SYSTEMS, SKILLS, AND LANGUAGE LEARNING

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1. LANGUAGE AS SKILL

Language behaviour, like any other complex human activity, can be approached from a variety of viewpoints. One could be mainly concerned with the actual or potential output of such behaviour, i.e. with the structure of a corpus of language. Alternatively, attention could be directed to the communicative function of language, the transmission of intentions from speaker to hearer and the interpersonal variables that play a role in such communication.

Somewhere between the purely linguistic and the purely social-psychological points of view is the approach which considers language as a human skill. A skill analysis of language borrows from linguistic analysis in that the linguistic structure of the input or output message is systematically varied in order to measure its effects on speed, accuracy, timing and other aspects of linguistic information decoding and encoding. In its turn, knowledge of language as a skill is required for effective analysis of language as interpersonal communication. It is especially important to have an understanding of the mechanism of selective attention and motivation in the transmission of linguistic information in order to fully appreciate the facilitative or inhibitory effects of interpersonal variables in the functional use of language.

Apart from bridging the gap between a more structurally and a more functionally directed study of language, the skills approach to language behaviour has the definite advantage of leading to a natural integration into an already existing body of psychological knowledge. The study of human skills, including symbolic skills, has been intensive and quite successful since World War II. This is not the place to review the vast developments in the post-war study of 'human factors', nor to outline the deep influence of cybernetic thinking on the analysis of skills. For an appreciation of this revolution in psychological thinking, the reader may be referred to a recent volume on one symbolic skill: human problem-solving (Newell and Simon, 1972).

Herriot (1970), who was one of the first authors to stress the analogies between language behaviour and other skills, especially mentioned the

following features of skills, which have been intensively studied, and which are equally central to language.

a Hierarchial organization. It is not necessary to convince linguists of the hierarchial nature of language; we shall return to this in section 3. But many other skills as well are hierarchical in structure. The successful completion of a task is, in almost all skills, dependent on the accurate performance of subtasks, plus the correct temporal or spatial integration thereof.

b Feedback. Nearly all human performance is controlled by comparing the behavioural effects with some internal standard or aim. The difference is then reduced by taking appropriate measures. This is especially salient in problem-solving behaviour, but it is also true for many aspects of language. A speaker's behaviour, for instance, depends to a large degree on signs of understanding on the part of the listener.

c Automation. After a skill has been acquired it is to a large degree automatic, i.e. it does not require conscious control of each of its subtasks. Automobile driving is an example in case: during normal driving, one's attention is free for even rather complicated discussions. Skilled language use is similar in that there is no conscious attention to articulatory movements, or even to choice of sentence schemes. Attention is normally mainly directed towards the semantic contents; at times towards the choice of appropriate lexical 'core' terms.

d Anticipation. In skill research subjects often 'react' *before* the appropriate stimulus is given. The accurate timing of the concert soloist is not achieved by rapidly reacting to the conductor's sign, but by anticipating the critical moment. Any skill which involves planning also allows for anticipation. Speech perception relies on 'being ahead of the speaker.' This is possible because all speech is redundant. To the degree that the listener is familiar with the theme, he is able to anticipate by making hypotheses about what the speaker is going to say. As for every skill, this does not require much of a conscious effort. Anticipation is not necessarily a conscious phenomenon.

One could easily add other typical skill features that are equally essential in language behaviour. Instead of expanding this issue any further in the present context we will finish this paragraph by mentioning two more reasons why the skill point of view can be especially fruitful for the study of language.

Of all psychological study of skills the major part concerns skill *acquisition*. Much is known about factors which facilitate or interfere with the learning of skills (see e.g. Bilodeau, 1966). It would be interesting to know how many of these findings can be generalized to language acquisition. Especially the study of second language learning should profit from these findings, as almost all skills are learned on the basis of already existing skills, just as in second language learning. The degree of compat-

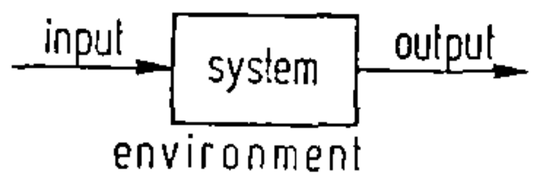
ibility between the old and the new skill has been a central issue in the study of skill acquisition.

