LUND UNIVERSITY
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A MICROCOMPUTER PAUSEMETER FOR LINGUISTS

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INTRODUCTION

The existence of pauses at certain points of utterances has long been noted. Some references from the latest decades are the following: Lounsbury (1954), Goldman-Eisler (1958), Boomer (1965), Gårding (1967), Beattie (1979). Current interest in speech production has focused on pauses as they seem to be important clues to speech planning activities, see e g Butterworth (1980), Kempen and Hoenkamp (1982). Pause behaviour in simultaneous interpretation has been studied by e g Goldman-Eisler (1972), Barik (1973) and Vamling (1982). The relation between pauses and anxiety is treated by Cook (1969). Differences in pause behaviour between men and women are treated by Einarsson (1978).

Measuring pauses and speech segments by hand on spectograms, oscillograms or their digital equivalents gives detailed information about the speech signal. But it is time-consuming and requires good training in phonetics. Many linguists would welcome an automatic pausemeter as a simple tool for determining the pause characteristics of utterances. An automatic pausemeter may process the speech signal and display or print diagrams and tables showing the durations of pauses and speech segments.

Automatic pause measuring equipment developed in recent years is mentioned by e g Barik (1973), Beattie (1979). It has not, however, been discussed much among linguists and phoneticians

to whom such instruments should be of great interest. Automatic pausemeters do not belong to the standard equipment of linguistic or phonetic laboratories, although their potential for speech research is very promising.

The purpose of this paper is to describe a simple automatic pausemeter which can be built at any department where a microcomputer and some standard electronic components are available. The pausemeter to be presented exists in two versions: One (1) is a display (real time) version which shows the duration of the pauses or speech segments as you produce them.

The other (2) is a more exact version that stores measured time values for subsequent use for various computations, displays and print-outs. This second version prints tables of the duration of all pauses and speech segments, computes their average durations and standard deviations and plots various diagrams.

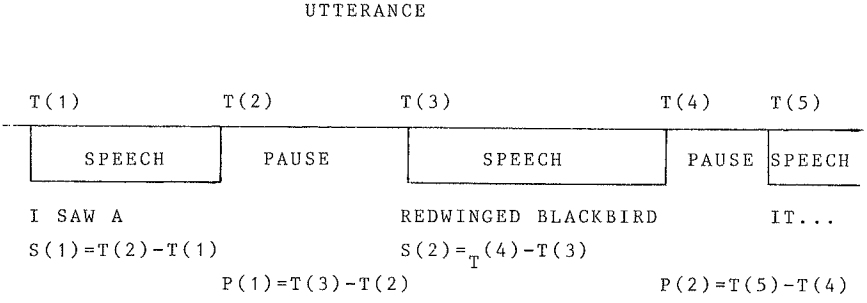
The hardware has been developed by Jönsson, the programs (in Basic) have been written by Sigurd and Mandersson has assisted in the conception and design of the system. Sigurd has written the body of this paper. Jönsson and Mandersson have written the description of the pause-speech decision unit and contributed to the discussion of the problems of distinguishing pauses in speech.

PAUSES AND SPEECH SEGMENTS

To the discourse analyst the pauses of focal interest are those between paragraphs, clauses, phrases and words. We will call these discourse pauses. Such pauses of interest are marked by (p) in the following example:

> I saw a (p) redwinged blackbird (p) It was (p) perching in a (p) redbud tree.

The beginning of the utterance can be depicted as in fig 1.



T(i): Time reading number i

S(j): Speech segment number j

P(k): Pause number k

Fig 1 Idealized view of the pauses and speech segments in speech.

The basis of the pausemeters are the time (clock) readings at moments when there is a change from pause into speech or vice versa (T(i)). The duration of a speech or pause segment can be derived by subtracting a preceding time reading from the current reading. Generally the duration of a speech segment (S(j)) can be computed by deducting uneven readings from even ones and pauses (P(k)) by deducting even readings from uneven ones. Given the duration of all speech and pause segments further calculations can be undertaken.

The decision whether there is a pause or a speech segment is a binary decision and it is not easy to take. A human listener may mark pauses by ear and even measure them roughly by a stop

watch, but as is seen on any spectrogram or in experimenting with automatic pausemeters it is not easy to design an automatic device which achieves results in accordance with human preception.

DETERMINING THE PAUSES OF SPEECH

A pause may be defined as a time segment where there is no energy present. Disregarding the so called filled pauses, which of course cannot be defined in this way, discourse pauses should be discoverable by looking for segments of no energy. Several problems, however, turn up in practice.

One problem is the fact that there are segments where there is no energy even within individual speech sounds, e g in stops such as p, t, k in such words as apa, ata, aka, or even longer in appa, atta, acka. The duration of the silent phase of the stops in the first words can be as much as 175 msec, the second 200 msec, when pronounced by a Swede. These pauses could of course be of interest and the pausemeter to be presented can easily measure the duration of pauses in such stops if set to do so. But such pauses should not be counted among the discourse pauses.

Another problem is the low energy of such sounds as f, th, h. A pause detection device designed to measure discourse pauses must be able to skip the pauses inherent to certain speech sounds such as stops, but still react to weak speech sounds. If the device finds pauses at stops and weak speech sounds within words it will register too many pauses. If it does not note the existence of weak sounds in the beginning or at the end of certain words the durations of utterances and pauses will not be correct.

Rabiner & Schafer (1978) have discussed the difficulty of determining the beginning and end of words and state that they are difficult to locate if there are

1 Weak fricatives (f, th, h) at the beginning or end

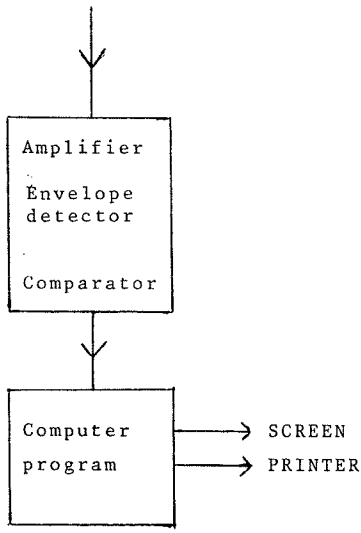
2 Weak plosive bursts (p, t, k) at the beginning or end

3 Nasals at the end

4 Voiced fricatives that become devoiced at the end of words

5 Trailing off of vowel sounds at the end of an utterance

Rabiner & Schafer describe an algorithm that is intended to discover the beginning and end of utterances (speech segments) on the basis of two time-domain measurements - energy and zero-crossing rate. We have to rely on simpler methods in the pausemeter to be described. The general construction of the pausemeter is shown in fig 2.



Function

Decides whether pause or speech segment is at hand

Measures changes between pause and speech.
Computes (and displays) the durations of pauses and speech segments.
Draws diagrams and prints tables.

Fig 2 Block diagram showing the overall concept and function of the pausemeter

THE SPEECH-PAUSE DECISION UNIT

The speech-pause decision unit distinguishes between speech and pause by comparing the signal envelope with a predefined threshold. The signal envelope is determined by an envelope detector and it is assumed that the envelope suitably approximates the short-time signal energy. The principle of the unit is shown in fig 3a. The speech signal is first amplified. Then the signal envelope is determined by the envelope detector where the time constant is variable. The output from the envelope detector is compared with a threshold in the comparator. The output from the comparator is either 0 or 1 and this signal is tested by the microcomputer every 20 ms.

Fig 3b shows the circuit diagram and component values. Even non-engineers should be able to build it. The diode at the data output limits the output voltage to positive values. A LED circuit is also used to indicate the result of the comparison and facilitate the use of the device.

The input signal to be processed is taken from a tape recorder either from a microphone or a tape. The tape recorder level meter is used for speech level adjustments. The time constant can be varied. A time constant of about 33 ms is found to be suitable in most cases. This value is also used in a similar device mentioned in the literature. However, it is not only the time constant but also the threshold value that affects the speech/pause desicion. This level is not variable. Instead the input amplification can be varied and is adjusted so that the LED circuit indicates that the unit is working properly.

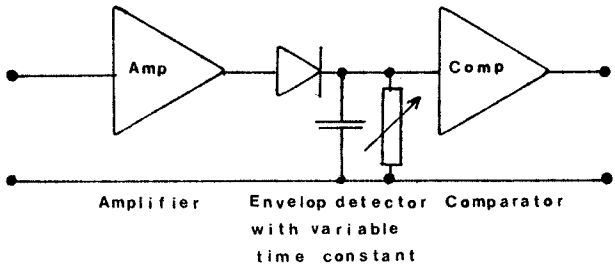


Fig 3a

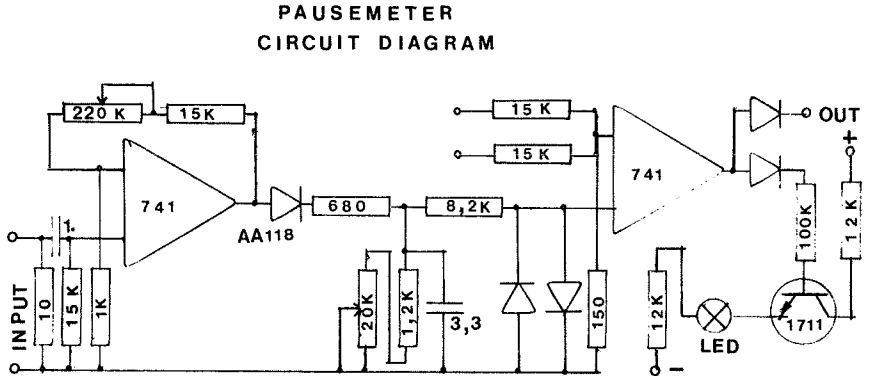


Fig 3b

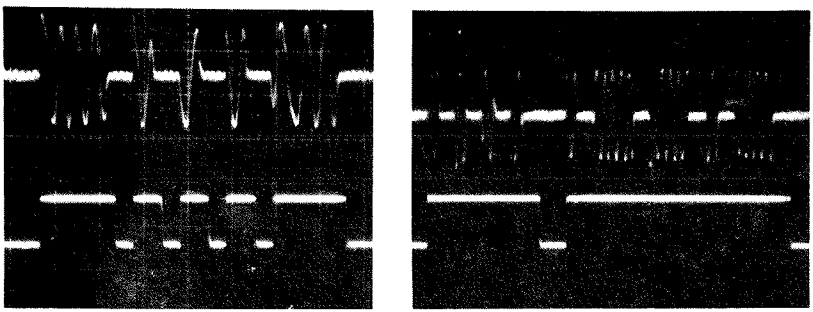


Fig 3c

Fig 3a Main features of speech-pause decision unit.

3b Circuit diagram of speech-pause decision unit.

3c Lower curves show the decisions of the speech-pause decision unit for two cases with small and large time constant respectively. The signal shown here is a Morse signal which has been used in calibration and testing.

