between speech and writing. A glance at any of the modern textbooks on linguistics will amply illustrate this. Linguists are still all too conscious of the fact that the purport of this finding has in many respects not yet been brought home to the literate public at large, which includes their fellow scientists.

For our present purpose, this distinction means that the graphic system used in a particular culture area (a specific subtype of Cyrillic, in this case) is not identical with the phonemic system of a particular language (Russian in this instance). Indeed, the two can be analyzed quite independently. Only in rare instances are the two systems nearly congruent (Finnish is such a case), so that the distinction may be ignored altogether. In addition, we must remember that there are, too, the graphs of the target culture (a subtype of West European Roman, in our own case) and the phonemes of the target language (American English for us). There are, then, four separate systems in play, whose useful combinations we must now consider.

No one, presumably, is interested in matching Cyrillic graphs directly with English phonemes—that is, devising an arbitrary way for reading off a line of printed Russian with a thoroughly English accent. We get that result without strain from the less apt students in a Russian class. (The question is not idle, however, in principle; Egyptologists must decide how to cite forms intelligibly to one another aloud, even though they can scarcely guess at all what a large portion of the language sounded like.) Similarly, we have no immediate use for Roman letters with a Russian accent, unless perhaps we are training actors. There is very great use for comparison of Russian phonemes with English phonemes; that is what a linguist must consider in designing adequate and efficient teaching materials—both for Russians and for Americans. Finally, there is the problem of matching Cyrillic graphs with our Roman graphs; we will call this task "transliteration," *sensu stricto*.

At one point (page 1111), Razran says: "The rationale of the practice is presumably that of facilitating library cataloging and filing by indicating that the English combinations of letters correspond to single Russian letters. But, plainly, this limited and doubtful advantage must be pitted against the fact that ligatures and extra capitals are both expensive and unesthetic, add nothing from the standpoint of approximate pronunciation, and, indeed, have hardly ever been maintained consistently." Consistency is something which, like Razran, we all hope for, but which the linguistic engineer cannot enforce. Expense and esthetics are problems apart, and we must consider them judiciously in turn. But the "limited and doubtful advantage" of unambiguous transliteration is a matter of considerable concern to a

fair number of consumers—for example, the librarians to whom automatically convertible alphabetization is important. It should be emphatically noted that efficient transliteration can be made and be used without any knowledge of pronunciation (that is, phonemics) at all. This point is worth making, quite apart from Razran's statement, since it is a point that linguists, whose prime interest understandably is spoken language, tend characteristically not to be at pains to underline for the benefit of nonlinguists.

Yet another task may fruitfully be considered. We may take Russian phonemes (*not* Cyrillic graphs), assign them values (in whatever symbolic system we please; linguists observe technical conventions on this point, which need not detain us), and then transcribe these values into suggestive Roman graphs. We call this operation transcription. This is clearly what Razran means (page 1113) by "a discriminating use of English as is."

Transcription is obviously different from transliteration, and Razran is in effect collapsing this distinction when he says (page 1113): "The objective of any system of transliteration is obviously to convey to the reader as closely as possible the phonetic value of the transliterated material." The system which he proposes, laudable as it may be, falls far short of phonetic (or better, phonemic) adequacy—and I am not thinking here of the requirements of technical linguists but of those which the layman may reasonably lay down. For example, not only is the place of stress important—even crucial—in Russian, but the values of the vowels are very different in stressed and unstressed syllables. Any attempt to stick close to the Cyrillic graphs will fail to bring this out.

In short, with Russian as with many written languages, one cannot serve two masters simultaneously—graphs and pho-

nemes—and produce the results desired and often claimed. Some of the confusion deplored by Razran results from just this; but Razran's proposal itself does not really come to grips with the basic problem. Instead, he simply decides in advance which aspects he thinks most worth conveying.

A number of alternatives are conceivable. One would be to have two completely different, but generally accepted, conventions: For newspapers and what we might call colloquial uses, we could settle on something admittedly makeshift, but plain and manageable, such as Razran has set forth. For more technical uses we could agree on both a transliteration and a transcription, each of which would be accurate and scientifically based, if admittedly a trifle "unesthetic" in places. Competent persons could then decide whether for a given purpose (for example library catalogs as opposed to certain technical manuals) the transliteration or the transcription was more valuable and effective. For a few special purposes (for instance, names occurring in geographic literature, where both oral-aural and visual recognition are desirable) the cumbersome but unambiguous method of writing the form twice could be used—the transliteration and the transcription, with the two separated, say, by a slant line. Rules of capitalization need apply only to the transliteration.

