

TRANSFER GRAMMAR

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0. The problem treated here is that of the difference between languages.¹ Can this be measured? The method outlined here enables us to measure the difference in grammatical structure, and to establish what is the minimum difference (or the maximum similarity) between any two language systems. Presumably, any method of specifying difference can contribute toward a classification of structural types among languages (as distinct, say, from a genetic classification). The method is also relevant to a proceduralized system of translation, and indeed can be put in the form of routine instructions for machine translations; and this not only because of the inherent connection between transfer and translation, but also because sentence-pairs under translation are used in certain transfer foundations (see 5). The method may also

¹ In working on this subject I have had the advantage of many conversations with Fred Lukoff. He is now completing a sketch of a transfer grammar between Korean and English, and the Korean examples used here, as well as various general points, are due to him. For the Korean phonemes and morphology, see Fred Lukoff, *Spoken Korean*.

be relevant for the learning or teaching of foreign languages; it suggests that it may prove possible to acquire a language by learning only the differences between the new language and the old (leaving those features which are identical in both to be carried over untaught); but here educational and psychological considerations enter in addition to any linguistic technique of minimizing the difference between the languages.^{1a}

One can construct purely structural transfers between the phonologies of two languages, or their morphophonemics, or their morphologies (only the last is discussed here, 2). And one can construct transfers between paired items in the two languages—paired by some useful criterion. We discuss below sounds paired phonetically (3) rather than purely structurally, and words (4) and sentences (5) paired by translation.

1. We begin by defining difference between languages as the number and content of the grammatical instructions needed to generate the utterances of one language out of the utterances of the other. If A is some large set of utterances in one language, and B is a set in another, then the list of changes that have to be made on A in order to transform A into B will be considered the difference B-A (i.e. it represents what there is in B over and above A; or, given A, how

^{1a} This investigation of structural difference does not suffice to define distance among language structures. For example, we will not be able to say that the difference between English and German is some specified function of the English-Danish and the Danish-German differences. However, we can now try to go further and define a distance (metric) among language structures with the aid of the measurement of difference discussed here.

much more has to be done to get from there to B). In certain cases, the list of changes that transform the set B back into the set A may not be simply the reverse of B-A, but may be a different list; this would be A-B (what there is in A over and above B). If among various lists of changes that would transform A into B we find one that is the smallest in number and content (under some way of measuring content), we will call it the least or minimum difference B-A. We will consider whether a least difference exists, how it can be found, and under what circumstances B-A is the reverse of A-B (in which case the amount of difference is independent of the direction).

A grammar may be viewed as a set of instructions which generates the sentences of a language. Since the set of instructions B-A generate sentences (of B) from other sentences (of A), it can be viewed as an appendix to the grammar of A.² That is to say, B can be obtained from the grammar of A plus the added instructions of B-A (which would take us from A to B). This would compare with the independent grammar (or grammars) of B, which generate the sentences of B directly, starting from scratch. Thus the difference B-A, or the transfer instruction, can be presented as a grammatical appendix to A, or as part of an indirect grammar of B (going via A). It is for this reason that it may be called a transfer grammar.

One can also consider a set of grammatical

² Even in the grammar of a single language by itself, it is possible to generate some of the sentences of the language out of other sentences of the same language by particular grammatical transformations. However the conditions for these transformations are quite different from those that carry us from the sentences of one language to those of another.

instructions Z, which does not in itself generate any known language, but is so selected that if we add to Z certain additional instructions A-Z we will get the sentences of A, while if we add to Z other additional instructions B-Z will get the sentences of B. Then Z is a grammatical base common to A and to B; and both A and B are obtained by an indirect grammar which goes via Z. One can select Z for various purposes, e.g. for translation or teaching convenience, or for minimality (such that the sum of Z and A-Z and B-Z is least). Then the difference between A and B is the sum of A - Z plus the reverse of B - Z.

2. One form of transfer is the difference between two whole grammatical structures. For example, we can consider for each language what are its major morpheme classes (and their subclasses down to some level), and what are the main combinations of these classes into its various successively-larger constructions (word, phrase, clause, or the like) until we get up to its whole sentences. We can ask what changes would have to be made in such a structural sketch of one language in order to obtain out of it a structural sketch of the other (at about the same level of detail). Such a list of changes would generate the utterances of one language out of those of the other, since the grammatical sketches of each language yield the utterances of that language (up to some level of detail), so that transferring from one sketch to the other will suffice to transfer from one set of sentences to the other.