THE REAL-TIME PAUSEMETER

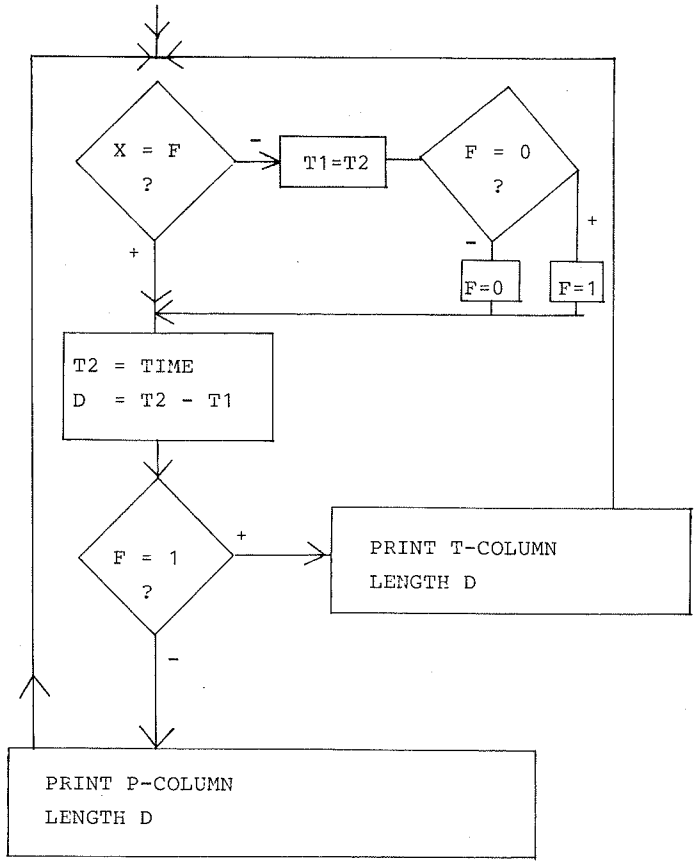
The overall design of the pausemeter is shown in fig 4. The real-time version is characterized by the following features (cf the print-out of the program at Appendix I).

The program starts by asking for the number corresponding to speech (LÅT TAL VARA PÅ OCH TRYCK PÅ J, "LET SPEECH BE ON AND PRESS J"). This number is then used as response to the question SKRIV IN DENNA SIFFRA VID ? ("WRITE THIS NUMBER AT ?")

The number may change with the equipment (e g printer) connected to the computer; that is why it is necessary to ask this question.

The computer is now ready for measuring as long as J is held down (TRYCK J FÖR MÄTNING, "PRESS J FOR MEASUREMENT"). The real-time pausemeter displays the duration of the successive speech and pause segments by building a vertical diagram on the screen where the columns grow to the right. The columns grow as the speaker speaks or makes a pause. When a pause or speech segment is finished its duration is given by the last figure and the computer starts measuring and displaying the growth of the next (pause or speech) segment. Speech segment columns are filled with T's while pause columns are filled with P's. The screen may be filled with 22 columns at a time and therefore a short utterance can often be shown in full on the screen. One may take a photo of the screen (no print-out facilities are included in this real-time version) to get a record of the pause structure of the utterance recorded.

The precision of the real-time version is limited and the results should be used with care. The real-time version is, however, very good for displaying typical pause-speech relations. One may e g talk spontaneously and record the pauses and speech segments immediately for presentation in class. Typically speech segments last 2-3 seconds while pauses last 0.5 second and the corresponding graphic pattern is easily seen. The real-time version of the pausemeter may



X: INPUT (0/1)
T: SPEECH (1)
P: PAUSE (0)
F: TEST VARIABLE

Fig 4 Flow chart of real-time pausemeter

be used to show how long one is able to speak without pausing. It may be connected to a radio to show differences in pause behaviour between speakers, languages etc. It is important to remember that this version does not store any values and the speech must be recorded if it is to be examined further.

The function of the real-time pausemeter is very simple. The input number appears in INP(58%). If this number equals the number in the test variable F% the system assumes that speech is going on, the time is read and printed at the screen at the end of the column of T's (line 55). If the input signal is not the number for speech the system reads the clock and starts building the pause column (line 60).

The program includes a scale factor (0.05, lines 55,60) which can be changed if the columns of the diagram are required to grow at a different speed. The time is read in PEEK(65008%) and is assumed to be long enough for this version of the meter.

THE PRINTING PAUSEMETER

The flow chart at fig 5 shows the main features of the pausemeter. A print-out of the program is found in Appendix II. The computer starts by asking how long pauses (or speech segments) should be skipped (HUR LÅNGA PAUSER OCH TALSEGMENT SKALL ÖVERHOPPAS?) If 1 is the response segments shorter than 20 msec are skipped; if 2, segments shorter than 40 msec etc (line 15). The system then asks for the numbers for speech (tal) and for pause which vary according to the equipment attached and therefore need to be specified by the operator (lines 17-19).

The system then asks whether it is to start measuring (SKALL JAG BÖRJA MÄTA J/N). If J is pressed it starts and goes on until CTRL-A is not pressed. (It is thus not necessary to hold J down for the whole measuring period, as is the case with the real-time version.)

In line 110 the counter for time values (N) is set to 0 and the test variable F is set to the pause number previously entered by the operator, to make the meter start by measuring the change from the pause value (= the beginning of a speech segment). In the flow chart fig 5 the test variable has been given the values 0 and 1.

Line 120 sets the clock by inserting the values 255 in both cells from which the count down starts. The measuring loop is 130-170. Line 130 checks whether there is a change in the input signal, as this is what the system looks for. If so the clock is read by lines 143-147. A certain correction is done in lines 143, 144, due to the design of the computer clock. Line 148 checks whether enough time has passed since the last measurement was taken. If this is the case the time reading is stored by line 150, if not the system returns to line 130. Line 155 prints a T (tal, speech, talk) or a P (pause) preceded by a number on the screen for the information of the operator. Line 160 inverts the value of the test variable. Line 170 checks whether more than 1000 values have been stored, which is the maximum of the present version. If not, the process continues. If more than 1000 time values have been stored or the process has been stopped by pressing CTRL-A line 180 prints the stored values on the screen. Line 190 asks whether a print-out is required (ÖNSKAS UTSKRIFT). If a print-out is required this is handled by 200-220.

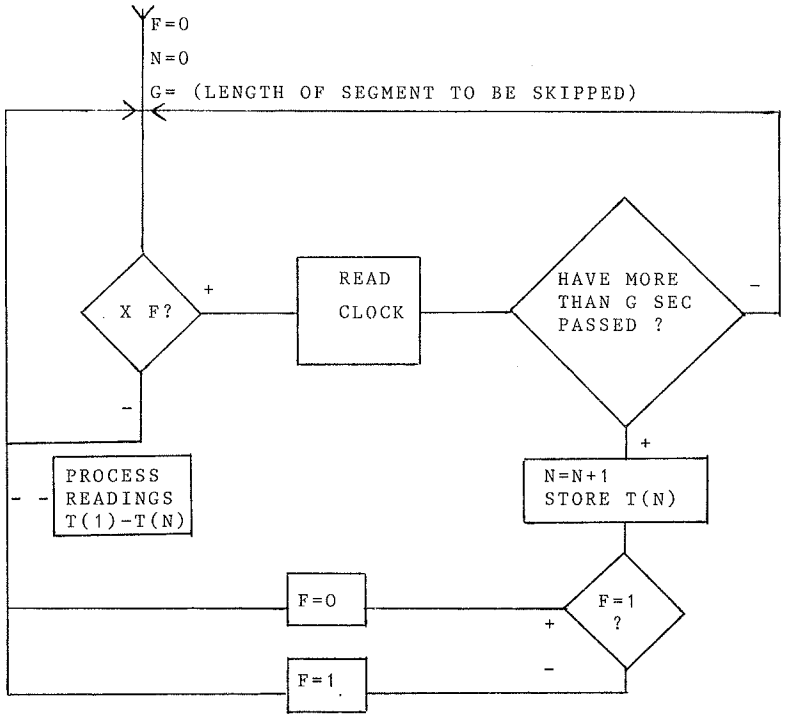


Fig 5 Flow chart of pausemeter. X is an input variable varying between 1 (speech) and 0 (pause) and given by the comparator (pause detector). F is a help variable varying between 1 and 0 for comparison. G is a variable set by the operator and used to avoid measuring too short pauses and speech segments. The system notes changes in the input signal and reads the time whenever a change is noted. The time readings (T(1) to T(N)N are stored to be processed later.

Line 225 asks whether a reduction of the values is required. If 0 is pressed no reduction is made, if 1 or higher number is pressed a reduction of 20, 40, 60 etc msec is made. This reduction affects the end of all subsequent calculations of speech segments as can be seen from line 227 where every other value is reduced by the value given. A print-out is also offered. Note that the original time values cannot be retrieved once they have been changed.

The next parts of the program give various tables and diagrams, calculated on the basis of the time values obtained. Lines 229-280 calculate the duration of the successive time segments, the total duration of speech segments, the average duration and the standard deviation. If required a print-out is made. Lines 340-470 offer the same information for pauses. Lines 480-570 offer a table of the duration of successive pause and speech segments. Lines 600-660 offer the same information in the shape of a histogram (STOLPDIAGRAM).

Lines 700-845 offer a diagram showing the difference between the duration of a speech segment and the preceding pause. The values are plotted as a star that moves around 0. It moves to the right (is positive) if the speech segment is longer than the preceding pause and to the left if the pause is longer than the following speech segment. Normally people talk more than they pause and the stars are consequently generally found to the right of the zero line. This diagram is offered as an example of the kind of diagram a program can be designed to present. The diagram was devised to study the relation between the duration of pauses and speech segments. For example, Beattie (1979) has hypothesized that alternating cycles of fluent and hesitant speech would be reflected in pause durations being shorter or longer than speech durations. This would appear in our plot as alternating concentrations to the right and left of zero respectively.

The print-out for version (2) is illustrated at Appendix III.

CONCLUSION

Automatic pausemeters will facilitrate the investigation of overall pause behaviour in speech, but for detailed information about the speech signal spectrograms are still required. The features of pausemeter programs can easily be modified to meet special requirements (custom made). The versions presented have been found helpful in certain kinds of investigations. The real-time version is a convenient pedagogical tool for presenting typical or individual pause-speech patterns in class or for explorative purposes. The printing version has been used by Kàrina Vamling for detailed studies of pause behaviour during simultaneous interpreting. Such studies could hardly be undertaken without the aid of an automatic pausemeter. The meters presented will be used in experiments in psycholinguistics and phonetics and it is assumed that new and better versions will be developed.

APPENDIX I

Real-time pausemeter

```
1 ; "REALTIME PAUSMETER SEPT 1982"
5 ; "LET SPEECH BE ON AND PRESS J"
10 GET V$ : ; INP(58%)"=TAL"
12 ; "WRITE THIS NUMBER AFTER ?" : INPUT T%
15 ; "LET SILENCE BE ON AND PRESS J" : GET V$ : ; INP(58%)"=PAUSE" : INPUT P%
20 POKE 65008%,255% : POKE 65009%,255% : F%=P% : T1%=0% : T2%=0% : N%=0%
25 ; CHR$(12) : ; "PRESS J FOR MEASUREMENT"
30 GET X$
35 IF X$<>"J" GOTO 20
40 IF INP(58%)=F% THEN 45
41 T1%=T2% : IF F%=T% THEN F%=P% ELSE F%=T%
42 IF N%<22% THEN N%=N%+1% ELSE ; CHR$(12) : N%=0%
45 A%=PEEK(65009%) : A%=PEEK(65008%)-1% : IF A%=-1% THEN A%=255%
50 T2%=256%*(255%-A%)+255%-A% : D%=T2%-T1%
55 IF F%=T% THEN ; CUR(N%,0%);STRING$(D%*.1,84),.02*D% : GOTO 30
60 ; CUR(N%,0%);STRING$(D%*.1,80),.02*D% : GOTO 30
```