There would be, of course, for each written language as many transliterations as there are other (target) graphic culture areas and as many transcriptions as there are other languages (target standard phonemic systems), the latter in turn being subdivided in a few cases (as in Serbo-Croatian), where more than one graph system serves the same language.

It would not be at all difficult for

competent linguists to design workable standard systems of transcription and transliteration. For example, Table 1 gives a possible consistent transliteration system which is relatively free of diacritics.

A reasonable approach to a satisfactory transcription system would take more technical discussion than is appropriate here.

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Comment by Fabergé

Razran regrets the existence of seven or more systems for transliterating Russian into English and proceeds to contribute one more such system. Any conceivable transliteration is at best a crude compromise between exactness, simplicity, expediency, and typography, and it does not seem to me that the new proposal has any marked merit, on balance, over several of those already in current use; thus, its introduction can only add to confusion.

The requirements of bibliographic cataloging and of the daily press are different; in the latter case it may be good to use rough English phonetic equivalents, so that approximate pronunciation is achieved at sight. In bibliographies phonetics are not the primary requirement, but some attention must be given to etymology. Many languages using the Latin alphabet have very divergent phonetic values for letters, yet in practice there is no requirement for transliteration, mispronunciation notwithstanding. Thus, few Americans would pronounce *all* of the following correctly: de Broglie, Brouwer, Cajal, Chasle, Fresnel, Hammarsten, James Clerk Maxwell, Perrin, Szasz, Zernike. I do not know the "correct" pronunciation of "Joule" (10 million ergs) or of "Demoivre's theorem," since both discoverers lived in England but were of French origin. Luckily, no one has yet proposed that any of these be transliterated.

Systems which are based on a related language that uses the Latin alphabet, such as Czech in the case of the *Mathematical Reviews,* and which give some attention to etymology, result in a measure of consistency and are of fairly wide applicability. They are not confined to English. The new proposal, on the other hand, is purely Anglocentric and would

Table 1. A possible system for transliterating Russian into English.

Russian	English	Russian	English	Russian	English
а	a	к	k	х	kh
б	b	л	l	ц	c
в	v	м	m	ч	ch
г	g	н	n	ш	sh
д	d	о	o	щ	shh
е	e	п	p	ъ	"
ё	ë or ö	р	r	ы	y
ж	zh	с	s	ь	'
з	z	т	t	э	è or ə
и	i	у	u	ю	ü
й	j	ф	f	я	ä
		ө	ph		

be most inconvenient to, say, a German or a Frenchman. In saying that *Pawlow* and *Pavloff* are quite obsolescent, Razran is merely giving the current (and far from obsolescent) German and French variants, respectively, of what is essentially his own system in these two languages. English is one of the worst bases for phonetic transcription, because of the multiplicity of phonetic values of almost all letters: it will be sufficient to remember Bernard Shaw's word for fish, "ghoti."

There are also some specific points where the new proposal seems unacceptable.

In my judgment the aspirated English *h* (as in *hat*, pronounced by a non-Cockney) is a very close approximation to the Russian х (though not to the Ukranian pronunciation); this *Mathematical Reviews* correctly recognizes. The spelling *Hrushchev* yields at once a fair approximation, while *Khrushchev* merely forces the Englishman to produce an inhibited pout, followed by a sneeze. In reverse, Russians themselves usually transliterate *h* as г, but the reasons for this are historical rather than phonetic.

It is true that the genitive -го sounds like -во, but to anyone knowing Russian, the proposal to transliterate this invariably as -*vo* is shocking because it looks like an illiterate error of grammar.

The use of *ye* for е is often phonetically correct, but not always; it would, moreover, result in names that begin with the same letter in Russian appearing near the opposite ends of alphabetical lists. To make invariably *k* equal to к is also questionable. I spent a frustrating hour in one university library trying to find the *Doklady* of the Academy of Sciences of the U.S.S.R. In vain I tried *doklady, doclady, comptes rendus, proceedings, academy, academie, nauk, St. Petersburg, Petrograd, Leningrad, U.S.S.R.*, and *Russia*; I was then told that no such publication existed, but finally found it under *Akademia*. Why not "Akadaymee day Sians do Parry?"

The proposal to distinguish between Russian and Polish names by using -*sky* and -*ski*, respectively, is impractical, since many "Russian" names such as Lobachevsky and Tchaikovsky are in fact of Polish origin, as is obvious to a Russian.

