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ABSTRACT

Advanced learners' processing of linguistic knowledge in connection with a translation task from Danish into English is discussed. The focus of the discussion is on learners' use of different types of linguistic knowledge (the degree to which they use this linguistic knowledge and the form in which it is represented). The following issues are addressed: (1) introspection as an elicitation method in data collection; (2) a theoretical model based on cognitive psychology; (3) a taxonomy of three types of knowledge representation; (4) an analysis of learners' mental representations of linguistic knowledge along two dimensions. Pedagogical implications, particularly the role of grammar instruction, are also discussed. Analysis suggests that if the learner does not identify any particular problems in the translation process, solutions are arrived at based on skill- and rule-based knowledge. If the learner identifies problems, the solution pattern involves the application of knowledge or rule-based knowledge. The linguistically most competent learners are able to activate skill-based, or at most, rule-based knowledge. (Author/MSE)

INFORMATION PROCESSING IN A TRANSLATION TASK

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Abstract:

The paper will comment on advanced learners' processing of linguistic knowledge in connection with a translation task of Danish into English. We shall focus on learners' use of different types of linguistic knowledge, on the degree to which they use it and on the form in which it is represented. The following issues will be taken up: introspection as an elicitation method in data collection, a theoretical model based on cognitive psychology, a taxonomy of three types of knowledge representation and an analysis of learners' mental representations of linguistic knowledge along two dimensions. Finally we shall discuss some pedagogic perspectives of the findings - in particular the role of grammar instruction in the classroom.

The analysis shows that if the learner does not identify any particular problems, solutions are based on skill- and rule-based knowledge. If the learner identifies problems, the solution pattern is one that should involve the application of knowledge- or rule-based knowledge. The linguistically most competent learners are able to activate skill- or as a maximum rule-based knowledge.

The following is an analysis of Danish learners' solutions to the task: a translation from Danish into English.

Focus is on the types of knowledge used by the informants, the degree to which they have access to knowledge, and the form this knowledge takes. The first section characterises the informants' educational backgrounds. The second section outlines our method of data collection: introspection; this is followed by a brief comment on the advantages and disadvantages of using this form of elicitation. The third section describes in more detail how the method was used in practice in video recordings. The central section is the theoretical section which outlines our categories of analysis which are based on models of cognitive psychology and artificial, 'intelligent' systems. The section on theory is concluded by a model of the development of ideal translation competence. Following this, we include our informants' task solutions and an outline is given of the conventions used in protocol transscripts. After this, extracts from informant introspection are presented together with an analysis of their information processing. The analysis is based on the model outlined in the section on our cognitive model. The informants are rated both relative to each other and in relation to the outline of ideal translation competence. On the basis of the results of our analysis, we finally discuss pedagogic perspectives, in particular the role of grammar instruction.

Informants

We have two groups of informants whose instructional focuses are different,: Group I from The Copenhagen Business School students and Group II from the Danish Civil Defence Corps Academy.

The Group I informants are studying English at university level; the aim of their education is to make them professional translators and interpreters, especially with regard to the translation of ESP-texts. It is considered important for the candidates to reach a high level of linguistic competence and to be acquainted with scientific methods which will enable them to carry out investigations into the use of ESP, do research, and teach at university level. Translation and grammar are the subjects studied that we are interested in here. Within these subjects, instruction is aimed at enabling the students to:

"produce linguistically correct, adequate and stylistically correct translations into and from the L2"

and

"increase theoretical and practical grammatical knowledge"

and produce

"a well-argumented and systematic account of grammatical rules and relations."

(Studievejledning EK/EOT, 1985, Copenhagen Business School, our translation).

The Group II informants' education aims at enabling the students (who will be commissioned officers at the end of their 4 years' education) to function as leaders at intermediate level, ie be responsible for the planning of instruction for conscripted personnel and NCOs, lead and command a force of about 100 men and perform administrative duties, ao in connection with international cooperation. On top of civil defence subjects and leader-ship instruction, these informants' education has a general part which contains ao German and English. The English course takes up 150 hours and focuses on:

"enabling the student to prepare and carry out instruction in English and participate in meetings at which English is used."

(Bestemmelser for uddannelsen, Videregående Befalingsmands-uddannelse, 1987, our translation).

The two groups of informants distinguish themselves by having different instructional foci, and it is our assumption that this will be reflected in their information processing, in their approach to the task, and in their ability to verbalise about linguistic problems in relation to the task set.

Method

In our investigation we use introspection to elicit information about the information processing of the study's informants. This method is based on a range of assumptions which we shall present below.

Introspective methods have been the subject of much debate. The methods were first used by psychologists to investigate human problem solving strategies; as we consider the processing of linguistic material and the production of language as problem solving, the method is well suited for eliciting data about the information processing involved in the solution of a translation task. Using introspective methods is not unproblematic, however; the method has been criticised for:

- not giving access to all processes,
- only revealing the product and not the process,
- changing information processing as a result of the demand for verbalisation,
- revealing only part of the information processing.

We shall not deal with this criticism here, but refer to ao Nisbett and Wilson (1977) and Borsch (1986) for detailed discussion. We are of the opinion that despite the points of criticism mentioned above, our cognitive model (see below) warrants the use of introspective methods.

Two methods of introspection are used; they are both assumed to provide information about the processing related to the task set; they are: loud-thinking and retrospection. Loud-thinking is characterised by being verbalisation that is simultaneous with task solution; it elicits information on the informant's use of automised or controlled processes by being the direct coding of the conscious thought and by eliciting information about the content of short term memory at a given point in time (see section on the cognitive modelfor a more detailed discussion of this).

In this study we are primarily interested in the information rendered by loud-thinking on the question of whether an informant has automised a process or not. If there is loud-thinking on an issue the process can be described as more or less controlled, if no loud-thinking is found, the process has been automised (see Analysis section for examples of this).

In the retrospection we find data that are collected by the researcher immediately after task completion. The retrospection is carried out in the following way: there has to be contextual information - in this case the informant's translation together with extracts from the video-recording, which show how the informant acted in the situation in question. The researcher does not discuss matters that do not relate directly to the task set as this might give an incorrect picture of the information processing involved. The retrospection is an elaboration of what the informant did during loud-thinking. It is an important part of data

collection as it may provide more information and lead to further comments which can be central to the interpretation of the informant's information processing.