APPENDIX II

Printing pausemeter

```
------
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
5 REM PAUSKRIVARE JAN 82 BS
10 DIM T%(1000%)
15 : "HUR LÅNGA PAUSER (OCH TALSEGMENT)  SKALL ÖVERHOPPAS?1=20 MSEK,2=40 MSEK,25
=0,5 SEK,50=1 SEK" : INPUT G%
17 : "EN SIFFRA SYNS NÄR TAL PÅGÅR OCH EN ANNAN  NÄR PAUS.LÅT TAL VARA PÅ (RÖD L
AMPA) OCH TRYCK PÅ J" : GET V%
18 : "TAL ="INP(58%) : : "SKRIV DENNA SIFFRA VID ?" : INPUT T% : : "TRYCK PÅ J V
ID PAUS" : GET V% : : "PAUS="INP(58%)
19 : "SKRIV DENNA SIFFRA VID ?" : INPUT P%
20 PRINT "STOPPA MED CTRL-A.SKALL JAG BÖRJA MÄTA,J/N" : GET Ö%
30 IF Ö%()"J" THEN GOTO 20
90 PRINT CHR%(12)
110 N%=0% : F%=P% : REM BÖRJA SÖK TAL
120 POKE 65008%,255 : POKE 65009%,255
130 IF INP(58%)()F% THEN 143
140 IF INP(56%)()1% THEN GOTO 130 ELSE 180
143 A%=PEEK(65008%)-1%
144 IF A%=-1% THEN A%=255%
147 T2%=256*(255-PEEK(65009%))+255-A%
148 G1%=T2%-T%(N%) : IF G%)G1% THEN 130
150 N%=N%+1% : T%(N%)=T2%
155 IF INP(58%)=T% THEN : INP(58)" T" ELSE : INP(58%)" P"
160 IF F%=P% THEN F%=T% ELSE F%=P%
170 IF N%(1000% THEN GOTO 130
180 FOR Z%=1% TO N% : : T%(Z%) : NEXT Z%
190 : "ÖNSKAS UTSKRIFT,J/N" : INPUT Q%
200 IF Q%()"J" THEN 225
210 OPEN "PR:" ASFILE 1
220 FOR Z%=1% TO N% : PRINT #1,"T"Z%";"T%(Z%) : NEXT Z% : CLOSE 1
225 PRINT "ÖNSKAS REDUKTION AV TALSEGMENT PGA EFTERSLÄPNINGE?NEJ=0%,1%=20 MSEK,2
%=40 MSEK ETC" : INPUT Ö1%
226 IF Ö1%=0% THEN 229 ELSE 227
227 FOR A%=2% TO N% STEP 2% : T%(A%)=T%(A%)-Ö1% : NEXT A% : FOR Z%=1% TO N% : :
T%(Z%) : NEXT Z% : : "ÖNSKAS UTSKR?J/N"
228 INPUT Q% : IF Q%()"J" THEN 229 ELSE OPEN "PR:" ASFILE 1 : FOR Z%=1% TO N% :
: #1,"T"Z%";"T%(Z%) : NEXT Z% : CLOSE 1
229 PRINT "ÖNSKAS TIDSLÄNGDER J/N?" : INPUT Q%
230 IF Q%()"J" THEN 340
240 N1%=FIX(N%/2) : N2%=2*N1% : M%=1%
245 DIM T1(500%)
250 FOR U%=2% TO N2% STEP 2% : T1(M%)=.02*(T%(U%)-T%(U%-1%)) : : "TALSEGMENT"M%"
:"T1(M%)" SEK" : M%=M%+1% : NEXT U%
260 FOR Z%=1% TO M% : V=V+T1(Z%) : NEXT Z% : : "TOTAL TALLÄNGD:"V" SEK" : L=V/M%
: : "MEDELLÄNGD:"L" SEK"
270 FOR Z%=1% TO M% : S=S+(T1(Z%)-L)Ü2% : NEXT Z%
280 D=SQR(S)/M% : : "STANDARDAVVIKELSEN:"D" SEK"
300 : "ÖNSKAS UTSKRIFT?J/N" : INPUT Y%
310 IF Y%()"J" GOTO 340
315 OPEN "PR:" ASFILE 1
320 M%=1% : FOR U%=2% TO N2% STEP 2% : T1(M%)=.02*(T%(U%)-T%(U%-1%)) : : #1,"TAL
SEGMENT"M%";"T1(M%)" SEK" : M%=M%+1% : NEXT U%
330 : #1,"TOTAL TALLÄNGD:"V" SEK" : : #1,"MEDELLÄNGD:"L" SEK"
335 : #1,"STANDARDAVVIKELSEN:"D" SEK" : CLOSE 1
340 : "ÖNSKAS PAUSLÄNGDER?J/N" : INPUT A%
350 IF A%()"J" THEN 480
360 DIM P1(500%) : K%=0%
370 FOR U%=3% TO N2%-1% STEP 2% : K%=K%+1% : P1(K%)=.02*(T%(U%)-T%(U%-1%)) : : "
```

```
PAUS"K%";"P1(K%)" SEK" : NEXT U%
380 FOR Z%=1% TO K% : H=H+P1(Z%) : NEXT Z% : : "TOTAL PAUSLÄNGD:"H" SEK" : B=H/K
% : : "MEDELLÄNGD:"B" SEK"
390 FOR Z%=1% TO K% : C=C+(P1(Z%)-B)Ü2% : NEXT Z%
400 W=SQR(C)/K% : : "STANDARDAVVIKELSE:"W" SEK"
410 : "ÖNSKAS UTSKRIFT?J/N" : INPUT Q$
415 IF Q$()"J" THEN 480
420 OPEN "PR:" ASFILE 1
430 FOR Z%=1% TO K% : : #1,"PAUS"Z%":"P1(Z%)" SEK" : NEXT Z%
440 : #1,"TOTAL PAUSLÄNGD:"H" SEK"
450 : #1,"MEDELLÄNGD:"B" SEK"
460 : #1,"STANDARDAVVIKELSE:"W" SEK"
470 CLOSE 1
480 : "ÖNSKAS PAUS-TALTABELL?J/N" : INPUT Q$
490 IF Q$()"J" THEN GOTO 600
500 FOR Z%=1% TO K%+1%
505 : "TAL "Z%":"T1(Z%)" SEK"
510 IF Z%()K%+1% THEN : "PAUS"Z%":"P1(Z%)" SEK"
515 NEXT Z%
545 : "ÖNSKAS UTSKRIFT?J/N" : INPUT Q$
547 IF Q$()"J" THEN GOTO 600
548 OPEN "PR:" ASFILE 1
550 FOR Z%=1 TO K%+1
560 : #1,"TAL "Z%":"T1(Z%)" SEK"
565 IF Z%()K%+1% THEN : #1,"PAUS"Z%":"P1(Z%)" SEK"
568 NEXT Z%
570 CLOSE 1
600 : "ÖNSKAS STOLPDIAGRAM?J/N" : INPUT Q$
610 IF Q$()"J" THEN 700
612 : SPACE$(4)"1"SPACE$(4)"2"SPACE$(4)"3"SPACE$(4)"4"SPACE$(4)"5"SPACE$(4)"6"SP
ACE$(4)"7"SPACE$(4)"8 SEK"
615 FOR Z%=1% TO K%+1%
620 : STRING$(T1(Z%)*5%,84)Z%
625 IF Z%()K%+1% THEN : STRING$(P1(Z%)*5%,80)Z%
630 NEXT Z%
635 : "ÖNSKAS UTSKRIFT?J/N" : INPUT Q$
640 IF Q$()"J" THEN 700
643 OPEN "PR:" ASFILE 1
645 : #1,SPACE$(4)"1"SPACE$(4)"2"SPACE$(4)"3"SPACE$(4)"4"SPACE$(4)"5"SPACE$(4)"6
"SPACE$(4)"7"SPACE$(4)"8 SEK"
647 FOR Z%=1% TO K%+1%
650 : #1,STRING$(T1(Z%)*5%,84)Z%
655 IF Z%()K%+1% THEN : #1,STRING$(P1(Z%)*5%,80)Z%
660 NEXT Z% : CLOSE 1
700 : "ÖNSKAS TAL-PAUSDIFFERENSDIAGRAM?J/N" : INPUT Q$
710 IF Q$()"J" THEN 800
715 : SPACE$(11)"5"SPACE$(6)"-0+"SPACE$(6)"5"
720 FOR Z%=2% TO K%+1%
730 A1%=2%*T1(Z%)-2%*P1(Z%-1%)+19%
740 : SPACE$(A1%)"*T"Z%"-P"Z%-1%
750 NEXT Z%
800 : "ÖNSKAS UTSKRIFT?" : INPUT Q$
810 IF Q$()"J" THEN 870
815 OPEN "PR:" ASFILE 1
820 : #1,SPACE$(11)"5"SPACE$(6)"-0+"SPACE$(6)"5"
825 FOR Z%=2 TO K%+1%
827 A1%=2%*T1(Z%)-2%*P1(Z%-1%)+19%
830 : #1,SPACE$(A1%)"*T"Z%"-P"Z%-1%
840 NEXT Z%
845 CLOSE 1
870 STOP
```