To have any phonetic value at all, a transliteration must include the position of the stress. Russian tonic accent follows no rule and has to be learned arbitrarily; Russians themselves may not

know whether a man chooses to call himself Ivánov or Ivanóv.

Strict adherence to some system would produce more confusion than it removes in the case of names of Russians whose main scientific work has been published in foreign journals and who are consequently already cited in many bibliographies with the corresponding spelling—for example, Markownikoff, Tschitschibabin, Tschetwerikoff.

It seems to me that any conceivable new transliteration system can result at best in negligible improvements, and that it is far better to avoid confusion and to take one of the extensively used systems, imperfect as they are. Above all, the practice of giving literature citations and making library cards in the Cyrillic alphabet should be encouraged. It takes little more time to learn the letters than to master some one of the transliteration systems, and many rather monstrous difficulties are thus avoided. These problems are not confined to Russian; readers may be amused to look at the last two pages of the preface to T. E. Lawrence's *Seven Pillars of Wisdom* to see the much greater difficulties encountered in Arabic, as well as that author's very sane attitude toward transliteration.

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Comment by London and London

The system of Russian transliteration presented by Razran contains, to be sure, certain simplifications. Unfortunately, it also presents certain insuperable difficulties for the cataloger who is not in full command of the Russian language—namely, with regard to the transliteration of е and ё as *e* or *ye* and *o* or *yo*, respectively. The fact is that the dieresis over the е is almost never indicated in Russian publications and the conscientious cataloger would have to consult a dictionary or even a Russian-speaking person in every case to determine whether *e, ye* or *o, yo* were indicated. (There are, moreover, no easy rules for such determination, as many beginning students of Russian have discovered.)

For the non-Russian cataloger even the transliteration of the genitive endings -ого and -его as -*ovo* and *evo*, respectively, following Razran's suggestion, cannot be entirely automatic. The cata-

loger must be able to distinguish genitive from nongenitive endings having the same spelling but retaining the sound *g*. The words много, немного, строго, and убого, for example, must all have the transliterated ending -*ogo*, not -*ovo*. This is not to mention, of course, a word such as благо, ending in аго, which must be transliterated as *blago*. The cataloger must also be careful to distinguish between the г which is pronounced as *v* in the *middle* of the word сегодня, and the г which retains the sound *g*— for example, in the middle of the word снегопад.

As to the value of any system of transliteration in itself as an aid to pronunciation—and to Razran this is *the* obvious function of any system of transliteration—it is doubtful that any foolproof scheme can be devised. While Razran's proposed substitution of *y* for ĭ in the transliteration of й may represent an improvement in certain instances, it is actually misleading in others. For example, how many would suppose that the transliterated word *day* (formed according to Razran's system) for дай is pronounced like *die*?

We may also note that, while the daily press may have evolved in some instances a more uniform system of transliteration, this system is not necessarily better geared to correct pronunciation. Otherwise, we should be reading (and hearing) *Khrushchov* (according to Razran's system) or *Khrushchóff*, or even *Khrooshchóff* (if one is really going to be serious about getting the name down right).

Actually, is not guaranteeing approximate pronunciation of transliterated items in the *scientific* literature a dispensable luxury? For example, how many of us can correctly pronounce French, Italian, or Polish references, which are already in the Latin script? The Library of Congress system of transliteration, with its uncomplicated one-to-one correspondence between Cyrillic and Latin symbols, serves the cataloging function admirably and, at the same time, makes possible easy recognition of the original Russian by qualified persons. With the exception of the ligatures —which could readily be eliminated— it would appear simplest to retain this system intact and recommend its universal adoption in the *scientific* press.

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Comment by Ray

Razran's article once more demonstrates that the last word will probably never be said on the subject of transliteration.

Fortunately, the summary concisely states the premise upon which the suggestions proposed in the article are based. "The objective of any system of transliteration is obviously to convey to the reader as closely as possible the phonetic value of the transliterated material." It is precisely this assumption, made also by many others in the thorn-strewn field of transliteration, which has led to difficulties. The assumption as stated is unworkable.