2.1. The following very sketchy structures of Korean, English, and Hebrew will give some impression of what can be done here:

Major Morpheme Classes

K:	B ⁻	D	N ⁺	V ⁺			mm	ww	vv	nv ⁻	vn																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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B: affixless p sentences.

C: conjuncti like construct single construc

D: generally in whole clause

R: roots, mc a part of some (i.e. common t

N: nouns, e M which cont are from zero clause; N with of V or A.

M: see N.

n: noun-vo

proM: pro phrase.

A: adjecti position of N

a: adjecti R+a = A (N).

V: verbs, containing usually one several W with affixes

W: see V.

v: verb-v

proW: p phrase.

P: prepc fore M.

T: artic English, T mm.

vn: V+

xy: X+

M; N+na

Korean

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sentence

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Korean

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zn	..?z!
n na va aa ad-	..?!
n na-	ad-..?!

B: affixless particles, occurring as whole sentences.

C: conjunctions, occurring between two like constructions, sometimes before a single construction.

D: generally affixless adverbs, insertable in whole clause or verb constructions.

R: roots, most of them appearing both as a part of some N and as a part of some V (i.e. common to N and to V).

N: nouns, each is head of a noun-phrase M which contains one or several N; there are from zero or one M up to several in each clause; N with affixes may occur in positions of V or A.

M: see N.

n: noun-vowel morphemes, $R+n = N$.

proM: pronouns, substituents for noun phrase.

A: adjectives, occurring with N or in position of N.

a: adjectival noun-vowel morphemes, $R+a = A$ (or rather, = adjective-position N).

V: verbs, each is head of a verb-phrase W containing one or two or so V; there is usually one W in each clause; there may be several W in WCW constructions; V or W with affixes may occur in positions of N or A.

W: see V.

v: verb-vowel morphemes, $R+v = V$.

proW: pro-verbs, substituents for verb phrase.

P: prepositions, occurring primarily before M.

T: article; in Hebrew, and perhaps in English, T can be viewed as a member of mm.

vn: $V+vn = N$, and in general:

xy: $X+xy = Y$, e.g. $M+mm$ affix = M; $N+na$ affix = A.

Korean clause-finals and sentence-finals (verb affixes occurring only at clause and sentence end respectively) can be viewed as special subclasses of ww (with important distributional characteristics absent from ww in English or Hebrew).

Korean e genitive occurs only in $NeN = N$, hence is like some occurrences of certain

P, or else like an nn which yields only non-final N (since Ne could be viewed as non-final N).

Korean nv can also be analyzed as V (the verbs i, ha), yielding $N+V =$ last part of a clause; if we take i, ha as verbalizing suffixes, they yield $N+nv = V$.

Korean vn (participles, gerund) change a V or clause (V with preceding N) to N.

A clause is defined as a substructure of a sentence, ending in /,/ , such that a sentence is merely a sequence of clauses, at most with C between them. A sentence is a structure, ending in one of /?z!/, such that a discourse is a sequence of sentences.

- indicates that there are very few members in the class.

+ indicates that there are very many members in the class.

From this table we can read off K-E, E-H, K-H; E-K is the reverse of K-E, and so on. When we say, for example, that C occurs both in E and in H, we mean that both E and H have a class of morphemes with roughly the distribution stated for C. The detailed distributions of Hebrew C and the English C may be quite different. Some of the differences will appear in the very sketchy distributional statements below, but many more are not indicated here. It may be possible to minimize the differences between two languages by classifying the morphemes in both with maximal use of approximately the following criterion: If some morphemes A of language A have (major and regular) similarities of distribution with some morphemes B of B, we form a class z representing the common distributions of A and B. Then the distribution of A is z plus A-z (which are the additional distributions of A over and beyond z), and the distributional difference between A and B is the sum of A - z and reversed B - z. When we do this for all the morphemes of languages A and B, we are constructing a joint system of morpheme classes in much the same way as we construct morpheme classes for a single language (there too we maximize the grouping of morphemes with

similar distributions). To some extent this has been done in the table above, for example when Korean clause finals and sentence finals were considered to correspond with (or be in the same joint class as) ww.