The researcher gets the opportunity to ask further questions and focus on subjects that are of special interest. In the present study interest centered around the informants' use of analysed knowledge and their use of the control dimension. We assume that the loud-thinking will primarily elicit information about the control dimension whereas the retrospection session will primarily elicit information on the informant's use of analysed knowledge.

Design

The data used in the study were collected in the following way: A number of informants were selected: five in each group. They were asked to complete the same translation task. The task had been selected with a view to providing as much information as possible about the informants' information processing in relation to the expression of future reference in English. The informants had no access to reference books or grammars while solving the task. After the informant had produced the translation per se and thought aloud in connection with this, the retrospection session was carried out. The informant had not been informed about this in advance. In the retrospection session, the translation - which had been written on a vufoil - and/or the video-recording of task solution were used to support the inform-

ant's memory. After the completion of the test, the tapes were transscribed and qualitative analyses of the protocols were made.

After a preliminary analysis of the transscripts, four informants - two from each group - were selected for further analysis of ao vocabulary. These informants illustrate characteristic information processing. The analyses are based on a simple system of categories; the reasons for using this system and an outline of it is given below.

The Cognitive Model

The aim of this section is to give a brief description of the theoretical framework on which we base the categories of analysis. It should be stressed that as it is the case with all models, this one is also a simplification of reality. It is an abstraction to attempt a description of human behaviour beyond the immediately visible; but the framework established enables us to make what has become visible, comprehensible as well.

The starting point is that using a language is a complex skill which can be analysed at several levels. We are particularly interested in the types of knowledge that contribute to performing this skill. We are therefore operating on the basis of a production model. Knowledge is used in the broadest sense possible: it refers to the total mental activity behind any linguistic action; that is both conscious knowledge that the informant can verbalise about and knowledge to which there is not direct access.

First we outline the model of language acquisition adhered to in this study, secondly we outline the structure of the knowledge representation. This leads to a production phase in which the knowledge in question is activated. Thirdly we look at the control exercised by the language user over the knowledge activated and the degree to which this influences task solution. Finally we set up a simple system of categories which is used to analyse the collected data.

Learning

What does it mean to learn? The concept is used in everyday language and we all have some sort of intuitive feeling of what it means. It has, however, proved quite difficult to provide a scientific definition. Some even claim that eg language is not learnt, but that is rather grows and develops like any other organ (Chomsky,1988). The position that nothing can be learnt, which is not already laid down in a genetic code is the ultimate consequence of the position which is also that of this article: learning is the development of new programmes to process and produce data. We deviate, however, from the extreme rationalism represented by Chomsky, by assuming the smallest possible innate inventory and by concentrating on the role of interaction (for reasons based on developmental psychology see Jensen/Kiel, 1988 and for a neurolinguistic argumentation, see Jacobs, 1988);

"in general terms, learning is the construction of new programs out of elements of experience."
(Johnson-Laird 1988: 133)

A minimum of innate knowledge is assumed because developed programming languages show that in principle only very simple basic elements are needed to build up very complex systems:

> "Only a small set of procedures need to be innate before there exists a basis for constructing any possible program. This conclusion follows because only a small number of building blocks are needed to construct a universal Turing machine, i.e. a device that can compute anything that is computable."
> (Johnson-Laird 1988: 133)

From this perspective, the basic difference between machine and man is that man is <u>self-programming</u> because, as opposed to the machine, he is equipped with intentions and acts in contexts where his actions are important relative to the changing demands of the surrounding world. How do we learn then? First in a purely quantitative way by the addition of knowledge. But taking in new knowledge is always dependent on already existing knowledge; at the same time it restructures already existing knowledge (Piaget's assimilation and accomodation). Self-programming is therefore dependent on the present status of the system, and input from the surrounding world; feedback on output can result in

extention, restructuring or more effective access to existing knowledge (see also Analysis and Control section). This leads to a description of how knowledge is stored in memory.

The Structure of Knowledge

Our model of the mental knowledge representation has two elements: a knowledge base, and the procedures which interpret and manipulate this base. There is no universally correct model of the mental representation of knowledge, but a general framework can be set up on the basis of what memory should be able to provide:

1. registration of events and an evaluation of whether storage is worthwhile;
2. the establishment of a mental representation of an event in memory;
3. potential long time storage in memory of the event;
4. the rapid and efficient retrieval from memory when necessary, either controlled or automatic (see below);
5. conscious storage of retrieved information for a brief period during which is contributes to thought.

(Johnson-Laird 1988).

This provides a preliminary division into three components. A short term memory in which incoming data and retrieved knowledge are stored briefly under conscious attention while they are part of ongoing thinking. Secondly a long term memory in which data have been stored as traces

in memory that can be activated in a given situation. Thirdly a control unit which regulates the system.

It is, however, not all incoming data that are under conscious control. Many impressions are only registered unconsciously and for a brief moment before they disappear again. The part of short term memory under conscious control is termed working memory. This is where thinking per se goes on and it is the place where selected incoming data, which have received preliminary processing in the sensory-motory system, meet data from long term memory.

Long term memory is divided into two types of knowledge: a permanent memory for important skills - procedural knowledge and another memory for previous experiences and factual knowledge - declarative knowledge. So far we have only stated that data is stored in long term memory without considering the form in which this knowledge is stored. On the basis of introspection 1), it could be assumed that data are encoded in natural language; but this is not the case. The data we obtain through introspection do not come directly from either of the types of long term memory, but from working memory where they are under conscious control. It is therefore assumed that a 'language of memory' exists.

Here we have to select the level of analysis. In the last resort, all cognitive activity is based on chemical processes which produce electric charges in nerve cells. They fire when they reach a certain threshold level. The crucial point is, however, how one gets from the basic neurological level to the level of concept formation:

> "To paraphrase Wittgenstein, one can know every brain connection involved in concept formation, but that won't help one bit in understanding what a concept is." (Gardner 1987: 286-287)

The following outline is therefore in a high level language which forms a bridge between the biological 'machine language' and the conscious 'user language'. It is the general opinion that declarative knowledge is stored as hieracically built propositional networks (Johnson-Laird 1988). This type of knowledge is <u>analytic</u> and this is where we find analysed rule systems. This is the type of knowledge that the informant has most direct access to and can account for in the greatest detail:

> "Analysed knowledge is assigned a propositional mental representation which makes clear the structure of the knowledge and its relationship to other aspects of knowledge(....)Because the structure is apparent the learner is able to operate on this knowledge by transforming it, comparing it to other events and using it as a means of problem solving." (Bialystok 1982:183).