We must start afresh. One must redefine the problem of transliteration in such a way as to exclude from it the task of teaching the pronunciation of Russian, or of any other language which is normally written in other than Latin characters. It has been amply demonstrated by contemporary American descriptive linguists that the teaching of a spoken language is a task which presupposes a phonemic analysis of that language. There is no necessary correlation between the phonemic structure of a given oral language and the writing tradition in use by the speakers of that language. The relationship between a spoken language and the writing tradition of the corresponding written language is inevitably historical rather than synchronic. A further elucidation of this point is beyond the scope of the present remarks.

What, then, should "transliteration" aim at? It is here proposed that the objective of a transliteration system should merely be that of providing a means of letter-for-letter substitution in passing from one script to another. This is even implicit in the etymology of the verb *trans-literate*. Ideally, an unambiguous one-to-one correlation of symbols would be desirable.

Obviously a one-to-one correlation is impossible between a writing system with 26 symbols and one with the 32 symbols of the Russian Cyrillic script, as reformed in 1917. Hence, in certain instances a group of two or more Latin letters must be designated as equivalent to a single Russian letter. Failing that, the only other way to make 32 letters out of 26 letters would be to mark at least six of the 26 in some distinctive way. Transliteration systems for Russian, of course, do not use the available Latin letters *q* and *w*. Some less commonly

known systems use *j* and *x*. Although the use of diacritics goes contrary to the writing tradition of the English language, it occurs in the system of the *American Slavic and East European Review*, where *ž, č,* and *š* are merely the adaptation to Russian of the normal phonetic significance of *ž, č,* and *š* in Czech, Croatian, and Slovenian. As such, the system of the *American Slavic and East European Review* has much to recommend it. At any rate, once the problem is redefined as one of expanding a 26-sign system into a 32-sign system, we may proceed.

Now as a practical fact, in performing this expansion we are indeed, whether we wish it or not, constrained by the writing traditions of both the English and the Russian languages. And at the same time, in designing a transliteration system for the two, we have only the most marginal concern with the present-day pronunciation of spoken English and spoken Russian. It is here suggested that the Library of Congress transliteration system, once its objective is understood, adequately fulfils the requirement of a one-to-one correlation between the Russian Cyrillic alphabet and certain conventionally established letters and groups of letters of the Latin alphabet. A very important function of transliteration is that of making possible conformity to the limitations of more generally available type fonts. Hence ligatures are to be avoided. The Library of Congress system uses ligatures with only three combinations: *iu* for ю, *ia* for я, and *ts* for ц. The Library of Congress system does not use any ligatures over the combinations *zh, kh, ch, sh,* and *shch*.

It is in the matter of vowels that there is the greatest need to adhere rigidly to the symbol-for-symbol correlation principle. We may not say "one-to-one" because the Russian Cyrillic script, as reformed in 1917, uses twice as many letters to represent Russian vowels as are available to us in the five Latin letters *a, e, i, o, u*. We have somehow to represent а, е, и, й, о, у, ы, э, ю, and я. The solution to this problem has become confused with the fact that palatization is a phenomenon which pervades the phonemic structure of modern spoken Russian, as well as that of the Old Church Slavic language, from which the writing tradition of Russian developed.

We may expand the facilities of the Latin alphabet for representing Russian vowel letters by designating the Latin letter *y* as equivalent to one of the Rus-

sian letters. Casting about for the equivalent to be assigned to Latin *y*, the perhaps somewhat irrelevant choice of the Russian ы has frequently been made. This comes to us from the writing tradition of two Slavic languages which normally use the Latin script—namely, Polish and Czech. So long as we do not alter the equation ы = Latin *y*, we avoid confusion. Preoccupations with the function of the Latin letter *y* to designate a "semivowel" belong in the realm of the phonetics and phonemics of the English language and should be excluded from consideration in designing a transliteration system for the Russian Cyrillic script. Any other uses for the Latin *y* involve us in the familiar dilemmas which beset those who are forever tinkering with Russian transliteration. For example, in the article under discussion, the following multiple functions are proposed for the Latin letter *y*: (i) as an equivalent for the Russian Cyrillic letter ы; (ii) as an equivalent for the Russian Cyrillic letter й; (iii) as a member of the two Latin-letter digraphs which must of necessity be fixed to designate the two Cyrillic letters ю and я; (iv) sporadically, when the palatalizing vowel phoneme of spoken Russian /e/ occurs in its allophones [ie] or [io]. Those who plead for rigid adherence to the simple equation ы = Latin *y* have in view merely the avoidance of these pitfalls. They are not concerned with whether the resulting transliterated Russian is "likely to be disyllabized in accordance with English usage." The way to learn to pronounce Russian is to study Russian with a competent teacher, not to make futile stabs at pronouncing a transliteration system.