Finally, the cybernetic revolution in skill research has led to a high degree of theoretical modelling in the analysis of skill, and especially to the introduction of very general formal systems for the description of skilled behaviour. Skill research is increasingly profiting from what is known as *systems analysis* or system theory, some basic notions of which will be introduced in the next section. Such formal models have been specially designed for the theoretical representation features such as feedback, hierarchy, anticipation, control, automation, learning. It is, therefore, surprising that no *systems analysis* of (aspects of) human language behaviour has ever been envisaged. The remainder of this article is intended to provide some general thoughts on the issue. We will first introduce some central notions of system theory (section 2.). Next, we will devote a few words to a stratified description of the language user (section 3). Leaving the general mode, we will select one stratum, the syntactic level, for further analysis in terms of systems (section 4). It will be shown that empiricist and rationalist models of language acquisition can be theoretically analyzed in such terms and that both are wrong in principle (section 5). Finally attention is given to some more global aspects of second-language acquisition (section 6). This article does not present any new empirical finding; its only aim is to offer an approach to aspects of language acquisition which, though not new in itself, might lead to fruitful theoretical integration of grammar, skill research and applied linguistics.

2. SYSTEM THEORY: SOME BASIC NOTIONS

There are many rather differing definitions of the notion 'system' (see e.g. Bertalanffy, 1969). Throughout this article we can neither be complete, nor go into much mathematical detail. In this section we will arbitrarily choose the following description of what we mean by a system. *A system* is any part of the real world which is set apart from the rest of the world. This latter, the complement of the system, is called the system's *environment*. The environment may influence the system by means of what is

Fig. 1



called *input* of the system. In its turn the system may affect the environment by means of a certain *output* (cf. Fig. 1). The system may be in any of a finite or infinite number of *states*. The state is the present condition of the system. It is defined in such a way that for all possible cases it is true that given the state of the system as well as the input it receives in that state, it is fully determined what the next state and the next output will be.

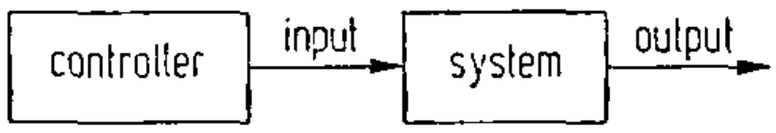
Different classes of systems can be distinguished dependent on the types of input, output and state descriptions which one chooses. If input, output and state transition are to be considered as occurring at discrete moments in time, the system is called a *discrete-time system*. Successive instants can then be numbered, and the behaviour of the system can be completely described by the *state-transition function*, which gives the state at the next instant as a function of the present state and the present input, and the *output function*, which gives the next output as a function of the present state and the present input. If moreover, the set of elementary inputs (i.e. inputs that can be applied at one given instant) and the set of elementary outputs are finite, the system is called an *automaton*. The automaton is *finite* if the set of states of the system is finite, it is *infinite* otherwise.

It is, in the present context, useful to think of systems in terms of automata, because most language behaviour is characterized by discreteness in time **and** finiteness of input and output vocabulary. It should be kept in mind, however, that this limitation is not essential in system theory.

Essential in system theory is the notion of *control*. Assume that the system contains a designated *initial state*, s_o, as well as a designated *final state* s_f. The *initial state* s_o *is controllable* if there is a string of input which leads the system from s_o to s_f. *The system is controllable* if every state of the system is controllable.

The idea of control is that we want to bring the system in a desired state (giving a desired output), and the question is whether we can do it, and if so, what string of inputs should be applied in order to obtain this goal. This can be depicted as follows:

Fig. 2



This notion of control will be used in section 4, where we shall consider the listener as the system, the state of the listener in which he accepts the message as the desired state, and the speaker as the controller who has the task of leading the listener into this desired state, by choosing an appropriate input string of words.

The notion of *feedback* comes in if the controller is able to compare the factual output of the system with the desired or reference output. This is depicted in Figure 3: For the sake of clarity the comparison of factual

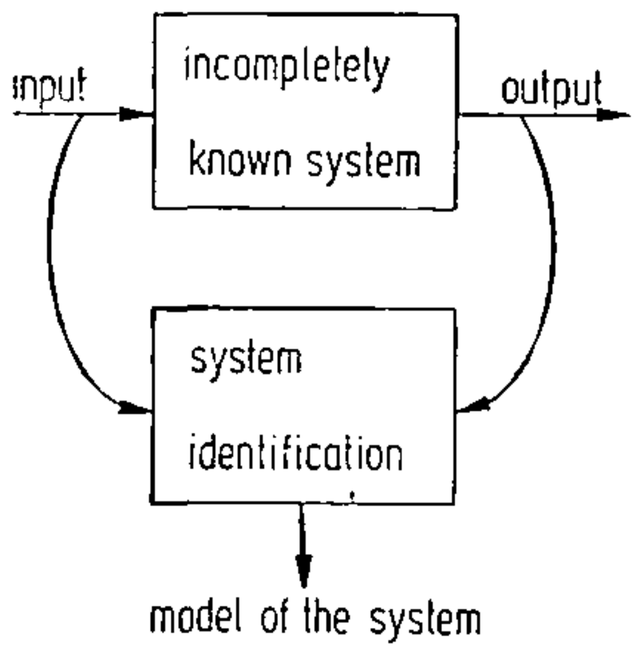
Fig. 3

and desired output has been set apart in a separate box. The controller acts on the basis of the noticed difference and chooses an input which may lead to a decrease of the difference.