APPENDIX III

the measurement of short sequence with 5 pauses

```
T 1: 24
T 2: 112
T 3: 137
T 4: 220
T 5: 223
T 6: 280
T 7: 289
T 8: 376
T 9: 430
T 10: 513
T 11: 541
T 12: 621
T 13: 625

TALSEGMENT 1: 1.76 SEK
TALSEGMENT 2: 1.66 SEK
TALSEGMENT 3: 1.14 SEK
TALSEGMENT 4: 1.74 SEK
TALSEGMENT 5: 1.66 SEK
TALSEGMENT 6: 1.6 SEK
TOTAL TALLÄNGD: 9.56 SEK
MEDELLÄNGD: 1.36571 SEK
STANDARDAVVIKELSEN: .223139 SEK

PAUS 1: .5 SEK
PAUS 2: .06 SEK
PAUS 3: .18 SEK
PAUS 4: 1.08 SEK
PAUS 5: .56 SEK
TOTAL PAUSLÄNGD: 2.38 SEK
MEDELLÄNGD: .476 SEK
STANDARDAVVIKELSE: .159138 SEK

TAL  1: 1.76 SEK
PAUS 1: .5 SEK
TAL  2: 1.66 SEK
PAUS 2: .06 SEK
TAL  3: 1.14 SEK
PAUS 3: .18 SEK
TAL  4: 1.74 SEK
PAUS 4: 1.08 SEK
TAL  5: 1.66 SEK
PAUS 5: .56 SEK
TAL  6: 1.6 SEK

    1    2    3    4    5    6    7    8 SEK
TTTTTTTT 1
PP 1
TTTTTTTT 2
 2
TTTTT 3
 3
TTTTTTTT 4
PPPPP 4
TTTTTTTT 5
PP 5
TTTTTTTT 6

           5       -0+       5
                     *T 2-P 1
                      *T 3-P 2
                       *T 4-P 3
                    *T 5-P 4
                     *T 6-P 5
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INTERPRETING SENTENCES WITH MULTIPLE FILLER-GAP DEPENDENCIES

Elisabet Engdahl

INTRODUCTION

The aim of this study is to try to arrive at a better understanding of what kinds of strategies people use when they interpret complex, potentially ambiguous, sentences. It is hoped that this in turn will shed light on the human sentence processor in general. In the studies to be reported here, I am looking at to what extent people rely on and/or use semantic/pragmatic information and to what extent people use content-independent structurally or procedurally based interpretation strategies when they are faced with sentences with complex dependencies. First some terminological clarification.

Following Fodor (1978) I will use the word filler to refer to a preposed constituent in constructions like constituent questions, relativization, topicalization, and tough movement. In these constructions, there is typically a dependency between a filler and a gap, i e an argument position that is not filled with lexical material. When I talk about filler-gap dependencies, I only have in mind those dependencies that arise through the (unbounded) constructions mentioned above. The constituent question in (1) illustrates what I call a non-local filler-gap dependency.

(1) What$_i$ do you think John put __$_i$ in the basket?

I am not looking at the interpretation of gaps that arise through optional object deletions, as in (2), nor at the kind of dependency that certain linguists postulate in Raising and Equi contexts, as illustrated in (3).

(2) John eats (__).

(3) John tries [(__)to leave]

The types of sentences I am looking at involve multiple filler-gap dependencies. They all conform to the general pattertn in (4) and an example is given in (5).

(4) $F_1 \ldots F_2 \ldots \_\_ \ldots \_\_ \ldots$

(5) $\underset{F_1}{\text{Which pot}}$ is $\underset{F_2}{\text{this soup}}$ easy to cook __ in __?

When a person hears a sentence like (5), he or she somehow has to associate each of the fillers with one of the gaps in order to arrive at an interpretation. In a sentence with two dependencies there are two logically possible ways of linking up the fillers and the gaps, by a nested assignment or by an intersecting assignment. The questions I want to address here are: What types of restrictions, if any, are there on gap-filling operations? Where in the process of sentence interpretation do these restrictions apply? To what extent is filler-gap association a syntactic process?

With respect to the last question we can formulate three hypotheses about the role of syntactic processing in filler-gap assignment.

(I) Single Analysis Hypothesis

The syntactic processor only computes one assignment. If this doesn't make sense, the semantic/pragmatic processor takes over and tries to come up with a plausible interpretation.

(II) Multiple Analysis Hypothesis

The syntactic processor computes all assignments. People may still only be aware of assignments that make sense.

(III) No Syntactic Analysis Hypothesis

Filler-gap association is not a syntactic phenomenon at all. Such associations are computed by the semantic/pracmatic processor.

Before entering the discussion of these hypotheses, I will provide some background and describe an experiment that addressed the questions above. This way it will hopefully become clear what I mean by relying on semantic/pragmatic information.

Background

It has been noted in the literature that English sentences like (5) only get interpreted in the way diagrammed in (6), viz with a nested association pattern (Kaplan 1973, Bordelois 1974, Chomsky 1977, Bach 1977, Fodor 1978).

(6) Which pot is this soup easy to cook __ in __?

If you switch the order of the fillers, as in (7), it is claimed that the only interpretation available is the nested one, although this leads to a silly reading.

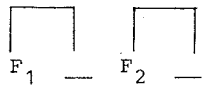
(7) Which soup is this pot easy to cook __ in __?

In her paper Parsing Strategies and Constraints on Transformations, Janet Fodor discusses examples of this type, together with a whole array of other examples that involve multiple filler-gap dependencies. She argues that the preference for nested interpretations follows from a parsing motivated no-ambiguity constraint, which she formulates as in (8).

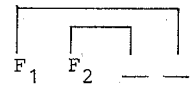
(8) The Nested Dependency Constraint (NDC)

> If there are two or more filler-gap dependencies in the same sentence, their scopes may not intersect if either disjoint or nested interpretations are compatible with the well-formedness conditions of the language.
>
> (Fodor 1978:448)

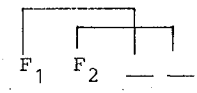
The effects of this constraint can be summarized by the diagrams in (9), for the types of structures we are interested in here.

(9) a 

disjoint

b 

nested

c 

intersecting

There have been some attempts at explaining why the pattern in (9 b) is generally preferred in English. Some of these explanations make reference to the structure of Push Down Automata where items are put on a stack and then taken off in the opposite order to which they were entered, thus giving a nested pattern. We will return to this line of explanation later. Fodor does not adopt this account, but proposes that the NDC follows from what the parser is trying to do. Fodor uses the term 'the parser' as a convenient name for the system of processors which are taken to interact in sentence processing. Fodor assumes that the parser attempts to construct a well-formed deep structure for the sentence it is currently parsing. The parser tries to construct as long streches of well-formed deep structure possible which can be interputed. Given a structure F_1 ... F_2 ..., assigning F_2 to the detected gap would result in a well-formed deep structure. On the other hand, if the parser assigned F_1 to the gap, it would do so across an unassigned filler, and would thus not create a stretch of well-formed deep structure.

Fodor notes that it is quite possible to deviate from the NDC in English if the two fillers are of different syntactic category, as in (10).

(10) [Which crimes]$_{NP}$ did the FBI not know [how]$_{ADVP}$ to solve [$\_$]$_{\overline{NP}}$ [?]$_{\overline{ADVP}}$

However, in Scandinavian languages it is possible to deviate from the NDC even if the two fillers are of the same category (Engdahl 1979, Christensen 1981, 1982). Consider the Norwegian example in (11).

(11) Lingvister$_i$ finns det mye$_j$ som Petter inte kan snakke med $\_\__i$ om $\_\__j$.

Linguists, there is a lot that Peter can't talk to $\_\_$ about $\_\_$.

The preferred interpretation for (11) involves an intersecting filler-gap assignment, but that apparently does not pose any problems for speakers of Norwegian. However, if the preference in English for nested assignments follows from some principle which reflects the working procedure of the processor, then we would expect the same to apply to other languages as well, at least to structurally similar languages. In view of the existence of intersecting interpretations like the one given in (11) in Norwegian, the NDC must be taken to be language specific. But that makes a processing explanation for the NDC less convincing.

In order to begin to sort out the facts about the availability of nested and intersecting interpretation in Swedish I designed and carried out an experiment during the summer and fall of 1981. The experiment was intended to test under what conditions people understand sentences with multiple filler-gap dependencies (MFGD) in a way which requires associating fillers and gaps in an intersecting fashion. In particular, the experiment aimed at testing to what extent semantic/pragmatic information, expressed by the selectional restrictions of the verbs in the sentences, influenced people's interpretations. Fodor formulates the NDC as a No-ambiguity constraint which is sensitive to syntactic (categorial) information only. It applies in cases where there are two or more fillers of the same syntactic category and prevents the parser from computing an intersecting assignment regardless of the semantic content of the fillers and the nature of the verb. On her account, we would not expect any difference in interpretation due to semantic/pragmatic factors, as K K Christensen has pointed out. Rather, we would expect subjects to give uniform nested interpretations in all conditions. In case a sentence is pragmatically biassed towards an intersecting reading as in (7) above, we would expect subjects to give either the silly reading, which results from a nested assignment, or no interpretation at all. On the other hand, if semantic/pragmatic factors do influence

what interpretations subjects assign to MFG sentences, we would expect people to report the sensible reading in all cases, regardless of whether it inovlves nested or intersecting assignments. In sentences where there is no bias towards either assignment or only a weak bias towards one assignment, we would expect subjects to report either nested or intersecting readings. If there is no preference at all for nested assignments, we would expect the percentage of nested and intersecting readings in these conditions to be equal.

Experiments

Experiment I consisted of a paraphrase/sentence-completion task. 34 native speakers of Swedish varying in age between 19 - 56 years were given booklets containing 25 sentences in varying order. The subjects were instructed to read the test sentence carefully until he/she had understood it and then to paraphrase the sentence, using the words given below the test sentence as a cue. An example of a test sentence together with its response cue is given in (12) with English translation added.

(12) Den här formen är sockerkakan lättast att baka i.
This pan, the pound cake is easiest to bake in.

Det är lättast att ...
It is easiest to ...

Subjects were told that some of the sentences in the experiment could be paraphrased in more than one way, corresponding to different readings. Subjects were instructed to write down all paraphrases they could think of in such case, and to try to do so in the order they 'got' the different readings. Subjects were asked to work rapidly but there was no timing of the task. Subjects took between 12 and 30 minutes to complete the task.

The stimulus materials, which had been selected through a pretest, all conformed to the structure illustrated in (4). There were no questions among the test items because subjects might find them hard to paraphrase according to the model. Instead, all sentences were topicalizations. The leftmost

filler was in all cases a topicalized NP. The second filler also of the category NP was either the subject of a tough predicate, the head of a relative clause, or an interrogative phrase introducing an indirect question. Extractions out of indirect questions and relative clauses are possible in Swedish (cf Engdahl & Ejerhed (1982) for illustrations). The types of constructions were systematically varied across conditions. There were 5 sentences in each of 5 conditions. The conditions varied with respect to how much they were constrained by pragmatic bias and which association pattern was facilitated. The 5 conditions are illustrated by the examples in (13) through (18).

(13) Strong nested bias (SN)

Teckenspråk finns det till och med några apor som man
Sign language there are even some apes that one

lärt att använda.
has taught to use.

(14) Strong intersecting bias (SI)

Strömming är den här kniven omöjlig att rensa med.
Herring this knife is impossible to clean with.

(15) Weak nested bias (WN)

Småbarnen är faster Hulda den sista man kan
The small kids, aunt Hulda is the last person one can

be ta hand om.
ask to take care of.

(16) Weak intersecting bias (WI)

Lisa vore Kalle lämplig att gifta bort
Lisa, Kalle would be suitable to give-away-in-marrigage
' verheiraten '

med.
to.

(17) Scouterna minns jag inte vilka turister man
The scouts, I don't remember which tourists one

uppmanade att ta reda på.
told to look for.

(18) No bias (NB)

Mina föräldrar är det få personer jag vill presentera för.
My parents, there are few people I'd like to introduce to.

The criterion for assigning a sentence to one of the strong conditions, SN or SI, was that the selectional restrictions of the lexical items made just one assignment possible. I will refer to this as semantic/pragmatic knowledge, but it might be equally appropriate to talk about conceptual knowledge.

The criterion for the sentences in the weakly biassed conditions, WN and WI, was that, although one reading was not completely excluded (as in the case of strong bias), one of the readings was significantly more plausible due to socio- cultural knowledge shared by the subjects.

Finally, in the unbiassed condition, UB, it was required that both fillers satisfy the selectional restrictions associated with both gaps and that both filler-gap assignments be equally plausible. (See the appendix for a list the test sentences.)

Experiment II consisted of the same test sentences administered to 10 subjects in an oral test. Instructions were as in Exp I. The experimenter (myself) read the sentence out aloud. The subject repeated the sentence. The experimenter then gave the cue phrase and the subject completed the sentence in one or two ways.

Results