Declarative knowledge is the basis of logical thinking and problem solving. Only a part of thinking follows rational and logical principles, however. A large part of mental activity is based on unanalysed knowledge. Unanalysed knowledge is not the same as knowledge that is without system, it is "just" knowledge to whose structure the individual does not have access:

"Unanalysed knowledge is the general form in which we know most things without being aware of the structure of that knowledge (....) Although unanalysed knowledge is structured, the mental representation does not include access to that structure, and so transformations and operations on that structure are precluded." (Bialystok 1982: 183)

This type of knowledge is sufficient to think and act in routine situations. It constitutes the everyday mental models on which action is taken:

"It is now possible to suppose that mental models play a central and unifying role in representing objects, states of affairs, sequences of events, the way the world is, and the social and psychological actions of daily life." (Johnson-Laird 1983: 397)

As opposed to declarative knowledge, procedural knowledge is holistic. The distinction between the two types of knowledge is not one of clearly separated categories but one of continuum representation. Knowledge can be more or less analysed. In relation to linguistic knowledge the difference is one of the exhaustive, scientific, grammatical explanation as opposed to the non-exhaustive rule of thumb.

Some, ao Anderson (1983 and 1985) , are of the opinion that all knowledge is initially represented in a propositional form which has the form of strings of symbols 2), which are incorporated in working memory under conscious

control. Through practice this knowledge may be converted into procedural knowledge. As stated below, this is probably not an adequate description, but for a start it is used as a working hypothesis. Anderson's 'ACT*-model proposes the following memory system :

Figure 1

"ACT* is a theory of cognitive architecture - that is, a theory of the basic principles of operation built into the cognitive system. ACT stands for Adaptive Control of Thought" (Anderson 1983: 19 og ix).

As we can see the model has three components: a working memory with limited capacity, which is controlled by the individual and works as the conscious control unit of the system. The declarative memory contains more or less analysed knowledge which may be verbalised. Production memory contains unanalysed, skill-based knowledge to which the individual does not have conscious access and which is therefore not available for verbalisation.

Production

We are now able to describe the relationship between declarative and procedural knowledge and their activation in task completion. Anderson (1983,1985) views the acquisition of a skill as three-phased. In the first, cognitive phase,

the skill is carried out by means of the rules of explicit, declarative knowledge. In the second phase compiling of information processing takes place via practice, or put differently: the organisation of knowledge is restructured, and the person in question draws informed conclusions ("matching" in the ATC* model). The conclusions are based on a pattern which is activated without employing conscious rule knowledge. The process is, however, dependent on a formal, logical set of rules.

Rasmussen (1987) critises this. He maintains the three stage model, but the relationship between declarative and procedural knowledge is analysed differently. Procedural knowledge is not compiled, declarative knowledge, but a fundamentally different knowledge representation, which is established via practice under the governing control of analysed knowledge.

In the initial phases, the skill in question is carried out under attentional control, but later the new knowledge is disconnected from the rule-based knowledge and it becomes a new type of knowledge, which has it own regularities. The new type of knowledge is holistic and is triggered through signs in the incoming data ('encoding'). Simultaneously, conscious knowledge of the more abstract rules, which the activity was originally based on, may disappear. (Rasmussen 1987:18).

The knowledge representation, proposed by Rasmussen, is divided into three levels. The lowest level is the skill level. This level corresponds to the redefined production

memory of the ACT* model. Behaviour is triggered by certain input patterns ('matching-> application-> execution'). It is still governed by regularity, but not by the same rules as behaviour based on declarative knowledge. Input operates as signs, not as symbols (see below). There is not direct access to this knowledge, and it therefore cannot be conceptualised in the language of consciousness (Rasmussen 1987:22).

The next step is behaviour based on rules in the form of the conscious combination of sub-routines in well-known situations. This is termed the know-how level because it is based on rules, which may be deducted empirically from previous situations, learnt via another subject's know-how by way of instruction, or released in the situation through conscious problem solving and planning (Rasmussen 1987:12). The action is goal-oriented, and the subject acting is aware that there are several options which s/he has to choose between. We are here at the rule-of-thumb level (see above):

> "the higher-level rule-based co-ordination in general is based on explicit know-how, and the rules used can be reported by the person, although the cues releasing a rule may not be explicitly known" (Rasmussen 1987:14).

The rules are practical rules that would lead to the desired goal in normal situations without a deep analysis of the conditions of use and the scope of the rules. The selection of rules is made on the assumption based on experi-

ence that the rule seclected will lead to the desired result. In the ACT* model this is the compiled part of declarative knowledge.

The third level is the knowledge-based level, where knowledge is used in the narrow sense of "know why":

> "In this situation, the goal is explicitly formulated based on an analysis of the environment and the overall aims of the person. Then a useful plan is developed - by selection." (Rasmussen 1987:14)

The choice of level of action is made on the basis of a well-established problem space, which is delineated by means of an analysis of part/whole and means/end. In relation to foreign language production this means meta-linguistic analysis based on scientific, grammatical categories. The problem is formulated in an abstract form and its solution is based on abstract symbols related to the rules of the theory in question. The problem is placed in a theoretical framework and is no longer processed by means of the concepts of a practice-oriented type of information processing. In the ACT* model this is the theoretical, declarative type of knowledge.

Control

In the preceding section, we described the structure of knowledge representation, but in order to understand action

taken, it is also necessary to describe how different types of knowledge are related to a subject's control of the mental activity on which action is based.

McLaughlin (ao 1987) and his co-workers have worked with a division into controlled and automatic processes within information processing 3):

> "Automatic processing involves the activation of certain nodes in memory every time the appropriate inputs are present. This activation is a learned response that has been built up through the consistent mapping of the same pattern of activation over many trials... Once learned an automatic process occurs rapidly and is difficult to suppress or alter." (McLaughlin 1987:134)

If we compare this with the revised ACT* model, it corresponds to the description of the processing found in production memory. The advantage is fast processing, which is not attentionally controlled by the subject and therefore demands very little mental energy (see above). The price paid for this efficiency is lack of flexibility in use.