What, then, shall we do about ю and я? If we set up the equivalents *ju* and *ja*, we invoke the writing traditions of German, Dutch, the Scandinavian languages, Italian, and those Slavic languages which use the Latin alphabet. While this may do for the readers of the *American Slavic and East European Review*, it manifestly runs counter to the linguistic habits of the average American reader of publications devoted to the physical sciences. Probably no speaker of English will object to the equation и = *i*. If the Latin digraphs *yu* and *ya* are denied to us as fixed equivalents to ю and я for the reasons stated above, let us examine the suitability of *iu* and *ia* (with ligatures).

Unfortunately, due to the influence upon Russian itself of the writing tradition of Western European languages, *ia*

(without ligature) may not be used as an unambiguous equivalent for я. We have, for example, loan words like материал and потенциал which, with their derivatives, are of fairly frequent occurrence in Russian scientific literature. It is to conserve the symbol-for-symbol correlation principle, and not out of any desire to embarrass printers, that the Library of Congress has set up the equivalents *iu* and *ia* (each with a ligature) for ю and я, as distinguished from a possible иу and иа. On the same principle, the ligatured digraph *ie* is used, when necessary, to transliterate the obsolete letter ѣ, which occurs in Russian publications printed before 1917. Again, this use of *ie* (with ligature) has no reference to pronunciation; its only purpose is to make possible the exact restoration of the original Russian unreformed orthography where it occurs.

Fortunately, there is a simpler solution of the irksome ю and я problem. We may simply ask our printer to supply the not-unavailable letter ĭ. This is possible because of the principle of complementary distribution. It happens that in written Russian there are no instances of the occurrence of йу and йа. Consequently, when the Latin-letter digraphs *ĭu* and *ĭa* occur, we may invariably know that they designate the *single* Cyrillic letters ю and я. On the contrary, when the Latin-letter combinations *uĭ* and *aĭ* occur, we may be sure that the original Russian will have *two* Cyrillic letters, уй and ай, in every case. Thus, the common word хозяйство can be unambiguously transliterated *khoziaĭstvo*, rather than *khoziaĭstvo*, as in the Library of Congress system.

Again, we may apply the symbol-for-symbol principle in fixing an unequivocal transliteration for the Russian Cyrillic letters е and э. Let cyrillic е under all circumstances be transliterated by Latin *e*. Granted that the Library of Congress *é* is generally unavailable at the printer's for э, we may use *é*, *è*, or even *ê*, provided only that a distinction is somehow contrived. If these equivalents offend the sensibilities of readers of French, we may use *ĕ*.

There now remains only the problem of ц. Those accustomed to the German and west Slavic writing traditions for the Latin alphabet will find that the equation ц = *c* presents no difficulty, but this admittedly will not do for most Americans. From the point of view of pronunciation it is quite unnecessary to show any distinction between ц and тс. But

here again, a transliteration problem is not necessarily related to pronunciation. In Russian orthography, the choice between ц and тс is governed by etymology, not by pronunciation. тс occurs when a word normally ending in т has added to it a suffix beginning with the Cyrillic letter с. Two common cases may be mentioned. First, the adjectival ending -ский, and second, the ending -ся for the reflexive of finite verbs. Thus, we have: the following three examples for the first case: брат, братский (not брацкий) for *fraternal*; совет, советский (not совецкий) for soviet (as an adjective); азиатский (not азиацкий) for *Asiatic*. For the second case, we have являет, является (not являеця) for *is*; определяет, определяется (not определяеця) for *is determined*; and вызывает, вызывается (not вызываеця) for *is caused*.

On the contrary, instances where ц occurs, but never тс, are, for example, original Slavic words, like овец, яйцо, солнце, and отец and loan-words from Western European languages, representing a -*tion* ending in French or English. For example: ионизация (not ионизатсия) of *ionization*; авиация (not авиатсия) for *aviation*; and организация (not организатсия) for *organization*. Consequently, an English-speaking person will require some knowledge of Russian if he is to know when a transliteration *ts* represents ц and when it represents тс. In the transcription of titles for bibliographies, and especially in preparing catalog entries for library filing, we can ordinarily assume no expert knowledge of Russian on the part of clerical assistants or even users of the bibliographies or card catalogs. Consequently, the symbol-for-symbol substitution principle is employed, wherein *ts* (with a ligature) invariably represents an original ц and *ts* (without ligature) represents an original тс. Since the character with the ligature is not generally available, *ts* seems to be a practical substitute.