2.2. The table below gives the occurrence of the above classes in each language. The sentences of each language are built out of the classes via the intermediate structures shown in the column for that language. The

transfer instructions are those that carry us from one column to another, and in particular from each row (e.g. the *W* of *K*) to the corresponding row in the other column (e.g. the *W* of *E*). To take a simple example, *V* of *E* minus *V* of *K* consists in the inclusion of *A ar*. We can generate each structure of English by adding to the corresponding Korean structure whatever is the difference between the two.

Major morphological structures

	K	E	H
Sentence with/ =	clause with particular ww name with vocative suffix	M W some A	M W A some D
Sentence with.or?or! =	some B some M {M + certain mm,} {clause,} clause	B M D some A clause	M A D !e W clause
Clause =	{M} W	{C} {D} MW {PM}	{C} {D} MW {PM} M (proM ₃) (P) M
W =	{D} {V + gerund} V ww	{D} {ww} {V to} $\frac{V\{PM\}}{proW}$ {D}	{ww} {V !e} V ($\frac{P}{!e}M$) (D)
V =	V{vv} N nv	V{vv} N nv A av	R v {vv}
M =	{N} N {-N} (mm)	T{D}A{N(mm)} (T){D}A when no N follows M P M M to V M wh S	(mm) N̄ {N̄} (proM ₃) (!e) PM (!eS) (mm)N̄(M̄){N̄}(proM ₃)(!e)PM(!eS)
N =	(Ne)N before N or mm also clause + participle V + gerund	{N}N + 'on first N, ' on others N(nn) V vn A an	R n (nn) V vn A an
-N =	final bound N stems		
A =		A {aa} N na V va	R a N na
D =		A ad	
X =		X C X some X(,)X	X C X some X(,)X

() indicates zero or one, { } indicates zero or more, otherwise each item occurs once.

proM₃: third-person pronoun.

' main stress, ' secondary stress.

English mm extends over following W.

Hebrew mm extends over all N and following W (but the article is zero over N, W).

X₁X₂ indicates that both x₁y and x₂z occur.

H: !e 'to'

et accusative preposition

!e 'that'

K: e genitive

E: wh relative

ww includes preverbs (can, etc.) and tenses

The same remarks for the preceding more room here ingenuity in so st in so arranging th bring out maxim two languages. Al to change a line line in E can b some of which ca similar to other where.

Even these ro similarity betwe the former two which have (anc had) considerab

3. Languages their sounds an among the sou importance for each morpheme tive entity. Ho guage-learning, and type.

3.1. The m phonetic differ (sound types, which are clos example, we s English m, English i. Th corresponding and will have relevance of t a learner wil sounds for th guage, or hea nearest them cases the di tween certair matchable so a number Korean æ co (different in æ (different

* The relat others often phonemes to

are those that carry in to another, and in row (e.g. the *W* of *K*) in the other column. Take a simple example, consists in the inclusion of each structure of to the corresponding whatever is the difference

H
M
W
A
some D
M
A
D
le W
clause
{C} {D} MW {PM}
M (proM ₁) (P) M
(w) (V le) V ((_{le})M) (D)
R v (vv)
f {N} (proM ₁) (le) PM (leS)
{M} {N} (proM ₁) ((le)PM) (leS)
R n (nn)
V vn
A an
R a
N na
X C X
some X()X

nd xs occur.

in, etc.) and tenses

The same remarks hold for this table as for the preceding one. Except that there is more room here for modification and for ingenuity in so stating the structures, and in so arranging their substructurings, as to bring out maximum similarity between any two languages. Also, the instructions needed to change a line of *K* to the corresponding line in *E* can be stated in various ways, some of which can be simpler or can be more similar to other instructions required elsewhere.

Even these rough tables show the greater similarity between *E* and *H* as against *K*, the former two being members of families which have (and to an even greater extent had) considerable structural similarities.

3. Languages differ from each other in their sounds and in the phonemic relations among the sounds. This is a matter of no importance for written translation, where each morpheme can be treated as a primitive entity. However, it is relevant for language-learning, and for linguistic distance and type.