An interesting chapter of system theory is concerned with the so-called

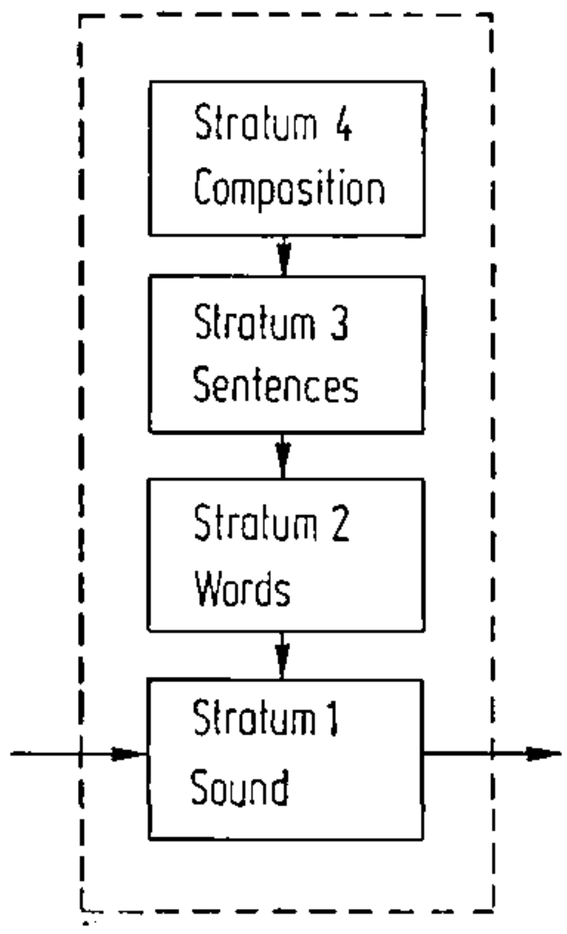
identification problem. If our knowledge of a certain system is limited, how can we learn to control the system without opening it? In that case we have to estimate as accurately as possible the structure and parameters of the system by systematically sampling input/output pairs. Another way of formulating the identification problem is: can we devise a procedure which gives us an accurate model of the system, by observing a finite set of input/output pairs? If an accurate model, i.e. a model which simulates the system perfectly, can be derived, we can approach the control problem by trying to solve it for the model. The identification problem, which will be related to the problem of language acquisition in section 4, is summarized in the diagram of Figure 4.

Fig. 4



It is often possible to organize the description of a system in terms of sub-systems and their interrelations. There are several different notions of hierarchy in system theory; we shall limit ourselves to one: the notion of a *stratified hierarchical system*. One may consider the same system on different levels of detail. Figure 5 is not taken from a linguistic or psycholinguistic text, but from a test on hierarchical systems (Mesarovič et al., 1970).

Fig. 5



One may consider one and the same system, for instance a speaker giving a talk, from a very detailed point of view (e.g. as a producer of a se-

quence of elementary sounds), or from a global point of view (as a producer of a certain textual composition), or from several intermediate levels of detail. Each level of description has its own sets of inputs, outputs and states. On the level of sentences, for instance, the elements are words (or morphemes), but it is irrelevant whether these words are written or spoken, or spoken by a male or a female voice, etc. The latter features, however, are essential for a stratum 1 description.

In general, the description of one stratum cannot be derived from the description of another stratum. Each level has its own concepts and principles. It is, especially, impossible or unfeasible to describe a high-level stratum in terms of a low-level stratum. One cannot *derive* processes of human problem-solving from principles of neural interaction, or the principles of text composition from syntax. But one should keep in mind that in a stratified description it is the *same* system which is described on different levels. A state of this system is the composition of the different states of the subsystems at a certain instant in time. The state of a lower level subsystem is co-determined by the output of a higher level stratum. This influence is called *intervention,* and is depicted in Figure 5 by downward arrows. The intervention of stratum 4 upon stratum 3 means that the text-generating system does not generate a random sequence of sentences, but that successive sentences are chosen so as to produce a coherent text.

There are some general principles that hold for all stratified systems: (a) The higher level is concerned with larger portions and broader aspects of the system's behaviour, (b) decision times on the higher level are usually longer than decision times on the lower level, (c) the higher level is concerned with the relatively slow aspects of the system's behaviour, (d) description of a higher level is usually less structured, less certain, and more difficult to formalize than the description of low-level behaviour of the system.