The results are summarized in Table 1 for Exp I, written presentation to 34 subjects, and in Table 2 for Exp II, oral presentation to 10 subjects. The questionnaires were scored according to response type: N for a single nested reading, I for a single intersecting reading, NI for multiple readings in the order nested intersecting, IN for multiple readings in the opposite order. The tables give percentage of response types in the various conditions. As can be seen from a comparison of the tables, the results in Exp I and II were very similar. According to a Spearman rank correlation test over the 25 items, corrected for ties, the correlation was .96. There was a higher percent null responses in the oral version, 5.6% as compared to 2.4% for the written version. This difference may be due to short term memory limitations in the auditory task, leading to problems with sentences of 12 - 14 words length. The No response + error column also includes sentences where subjects changed the word order of a sentence so that it no longer could be scored according to the norm.

(19) Table 1 Percentage responses, written test, 34 subjects

Response type	I	IN	NI	N	No resp + errors	IN + NI
Condition						
Strong Intersect	93.6	2.3	0.0	2.3	1.8	2.3
Strong Nested	0.0	0.0	0.0	100.0	0.0	0.0
Weak Intersect	39.4	14.2	9.4	33.5	3.5	23.6
Weak Nested	0.0	0.6	5.3	91.2	2.9	5.9
No bias	25.3	8.9	20.0	42.3	3.5	28.9

Total number of responses in each condition: 170

(20) Table 2 Percentage responses, oral test, 10 subjects

Response type	I	IN	NI	N	No resp + errors	IN + NI
Condition						
Strong Intersect	86	6	0	4	4	6
Strong Nested	0	0	0	100	0	0
Weak Intersect	32	22	10	30	6	32
Weak Nested	0	0	0	92	8	0
No bias	18	8	12	52	10	20

Total number of responses in each condition: 50

As can be seen from the table, the responses in the strongly biassed conditions, SN and SI, were very uniform, as well as in WN. In SN, there were no deviations from the pragmatically most plausible reading, nor any multiple readings. No failures to respond occurred in this condition. A few I readings occurred in WN, but always as the second reading, i e in the NI order. The number of N readings in the SI condition is very low, and the overwhelming majority replied with a single I reading.

The WI and NB conditions display a much more varied response pattern. First we note that it is in these conditions that we find a signaficant number of multiple readings, that is, these were the sentences that subjects found to be genuinely ambiguous, 23.6% in WI and 28.9% in NB.(1)

A non-parametric analysis of variance, based on the number of I readings in each condition, showed that the conditions differd significantly, both ^{by} subjects, ($p < .001$ by a Friedman test) and ^{by} items ($p < .001$ by a Kruskal-Wallis test). A pairwise analysis showed the SI condition to be significantly different from all others, in particular from the WI condition ($p < .005$ by a one-tailed Wilcoxon test for subjects, both in the written and in the oral test, and $p = .001$ by a Mann-Whitney U test for items in the written task, $p = .016$ in the oral test). There was no significant difference between the SN and WN conditions but the difference between these and the NB condition was significant. With respect to the number of I readings, there was no significant difference between WI and NB. However, the order of reported multiple readings varied significantly between these conditions. In WI, subjects report in the order IN more often than in the order NI, whereas in NB, subjects respond in the NI order twice as often as they respond in the IN order ($p < .008$ by a Mann-Whitney U test by items.) (The relative low percentage multiple readings over-all (approximately 25%) together with the low item per subject ratio in each condition (5) did not permit a meaningful analysis by subjects.) The tendency to report in different orders in WI and NB is a very interesting finding. However, it is not clear that the order of reported readings is a reliable measure. Although subjects were instructed to 'try to report the readings in the

order they got them,' the results presumably reflect a post-processing effect. Several factors may have interfered with the results. In order to be able to say something more conclusive about whether there is a systematic difference in which reading subjects get first in the various conditions, we need a more accurate technique that ideally applies on-line and is less susceptible to subjective judgments.

It is conceivable that subjects in an experiment like this would adopt either of two (possibly task-influenced) strategies, i e either consistently report multiple readings or consistently report only one reading. This was not the case in the present experiment. The total number of multiple readings varied from 0 (for 5 subjects) to 7 (for 2 subjects). The distribution of multiple readings was relatively homogeneous. (A X^2 analysis showed the variance to be non-significant).

Discussion

We will now look at how our three initial hypotheses fare with respect to the results from Exp I and II. Hypothesis I, the Single Analysis Hypothesis, assumes that the syntactic processor is somehow and for some reason (to be discussed later) constrained to use a gap-filling routine that always computes a nested assignment. If this reading doesn't make sense, then by default the hearer may use the semantic or pragmatic information available in the sentence in order to come up with a sensible interpretation. One could of course propose various refinements of exactly how this interaction between syntax and semantics proceeds, when the semantic information is used in the default condition, etc. The fact that sentences usually are meaningful probably plays a role in making the subject try to construct an interpretation. This might have been heightened by the fact that subjects were told that this was an experiment

about sentence comprehension. There were no clear nonsense sentences in the experiment.

Hypothesis I accounts well for the uniform N responses in SN and WN. However, it fits less well with the high percentage of I readings and multiple readings in the NB condition. Given that a nested assignment in this condition always led to a meaningful sentence, we would not have expected any deviations from the N pattern.

The relatively high percentage I readings and multiple readings in the WI condition is a further indication that even a slightly anomalous reading may result in the search for an alternative assignment that makes more sense. But then we would expect to get the response type NI as the single alternative to N readings contrary to what is the case in WI, where in fact IN readings are more frequent than NI readings. But, as already mentioned, it is not clear that the subjects' own reporting of order of reading is a reliable measure.

On the second hypothesis, the Multiple Analysis Hypothesis, the syntactic processor is not constrained to nested assignments but compute all assignments. Exactly how this would look depends on if one assumes serial or parallel processing. Further more, we need to distinguish extraustive and self-terminating processing. Given a serial self-terminating procedure, the processor would start with only assignment. If it leads to a sensible interpretation, then that reading is reported and the process terminates. This would predict that only one reading is reported in the NB condition, contrary to what was in fact the case. If the serial processing were exhaustive, it would fit that response pattern better. Assuming that the processor computes all assignments in parallel, we can explain the multiple readings in the WI and NB conditions. The fact that the percentage of multiple readings is rather low (20% in NB, 32% in WI) could be accounted for by assuming that the parallel processing terminates as soon as one acceptable reading is reported. Unfortunately, the type of experimental technique used here does not permit any definite conclusions about the working

mode of the processor. How can we distinguish the serial non-deterministic account from the parallel processing account? If we could show that by manipulating the relative salience of either of the fillers, we could make the assignment that first uses this filler, the preferred assingment, then this might count in favour of the serial account. Frazier, Clifton and Randall (1981) report two experiments which they argue show that the salience of a filler plays a role in simple filler-gap dependencies in English. For MFG sentences it would be interesting to investigate whether increased salience of F_1, the leftmost filler, would be correlated with a preference for an intersecting assignment. This is what one would expect if it is the salience of the filler, rather than the recency, that determines its availability. In the oral task, one could look at sentences in the NB condition and vary the amount of stress on F_1. In the written task one could maybe vary the amount of descriptive content given to F_1, to see if this influences the subjects' first or preferred reading (this of course presupposes that a satisfactory technique for identifying first readings has been found).

In this context it is worth noting that failure to report multiple readings in any one case can not be taken as evidence that subjects did not perform some syntactic processing pre-requisite to the non-reported reading. Subjects might well have noticed the alternative assignment 'at some level' without being aware of it. Flores d'Arcais (forthcoming) reports a series of experiments that show that subjects monitoring for errors, report syntactic errors much less frequently than semantic and pragmatic anomalies. However, using eye movement recordings he found that subjects fixate on the region containing syntactic errors significantly longer than in the correct control cases and that fixation times for syntactic errors are equally long whether subjects detect and report the error or not. It is thus concievable that even in the strongly biassed conditions, SI and SN, subjects perform the same kind of syntactic analysis as in the other conditions, but that one analysis doesn't transmit sufficiently for a representation of the meaning to be formed. Evidence for this hypothesis could maybe be found in an eye movement study. If we found the same

fixation and regression pattern for a given subject in the cases where he/she reports one reading as when he/she reports two readings, this would at least be highly suggestive evidence that the same syntactic analysis is performed in both cases, although only in one of the cases is the subject aware of considering two readings.

The third hypothesis, the No Syntactic Analysis hypothesis, claims that filler-gap assignment isn't a syntactic process at all, but that listener's rely entirely on semantic/pragmatic information about the fillers and the gap positions in order to associate them. The type of processing involved in making a filler-gap assignment would be guided by the same type of factors which influence how people choose referents for pronouns. (See Ejerhed (1982) for an illustration of this type of approach to filler-gap assignment, implemented in a phrase structure grammar for Swedish.)

It might also be argued that these MFG sentences present such a complex task that they are sent off right away to something like Forster's General Problem Solver, and that no syntactic processing takes place at all. This is rather unlikely, however, in view of the fact that syntactic analysis most likely is automatic (Forster 1979, Flores d'Arcais (forthc) and that it cannot be switched off at will.

However, there are some results from the experiment that are not accounted for by hypothesis III. On this account, we would not expect any N readings in the WI condition at all, but there are in fact as many as 33.5%. Furthermore, on this hypothesis it remains unexplained why there should be any IN readings at all in WI (14.2%). For the NB condition, this hypothesis predicts that we should get roughly the same number of I readings as N readings. The results were that subjects reported N readings about twice as often as I readings in this condition.

One way to try to refute hypothesis III would be to provide positive evidence for some syntactic effect, depending on filler-gap association. For instance, if it turned out that people detect syntactic or morphological deviations in positions which require that they have performed some kind of gap-filling operation, then one could argue that gap-filling is not totally

separated from syntactic analysis. Suppose subjects would detect morphological mismatches between a filler and the context of the gap, as illustrated in (21), assuming that the sentence is pragmatically biassed towards an intersecting assignment,

(21) $F_1 \ldots F_2 \ldots \_\_\_ V \ldots$
$[+\alpha] \qquad [-\alpha]$

then that would at least be an indication that gap-filling takes place at some level of representation that is sensitive to syntactic/morphological constraints. Since Swedish has both number and grammatical gender agreement in predicate complements, this can be tested. For single filler gap dependencies, Swedish speakers clearly do detect mismatches, but it needs to be proven that the same holds for MFG sentences.

However, even positive outcome on such a test would not refute hypothesis III, I think. It will still be possible to maintain that gap-filling is a non-syntactic phenomenon, even if it occurs in parallel with syntactic processing. In the absence of better criteria for syntactic processing and without any on-line experiments on MFG sentence interpretation, I find it hard to say anything conclusive about whether gap-filling is a syntactic process or not.

In the context of discussing morphological evidence, I will just mention a few results from a pilot experiment to the present study. In the pilot test, I included sentences of the NB type where one assignment was excluded for reasons of morphological disagreement. A morphological bias towards an intersecting reading could take the form illustrated in (22).

(22) $F_1 \ldots F_2 \ldots \_\_\_ V \ldots$
$[SG] \quad [PL] \quad [SG]$

In a large number of cases (50% oral presentation, 35% written presentation) subjects changed the form of the verb phrase so that it would permit a nested interpretation. In the oral test, at least, it became evident that they were not aware of the fact that they had changed the original sentence. I also tested