3.1. The most direct way to measure phonetic difference is to match those sounds (sound types, sets of similar free variants) which are closest in the two languages. For example, we set Korean *m* corresponding to English *m*, Korean *i* corresponding to English *i*. The phonetic differences in a corresponding pair may be small or large, and will have to be stated. The practical relevance of this matching is obvious, since a learner will usually substitute his own sounds for the nearest ones in the new language, or hear the new ones as the sounds nearest them in his own language. In some cases the differences and similarities between certain sounds of *A* and the possibly matchable sounds of *B* are such as to permit a number of alternative pairings: e.g. Korean *æ* could be matched with English *e* (different in that it is lower), or with English *æ* (different in that it is higher).³ However,

³ The relation of one matchable pair to the others often is decisive for determining which phonemes to match. For example, since English

there are gross similarities among most languages in respect to kinds of sounds (e.g. often labial, dental, palatal; stops, spirants, vowels; voiced, voiceless), so that the candidates for pairing are usually within a small group: to English *p* or *b* (or the *p* allophone) one could only match Korean *pp*, *ph*, or *p* (or the allophone *b*), but not, say, *m* or *t* or *i*. Finally, there may be new sounds in *A*, i.e. ones which are left over after pairings, or are so different from anything in *B* that they are not paired with any sound of *B*.

The list of phonetic pairings and new sounds constitutes one set of differences between *A* and *B*, covering all the utterances of those languages. The phonetic elements common to each pair constitute the common *Z*, and the differences are the *A-Z* and the *B-Z*.

To this may be added the differences in types of sequences (clustering, etc.) between the sounds of *A* and the corresponding sounds of *B*. Learning considerations may favor certain correspondences as against others, in order to center the attention on certain phonetic differences or types of new sequences which are easier to learn (easier in general, or easier for the speakers of the particular language).

3.2. The grammar of a language lists its sound types and their phonemic relations (how they are grouped into phonemes). Once we have the sound correspondences, the remaining phonological difference between *A* and *B* lies in the phonemic status of the corresponding and new sounds. This would seem to be quite a job, since in each language each of the sounds may be a free or a positional variant of some other sound, or may contrast with any particular sound in one or all positions, or may constitute a whole phoneme by itself, and so on.

It is possible to combine the sound correspondences and their phonemic statuses in some chart such as the following, upon which the transfer instructions can then draw:

has two front vowels higher than its *æ*, and Korean has two higher than its *æ*, it is far simpler to match *E* and *K* *i-i*, *e-e*, *æ-æ*, rather than *E* *e-K* *æ*.

K \ E					
	x is a whole phoneme or phonemic sequence (except for variants noted elsewhere)	ditto, but x occurs in important positions where it is absent in the other language	x is a positional variant (of y: x/y)	x contrasts with y: x/y	x doesn't occur as a sound type but y occurs in the position where x occurs in the other language
x is a whole phoneme or phonemic sequence (except for variants noted elsewhere)	m, n, ŋ i, e, ae, a, o u(K. ㅜ) a(K. ø) uw(K. u)	ss (E. z), pp(b), tt(d), kk(g); ph(E. p), th(t), kh(k), ch(č); y, w; clusters			
ditto, but x occurs in important positions where it is lacking in the other language	l				
x is a positional variant of y: x/y				p/b etc. l/r š/i/s f/h	x/h š/h m ^b /m, n ^d /n. d ^l /l
x contrasts with y: x/y			p ^b /p, etc.		
x doesn't occur as a sound type, but y occurs in the position where x occurs in the other language			flap d/d		
x doesn't occur as a sound type nor does y (if x/y)	v, θ, ʊ, ž, j, the pre-r vowels		flap t		

Where the corresponding sounds are written differently for the two languages, the spelling for one of the languages is put in parentheses.

Example of alternative statement: If K. u were matched with E. u, then K. ㅜ and ø would be matched with E. ə and ʌ; but E. ə and ʌ are positional variants of each other (ə being unstressed), while K. ㅜ and ø are full phonemes without stress restrictions. K. l occurs in the special cluster ll, where E. l does not (except across juncture); on the other hand, English has many clusters lacking in Korean.