The opposite situation occurs in relation to controlled processing:

> "The second mode of information processing, controlled processing, is not a learned response, but a temporary activation of nodes in a sequence. This activation is under attentional control of the subject and, since attention is required only one

such sequence can normally be controlled at a time without interference (cp the limited capacity of olled processes are thus highly capacity limited , and require more time for their activation. But controlled processes have the advantage of being relatively easy to set up, alter and apply to novel situations" (McLaughlin 1987:135).

This type of data processing corresponds to the processing of the two types of declarative knowledge: knowledge-based and rule-based knowledge. As they are both under conscious attentional control and thus serial, the subject is able to verbalise the knowledge used (within the previously defined limits, ie dependent on the depth of the knowledge activated). This is not possible with automatic processing, which is not encoded in a propositional language.

The difference between the two types of processing and related information structure is partly related to the way in which knowledge is encoded in memory, partly related to processing per se of the knowledge used. Declarative, controlled knowledge is processed <u>serially</u> and is therefore limited by the capacity of consciousness, while procedural, automised processing is <u>parallel</u>.

Serial processing is known from traditional computers, but there are clear indications that man mainly performs pa-

rallel processing. In neural networks (see eg Brunak and Lautrup, 1988), parallel processing can be simulated. In this connection, it is interesting to note that these networks are not programmed via explicit rules, but they 'learn' via feedback on output in series of practice cycles. The problem with this type of 'learnt' knowledge is that cannot be altered through a change of the rules of the programme, as there are no explicit rules.It demands a new series of practice cycles. On the other hand, incorporated knowledge can be generalised into new data within the same area of knowledge (see eg Rumelhart/McClelland 1986 and McClelland/Rumelhart, 1986). This generalisation is not based on rules, but on regularities. This again means that in a way, this type of knowledge is related to rules. There are thus no strict dividing lines between the different types of knowledge.

Rule-based knowledge - whether based on restructuring (compiling) of controlled knowledge or on generalisation of automised knowledge - is the creative knowledge where knowledge-based and skill-based processing meet:

> "Finally, all tasks are carried out by complex mixtures of controlled and automatic processes used in combination." (Schiffrin/Schneider 1984:268)

All three types of knowledge and both types of processing are important in relation to translation tasks. Automised knowledge caters for the lower levels of production, ie the elements of the task, where the informant has stored

patterns of behavior, which on the basis of unanalyzed knowledge are triggered by certain signs in the task. Rule-based knowledge see to the more routine-like conscious processing, ie the combination of automised sub-routines. Finally knowledge-based, declarative knowledge takes care of problem solving which is based on metalinguistic knowledge in analysed symbols systems.

Translation is a combination of analysed - unanalysed and controlled - automatic processing. The individual informant decides where attentional focus should be, and this depends on the aim of doing the translation. Previous experience with translation, task complexity relative to level of proficiency and storage of linguistic knowledge (based on previous instruction) decide whether focus is on knowledge-based declarative knowledge because correctness is central or on rule-based, automised knowledge because content is central. Furthermore, the informant's ability to combine declarative and procedural knowledge influences task completion, eg the careful use of the monitor (Krashen 1985).

Figure 2

The combination between serial and parallel processing is not only the most likely one, it is also the most efficient and flexible one. This comes out in relation to task solution in the form of the ability to change focus from form to content. The more automised low level task solution is, the more time is left for overall planning and high level problem solving.

Data

As we stated in our section on design, we have three types of data: loud-thinking, retrospection and written text. Examples of loud-thinking and retrospection data are included in the following section together with analyses of data; the introspection was done in Danish - the L1 of the informants - the examples included below have been translated into English. The protocols are very long, and it is not possible to reproduce them here or to analyse them on all points of potential interest. The analysis in the following sections will focus on the solutions offered to one grammatical problem: future reference by means of present tense or future tense/ going to/ will + progressive, and two lexical problems. The following conventions apply:

'____' indicates English words that are used in the translation or suggested as possible solutions

Danish text is indicated by single quotation marks: '...'

'-' indicates a pause

'..'indicates unfinished utterance

'(...)' indicates excluded text

I = the informant

R = the researcher

To ease the identification of the following extracts the following notation is used: Informants are indicated by group adherence and letter of identification, H refers to loud-thinking protocol extracts, R refers to retrospection data. For instance: 1AH, Group I, informant A, loud-thinking protocol extract.

Below we find the first and last clauses of the text that the informants were asked to translate from Danish into English. After that the individual informant's translation is included, in the form in which it was handed in. The following apply to these translations:

'*' = changed into the following word

'**'= deleted.

Danish text:

Den britisk-franske Concorde flyver i de kommende uger ind i en uvis fremtid, nøje overvåget af den britiske regering, som til efteråret træffer afgørelse om Concorde-projektets skæbne.
Så vil briterne konstatere, hvad et supersonisk brag vil sige, når maskinen flyver ned gennem en korridor mellem Irland og England.

Translations:

Group I informant A

In the coming weeks, the British-French Concorde will fly into an unknown future - closely followed by the British government, who are to decide about the future* fate of the Concorde project this autumn.
Then the English will observe what a** supersonic noise is like, when the aircraft flies through a corridor between Ireland and England.

Group I informant L

During the next few weeks the Gr** British-French Concorde will fly into an uncertain future closely* under close surveillance by the British government, who will decide on the fate of the Concorde-project in the autumn.
Then the British will experience the sound of** a supersonic boom when the plane will fly* flies down a corridor between Ireland and England.

Group 2 informant D

The British-French Concorde will fly into an uncertain future in the weeks to come. It will be carefully surveyed by the British government which will make a decision about the fate of the Concorde project in the autumn.
When the aircraft flies down a corridor between Ireland and Great Britain the British will find out what a supersonic bang means.

Gruppe 2 informant G

The British-French Concorde flyes into an uncertain future in the upcoming weeks - closely surveyed by the British government. The government makes the decision of the faith of the Concorde-project this autumn.
When the plane passes through a corridor between Ireland and England, the British population is going to learn what a supersonic bang is.

Analysis

The following analysis is based on the division into knowledge types which was outlined above under Production. The three types of knowledge are:

- knowledge-based knowledge
- rule-based knowledge
- skill-based knowledge.

In the analysis, the four informants' information processing is discussed relative to the three knowledge types. We also comment on:

- the analysis and control dimensions
- the informants' task focus
- the informants' interlanguage.

Analysis and control

The four informants all use all three types of knowledge and both dimensions in task sclution (cp Schneider and Schiffrin quoted above). Below we outline an information processing profile for each informant.