some sentences of the structure given in (23), in which both gaps occured in prepositional phrases as in example (24).

(23) $F_1 \ldots F_2 \ldots P \_\_\_ P \_\_\_$

(24) Barnavårdsnämnden vet jag inte vilka problem
The child care department, I don't know what problems
man kan prata med ___ om ___.
you can talk to ___ about.

This sentence is biassed towards an intersecting assignment. However, several subjects reported it with the order of the PPs switched around, thus making a nested assignment possible.

The preference for nested assignments and the Push Down Store

From looking at the overall results it becomes evident that there is a strong preference for assigning nested interpretations in the absence of strong pragmatic counterindications. This shows up for instance in the contrast between the two weak conditions. In the WN condition, there are hardly any I readings reported. When they are reported, it is always in the order NI. In the WI condition, however, we get a total of 57.1% N readings (at all) and 33.5% simple N readings. The percentage N readings in the NB condition is almost double the percentage I readings. The question is now, where shall we locate the cause for this difference?

Fodor, as mentioned above, takes the preference for nested interpretations to follow from the working strategy of the parser. The NDC, on her account, serves to simplify gap-filling routines and is used on-line to exclude one otherwise acceptable analysis before, as she puts it, 'the parser has expended any effort on computing it! This might fit the English facts, but it doesn't account for the Scandinavian facts where intersecting readings are available without any noticeable extra effort (cf 93.6% I readings in the SI condition) consequently, it is less plausible to use a processing explanation for the English facts.

The nested assignment pattern would follow automatically, as several people have pointed out (Kaplan 1973, Bach 1977, Ades & Steedman 1982), if the human sentence processor used a push down store facility on which it put constituents that could not immediately be entered into the structure under construction, i e fillers, in the terminology used here. Because of the last-in-first-out property of push down stacks, the fillers would always be accessed in inverse order to the order in which they were put on the stack.

In a series of recent experiments, W Levelt has found evidence that speakers use a push down type organization in complex production tasks which can be modelled by an ATN grammar (Levelt 1981). He argues that this follows in turn form very general 'minimization strategies' which have the joint effect of minimizing the load on short term memory. In the task at hand, describing a route through a spatial array with branching nodes, applying a last-in-first-out principle minimized the size of the return jumps to choice items, i e branching nodes. To what extent can this explanation be carried over to the domain of sentence comprehension? In some sense, a detected gap will work just like a choice item in Levelt's task. At he point of recognizing a gap, the listener must choose which filler to associate with it. It is not evident, however, what the measure 'size of the return jump' would correspond to in the case of sentence processing, unless you assume that the speaker maintains some kind of linear representation of the sentence. Since most sentences involving MFG dependencies will have two or more clauses, it will most likely be the case that when the gap is detected, most of the previous context will already have been shunted off. The fillers must still be, in some sense, 'available'. (I think it is highly desirable that one tries to get beyond the metaphorical talk about fillers being 'available' and establich some correlate to this theoretical construct. In the absence of more precise terminology, I will continue using metaphors.) Suppose that what happens when a clause is shunted, is that the filler remains in some kind of working store. The application of Levelt's model to sentence processing would then be the claim that this working store is a push down store. However, this can not be the full story, as the acceptable

sentences with intersecting dependencies show. To account for (10) where the fillers were of different syntactic category, we would have to assume that there are different stores for different syntactic categories, maybe not a totally implasusible assumption. However, it is hard to see how this multiplication of stores can be extended to the intersecting dependencies in the Swedish examples in conditions SI, WI, and NB. There is no difference in syntactic category between the fillers, and nevertheless an intersecting reading is possible and in some cases even the only possible.

Fodor give some further arguments against the PDA hypothesis. First, she notes that there is ample psycholinguistic evidence that people are in general very bad at coping with center-embedded structures. This goes against the assumption that the sentence processor be equipped with an PD store facility.

Second, Fodor claims that the NDC holds for gap first dependencies too, i e for the structures G G F F and F G G F, and that it's not clear how one could put a gap on store. To the last remark, one could maybe reply by assuming that gaps are recognized as gaps of a certain category, and that the information entered in the store is something like 'missing a NP' (cf the use of derived 'slashed' categories in Generalized Phrase Structure Grammar, Gazdar 1981, 1982)[2]. The facts about gap-first dependencies are a lot less clear, unfortunately. As an illustration of the claim that a G G F F pattern always receives a nested interpretation, Fodor gives an example with two extraposed realtive clauses, as in (25).

(25) No one $(\_\_)_i$ puts things $(\_\_)_j$ in the sink [that would block it]$_j$ [who wants to go on being a friend of mine]$_i$. (Fodor 1978:(60))

(26) *No one $(\_\_)_i$ puts things $(\_\_)_j$ in the sink [who wants to go on being a friend of mine]$_i$ [that would block it]$_j$.

Fodor takes contrast between (25) and (26) to be due to the NDC. However, it is not clear that relative clause extra-

postion fits our definition of filler gap dependencies, since relative clauses are not obligatory constituents in the sence that certain NPs and PPs are obligatory in some contexts. (25) without the relative clauses would be a well-formed sentence. Thus, one could argue that this is not a case of (syntactic) gap filling, but rather an instance of semantic interpretation. On the other hand, people most likely would detect number mismatches between the head NPs and the extraposed clauses, so by the same reasoning we applied earlier to filler-gap association, that should be the same type of process, related in the same fashion to the syntactic processor. There is another rightward dependency that does involve a gap in our sense, namely Heavy NP Shift. Although it is unlikely that you would ever find a sentence with two shifted heavy NPs, it may interact with leftward dependencies to give rise to the pattern F G G F as in (27), also taken from Fodor.

(27) * This form$_i$ foreign students are required to state $\_\__j$ on $\_\__i$ [that they have never previously visited the US]$_j$.

In order to test whether the NDC applies to gap first dependencies in Swedish, I constructed a number of examples, modelled on (25) - (27). By varying semantic/pragmatic factors as well as morphological agreement, I attempted to make the intersecting reading the most plausible. Unfortunately, the results are totally inconclusive. When sentences involve iterated applications of optional processes, like extraposition, then it is extremely hard to get judgments on relative acceptability. These sentences easily become awkward and complicated. Since there is always the option of not extraposing, speaker prefer taking this option. The processes that give rise to filler first dependencies, on the other hand, are obligatory (clearly so for question formation and relativization, less clearly so for topicalization). There is no alternative way of expressing the message if one wants to stay within the limits of a single sentence. Christensen (1982) offers the following sentence as an example of permissible intersecting assignments in a F G G F structure in Norwegian.

be seen from the fact that in the present experiment people did not hesitate to assign an interpreting interpretation to the structure F F __ __ in the SI condition. From the present experiment it is not possible to tell whether speakers would have preferred a F F Pro __ structure in these cases, since the subjects did not have any options. I am planning to investigate this further in some follow-up experiments. I want to look more closely at

(a) how widespread the use of the disambiguating pattern in (29) is.

(b) whether it can be shown that the presence of a resumptive pronoun facilitates comprehension and production of these sentences.

Wall & Kaufmann (1980, reported in Zaenen & Maling, 1982) found that resumptive pronouns may facilitate comprehension in difficult contexts. English speakers were presented with sentences with unbounded dependencies either with or without resumptive pronouns at 80%, 60%, and 40% compression. Subjects were asked to write down what they recalled immediately after hearing the sentence. Recall was significantly better for sentences with resumptive pronouns than for comparable sentences with gaps, especially at 40% compression.

To test whether resumptive pronouns also facilitate in the complex task för MFG sentences, I am planning to do an experiment where MFG sentences like in (30) are presented rather rapidly, with or without a resumptive pronoun.

(30) Mina föräldrar är det få personer jag vill presentera (dom) för.

My parents there are few people I want to introduce (them) to.

Immediately after the presentation of the sentence, subjects will be asked to answer questions like Jag vill presentera vem för vem? (I want to introduce whom to whom?) The purpose of the experiment will be to find out primarily if the presence of the resumptive pronoun leads to an increase in comprehension and secondly if it influences people towards the

intersecting reading. I would appreciate suggestions for other experiments in this area.

Future experiments

It has become clear that we need to do further experiments in order to determine which of our three initial hypotheses about the role of syntactic processing is supported from data having to do with how people process sentences with multiple filler-gap dependencies, and if any of them can be ruled out entirely. We have seen that we can not draw any direct conclusions about the amount of syntactic processing involved on the basis of the reports of available readings that were the result in the present experiment since these reflect a post-processing stage. Other researchers (e g Flores d'Arcais, Foster, Frazier) have found that syntactic processing is automatic. However, it appears that the syntactic analysis does not always lead to a reading for the sentence that the listener is aware of. Rather, it seems that semantic and pragmatic processing, which presumably are sensitive to what are plausible readings, determine which analyses are processed completely until we become fully aware of a reading. Once we have found a reliable and workable technique for tapping on-line sentence processing, we might expect to find out some interesting things about the interaction of real world knowledge with the linguistic analysis people perform when they try to interpret an utterance.

When it comes to the preference for nested assignments, which shows up rather clearly in this experiment, we need to establish whether computing a nested assignment is in some sense easier to the parser than an intersecting one. We could try to establish baselines for comprehension of sentences which are clearly biassed towards a nested or an intersecting reading, and see if people are quicker at comprehending nested sentences than intersecting ones, even in strongly biassed conditions. If it would turn out to be the case that people take longer to understand a sentence involving intersecting dependencies, this would at least be suggestive evidence that the preference for nested assignments reflects some integrated property of the parser.

NOTES

This is a slightly revised version of a paper that I wrote at Max-Planck-Institut für Psycholinguistik in October 1981. I have benefitted from comments on the earlier version from Charles Clifton, Eva Ejerhed, Lyn Frazier, Willem Levelt, Mark Seidenberg, and Mark Steedman. This paper is mainly a report on work in progress. I welcome comments, criticisms, and suggestions for further experiments. I am grateful to Eva Ejerhed and Sören Sjöström for helping prepare and carry out the experiment, to Östen Dahl and Susanne Schlyter and their students for participating as subjects, and to Bob Jarvella for help with the statistical analysis and for clarifying discussions.

1. One sentence, number 15 in the appendix, which according to the pretest belonged to the WI condition, was interpreted much more like the SI sentences (29 I readings, 1 IN, 0 NI, and 3 N). If this sentences was excluded from the WI condition, then the percentage multiple readings in WI rose to 28.7%.

2. Mark Steedman (personal communication) reports that Stephen Isard at the Laboratory for Experimental Psychology at Sussex University has showed how one can handle gap first dependencies with a Push Down Automaton.

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APPENDIX

Test sentences for Exp I and II

Strong intersecting (SI)

1 Strömming är den här kniven svår att rensa med.
'Herring, this knife is hard to clean with

2 Även småbarn är det otroligt mycket man kan lära.
'Even small schildren, there is a lot you can teach'

3 Skatter och löner är arbetskamraterna dom sista man bör diskutera med.
Taxes and salaries, your colleagues are the last people you should discuss with.

4 Clark Olofsson undrar jag vilka bankrån man hört skryta om.
'Clark Olofsson, I wonder which bank robberies one has heard boast about' (renowned bank robber in Sweden)

5 Byråkrater finns det mycket man inte bör fråga om.
'Bureaucrats, there is a lot one shouldn't ask about'

Strong nested (SN)

6 Den där runda formen är sockerkakan lättast att baka i.