The only sound guide in devising a workable, unambiguous transliteration system for any language, including Russian, is a rigorous letter-for-letter, or symbol-for-symbol, substitution. The objective sought is a system which will make possible accurate reconversion to the original non-Latin script for positive identification. In the case of Russian, these objectives can be realized with minimal use of diacritics, by using *ĕ*, *ĭ*, and *ts*. The Library of Congress trans-

literation system may then be followed, with the following simple and obvious variations: э = *ĕ* instead of *é*; ц = *ts* instead of ligatured *ts*; ю = *ĭu* instead of ligatured *iu*; я = *ĭa* instead of ligatured *ia*.

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Razran Replies to Critics

Specifics of Russian-English Transliteration: Reply to Hamp

Hamp's theoretical discussion of the linguistics of transliteration as such is of course very welcome, and is well taken. However, with respect to the specifics of Russian-English transliteration, he overlooks the following: (i) the high correlation between the Russian phonemic and graphic systems (much more like that in German and Spanish than like that in English and French) which permits, within limits, the coalescing of "transcription" and "transliteration" (I prefer "phonemic and graphic transliteration"); (ii) the relative simplicity of the Russian phonemic system and its *comparative* closeness to the English one (it is certainly simpler and closer than the Celtic or Arabic system), characteristics which point to relatively simple substitutive means of representing it by the modal phonemic values of English graphs; (iii) the near-ubiquity of the transliterated material in printed English media, which makes economy and esthetics cardinal considerations; (iv) the linguistically nontechnical and operationally limited nature of 99.9 percent of the needs of those who use the transliterations, which contraindicates exacting precision; and (v) the traditions or habits which underlie existing practices and the psychologist's concern with efficiency and with avoidance of engrams that are not readily realizable. Serving "two masters simultaneously — graphs and phonemes" is indeed the intent and, I contend, the achievement of my proposed, not particularly original, system.

Enlargement and elucidation call for structuring the problem and adducing concrete examples. The total consumer population for Russian-English transliteration will, accordingly, be divided into three classes: (i) the technical linguist who for his technical purposes requires complete phonemic *and phonetic* analyses of Russian speech and

writing, but who constitutes presumably no more than 0.1 percent of the consumer population; (ii) the general English-reading and -speaking public, ranging from the most exact nonlinguist scientist to the barely literate layman, who needs no more—and really can use no more—than a pronunciation that is *constant for English speakers* and is reasonably close to that of Russian speakers or, indeed, of any speakers not too far removed from English and Russian phonetics (the Russian and English readers and writers who initiate the consuming of the transliteration and the editors concerned with uniformity and conflation might be regarded as special groups serving and supervising the needs of the general public); (iii) the cataloger, who should be able to function faultlessly with absolutely no auditory or vocimotor involvements and who may even be a deaf-mute. The proposed system satisfies fully the needs of the consumers of the second and the third classes; what the consumer of the first class really needs is a phonetic transcription rather than a more exact—if more exact it can be —phonemic one. Concrete examples follow.

If **Павлов** is transliterated as *Pavlov,* each of the six Russian phonemes is detectably different from its English correspondent: the initial *P* is not aspirated, the final *v* is unvoiced, the four consonants are duller and involve some lip thrusting, and the two vowels have some special characteristics. Yet it is obvious that the pronunciation of *Pavlov* will be quite constant among English speakers and, despite the minor interphonemic differences, the word as pronounced will probably be quite recognizable to Russians. But suppose **Толстой** is transliterated as *Tolstoj* and, let us say, **Чубяшец** as *Čubjašec.* Most readers will undoubtedly use the wrong final phoneme in the first case and be totally confused with respect to the second; there will be no consistency of phonemic usage, and there will be little interconsumer auditory recognition and communication. Yet when the two names are rendered as *Tolstoy* and *Chubyashets,* the transliteration assumes the phonemic adequacy of *Pavlov,* just as *Pavlov* changed to *Pawlow* loses it. Now consider **быт** and **бой,** transliterated as *byt* and *boy,* containing two different Russian graphs (**ы** and **й**) transliterated by the same English graph (*y*); this, on the surface, would seem to make the system unusable for consumers of the

third class. But **й** occurs in Russian only after vowels, while **ы** is found only after consonants and never at the beginning of words; the complementary distribution of the two Russian phonemes resolves the phonemic-graphic conflict of the system. Similarly, when (i) **Есенин** and **Андреев** are transliterated as *Yesenin* and *Andreyev,* with an extra English graph for the initial Russian **e** in the first word and for the second, syllable-initiating **e** in the second word, and when (ii) no extra English graph is allotted to **э**, as in transliterating **энергия** by *energiya* (Greek, ἐνέργεια), the positional differential makes the system usable by any cataloger. Each of the remaining 31 Russian graphs in my table is matched by a specific English graph, in some cases, of necessity, by more than one.