3. THE LANGUAGE USER AS A SYSTEM

The structure of a human language user is so complicated that we have little *a priori* knowledge about its possible states, state-transition function or output function. A complete and detailed description of such a huge and complex system is excluded from the beginning. On the one hand one wants to create a model of the language user's global behaviour, i.e. his communication with other language users about certain aspects of the real world. On the other hand, one has to fill in all the details of such behaviour on all levels of functioning. In such cases the system theorist resorts to a stratified description. He defines different levels of detail and tries to create more explicit models for each of the subsystems. The subsystems should be chosen in such a way that their functioning is as much as possible independent of other subsystems. This description can then be

extended by a specification of the intervention and other relations between levels and subsystems. It is, therefore, entirely legitimate to choose one particular stratum for further analysis. One should only keep in mind that it is a part of a larger system, and that its description should, in the long run, be integrated into a more general characterization of the system.

There is nothing new here for linguists. Linguistics is a highly stratified science with various levels of description such as phonology, morphology, syntax, discourse analysis, more or less comparable to the strata of the system in Figure 5.

Also in psycholinguistics the use of hierarchical models for speaker or listener is becoming increasingly common. This is especially so in studies directed towards computer simulation of natural-language understanding. The reader is referred to Winograd's (1972) system as a recent example. It consists of a hierarchy of subsystems, each having its own principles of functioning, but nevertheless cooperating in a global and sometimes surprisingly 'human' manner.

In this section we will not propose any stratified model for a language user. Instead, we will arbitrarily select one level of description, the syntactic level, for the purpose of discussing the contributions that system theory can make to the problem of (second-) language acquisition. The syntactic level is selected because results are most clear-cut in that area, not because this stratum is the most important for understanding language acquisition. In fact it will be shown in the next paragraph that a syntactic account of language learning is unfeasible. But the syntactic level is certainly the highest level for which such results could be obtained through formalized analysis.

4. SOME SYSTEM ASPECTS OF THE SYNTACTIC STRATUM

Consider the listener as a system. Though for the system as a whole the usual input is a text, and the desired final state is one of understanding that text, on the syntactic level this input/output relation is reduced to a sentence as input and a syntactic structural description as output. The syntactic subsystem reaches a final state if a correct structural description of the sentence is created. This state is called *the accepting state*. Generally, the listener does not overtly produce the structural description, so that the speaker does not know whether the accepting state has been reached. Nevertheless, control is often possible since the speaker shares the language with the listener and can therefore plan the input in such a way as to be sure that an accepting state is indeed obtained. The speaker/listener situation so far can be represented by the elementary control diagram of Figure 2, where the system is the listener, and the controller the speaker. If we call the state of the listener before the utterance is presented the initial state, this initial state is controllable according to system

theory if there is an input string which brings the listener into the accepting state. It is interesting to notice that in the ideal case, i.e. where the listener has unlimited memory, etc., *the set of all input strings by which the system can be controlled in the initial state is the language itself*. The linguistic notion of grammaticality, therefore, is a special case of the notion of controllability in system theory.

The notion of feedback comes in if the speaker is not completely familiar with the listener's linguistic outfit. Important cases are the child talking to his mother, and the beginning second-language learner who tries to make himself understood by a native speaker of that language, or more typically by his language teacher. In such cases it is very important for the controller to get feedback, as in Figure 3, about the state of the listener. If a certain utterance is not understood or accepted by the listener, the speaker could try a different wording if only the listener gives some clue with respect to his state of understanding. From the purely syntactic point of view this amounts to feedback with respect to whether a certain input string has led the listener into the accepting state or not.

This brings us to our main theme, the systems approach to language acquisition. In terms of system-theory language learning is an instance of the identification problem. The language learner is confronted with an incompletely known system, the fluent language user, i.e. the speaker/listener. In order to 'control' this system, i.e. to communicate in the new language, the learner has to make hypotheses about the system's structure and parameters and test such hypotheses by checking samples of input/output pairs. This is exactly the situation depicted in Figure 4. The system-identification box represents the language learner, who infers a model of the system by observing a set of input/output pairs. Again limiting our attention to the syntactic stratum, such a pair consists of, on the one hand, a string of morphemes or words and, on the other hand, some indication as to whether the string is acceptable or inacceptable to the system. If the system is a syntactically ideal system, this indication simply means, as we have noticed before, that the corresponding string is either grammatical or ungrammatical. Here it is immaterial whether the unknown system is a listener or a speaker of the language. Syntactically this amounts to an inversion of input and output, which does not affect the essential character of the pairs: they always consist of a string and a plus or minus sign. If the sign is positive, the particular pair is called a *positive example,* i.e. the learner knows that the particular string is a sentence in the language. Because a syntactically ideal speaker always produces a grammatical text, a positive example is best imagined as drawn from a speaker-system. If the learner is exclusively presented with positive examples, i.e. a sequence of grammatical sentences one calls such a sequence a *text presentation*. If, however, the sign is negative, i.e. if the string is not a sentence of the language, the pair is called a *negative example*. If we consider the unknown system as an informant to whom we

present strings with the question whether they belong to the language or not, we will sample a mixture of positive and negative examples: some strings turn out to be grammatical and others are faulty. Such a mixture of positive and negative examples is therefore called an *informant presentation.*