'That round pan, the pound cake is easiest to bake in'

7 Ryktet om Brantings homosexualitet undrar jag vem man trodde var upphovsman till.
'The rumour about Branting's homosexuality, I wonder who they thought was the source of'

8 Teckenspråk finns det till och med några apor som man lärt att använda
'Sign language, there are even some apes that one has taught to use'

9 Den här förklädnaden har jag ännu inte hittat någon jag lyckats lura med
'This costume, I still haven't found anyone I have been able to fool with'

10 Läxorna är pappa den siste jag skulle be om hjälp med.

'The homework, daddy is the last person I would ask to help me with'

Weak intersecting (WI)

11 Lisa vore Kalle lämplig att gifta bort med.

'Lisa, Charlie would be suitable to give-away-in marriage to'

12 Lena känner jag en pensionär som vi kan be hjälpa.

'Lena, I know a retired person that we can ask to help'

13 Tage Danielsson är Dracula svår att föreställa sig som.

'Tage Danielsson, Dracula is hard to imagine as'

14 Scouterna minns jag inte vilka turister man uppmanade att ta reda på.

'The scouts, I don't remember which tourists we asked to find'

15 En sådan molnformation är ett vulkanutbrott det första jag skulle tolka som tecken på.

'Such a cloud formation, a volcanic eruption is the first thing I would interpret as'

Weak nested (WN)

16 Fulla gubbar vet jag många som vi varnat för.

'Drunkards, I know several people that we have warned against'

17 Mormor bestämde vi raskt vilket barnbarn vi kunde skicka att hälsa på över sommaren

'Grandmother, we rapidly decided which grandchild we could send to visit over the summer'

18 Inbrottstjuvar är en hund lämplig att ha som skydd mot.

'Burglars, a dog is suitable to have as protection against'

19 Småbarnen är faster Hulda den sista man kan be ta hand om.

'The little kids, aunt Hulda is the last person one can ask to take care of'

20 Vakterna på Tivoli går 13-åringar lätt att smussla in för.
'The guards at Tivoli, 13 year olds to smuggle in in front of'

No bias (NB)

21 Mina föräldrar är det få personer jag vill presentera för.
'My parents, there are few people I want to introduce to'

22 Västvaluta går guld lätt att växla till sig för.
'West currency, gold is easy to exchange for'

23 Johan minns jag inte vem gamlingarna brukade jämföra med.
'Johan, I don't remember who the old people used to compare with'

24 Silvia ligger kungen närmast till hands att intervjua om.
'Silvia, the king is the closest person at hand to interview about' (the Swedish queen)

25 Erik är Olle den siste jag skulle be ringa upp.
'Erik, Olle is the last person I would ask to call up'

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Lund February 18, 1983

ERRATUM Working Papers 24, 1982

page 53 line 4: "good spellers do not write phonologically"

read: "good spellers do not write phonetically"

Working Papers 24 1982
Linguistics - Phonetics
Lund University

SPOKEN AND WRITTEN LANGUAGE - RELATIONSHIPS BETWEEN TWO LINGUISTIC MEANS OF EXPRESSION

Kerstin Nauclér

Paper presented at the Ninth Congress on Reading, 26 - 30 July 1982, Dublin, Eire

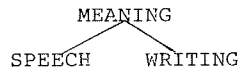
For some time, my research has concerned the relation between spoken and written language on the phonological level. More specifically, I am interested in how written language is handled by both skilled and unskilled users and how their performance is related to linguistic competence. This interest was evoked by the complexity of the system that connects spoken and written Swedish, a system which has been analysed and described by Allén (1969), Teleman (1972) and Hellberg (1974).

Writing is secondary to speech in many respects. It is a late invention in man's history, and even today there are human languages without a writing system. Children generally master written language several years after spoken language, and while speech is acquired without any formal teaching, reading and writing are skills that have to be taught. These and similar facts have led many researches to the conclusion that written language only reflects speech - in other words, written language is nothing but speech written down. This view can be formalized as in model 1.

Model 1

Model 1 implies that the meaning of written language can only be conveyed via phonetic coding (you see the word, you read it out and get access to its lexical meaning, or, having its meaning already, you articulate the word before writing it down).

Other scholars, however, maintain a different opinion. They deny that phonetic transcoding is necessary and advocate direct lexical access from visual input, as shown in model 2. One argument for this stand is that the high speed of a skilled reader hardly permits any phonetic "detour". In their opinion, the skilled reader handles an alphabetic text in much the same way as a reader of an ideographic writing system, e.g. Japanese kanji. They see speech and writing as two independent means of expression.



Model 2

In the literature on acquired linguistic dysfunctions, the hierarchical view of speech and writing dominates (Model 1). It is generally assumed that the deficient writing of an aphasic patient reflects his deficient speech (cf Huber et al 1975). An aphasic patient who writes better than he speaks is regarded as suffering from apraxia. There are, however, cases reported by e.g. Hier & Mohr (1977) and Ulatowska et al (1979) that contradict a hierarchical view.

In this presentation I will examine data from three investigations to find if there is support for either the two models, or if a third solution provides a better description of a skilled person's writing performance.

The first data to look at is an investigation by Nauclér (1981) of spoken and written errors made by some adults with acquired aphasia. The purpose was to investigate the occurrence of selective impairments in aphasic patients, a phenomenon described by scholars such as Weigl (1974, 1975), Marshall & Newcombe (1973), Shallice & Warrington (1975) and others. The selective impairment implies that the acquired linguistic disturbance of a patient does not necessarily hit his speech and writing abilities to the same degree. In the paper reported here, subjects repeated, copied, read aloud and wrote to dictation a set of ten words or phrases, i.e. the same ten words or phrases were given both auditorily, to be repeated

and written down, and visually, to be copied and read aloud. (Some subjects also named pictures, both orally and orthographically, corresponding to the same ten words or phrases given auditorily and visually.) The different tasks are shown in fig 1.

TASK	Repetition	Dictation	Copying	Reading	Naming
INPUT	Auditory		Visual (text)		Visual (picture)
OUTPUT	Oral	Graphic		Oral	Graphic

Fig 1 Oral and graphic tasks performed by some aphasic subjects

A subject's scores from the different task were only used intraindividually, i.e. not compared with those of other subjects. Some of the subjects were better at oral tasks, i.e. repetition and reading aloud, and some at written tasks, i.e. copying and writing to dictation, and some subjects were better when input was visual and others when input was auditory. But, none of the subjects repeated errors in both spoken and written responses.

If written language were nothing but speech written down, according to Model 1, the oral errors made by an aphasic subject should have been found in his written answers as well, and no writing errors should have occurred if the oral answers were correct. Since this was not the case in these results, Model 1 is not supported.

The second investigation (part of Nauclér, 1980), deals with spelling errors made by students from three different grades, the youngest being 10 years old, and the oldest around 17. It is concluded that the various types of errors made by both skilled and unskilled subjects are mainly phonetic. The phonetic analysis carried out by the subjects is usually correct, but the orthographic result is not. This is a fairly trivial conclusion, since it is only to be expected from an alphabetic writing system based not on phonetic but on phonological principles. But, interestingly enough, only the younger subjects

misspell because they cannot tell what phonetic facts are phonologically relevant. For example, when vowel quantity in Swedish is distinctive, i.e. when short and long vowels are different phonemes, the short vowel is marked orthographically by doubling the following consonant as in

kalla ['kala] vs kala ['ka:la] ("cold" vs "barren")

When the vowel quantity is redundant (non-distinctive), there is no orthographic marking, as in the following examples

kalas [ka'la:s] or kalv [kalv] ("party" vs "calf")

In unstressed syllables (first syllable of kalas) and when more than one C follows the short vowel (kalv), the vowel quantity is non-distinctive (neutralized). These are the cases that the younger subjects misspell, and they do it by assigning an orthographical mark (i.e. doubling the following C) to all phonetically short vowels, regardless of their phonological value (e.g. *kallas, *kallv).

The older subjects on the other hand misspell because their lexical knowledge (i.e. their knowledge about the origin of morphemes) is insufficient and misleads them. Their errors mainly turn up when they fail to observe what morpheme is hidden behind an accidental homonym (accidental as a result of inflection),

bygd ("district") vs byggd (i.e. bygg+d from bygga ("built, build")

sats ("sentence") vs satts (i.e. satt+s from sätta ("was put, put")

Many other orthographic sequences, although not homonyms, are superficially contradictory if the underlying morpheme is not observed, and may also mislead a writer into misspellings

filt ("blanket") vs fyllt (i.e. fyll+t from fylla) ("filled, fill")

smälta ("melt") vs smällda (i.e. smäll+da from smälla) ("exploded, explode")

The good speller, thus, is the one who recognizes morphemes and observes morpheme boundaries and who is not misled by phonetic details.

From the data presented so far, the first model can be ruled out for two reasons:

- even a correct phonetic analysis leads to misspellings
- good spellers do not write phonologically

The fact that good adult spellers make most of their errors as a result of insufficient lexical awareness points to model 2 as an appropriate description of normal adult performance, i.e. adults use a direct route between lexicon and spelling.

In order to examine this suggestion more closely, we will continue to the third investigation that can provide useful data. Nauclér & Söderpalm (1981) made a comparison between slips of the tongue, collected by Söderpalm (1979) and slips of the pen (from Nauclér, 1980). A slip of the tongue was defined by Boomer and Laver (1968) as "an involuntary deviation in performance from the speaker's current phonological, grammatical or lexical intention". From this follows that slips (or lapses) are performance errors, not competence error (e.g. many speech errors made by speakers of a foreign language are, or many spellings errors). A performance error can be detected and corrected, a competence error cannot.

The comparison between slips of the tongue and slips of the pen was based on the following parameters:

- error categories (fig 2)
- position of the error in the word
- distance between the error and its trigger

substitutions	a cup of coffee	→ a cuff of coffee
additions	statistically	→ stastistically
omissions	speech error	→ _peach error
metatheses	pancakes	→ canpakes

Fig 2 Classification of slips of the tongue and slips of the pen

From the comparison it was obvious that slips of the tongue and slips of the pen differed in several ways: The distribution of the error categories did not show the same pattern at all, the main category of errors in speech being substitutions and in writing omissions. The position of errors in the words differed, since the errors in speech occurred in initial position and the errors in writing in final position. And finally, the distance between the error and its trigger did not coincide either, as the distance was found to be three or four segments in speech and only one or two segments in writing.

At first glance these differences between slips of the tongue and slips of the pen could be seen as a support of model 2, implying that there is no connection between the ways a skilled subject speaks and writes. In other words, speech and writing are completely independent activities.

However, the disagreement between spoken and written lapses can easily be explained with reference to the different properties of the two output channels. Since speech is faster than writing, it is only to be expected that the distance between an error and its trigger is longer in speech than in writing. As writing is permanent and speech is not, writing can more easily be subject to corrections, errors are more likely to be discovered in initial position than in final position, and substitutions are easier to detect than omissions. Thus, the dissimilarities found between the spoken and written lapses do not entirely support the second model. In addition, there were similarities between the spoken and written errors that disfavoured model 2 in certain respects:

- in both speech and writing, disproportionately more consonants than vowels were involved in errors (even when the higher frequency of consonants in language was taken into account);
- in both speech and writing consonants were never substituted for vowels and vowels were never substituted for consonants;
- in both speech and writing, phonologically similar segments were substituted for the intended ones, i.e. the intended phoneme or grapheme and the segment actually produced (the error) differed by one (in a few cases by two) phonological features only.

This means than not only slips of the tongue but also slips of the pen can be described by means of phonological features.

If you slip and say for instance "A cuff of coffee" instead of "A cup of coffee" (cf fig 2), the feature separating the intended /p/ from the spoken /f/ is (in the terminology of Chomsky & Halle (1968) CONTINUANT, all other features relevant for the two phonemes being identical (ANTERIOR, VOICELESS, OBSTRUENT). Many of the written substitutions can be described in exactly the same manner:

folkhopen	→	folkhofen	p → f	[-CONT]	→	[+CONT]
ganska	→	kanska	g → k	[+VOICE]	→	[-VOICE]
följande	→	förjande	l → r	[+LAT]	→	[-LAT]