K. tt has been matched with E. d, and K. th with E. t (and so for the whole series), which is the way Koreans usually interpret English sounds (Lukoff). Other matchings are possible instead.

The entries in each column list the sounds that have the particular phonemic status stated at the top of that column, for one language. And the entries in each row list the sounds that have the particular phonemic status stated at the head of that row, for the other language. The chart is so arranged that the entries at a given column-row intersection show how the phonemic status of the given sound differs in the two languages.

For each sound in the chart we can change its phonemic status, from that of the column in which it is, to that of the row in which it is. Then we get an over-all change from the phonemic status of the sounds of the column language (English in the chart above) to the phonemic status of the corresponding sounds in the row language (here, Korean): K-L. And analogously from the row language to

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illustrates y: x/y	x doesn't occur as a sound type but y occurs in the position where x occurs in the other language
etc.	x/h x̃/h m ^b /m, n ^d /n. d ^l /l

the column language. The chart thus serves the purposes of transfer, since the instructions required to generate one language from the other can be read off from it.⁴ It is uniquely reversible, and in it K-E is the reverse of E-K.

It is possible to modify the chart for various purposes. For example, whenever a sound appears more than once (or whenever a phonetic similarity between the two languages has not been expressed as a correspondence) there is room for some rearrangement of what sound types shall be taken as corresponding, and what is the resulting phonemic difference. Thus we can say that the Korean l/r phoneme corresponds in certain positions (where its variant is l) to the English l phoneme; and in other positions (where its variant is a flap r) to the English r phoneme; while the Korean ll phoneme corresponds phonetically to English double l across juncture, or is a new sound cluster corresponding to nothing in English.⁵ Or we can say that the Korean ll phoneme corresponds to the English l phoneme, while the Korean l/r phoneme (with its l variant) corresponds to the English r phoneme.

If such modifications can be carried out all the way, the resulting chart would have each sound appearing only once, and its column and row would indicate its full difference of phonemic status in the two languages. In doing this, the headings of the

⁴ The chart does not show what are the phonetic difference (and similarities) between corresponding sounds, nor does it show most of the differences in phonemic sequence (clustering, etc.). These were considered in 3.1.

⁵ Double l occurs in English only across juncture. In Korean there is an L sound, with some phonetic similarities to a long l (and analyzed by Lukoff as a cluster of two Korean l) which often occurs across morpheme boundary: kil road, killo by the road (though there is no Korean open juncture here). However, there are also cases of Korean L not astride morpheme boundary; hence it would not be desirable to write every Korean L as l-l for English readers, but rather to write it as a cluster of l plus l—new for English readers.

columns and rows would be modified (and increased) to suit the particular sounds and their differences in status. Such a modified chart would give the most organized set of instructions for generating the phonemic statuses of one language out of the other, and would thus measure the difference between the two languages in this respect.

For teaching purposes, special considerations are involved. Certain changes in phonemic status (for corresponding sounds) seem especially hard to learn. If two sound types are positional or free variants of each other in one's language, it is quite hard to pronounce their corresponding sounds as contrasting phonemes in another language;⁶ or in general if x is a positional variant of y, it is hard to pronounce x in the position where y occurs in one's own language: e.g. for an English speaker to pronounce unaspirated p in word initial. In such cases it may be preferable to assign the correspondences on the basis of some other (perhaps less obvious) phonetic similarity; so that for example if an English speaker has to learn initial unaspirated p, it might be presented as the correspondent of English b (with the phonetic instruction that it should be devoiced), rather than as the correspondent of English p (with the phonetic instruction that it should be de-aspirated).

4. Any transfer between two languages will have to substitute the morphemes of one language for those of the other. In most cases this is a matter for a dictionary-like listing. However, some languages have many cognates in common, or many borrowings in one or both directions, or many international words; the latter may comprise a large part of the vocabulary of technical articles even though not of the language as a whole. In such cases, it may

⁶ E.g. a Korean says kil road, kiri road (as subj.); but in speaking English he will have to pronounce, by the side of keel, teary, also tear, mealy.