(Genitive **-го** transliterated as *-vo* and **ё** with the dieresis omitted, as it usually is in texts for adults, are two cases, and the only two, where Russian-English phonemic transliteration is impossible without a knowledge of Russian —impossible of course in *any* devisable system. However, this irremediable shortcoming obviously affects neither the initial consumer of the transliteration, who knows Russian, nor the general reader who consumes the final product, and it presents really no *extra* problems for the cataloger who has no knowledge of Russian and who of necessity will transliterate the aforementioned Russian graphs by *g* and *e.* All it really means is that in two single instances such a cataloger cannot provide complete phonemic information.)

Hamp states: "For newspapers and what we might call colloquial uses, we could settle on something admittedly makeshift, but plain and manageable, such as Razran has set forth. For more technical uses we could agree on both a transliteration and a transcription. . . ." I do not know what he means by "colloquial uses" and do not care to analyze the semantics of "makeshift, but plain and manageable." But do the Russian-English transliteration needs of the readers of the *New York Times* differ from those of readers of the *Nuclear Review Abstracts*? And isn't the area of "technical uses" very small indeed? In another place Hamp says: "For example, not only is the place of stress important —even crucial—in Russian, but the values of the vowels are very different in stressed and unstressed syllables." But are the vowels so "very different" and

is the stress "crucial" to a phonemic transcription? Are the changes, significantly characteristic of only some of the Russian vowels and varying considerably in different regions, more than phonetic shifts of a type common in English and even more in Portuguese? [Xoroʃó], [xˆrˆʃo], and [xərəʃo] are quite interchangeable and intercommunicable in Russia.

Hamp does not offer a phonemic "transcription" of his own, saying only "It would not be at all difficult for competent linguists to design . . ." one. However, the alphabet in his "table of transliteration" is quite puzzling. It is not that of modern Russian, including as it does the discarded **ѳ**, and it is not that of pre-1917 Russian since it lacks **i**, **v**, and **ѣ**.

Finally, I would like to suggest four minor additions to my proposed system: (i) transliterate **г** before **e** and **и** by *gh*; (ii) insert a hyphen between transliterated **ы** and succeeding **y** (vowels other than **y** either rarely occur after **ы** or present no problem), and also a hyphen between transliterated **т** and **c** (to distinguish **тc** from **ц**); (iii) transliterate **г** before voiceless consonants by *kh* and, perhaps, also **ч** before **н** by *sh*; (iv) transliterate **ё** by *yo* after **зж** and **жж**, leaving *o* for **ё** after **ж** that is initial or preceded by other letters. And then there is the problem of transliterating **Хрущёв.** The common transliteration *Khrushchev* is phonemically inadequate. It should be *Khrushchyov,* as the proposed system would have it.

My original article contained six typographical errors (page 1112): (i) **э** should be substituted for **з** in line 1 of the last paragraph of column 1; (ii) (*Sovetskiǐ*) for (*Sovetskii*) in column 2, line 12; (iii) **ё** for **ė** in column 2, line 24; (iv) *Novyǐ* for *Novyi* in column 3, line 5; and, in Table 1, column 2; (v) "Genitive **-го** = *-vo*" for "Genitive **-го**, *-vo*" in line 4; and (vi) *yo* and *o* for **yo** and **o** in line 8.