The Group I informants command much analysed knowledge. This is particularly clear from their retrospections where they expand on their reasons for selecting a particular option, but IA verbalises analysed knowledge already in the loud-thinking. 1A's use of analysed knowledge is prominent in her approach to syntactic problems (here: future reference and word order), where she verbalises knowledge-based knowledge in relation to a problem-space which she establishes:

Example 1 (1AH)

And 'flyver' that is neutral future reference, we must remember that, future tense: will fly.

The informant uses less analysed knowledge in relation to lexical problems, where she operates more on the basis of skill-based knowledge:

Example 2 (1AH)

And then we have got the 'brag' left. We have said crash, we have said bang and we have rejected large and big noise. Right now I cannot think of anything because I cannot remember anything in relation to the word 'brag'.

1L also operates on the basis of analysed knowledge, but however, she does not use knowledge-based knowledge, but rule-based knowledge; it does not have the same depth as 1A's knowledge. The retrospection shows, however, that the informant commands compiled, knowledge-based knowledge. Simultaneously with this compiling, a skill-based knowledge representation has been established so that the informant no longer has access to/ commands detailed, metalinguistically formulated knowledge.

Example 3 (1LH)

The British-French Concorde 'flyver' will fly into an unknown future.

Example 4 (1LR)

R: Then you have the expression 'flyver i de kommende uger', there you said very quickly: future: will.

I: Yes, reference is made to the coming weeks, it has not happened yet, then Danish often has present tense for future reference which English does not have as often.

R: Did you consider this particularly much? Besides the argumentation that you came up with while writing down, or was it more - ?

I: No, it came more or less by itself, because you have had it dinned into your head to often.

The informant's analysed knowledge is characterised by rules-of-thumb, and example 4 they provide sufficient information for the informant to solve the task. This is not the case in the following example. She reaches a correct solution, but based on rule-based knowledge and she therefore cannot explain why.

Example 5 (1LR)

R: (The last sentence): 'når maskinen flyver ned gennem en korridor mellem England og Irland' there you said: it is some sort of of future tense

I: Yes, I really considered the same as I did in the first sentence, that it does so somewhere in the near future, but the interesting point is that I do not stick to it, and fairly soon I discovered that I had forgotten it above, I inserted it and removed the other one.

R: Why?

I: I really do not know, they were too close so..I believe that I tend to...I like compact language, and why should I then point out twice within one type-written line that this is future tense. I believe it is part of the explanation. But I cannot explain why I kept it in the first sentence.

R: Could it be related to the structure of the sentence? Or, what type of sentence is it?

I: The subjunctive? No, I believe that it is a subordinate time clause. Well, I do not know. It relates to my concentrating on the words and then theoretical grammar is not my strong point, sometimes I am able to identify a mistake, but I cannot really explain.

It is characteristic of both groups of informants that they have a wide range of considerations in relation to their vocabulary; these considerations are often linked to a wish for lexical and stylistic variation and the precise rendering of single words/phrases.

Example 6 (1AH)

I prefer <u>in the weeks to come</u>, but it is a bit old-fashioned and stiff. We'll write as it says: <u>In the coming weeks</u>

Example 7 (1LH)

And then I have to find out what 'brag' is, and it has something to do with quality, it is not <u>quality</u>, but that type of word. And 'supersonisk' must be the same, I guess, and

before I said boom; it is pure guesswork and one may rely too much on that, because when I say boom I cannot think of anything but economy and a supersonic bang sounds childish; what else could 'brag' be, this is nasty, I think.

A comparison of the two Group I informants' characteristic information processing shows that the major difference between the two is that of automatisation. 1A has automised 4) a smaller part of her analysed knowledge than 1L: she operates in a more controlled way and she defines her problem-spaces explicitly.

Example 8 (1AH)
And 'flyver', I wonder whether this is also future reference. No, you cannot say when the aircraft will fly. No, there is some rule about a relative clause, then we do not need compound tenses, or something like that. I really ought to be able to remember this.

1L draws a higher number of informed conclusions, and via compiling - she has automised more of the knowledge-based input that she has been exposed to during her education. She therefore operates on a less controlled basis.

As expected, the Group II informants use less analysed knowledge than Group I. This is primarily linked to their educational background (see section on Informants). Their loud-thinking has little verbalisation but the retrospction has more. It is characteristic that the Group II informants

use skill-based and rule-based knowledge, which they try to use for explanation purposes in the retrospection.

Example 9 (2DR)

I had a good deal of discussion with myself about will and going to ect, and about which is better here. In the event it was at random after all, I think.

Example 10 (2GR)

R: You wrote: the government makes the decision of the faith of the Concorde-project this summer. Now that we are discussing tense, what tense of the verb have you got here? In the Danish text it says: 'som til efteråret træffer afgørelse'.
I: In principle the two are alike, I think, it is also...
R: And what do you mean by that?
I: Well, it should have said: the government is going to make a decision of the faith of the Concorde-project this autumn
R: Can you explain why?
I: Why? it is because I realise...or autumn is...you might as well, if it is winter now - if you imagine that it was winter now, and you were writing now, then you could still say: this autumn. No, then it would have said - No, no it does not work. But in this situation. I do not think that it can be misunderstood, this looks...No, it is no good either. What I would have said is that is was, it is this autumn , it could also be used about the autumn that was, or has been, although (...) that is the same, that is, for instance

this spring, isn't it; it could be something that had happened. But you cannot use it here.

There is a significant difference between the two informants, however. 2D operates on the basis of rule-based knowledge. He commands some syntactic rules-of-thumb, ao as regards word-order and the expression of future meaning in English, and he is able to define a problem-space by means of this rule-based knowledge.

Example 11 (2DH)

I think I have a small problem here, there is future reference in 'når maskinen flyver', but on the other hand, when the machine will fly, that is too heavy - I think I'll use ordinary present tense instead.

With regard to lexical problems, 2D primarily operates on the basis of skill-based knowledge, this can be seen from the following example:

Example 12 (2DH)

'Hvad et supersonisk brag vil sige': what a supersonic boom - that sounds silly, crash, no that has a different character. There is probably a fixed expression for 'et supersonisk brag'. I would probably try to look it up, but so far I'll choose boom. Bang, well, bang sounds better.

2G operates on the basis of unanalysed knowledge. He does not define local problem-spaces, and the global problem is just translation as such - not a particular type of translation which entails a specific response.