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be worth-while to set up instructions that would generate the words of one language from the semantically corresponding words in the other which have sufficient phonetic similarity (or whose phonetic difference is sufficiently regular); this would replace listing of translations for these words. For example, in many international words the English sound *a* corresponds to *o* in other languages. This is specifically the case for words which are spelled with *o* in English (and in the other languages), e.g. *comic*, *historic*; and such facts may be usable in the transfer instructions.

Such vocabulary-transfers mean that for a certain set of words or affixes, we can say that the morphemes in both languages are composed of the same common elements or spelling; except that in this case the elements are not the phonetically corresponding sounds or phonemes, but rather the sounds or phonemes that occupy corresponding positions (i.e. replace each other) in the two-language forms of this common vocabulary. These pairs of vocabulary-corresponding phonemes bear some resemblance to morphophonemes, i.e. to phonemes which replace each other in different positional variants of a morpheme; however the morphemic groups here within which the replacement occurs are not allomorphs but translations.

In contrast, morphophonemics proper, which connects the allomorphs of a single language, is usually very different from language to language. This applies even to the regular and phonetically "reasonable" morphophonemics of the various languages; though some assimilations, such as devoicing at word end, occur under fairly similar circumstances in different languages. And it applies for more to the irregular morphophonemics and suppletions, which occur in particular morphemes and have no phonetic basis. Here no transfer instructions can be devised, except to drop the morphophonemics of the old language and to add that of the new. In language learning, and in

constructing any translation procedure, these two steps have to be included.

When it comes to the actual listing of words or morphemes in one language and their translation in the other, we find that one word may have several translations, due to the different ways in which ranges of meaning are covered by vocabulary in different languages. Where two different words in one's own language are translated into the same foreign word (i.e. vocabulary transfer is many-one), no special instructions are needed; nor is it even necessary to call attention to the fact that the two translations are the same. But the transfer is then not uniquely reversible; for, starting from the other language one would not know which reverse translation to use. When one word in one's own language has two translations in the foreign, we meet the same one-many transfer that the foreigner meets (above) in reversing our many-one situation. (And the difference in translation may not coincide with any difference in meaning perceived by the native.)

Sometimes it is not of great moment which translation is used, though violence may thereby be done to style and subtleties of meaning; in this case we may call the two translations free variants for the transfer. Where the choice of translation is important, and is determinable by something in the environment of the given word, we may speak of the two translations as positional variants of the transfer of the given word. (The positions being the environment of the given word in the starting language.) The determining environment is often a grammatical or other necessarily-occurring feature; in this case we can consider that the starting material is not merely the word in question, but the two environmentally-distinguished occurrences of the word plus its environment, and each of these then has only one translation. E.g. *table* in N position may have a different translation from *table* in V position, *check* in *check up* may have a different translation than in *check*

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to the actual listing of in one language and the other, we find that several translations, due to differences in ranges of meaning, are required by vocabulary in different languages. Where two different words in one language are translated into one word (i.e. vocabulary difference), no special instruction is needed. It is not even necessary to state the fact that the two translations are reversible; for, starting with one word, one would not know which translation to use. When one language has two translations for one word, we meet the same one-to-many situation as the foreigner meets in our many-one situation. The difference in meaning is not a difference in meaning (i.e. a difference in meaning is not a difference in meaning.)

of great moment which, though violence may be done to style and subtleties of meaning, we may call the two environments for the transfer. The translation is important, not the word, but the environment. In the given word, we may have several translations as positional differences of the given word. The environment of the word (starting language.) The environment is often a grammatically-occurring feature. We can consider that the environment is not merely the word in itself, but the two environmentally-determined differences of the word plus each of these then has a difference. E.g. *table* in N position has a different translation from *check* in *check up* may have a different translation than in *check*

in. Or the determining environment may be the presence in the same sentence or discourse of other words drawn from one part of the vocabulary rather than from another (e.g. *masses* in sentences containing *uprising*, *classes* may translate differently than *masses* in sentences containing *charge*, *field*). In such cases the instructions may have to call for a sampling of certain neighboring words (often from among the members of particular word classes only); the unique translation would then be not of the original word alone, but of the word in the neighborhood of certain particular word sets.