Addendum: Reply to Fabergé, London and London, and Ray

My reply to Hamp, answers also, I think, the relevant animadversions in the other letters—London and London's concern with genitive **-го** and with **ё** without dieresis, Ray's concern with the multiple use of *y,* his "redefinition" of *transliteration,* and his all-too-lengthy discussion of **тc** versus **ц**, which may be rendered merely as *t-s* and *ts,* as discussed above. Likewise, if an English

graph is chosen to transliterate a Russian one, its *separate* phonemic value is supposedly retained also in combinations of English graphs (this in reply to the *ay* query of London and London) : literate Americans rhyme *Adenauer* with *Eisenhower* despite the *au,* and they do not silence *P* in *Pskov, k* in *kniga, Knobel,* or *Knut Hamsun.* Space forbids treatment of the large portion of irrelevant material in the letters—for example, the comments that English readers may as well mispronounce transliterated Russian words since they mispronounce French words; that a phonemic transliteration is no substitute for a competent Russian teacher (Ray); and Fabergé's strange logic in stating that к does not equal *k* because in "one university library" he could "find the *Doklady* of the Academy of Science of the U.S.S.R." listed only under *Akademia* and not under *Doklady.* (Let him try to find the *Proceedings of the National Academy of Sciences* under *Proceedings*—and, incidentally, no library system uses *Akademia,* only *Akademiia* or *Akademiya;* Fabergé's entire letter teems with irrelevancies and inaccuracies—for example, his remarks about the difficulties of transliterating Arabic and about the use of the Cyrillic alphabet, his comment that my proposal is Anglocentric, that x equals *h,* and so on.)

The writers of the letters are surely behind the times in their unawareness of what is currently being done in the ever-increasing Russian-English translation and abstracting programs. Consultants Bureau and the Pergamon Institute, the chief translation agencies for the physical and biological sciences, do not use the Library of Congress system and through the enforcement of their own system contribute greatly to uniformity, while the *Current Digest of the Soviet Press,* published by the Joint Slavic Committee of the American Council of Learned Societies and the Social Science Research Council, does not use the system of the *American Slavic and East European Review* but one whose "aim is to approximate Russian sounds without diacritical marks" (as stated in each issue of the journal). Plainly, what is needed is (i) greater and speedier efforts to achieve unity and (ii) a realization that, with respect to Russian, phonemic and graphic desiderata are reconcilable (as manifested in the fact that my proposed phonemic-graphic system differs but little from the Consultants-Pergamon graphic system, on the one hand, and from the *Digest's* system, on the other, and is really a compromise or synthesis of the two, though I have been using it for almost 30 years in about fourscore publications). Moreover, (iii) the entire matter is experimentally testable. For some time I have been asking English readers to read Russian material in my transliterated system, and on occasion have had the transliteration done by assistants whose knowledge of Russian was derived solely from my table of transliteration, in front of them. Almost always I have found the readers' pronunciations phonemically adequate (except of course for the irremediable x–*kh,* ы–*y* differences, and occasional difficulties with *zh*) and the assistants' transliterations errorless (except of course for corrections of their genitive -го and ё without dieresis). My judgment of degrees of phonemic adequacy may be disputed as subjective; yet, pronunciations could, obviously, be recorded and submitted to a panel of experts for consensual judgment. Let the systems, then, be put to a verifiable experimental test, let a choice be made upon the basis of objective evidence free from habit-bound and ego-involved opinion and conjecture, and let there be unity.

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News of Science

President and Congress Act on Appropriations

Appropriations for many federal departments doing scientific work are being rushed through Congress under the pressure of a move for adjournment by early September. Appropriations bills for the Department of Defense and the Department of Health, Education, and Welfare went to the President recently after being cleared by Congress. The Atomic Energy Commission and a number of smaller agencies also are now learning how much money they will have for fiscal year 1960.

The money bill for defense, which the President signed on 18 August, calls for $39.2 billion. This amount represents a compromise between the Senate bill, which authorized $39.6 billion, and the House bill, which authorized $38.8 billion. The final appropriation, which was cleared by the whole congress after conference, was almost $20 million short of the amount the President requested in his budget message at the beginning of the year.

For research and development, the bill authorizes more than $1 billion each for the three services, with the Air Force receiving the largest amount, $1.16 billion. The Advanced Research Projects Agency, the organization that sponsored the Atlas communications satellite last December, has an appropriation of $455 million. In addition, the Defense Department was given an emergency fund of $150 million, bringing the total figure for research and development activities to $3.8 billion.

HEW Funds Increased

On 14 August, the President signed the appropriations bill for the Department of Health, Education, and Welfare. This bill, sent to the White House 30 July, appropriates $3.446 billion, $282 million more than the President had requested. Almost all of the increases over the President's budget requests were made for health and education programs. The National Institutes of Health will receive $400 million; the Office of Education $431 million; and the Public Health Service $828.9 million. Following a well-established pattern, the funds for the NIH were increased by $105.7 million beyond the amount the President had asked.

In another action on appropriations, the Senate sent to conference a revised