Example 13 (2GH)

And then I'll try to write down what I have found out about; if it does not work then we'll have to corect it: decision. And then there is one of these words, well, I suppose I have to. OK, I'll write it: decision

The informant uses quick, skill-based decisions concerning a particular translation item. He is primarily interested in conveying the meaning of words, phrases and entire sentences, rather than in detailed translation. He uses automised, skill-based knowledge for this, and it is often not sufficient to solve the task in question.

Example 14 (2GH)

Well. 'Den britisk-franske Concorde flyver i de kommende uger in i en uvis fremtid, nøje overvåget af den britiske regering.' The beginning is not too problematic, it is quite straightforward. 'Flyver'...fly, I believe. So then: flys.

If we place our informants in the model outlined in 4.4. we get the following figure:

Figure 3

The figure shows how our informants use the two dimensions differently. 1A and 2D both operate in a more controlled manner than the other two informants. They both produce a controlled response, but on the basis of analysed knowledge that is used differently (see ex 1 and 11). 2D primarily controls via rule-based knowledge, 1A uses knowledge-based knowledge, that is, knowledge that is more analysed in character. The other two informants, 1L and 2G, use the control dimension considerably less, both as regards syntax and vocabulary. This is particularly the case with 2G who almost entirely uses skill-based knowledge, whereas 1L - like 2D - uses rule-based knowledge as well. The extent and type of analysed knowledge commanded by the informants differ, but the two informants resemble each other as regards their fairly extensive use of automised knowledge.

Example 15 (1LH)

...then the Brtish will experience the supersonic...when the plane flies down the corridor between Ireland and England; for some reason of other I resent changing my initial - somewhat risky - solution that the word is boom(...)I think that I'll stick to boom, it is a general word, and maybe it relates to the fact that I use much 'economic language'; I wonder if it is complete nonsense, but then it is just too bad.

Our second point of analysis relates to the informants attitude to the task, their evaluation of the problem-space(s) in question, and their work with these problem-spaces. The Group I informants are very much alike in this respect: they concentrate on form. They focus on individual items in their linguistic and contextual rendering of the source text, and the major part of their problem solving activities is focused on producing a translation which is as close to the source text as possible. Examples 1 and 7 show this focus on form and on correctness both as regards syntax and vocabulary. 1A often defines problem-spaces by using knowledge-based knowledge, she uses grammatical terminology in task solution (the text as symbol, see example 8). 1L operates in a less controlled and less analysed way and therefore uses more rule- and skill-based knowledge (the text as signs, example 5).

The Group II informants work from meaning to form. They concentrate on the context and produce - on the basis of what is syntactically and lexically within their reach - a contextually based version of the source text. They simultaneously change the form of the text in order to solve the task.

Example 16 (2GH)

Then I think that I'll put a full stop here and then start out by changing a relative clause into a main clause. Then

I'll move the constituents around a bit in order to make it work. (See also example 1)

The Group II informants do not use knowledge-based rules for problem solving itself, but in particular 2D uses rule-based knowledge to explain and support a given task solution (example 11), while 2G uses content and context to explain his skill-based solutions (example 10). It is characteristic that 2D uses rules-of-thumb to produce and explain, whereas 2G uses content/context to explain - not produce - the response in question.

Our four informants' problem solving strategies are different. In the loud-thinking 1A operates on the basis of knowledge, and the text is interpreted as symbols that constitute a theoretical framework for the search process. The solution selected can therefore be argued for in metalinguistic terms. 1L and 2D use rule-based knowledge. The text is interpreted as signs and a less well-defined problem-space and less clear-cut solutions follow from this approach. 2G uses skill-based knowledge almost entirely, as this knowledge is limited, the sign interpretation of the text leads to one solution only.

The informants' interlanguage will be commented on from two points of view. First its distance from the L2 norm and secondly the use of L1, L2 and transfer in task solutions.

The Group I informants' solutions come close to the target language norm, both with regard to syntax and vocabulary (see written translations in Data Section). They produce adequate translations of the source text. The Group II informants are further away from the target language norm; 2D primarily with regard to vocabulary, where he uses less stylistic variation than the Group I informants. 2G deviates with regard to both syntax and vocabulary. 2G's automised use of primarily unanalysed knowledge is not sufficient to solve the task adequately.

Example 17 (2GH)

Well, 'flyver' it can be used both in the physical sense of flies, and in a more figurative meaning, but it is probably the more physical fly - <u>fly</u> I guess. That is: <u>flys</u>. No, it probably has an <u>-es</u>. Normally I would look that up, check which is correct. But I am certain that it has an <u>-es</u>.

It is characteristic that syntax is the major trouble-maker to this informant. When rule-based knowledge is included, he operates on the basis of observed regularities; he establishes some content based guidelines that are then generalised to cover the entire problem solving task. In the

retrospection he concludes that the text refers to the future. He observes that he used is going to to express future meaning and he then generalises on this basis. His conclusion is that he ought to have used "these ing-forms" for all future reference examples in the text.

Example 18 (2GR)

R: Flies?

I: Yes, I think if it has an i, then it is the insect

R: This word has an i as well. Talking about the verb, did you consider anything in particular in relation to this sentence: The British Concorde flies into an uncertain future?

I: Well, yes I should have, I can see that now, because I did that later.

R: Yes you did - you considered it later

I: Because I have used the "ing-forms" there, I ought to have done that here as well: is flying into

R: I see; can you explain why you would select that?

I: Because the ing-form, I believe it is used when when something is happening, something happening now and which goes on in the future. And then I ought to have used it here as well.

R: That is, you would like to use is flying to indicate what?

I: To indicate that this is something that happens from now on and then onwards

R: Something that is going to happen, I see

I: That is future reference.

As we can see from examples 17 and 18, 2G operates on the basis of a strategy in his loud-thinking which is: transfer from Danish if possible. Transfer is his initial suggestion as regards future reference (see also example 14). When he includes rule-based knowledge in the retrospection, provoked by the researcher's question, he tries to describe his rule on the basis of content, not form (example 10).

With regard to vocabulary, he has several L2-based strategies of solution. This relates well to his extensive use of contextual, skill-based knowledge and his translation ends up being markedly different form the other informants' translations with regard to syntactic and lexical correctness; (see his written translation in the Data section).