5. The transfers of 2, 3 were based on certain similarities and differences of the whole set of utterances A and the whole set B in grammatical structure and in sounds. They do not lead us from any sentence of A to the particular sentence in B which is the translation of A. The transfer of 4 does something of this, since it takes us from the words of A to their translations in B. But this is far from enough. For one thing many words do not occur alone (e.g. prepositions, verbs in many languages), so that they cannot really be isolated for translation, and are often translated in stilted or non-comparable forms (e.g. 'speak—parler'). More important, certain morphemes and words have a great variety of translations, depending on environmental structure. This holds especially for those with more "grammatical" meanings, like articles, prepositions, cases, tenses, and affixes in general. Often these can be adequately translated only when their environments are grammatically defined. Finally, translating the morphemes ("word-by-word") is in any case not enough for translation, since the grammatical interrelation of the morphemes in each language is a matter of the subdivision of the sentence into constituents (in successive inclusion), which will often differ in the two languages; and the order of the morphemes within each constituent will often differ. The analysis of a sentence into successively included

constituents, and the composition and order of smaller constituents (down to morpheme classes) within each constituent, is therefore necessary for any method of translation that is to be reducible to mechanical procedures. And it is in general an interesting transfer question, to ask how sentences which would translate each other differ grammatically, i.e. what grammatical changes have to be made in a sentence of A to obtain the particular sentence (or sentences) in B which would translate it (given the transfer of dictionary morphemes).

5.1. We therefore introduce a transfer relation between each sentence of A and its translation in B, or between each grammatical construction of A and its translation in B (i.e. the part which is common to all the B translations of the various A sentences containing the A construction). A new consideration is thus added, which alters many of the correspondences of 2. Where in 2 many constructions and subdividings had no parallel, here we can find—on a translation basis—a parallel in one language to almost everything in the other. (Almost everything in any language can be translated into any other.) Furthermore, different grammatical constructions in A may be translated by only one or a few grammatical constructions in B; and two A constructions which are similar in A may go into two (or more) quite different B constructions.

In the matter of morpheme classes, N and V, for example, were matched in English and Korean by their distribution, and A was unmatched. If we ask how these appear in translation-paired sentences, we find that English N morphemes translate generally into Korean N morphemes, English V into Korean V, English A into Korean V+vn (participle), English N+na into Korean N. English A thus has a translation correspondent in Korean, even though it doesn't have a morpheme-class correspondent. And even though the structural

breakdown of 2.2 shows English N+na as substitutable for A, these two are translated into different constructions in Korean.

In the structural analysis of 2.2 we find, for example, no Korean parallel to the M wh S structure of English (*The man who came; The man whom I saw*). But under translation, we find that M wh S is usually translated in Korean by V+vn N, which also translates English V+va N and AN.

5.2. We can move in a more or less orderly fashion, from the actual pairs of each sentence and its translation to the summarized transfer instructions, by means of a chart of the following kind.

H \ E					
	V + ed	preverb + V	V to V	It's A that N V.	I
V + pers.	✓				
pers. + V		✓			
V la V		✓	✓		
A še pers. + V		✓		✓	
ani					✓
(ani) e-					✓
(ani) -ti					✓

Preverbs are *will, shall, can, could, may*, etc. V + pers. indicates that the personal elements are suffixed; pers. + V that these are prefixed. ani e- or e- is a prefixed 'I'; ani - ti or -ti is a suffixed 'I'.

Across the top we list various sentence types (or independent sub-structures of sentences) in one language (English)—each representing the many sentences which have that structure in English grammar. Down the left side we do the same for the sentence types (or sub-sentence structures) of the other language (Hebrew). Then we check which column is a translation of which row (and which row is a translation of which column).