As we have seen in section 2, the essential problem of system identification is whether we can devise a procedure which can generate an accurate model of the system by observing a finite set of examples. On the syntactic level, such a model is called a grammar of the language, and the question then arises as to whether a correct grammar of the language can be derived from a finite text or informant presentation. If the answer is affirmative, such a procedure could be an ideal model of the language learner, and actual language acquisition could be studied on the basis of such an ideal model.[1] If the answer is negative, however, it makes no sense whatsoever to even try to understand the acquisition of syntax as a relatively autonomous process. Before we study processes of language acquisition, we should first solve what Chomsky (1965) called the *adequacy-in-principle* of a theory of language learning. If there is no conceivable procedure to generate a grammar on the basis of a finite presentation of the language, be it text or informant presentation, then *any* theory in such terms must be wrong, since children and adults *do* acquire languages.

Before we introduce, in the next paragraph, some substantial results with respect to this adequacy-in-principle, we must add two more notions which are essential for a discussion of theories of language acquisition.

System identification is impossible without *some a priori* knowledge of the structure of the system. One should, for instance, have some knowledge of the sort of input accepted by the system, or linguistically speaking, the learner must have some idea about the class of language that is to be considered. The set of models, or syntactically speaking: grammars, which agree with this *a priori* knowledge is called the *hypothesis space* in system identification. It is obvious that language acquisition is greatly facilitated if the hypothesis space is made very narrow. This means that the learner already has very detailed *a priori* knowledge of the language to be learned.

Another way to speed up learning is to make the learner very 'clever.' He could be equipped with very powerful *heuristics* which would allow him to scan the hypothesis space in a very systematic way, and to process huge amounts of observations in a very short time.

5. ADEQUACY OF EMPIRICIST AND RATIONALIST ACQUISTITION MODELS

The system-identification procedure presented so far can be seen as a schema for organizing the discussion about language acquisition in terms of the syntactic stratum. It corresponds to what Chomsky and Miller came to call a *language-acquisition device* LAD (Miller and Chomsky,

1957; Chomsky, 1962). But there are two important points to keep in mind before we proceed with this discussion.

First, LAD is a schema which is limited to the syntactic stratum. As we have seen in section 2, concepts and principles can be quite different for different strata of the system and there is no reason whatever to expect that substantial results for the syntactic stratum will be valid for other strata as well. We should not expect to solve the language acquisition problem by solving it at the syntactic level. This is in sharp disagreement with Chomsky's position. Chomsky (1962) tries to minimize the additional role of the semantic stratum in language acquisition. He writes "For example, it might be maintained, not without plausibility, that semantic information of some sort is essential even if the formalized grammar that is the output of the device does not contain statements of direct semantic nature. Here care is necessary. It may well be that a child given only the input of (2) [i.e. of LAD] as nonsense elements would not come to learn the principles of sentence formation. This is not necessarily a relevant observation, however, even if true. It may only indicate that meaningfulness and semantic function provide the motivation for language learning, while playing no necessary part in its mechanism, which is what concerns us here." And Chomsky repeats this argument in *Aspects* (1965, p. 33). In a moment we shall discuss in how far this position can be maintained.

Second, LAD is *nothing but* a schema for the discussion of language-acquisition procedures. LAD is only meant to be a hypothetical system-identification procedure endowed with a hypothesis space and set of heuristics, with a text or informant presentation as input and a grammar, i.e. a model of the system, as output. On this point the literature is badly confused and quite misleading. The confusion mainly relates to the distinction between *empiricist* and *rationalist* acquisition models, which we shall now introduce. In *Aspects*, Chomsky formulates the distinction in terms of LAD as follows:

The *empiricist model* of language acquisition says that there is hardly any limitation with respect to the hypothesis space of LAD, it has little *a priori* knowledge of the system's grammar. Language learning occurs through strong heuristic principles by which the grammar is derived from observations.

The *rationalist model*, on the other hand, assumes that LAD's hypothesis space is very narrow or specific; there is a large *a priori* knowledge of the system's grammar. A relatively small set of observations will suffice for LAD to derive the system's grammar.

Both models, therefore, are special conceptions of LAD's structure. The main confusion in the literature has resulted from contaminating the LAD discussion schema with rationalist assumptions about LAD. The most outstanding example in this respect is McNeill (1970), but many others have made the same short circuit, often to their own disadvange. Braine (1971), for instance, weakened his argument against syntactic acquisition

models by making the same contamination, as we shall see.