This takes us to the use of L1 and L2 and transfer by the other informants. 1L and 2D use the L2 the most - in the control phase their evaluation is closely related to whether something "sounds correct", but 2D also has examples of transfer. 2D distinguishes himself from from 2G in so far as the examples of transfer are instances of positive transfer. 1L and 2D base the majority of their rules on L2 rules (see example 9) and they only operate on a contrastive basis in a few cases.

Example 19 (1LR)

R: You also make use of the expression: it sounds correct. What makes you say so?

I: It is intuition only, it has no relation to what I may have learnt.I don't know if it is related to books that I

have read, where some phrases are remembered. I love reading aloud to myself at home. I adore the charming expressions used.

R: You say yourself that your intuition takes precedence in the cases where you feel that something sounds better or something looks wrong; do you ever use more formal rules to check whether your intuition is correct?

I: Hardly ever.

Example 20 (2DH)

Well, I have to look at this; find out if I can use the same syntax as in Danish. I think that at any rate I have to put 'i de kommende uger' at the end of the first sentence. Yes, that is necessary - but otherwise it is almost as it is in Danish.

1A is different. She relates her solutions to her L1 by means of grammatical rules which resemble the rules found in grammar textbooks. She works on the basis of Danish grammar textbooks about English and she often uses a contrastive approach. She uses controlled, knowledge-based rules as we find it in the following example:

Example 21 (1AH)

Closely followed by the British government. And then I believe that an ordinary relative clause can be used here, and government; we have to look at it as plural here, and then I said - I cannot remember what I said. I am saying that I

will write who are to decide. That is a good English construction, it doesn't relate to hitting with a gun (træffe can be used in both contexts in Danish, eds.). Change their decision, we change the wordclass, that was my statement before. Who are to decide...I'll write that...We write who are to decide about the future, it was not future but fate even though it is in the future: who are to decide about the...fate of the Concorde project.

The informants' interlanguage and task focus are clearly influenced by their educational backgrounds and their personal style: whether they focus more on content than form or vice versa, whether they trust their feeling for the correct solution, whether they work in a controlled way and whether they define and perceive the task set in a particluar way. These factors are furthermore influenced by the informants' knowledge representation and a very complex picture is the result.

Conclusions

Our analyses show that there are characteristic differences between the four informants' task solutions. 2G solves the task in the shortest time. This is caused by his extensive use of unanalysed and automised skill-based knowledge. He has a problem, however, he has too little analysed and controlled rule-based or knowledge-based knowledge. This is particularly a problem as his skill-based knowledge is

insufficient and automatisation has been based on transfer of L1 knowledge.

The contrast to this informant is 1A, who has the longest task solution. This is caused by her extensive use of analysed and controlled knowledge-based L2 knowledge. Both 1L and 2D are characterised by using a good deal of automised, skill-based knowledge which is coupled with some analysed and controlled knowledge of the rule-based type in their task solutions. They distinguish themselves from each other with regard to the character of their rule-based knowledge. 1L seems to be an example of the learner who has compiled knowledge-based knowledge (compare her background, study guidance, section on Informants and example 4). This makes her focus on form (the "charming expressions", see example 19). 2D is more liable to generalise from observed regularities, this can be seen in his use of transfer (cp 2G). 2D's use of this approach leads to positive transfer, however.

Our model, see figure 2, which outlined the ideal development of a translator's competence, showed that the competent translator uses both automised and analysed L2 knowledge. This means that to the extent possible, the translator uses automised knowledge representations. They are used in an unanalysed form in a task solution when this solution proceeds without any problems. But the competent translator is also able to leave the automatic processing and change to more attention demanding rule-based and knowledge-based knowledge representation when this is deemed necessary. The shift takes place as the result of an identification and delineation of problem-spaces.

Our overview of the informants' position relative to the ideal translator's competence shows (see figure 3) that none of our four informants comply with ideal demands. 1A works in a very controlled way and based on analysed knowledge, but she lacks belief in her own skill-based knowledge, and she therefore ends up making the task more difficult for herself than necessary; she actually solves the task twice. She is - to use Krashen's terminology - a Monitor overuser (Krashen 1985). 2G is the absolute contrast to 1A. He hardly uses anything but skill-based knowledge, and this knowledge is often both insufficient and contradictory to the L2 norm. The retrospection shows, however, that he does command a good deal of rule-based knowledge (example 18). If this knowledge had been used in the loud-thinking is might have prevented certain unsuccessful solutions. In Krashen's terminology he is a Monitor underuser (Krashen 1985). Both 1L and 2D base their solutions on skill-based and rule-based knowledge. They differ from each other as regards task focus; 1L focuses on form, eg in the form of stylistic considerations introduced in order to produce a correct translation; 2D focuses more on content and is satisfied with a translation which conveys the meaning of the source text. They both lack the ability to include knowledge-based knowledge; this type of knowledge might have provided the informants with the knowledge necessary for producing the optimum translation. It is a joint characteristic for all four informants that the initial response to the task set is based on skill-based and rule-based knowledge.

Example 22 (1AH)

Now, I am going to try to read aloud a rough draft of the translation into English that I have in mind.

Knowledge-based knowledge - as we find in 1A's protocol is used as a checking device in relation to an initial draft. Skill-based and rule-based knowledge thus become the central types of knowledge representation. Knowledge-based knowledge is introduced to the extent that the informant has access to it and considers it necessary for production. This is shown by our figure 3 of the informants' position relative to our ideal translator's profile. 1L and 2D are characterised by shifts between skill-based and rule-based knowledge; they are the both "effective" translators compared to the time they invest in producing the translation, their linguistic competence and the result reached, and they therefore come closest to the ideal translator's development that we have outlined.

Pedagogic perspectives

Our conclusions about the four informants' information processing above shows ao that the best results are reached when the learners have access to analysed knowledge in the situations where they experience difficulties in relation to task solution. Another important result is that the use of unanalysed skill-based knowledge is prominent when task solution poses no problems. This again means that L2 instruct-

ion, which is aimed at assisting advanced learners, should take into account both the acquisition of sufficient analysed knowledge and sufficient skill-based knowledge. From a pedagogical point of view this means that grammar instruction is necessary as it supports the learner's understanding of why, and thus enables the learner to set up his/her own interlanguage rules. These rules are often rules-of-thumb that can be applied easily in task solution. Grammar instruction also helps the learner in his/her identification of problem-spaces and selection of relevant approach to the task. Grammar instruction may contribute to making grammatical knowledge conscious. If we relate this to the obtaining of translation competence, it seems that the aim should be to make grammatical knowledge assist in, but not control, task solution. (see informant 1L vs 1A, where 1L uses her grammatical knowledge to assist her in task solution, but without letting this type of knowledge dominate). Grammar should assist in the establishment of problem solving strategies, but is should not be the strategy itself.