When we find that a structure in one language is translated into two or more structures in the other, as in the case of English *V to V* or Hebrew *A še pers. + V*, we try to sub-classify it into two or more structures, each of which will have only one translation. If the structure is in terms of classes, we may succeed in this by dividing a class into subclasses. If possible, we find some property that distinguishes these subclasses. E.g. if we wish to subdivide the preverbs so as to match the Hebrew future tense, we note that the preverbs *will* and *shall* differ somewhat from the others, and have some characteristics of a tense: *will* and *shall* replace *-ed* when certain replacements occur elsewhere in the sentence (e.g. when *yesterday* is replaced by *tomorrow*), and *will* probably has a frequency more similar to that of *-ed* than to that of other preverbs, such as *can, may*.⁷ Since *will* and *shall* are the two preverbs which translate the Hebrew tense *pers. + V*, just as *-ed* translates the Hebrew tense *V + pers.*, we are glad to find grounds within English grammar for separating them off from the other preverbs. When we cannot find a property that would subdivide our structure so as to fit the other language, we simply list the members of the smaller subclass: thus in Hebrew *V la V*, the first *V* is divided into two sub-classes, the smaller one consisting of *yaxol can, muxrax must*, etc., and translating the English preverbs. We can also separate off from the preverbs those members which are translated into *A še pers. + V*: namely, *may, might, should*.

If the structure is in terms of morphemes, and sometimes also when it is in terms of classes, we can achieve unique translations

⁷ If *will V* had from the start been listed as a separate English entry, it (with *shall V*) would have had a unique Hebrew translation (except for differences in the range of the tenses). However *will* is most naturally seen in English structure as a member of the preverb group (rather than as a tense), and is not easily distinguishable grammatically from the preverbs *may, might*.

Within the given limits of detail, such an amended chart gives a one-one transfer between the languages. Starting with the broken-down structures listed here for English, one can change each listing to its Hebrew counterpart and thus obtain the Hebrew sentences which translate the English. These changes therefore constitute H-E, i.e., they show what instructions have to be added to English to obtain Hebrew. Going the other way, reversing each change, we start with Hebrew and end up with English: this is E-H (what is necessary to obtain E over and above H). Since each of the changes is a replacement of one linguistic structure by another, they can be viewed as a kind of grammar (of a transformational type): H-E is a grammatical appendix to E; and the grammar of E plus H-E yields H, and is thus an indirect grammar of H (via E). In this breakdown, E-H is the reverse of H-E, and each measures the morphological difference under translation (for translationally-paired sentences) between the two languages.

5.3. One can also try to construct the simplest and most inclusive in-between grammar, which would have a common part for each structural pair (e.g. $V + \text{affix}$ as a common part for $V + \text{pers.}$ and $V + \text{ed.}$). Then certain changes would yield E out of this Z, and other changes would yield H out of this Z. The difference between E and H would be the sum of these E-Z and H-Z changes. Given certain kinds of similarities between languages such a formulation in terms of an in-between grammar may be simpler than a direct E-H.

5.4. After we have the one-one chart, we can consider a further problem. The categories of the broken-down listings are often not natural ones for each language taken by itself. They were constructed so as to

yield a one-one relation. But for many purposes, e.g. translation or language learning, a many-one relation from the native to the new language is no trouble at all. The only trouble lies in the fact that the reverse would be one-many (i.e. would have several translations among which we could not choose). If we are not interested in the reverse, we can simplify our listings to make many-one (as well as one-one) correspondences. For example, going from English to Hebrew, we could match both *preverb + V* (except *may, might, should*) and *V to V* with Hebrew *V lo V*. We can even try to give this a new one-one form, by considering *preverb + V* as a sub-class of *V to V*, different only in that *to* has a variant zero after preverbs.⁸ Similarly, we can consider *will V* as different from *preverb + V*, and closer to *V + ed*, something which is made easy by the fact that the concepts of future and past "tenses" are common, and are associated with *will* and *ed*.

In this way we obtain a revised grammar of English based as far as possible on the categories of Hebrew, to the extent that such categories can be supported in English. The changes necessary to obtain Hebrew out of this revised version of English structure are fewer than before. We can thus work toward a minimum H-E. The same can be done in the other direction. But in the other direction we would revise Hebrew grammar in an English direction, and the resulting E-H (E over and above revised H) is not in general the inverse of H-E (H over and above revised E).⁹

⁸ In doing so, we use the fact that preverbs look somewhat like verbs (*I can*, like *I see*), even though from other points of view they are not verbs (*I can* is analyzable as *I + preverb + zero pro-verb*).

⁹ It should be clear that only the form of the grammar is revised in each instance. The revised grammar is still a grammar of that language, which correctly generates the sentences of the language.

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3. Third
4. Fourth
5. Fifth
6. Sixth
7. Seventh
8. Eighth
9. Ninth
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