A second source of confusion is the identification of *rationalist* with *innate,* and *empiricist* with *learned*. Though it is not implausible that the *a priori* knowledge of the grammar is innate in some sense, it is just as plausible to suppose that the strong heuristics in an empiricist model are innately given. Innateness has no intrinsic relation with the dichotomy under concern. Here we shall not go into the innateness issue. The reader is referred to Levelt (1974), where it is treated in much detail.

Let us put the discussion straight. The first question concerns the adequacy-in-principle. Can one conceive of whatever procedure which derives the grammar from a finite text or informant presentation? Only in the affirmative case does it make sense to pose the second question: how does the child, or second-language learner, compare with such an ideal procedure? Chomsky (1965) makes a very one-sided statement with respect to these questions. He writes: "In fact, the second question has rarely been raised in any serious way in connection with empiricistic views . . . since study of the first question has been sufficient to rule out whatever explicit proposals of an essentially empiricist character have emerged in modern discussions of language acquisition." In actual fact, however, the question of the constructability of a language acquisition procedure had not been solved at all in 1965. Substantial results in this respect were only obtained by Gold in 1967 and by Horning in 1969. These latter solutions have been completely ignored by both linguists and psycholinguists, so that it makes sense to give a very short summary of the main results. Technical detail, however, must be left out in the present context. The interested reader is referred to the original publications, or to Levelt (1974), volume I, chapter 8.

Gold (1967) was able to prove the following: With text presentation an error-free acquisition procedure can only be constructed if the hypothesis space is limited to finite languages. That is, with text presentation, a language can be learned in principle if and only if the learner knows in advance that the language is finite.

Since natural languages are quite clearly not finite, they cannot be learned by text presentation in Gold's sense. Gold's mathematical results were extended by Horning. Instead of discussing the error-free case, Horning discussed a stochastic version of the identification procedure. He proved that the difference between the grammar derived by LAD, and the 'real' grammar of the system can be made arbitrarily small in the case of (stochastic) text presentation, if LAD knows in advance that the system's grammar is of the non-ambiguous context-free type. Natural languages are clearly of a more complicated type, be it alone for the fact that natural languages are ambiguous, and the question is what the results would be for more complicated stochastic languages. This problem has not yet been solved. But for our purpose it is not necessary to wait for such solutions. With respect to the second question, the factual prop-

erties of the acquisition procedure, Horning was able to prove that even for the context-free case, where acquisition is possible in principle, the procedure is so time-consuming as to be completely unrealistic as a model of human language acquisition: "grammars as large as the ALGOL-60 grammar will not be attainable simply by improving the deductive processing." "But adequate grammars for natural languages are certainly more complex than the ALGOL-60 grammar." So, even with the strongest heuristics, a text presentation model for natural-language acquisition is excluded as a realistic model.

How is the situation in the case of informant presentation? This is very much better. Gold was able to prove that even if LAD only knows that language is primitively recursive, which is probably true for all natural languages, it can derive a correct grammar for the language. Though this might seem to be a hopeful alternative to the text presentation model, in this case we find too much empirical counterevidence. This has been formulated most clearly by Braine (1971). He argues that the language learning child is at best presented with positive examples. If presented with ungrammatical utterances, these are hardly ever marked as such. In our terms, Braine argues that the child is, at best, in a text-presentation situation. We mention some of several arguments: (1) The speech of many children is never corrected, i.e. marked as grammatical or ungrammatical. Nevertheless all children finally acquire their language. (2) If such marking occurs, it seems to be highly ineffective as a means for language improvement. This is clear from experiments by Braine (1971) and Brown (1970). Therefore, the 'this-is-ungrammatical' output of the adult can hardly be considered as input for the language identification procedure. It should be noted that the same is true for second-language acquisition. Experiments by Crothers and Suppes (1967) show that presentation of negative syntactic information does not improve the acquisition of certain syntactic forms in Russian. (3) Informant presentation in Gold's sense requires, roughly speaking, that every ungrammatical string shall, in the long run, occur in LAD's observations. This, however, is highly unrealistic, since it is known (see Ervin-Tripp, 1971) that the speech directed to young children is highly grammatical and hardly ever contains negative instances. It seems to me that this is also very much true for the second-language learning situation in so-called natural teaching methods. Students are almost exclusively presented with positive examples. (4) One might think that non-reaction of adults to ungrammatical strings might constitute implicit negative information for the language-learning child. This definitely cannot be the case. Initially, almost all utterances of the child are ungrammatical in the adult's sense. Nevertheless, the adult reacts if he can derive the child's intention. This means that many ungrammatical strings are 'marked' as positive. This is bound to confuse any language-acquisition procedure. The situation is fully comparable to the learning of a language in a foreign country, or to the learning by

means of most 'natural' methods. Conversation is not interrupted for reasons of ungrammaticality, but mostly for incomprehensibility only.