How can grammar instruction be adapted to these learner centred demands? The following may be suggested: learners are enabled to focus on larger chunks of language than the word: phrases, clauses and entire paragraphs; and a discourse oriented type of grammar is therefore assumed to assist the learner in a better way than the well-known word and sentence based grammar. Individual elements should be part of the learner's knowledge, of course, but for advanced

learners this type of knowledge - elementary grammar - is only relevant or necessary in very few cases.

The ideal grammar for the advanced learner is therefore - in our opinion - oriented towards the process, aimed at increasing the learner's understanding of the language as a whole, and focused on the acquisition of analysed and skill-based and/or rule-based knowledge. The starting-point therefore becomes the what kind of grammatical knowledge the learner may benefit from in a task solution, how the learner is made to use this knowledge and how s/he is brought to the point where s/he recognises the usefulness of using grammatical knowledge in the situations where this is necessary to ensure correctness in task solution. There is no single and unified answer to this problem, but the following elements of grammar instruction related to translation should be considered:

- focus on the contribution that grammatical knowledge may make to task solution;
- the usefulness of introducing contrastively based rules in task solution to avoid negative transfer;
- the possibility of getting confirmation of already established hypotheses; eg useful rules-of-thumb.

These elements of grammar instruction may contribute to motivating learners for using grammatical knowledge as a source of information when this is necesary and contribute to learners trusting their own skill-based knowledge in cases where no problems occur during task solution.

Notes:

Note 1: In this article the term introspection is used as a general term to denote both informants' loud-thinking and retrospection.

Note 2: In this connection we exclude mental pictures, which are assumed to be entities in themselves

Note 3 This division was originally set up by Schneider and Schiffrin/ Schiffrin and Scheider (1977)

Note 4: Automatisation is used here and in the following sections in the sense given under Production as skill-based knowledge. It is not really a question of analysed knowledge representation being automised. The knowledge in question can be both automised skill-based knowledge and the result of rule-based and knowledge-based knowledge.

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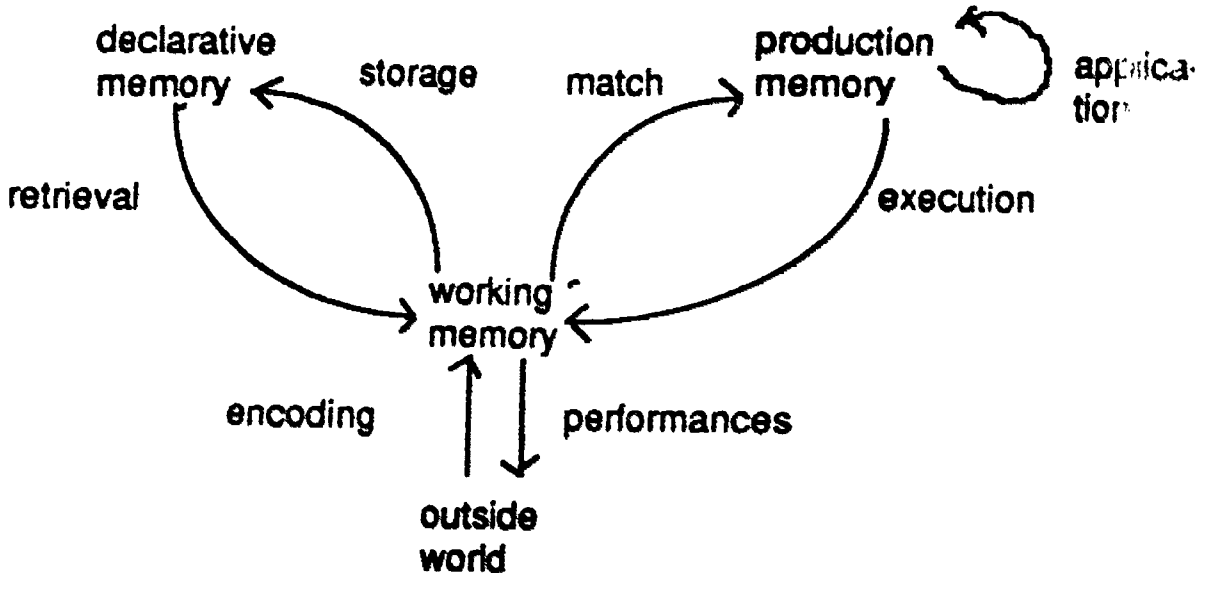
Figure 1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memory
storage
match
production
memory
retrieval
execution
working
memory
encoding
performances
outside
world

Figure 2

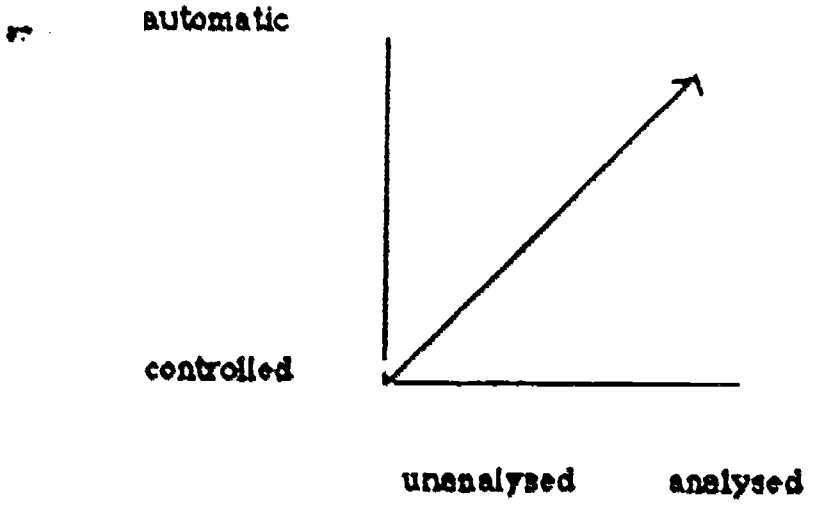

Figure 3