If these arguments are sufficiently convincing, it follows that the language-learning child, as well as the second-language learner in a foreign country (still the quickest way to learn a second language!), are essentially in a situation of text presentation.

But since the work of Gold and Horning we know that there is no conceivable real-time acquisition procedure for natural languages within the syntactic stratum. The conclusion therefore must be that the adequacy-in-principle question must be answered in the negative for all models of the LAD-family, i.e. not only for the empiricist models, but also for the rationalist models.

It is now interesting to look back at the literature. From the quotation above, it is clear that Chomsky (1965) rejects the empiricist model, without answering the adequacy-in-principle question. Even according to his own writing, however, the latter issue should have been solved first. It is only due to the lack of substantial results that Chomsky, and with him McNeill and many others, could go on believing in the adequacy of a rationalist model. On the other hand Braine (1971) quite correctly rejected the rationalist model by arguing that it is unfeasible with text presentation. He then made a case for an empiricist model. But it should be clear by now, that the text argument relates to the adequacy-in-principle of the LAD-schema as such, and that Braine's argument therefore leads to rejection of both versions of LAD, i.e. including his own empiricist version.

The only safe conclusion is that all exclusively syntactic accounts of language acquisition must fail for principled formal reasons, be they empiricistic or rationalistic. Chomsky's assumption which was cited at the beginning of this section, saying that an essentially syntactic account of language learning might suffice, cannot be maintained. This is, moreover, hardly surprising from the system-theoretical point of view, and even less so from what we know about language teaching.

One remark could be added. This discussion has not solved the rationalist/empiricist controversy. It can be re-formulated on another, especially a higher, stratum of the system description. Even about the level of intention and meaning one could ask whether a child or second-language learner acquires the structures by analyzing his observations by means of strong heuristic principles, or alternatively, whether he has strong advance knowledge of such structures and can easily select the correct structure by making only a relatively small amount of observations.

6. SOME GLOBAL ASPECTS OF SECOND-LANGUAGE LEARNING

In this final section we return from the syntactic stratum to some more global aspects of the language learner. More specifically, we shall make

some remarks on three points. The first relates to the question of facilitation and interference due to the first language. The second issue concerns the acquisition of hierarchical skills and possible conclusions for language learning. The third issue concerns some possible causes of failure in second-language learning.

a Facilitation and interference

One of the most intensively studied phenomena in skill research is the role of compatibility in skill acquisition (see for instance Bilodeau, 1966, Fitts and Posner, 1967, Welford, 1968). The question is how much the learning of a new skill is facilitated by similarity with an already existing skill. If one has learned to perform some task (e.g. writing) with the right hand, how easy is it to learn to do the same task with the left hand? If a child wants to learn to ride on a bicycle, is it advantageous if he already has some skill on a scooter? A very general summary of numerous experimental findings is the following: When there is compatibility between old and new tasks this is facilitatory in the sense that the initial skill at the new task is higher. The speed of learning however, is hardly affected. Compatibility, therefore, is not reflected in the speed of learning, but only in the maintenance of the initial advantage.

If this general result can be extended to second-language learning, one should expect that the learning of Japanese should not be slower than the learning of French, but that, throughout the learning period, the proficiency in Japanese will be less than the fluency in French. The large effect of compatibility on second-language learning has been demonstrated by Carroll and Sapon (1959). (See also Carroll, 1966).

Little is known about the causes of the compatibility effect. In terms of system theory one would suppose that the facilitatory effect of language similarity is due to the restriction of the hypothesis space that the language learner can afford. An interesting aspect of such restriction is that there is no *a priori* lower limit. The apparent similarity between first and second language can easily induce the learner to overrestrict his hypothesis space. This results in what is known as *interference* in skill and second-language research: the learner keeps making intrusions from his native language. I would not be surprised if it were shown that there exists an optimal similarity between languages: if the second language comes too close to the first, interference may predominate facilitation. In that case the task for the language teacher would be to expand the hypothesis space by contrastive teaching. Though Newmark and Reibel (1968) reject this approach, much more research is required to give a definite answer.

b Acquisition of hierarchical skill

Fitts and Posner (1967) distinguish three stages in the acquisition of hierarchical skills. The first stage is the *learning of individual components*. Each component initially requires full attention, therefore they can

only be trained in succession. The second stage is called *integration*. Dependent on the depth of the hierarchy some or all components are organized into larger wholes. The learner tries to become familiar with the spatial and temporal relations between the subtasks. Finally the stage of *automation* is reached. In section 2 we noticed that in a stratified system slow decisions are feasible at the higher levels, where the broader aspects of planning take place. All skilled behaviour is characterized by full automation at the lower levels, so that the subject's attention is available for controlling the performance as a whole.

All this applies to language learning as well. Initially the language learner has to give attention to all sorts of minor components of the skill: the pronunciation of individual sounds, the meaning of individual words, etc. Only then does integration become possible. In its turn this leads to an integrated component, at a higher level, e.g. a correctly pronounced and understood word, which requires further syntactic integration, and so on.

Horning (1969), after his negative conclusions with respect to language learning from text presentation, remarks that, in the case of the child, language learning probably proceeds quite differently. The child is not presented with the full-blown language, but with a very limite subset of the language. Probably the child initially does have an extremely limited hypothesis space and the parents are neatly matching it by presenting the child with a very simple language. One could say that the child learns a *mini-grammar*. Recent research (Ervin-Tripp, 1971) has indeed shown that the language which adults direct to their very your children is extremely simple in structure: it does not contain conjunctions, passives, subordinate clauses, etc. Moreover, sentences are very short. Therefore Horning may be correct: the child is learning a mini-language, which is gradually expanded at later stages. In terms of skill integration: the initial language becomes a higher-level component of the language at a later stage. In this way a growing set of already automated sentence schemes becomes available to the child, who in his turn keeps expanding his hypothesis space for whatever reason.

It is noteworthy that this idea has long been around in second-language learning practice. This is especially true of the Berlitz-method (1967). Right from the first lesson a mini-language is learned which suffices to discuss some small subject. In later lessons this is gradually expanded by new words and forms, but at each stage one aims at maximal automation or fluency before proceeding to the next stage. This is fully comparable to the teaching of other symbolic skills such as arithmetic. One preferably starts with one operation (addition) in a limited domain (1-9), and gradually expands if sufficient automation has been acquired.

But again, much more research is required with respect to the optimal organization of the training of hierarchical skills. No general principles are as yet available.

c Some causes of failure in second-language learning

From the systems point of view failure in language learning may be due to a variety of factors. We already mentioned interference through a too restricted choice of the hypothesis space. Here contrastive teaching might be helpful. Also, certain parts of the system's behaviour may not have been observed by the learner, and his model of the fluent language user will therefore remain incomplete. An example which has often occurred to me, but which does not seem to get much attention in language teaching is lip-position. It is well-known that in many cases exactly the same sound can be produced with different lip-positions. Though in a language course one does learn to make the correct sound, one is not taught that the native speaker has a characteristic lip-position for the sound. People tend to keep their 'native' lip-positions even if they pronounce otherwise faultlessly. Since looking at the speaking face is an important addendum to language understanding (see e.g. Campbell, 1970), such people may always be hampered in their verbal communication, as well as being recognized as foreigners.

As long as a task is not too difficult, performance may appear to be fully automated, whereas in fact the learner is still giving attention to several low-level components. This is immediately revealed if the subject's attention is distracted, either by a secondary task or by stress (speeding up performance or otherwise). The less a skill is automated, the earlier it will break down. If tasks during second-language teaching are kept too easy, the subject may seemingly acquire a high level of skill, but nevertheless fail in a stressful examination. During language classes, the teacher should from time to time 'test the limits' in order to detect which components are most likely to break down, and are therefore least automated.

Finally, some errors will persist because the learner intends to 'control' the native speakers in a very special way. He does not only want to make his intentions understood, but also the fact that he is a foreigner. This can often be quite advantageous for all sorts of social reasons. (See Diller, 1971, for a discussion of this point). On a higher level, therefore, the error is no error and can at best be 'corrected' by a psychotherapist. Here however, we leave the area of the language teacher's responsibilities.

DISCUSSION

In reply to questions about the instructional relevance of the models discussed by him, Professor Levelt said that he had only been concerned with 'competence' at the syntactic level. Within the hierarchy of a system an analysis of language acquisition would have to take place at a higher level. Unfortunately, neither at this level nor at the semantic are there

any formal models available which might contain clues for classroom procedures. In the absence of any operational theory Prof. L. would advise teachers to watch developments in both skill and system theory in order that a link might be established between both of these and the learning of a foreign language.

As for errors in foreign-language performance, Prof. L. felt that they are the result of insufficient mastery of the pertinent skills.

Whether the learning of a foreign language would lead to a new world-view besides that of the mother-tongue or to an expansion of the existing perceptual system is an interesting question for psychologists to which no answer has as yet been found.

As to the question of whether there exists something like a 'best method' of learning a foreign language, Prof. L. believed that for some time to come it would be impossible to settle this issue. Neither is it possible to speak of *the* learning strategy in relation to other skills. There are individual differences, rooted in intelligence and personality structure. Besides, it is not at all unlikely that, because of structural similarity to or geneological relationship with the mother tongue, a given foreign language is more readily acquired by one method than by another.

NOTES

1 The construction and testing of ideal models is common practice in many areas of psychology. Compare for instance the ideal preceiver models in signal-detection theory.