As further support for the phonological nature of writing, it was found that also errors written by the aphasic subjects could be described by means of phonological features:

arbete	→	albete	r → l	[-LAT]	→	[+LAT]
löv [lø:v]	→	lev	ö → e	[+ROUND]	→	[-ROUND]
snaps	→	stams	n → t p → m	[∝NASAL]	→	[-∝NASAL]

So, rather than being exclusively graphic in nature, which one could expect written lapses to be, they turn out to be dependent on rather abstract phonological features.

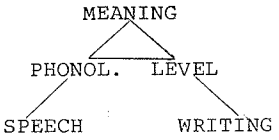
Summary

The following conclusions are drawn from the data from three different investigations:

(1) Written language is not speech written down. This was indicated by the selectivity of the aphasic errors and confirmed by the spelling errors made by skilled non-aphasic subjects. These facts disfavour model 1 and lead to model 2.

(2) Written language is not totally independent of spoken language, as was shown by the similarities between slips of the tongue and slips of the pen. Thus, model 2 is ruled out.

(3) Written language was shown to be related to speech on an abstract phonological level by the fact that not only speech errors but also slips of the pen and aphasic written errors can be described in terms of phonological features. We end up with model 3 as a more appropriate description of the relationship between spoken and written language.



Model 3

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CHANGES IN SWEDISH ADDRESS TERMS DESCRIBED BY POWER-SOLIDARITY DIAGRAMS

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It is generally assumed that a language reflects the social stratification and ideology of its speakers and various East Asiatic languages with honorific terms are often mentioned as evidence. Illustrations, however, can certainly be found in most languages. This paper will discuss the case of Swedish, which is interesting because radical changes both in the use of pronouns for second person reference and the use of first name for third person reference have occurred during the last decades. The changes will be discussed in terms of the two dimensions, power and solidarity, suggested by Brown & Gilman (1960) and a new kind of diagram based on these variables will be presented. The diagram used by Brown and Gilman has been found to be difficult to interpret.

The spread of du in recent decades in Swedish has been commented on by several authors e g Bratt-Paulston (1975) and Ahlgren (1978). The well-known change is generally taken as a sign of greater equality in Sweden. The increased use of first name when referring to third person is noted in Sigurd (1980) and it is generally taken to be associated with the increased use of Du, although it spread later. Although the frequent use of first name may be taken as a sign of greater equality and friendliness it has brought about a new anonymity. When we only hear the first names of people we meet and when people are only referred to by first name it is difficult to identify them later in telephone directories or similar larger contexts.

A version of this paper was presented as a lecture at the Department of Languages, University of York, Nov 1982. I am indebted in particular to Peter and Brita Green who took part in the discussion afterwards.

T and V pronouns

The old Germanic system included only the pronoun þu. It was used by everybody to everybody as far as one can tell from the sources. The Nordic usage is witnessed by the Icelandic sagas. When the Viking Egill Skallagrimsson talks to the English king Ethelred at York he does not use any other term of address than he uses to his fellow vikings or other persons he comes across in the British Isles. The Nordic þu developed into tu and du in the Nordic languages. To a British audience the word may be identified with thou in Shakespeare's plays.

In addition to du a pronoun Ni developed in Swedish (for details see Ahlgren, 1978). Etymologically, it is to be derived from I, the pronoun of the second plural, to which an n from the preceding finite verb form has been attached (e g through a phrase such as sägen I > sägen ni, "say you". Such cases of metaanalysis are well known from the history of languages (for a detailed discussion of different cases and many examples see Elert,1969). Ni has, however, never been a perfect partner of du which is well established. Ni is one of the alternatives available to a Swede, when he talks to a stranger, when he wants to be polite or show distance. Since the classical article by Brown & Gilman on the pronouns of solidarity and power the symbols T (after French tu) and V (after vous) have been used. The T/V situation in Swedish around 1950 can roughly be depicted as follows.

	Swedish	English equivalent
T	Du, used to friends and children	you
V	Ni, used to strangers (estranging) and superordinates (politely, humbly)	you, Sir

Alternatives and avoidance

As noted by many observers, however, Swedes have a number of alternative ways of handling the address situation. Bratt-Paulston (1975) made a point of the existence of these alternatives and took it as evidence of the kind of avoidance often

noted by anthropologists. Bratt-Paulston tested the acceptability of different alternatives by studying the ways the question What do you want? (What would you like to have) can be rendered. Below the most important renderings are given together with some brief comments.

Second person expressions:

Vad vill Du ha?	What do you want? To friends, children (and animals)
Vad vill ni ha?	What do you want, Sir? To strangers, politely (humbly) or distantly.

Third person expressions:

Vad vill hon/han ha?	What does he/she want? In certain rural dialects (rare and obsolete)
Vad vill frun/damen ha?	What does the wife/lady want? Used politely to potential customers in the market place (frun) or shops (damen).
Vad vill Ulla ha?	What does Ulla (first name) want? Used e g with a certain distance between (old) ladies or a mother-in-law addressing her daughter-in-law or a mother addressing her child.
Vad vill mor ha?	What does the mother (father or similar) want? Used (politely) e g by son or daughter.
Vad vill översten ha?	What does the colonel (etc) want? Used politely to superiors or at least persons with certain titles (royal, military, academic, ecclestastical). The address of royalty is carefully handled by the court. The king is always addressed as kungen (the king), but older terms such as Ers majestät (Your Majesty), Ers kunglig höghet (Your Royal highness) may be heard.

First person plural:

Vad vill vi ha?	What do we want? Used in particular by doctors when talking to patients (known from several anecdotes).

The most anecdotal alternatives are, however, those where the addressee is not mentioned, but a passive (with deleted addressee) or an impersonal construction is used. The following are som examples of these constructions.

Vad får det lov att vara?	What is it allowed to be?
Vad behagas?	What is required?
Vad önskas?	What is wished?
Vad kan jag hjälpa till med?	What can I help with? (Where the speaker but not the addressee is mentioned.)
Hur känns det?	How does it feel?
Hur mås det?	How well is it?

Most Swedes are able to come up with a series of such examples, some of which are stock examples and often laughed at. Bratt-Paulston thinks that this laughter is also of special interest and should be interpreted like laughter connected with other cases of avoidance mentioned in the anthropological literature.

Plotting the spread of Du

When we speak of the spread of a term we use a territorial metaphor. If we want to define this territory closer we may take the dimensions solidarity and power proposed by Brown and Gilman as the two dimensions, e g power as the y-axis and solidarity as the x-axis. We may furthermore try to scale the dimensions of this matrix by assigning the value +1 to the situation of great power or solidarity and 0 to the neutral situation, where no power or solidarity is present. If we plot the main address terms discussed above in the box diagram thus constructed we get the following figure (1).

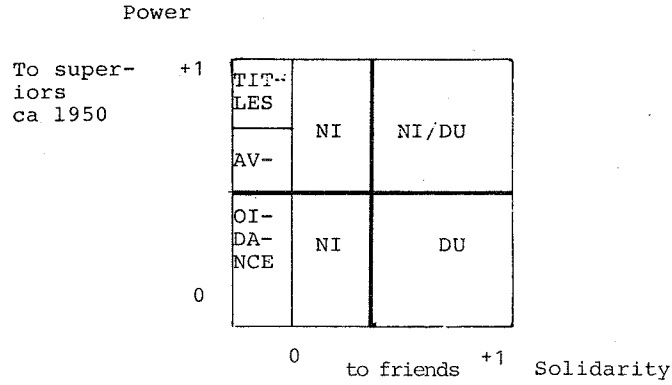


Fig 1 Swedish pronouns of address, titles and avoidance expressions about 1950 plotted in a power-solidarity diagram.

The square solidarity +1, power 0 (S:+1,P:0) denotes the situation when the addressee is a friend and neither superior nor inferior to the speaker. Du is the obvious choice in this square. If we would like to compare the situation in Sweden and France, where tu is used more restrictively, only to very close friends, we could plot tu only at the far right part of the solidarity axis. It is, however, reasonable not to grade the dimensions inside the cells and use the space to indicate the importance of different alternatives instead. This is the way the alternatives are represented in the diagrams in this paper.

The cell P:+1,S:0 represents the address to superiors, either because one has (unwillingly) to show inferiority (to be humble) or because one wants (willingly) to please the other (to be polite), e g when a prospective customer is being addressed. If a pronoun is used it is generally Ni, but titles are used at least to certain dignitaries and avoidance expressions also occur as was discussed earlier.

In the square where both power and solidarity is 0 we represent address to strangers. In the time we are discussing (around 1950) Ni was fairly common, as is indicated in the diagram. One might, in fact, distinguish between the situation when the

name and perhaps title of the addressee is known but he is not a friend and when he is a complete stranger.

In the square P:+1,S:+1we may think of the case when the addressee is a powerful person, but also my friend (as with school mates etc). In a conflicting situation Ni (and titles as in the square P:1+, S:0) would be used in formal situations, e g when a person addresses a school mate who is the judge in the court. But privately they would both use Du. This is indicated by the slash in the square.

What happened in the 1970's was a dramatic spread of Du, which should show as an invasion of Du into the other squares of the power-solidarity diagram. The situation is depicted in fig 2. Strangers would now be addressed by Du without much hesitation, and the amount of avoidance has decreased. This is shown by the exchange of Ni into Du and the smaller portion of avoidance in the particular square (P:0, S:0).

In the square where the address to superiors who are not also one's friends is shown Ni is still the main pronoun. But titles are also less frequent and so are avoidance expressions. Many Swedes of the 1970's would not hesitate to use Du as address even to powerful superiors and dignitaries and this is indicated in the diagram by the word Du in the square. One might, however, also interpret the increased use of Du as a sign of less respect for superiors. Many Swedes found less reason to accept other persons as superior, and therefore to use Ni or titles. This is part of the equalitarian society produced by the long social-democratic rule.

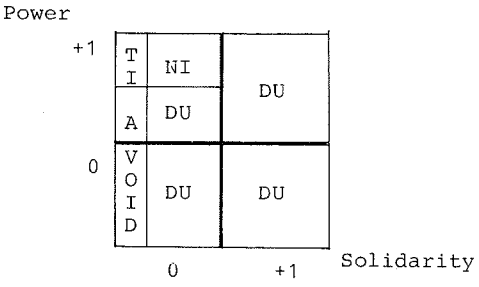


Fig 2 Swedish terms of address about 1975 plotted in a power-solidarity diagram.

In the square corresponding to the situation where the addressee is both a superior and a friend Swedes would use Du even in fairly formal situations around 1975. This is indicated by having Du only in the corresponding square of fig 2.

Evidence for the changes discussed can be found by talking to Swedes, in newspapers, where these matters are often discussed etc. There is, however, also more exact evidence from an investigation into Swedish advertisements covering 1950-1975, see fig 3 (after Nowak & Andrén, 1982). The figure shows the gradual decline of Ni and the increase of Du in advertisements. The year 1968, the year of the youth revolt, seems to be important here too. A dramatic rise of the curve of Du can be seen. We also note a certain levelling of Ni since 1973, which may also get support from the intuitions of many Swedes today (in the 1980's). Shop assistants were eager to be equal and used Du in the 1970's, but now in the beginning of the 1980's with renewed commercial interest and great unemployment it seems that selling, and pleasing the customers is considered more important than manifesting one's ideology. But detailed empirical investigations are needed if one wants to explain the changes more deeply.

Fig 3 can also be taken as evidence of a decreased avoidance. If the figures for the use of Du and Ni are added they represent the proportion where a choice is made and the problem is not avoided. If these figures are calculated we find that there was a tendency to avoid the choice between the two pronouns which increased until about 1968. After that important year not only did Du become common, but the tendency to take stand increased as well.

It is also to be noted that certain state agencies or departments decided that Du should be the official pronoun of address. Thus the new head of the social department declared that Du was to be used in his department 1968. Other state or private organizations followed more or less officially.

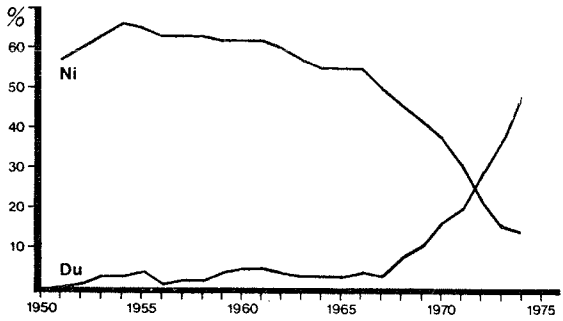
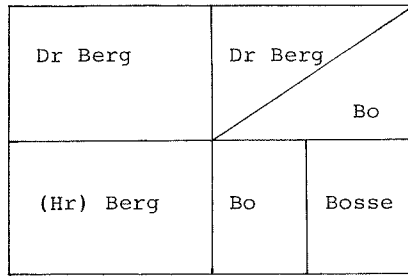


Fig 3 Percentage of the advertisements where the reader is addressed as Du and Ni (after Nowak & Andrén, 1982)

Reference to third person

Reference to a third person may also be plotted in a power-solidarity diagram. The situation around 1950 is presented in fig 4, a and b below. Diagram b is a formalized version using T:title, L:last name, F:first name, N:nickname.

a)



ca 1950

b)

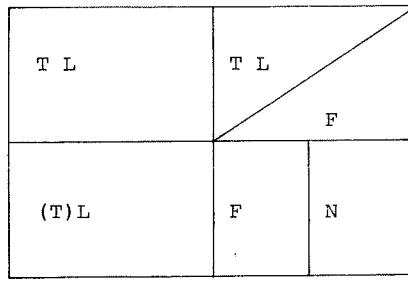


Fig 4 Reference to third person around 1950 demonstrated by ways of referring to a person named Bo Berg who is a doctor and is nicknamed Bosse by his closest friends. In diagram b T:title, L:last name, F:first name, N:nickname.

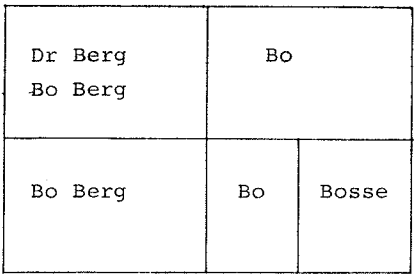
Figure 4 shows that a person who is a superior, or to whom one wants to be polite, may be referred to by his name and title. Typically the persons referred to in this way are dignitaries within the army, church, university, medicine, civil service. We note that the top of the hierarchy, the king, is referred

to by title and first name (TF). In the square where solidarity is +1 and there is no difference in power the natural way of referring is by first name. Among close friends a nickname may be used. In Swedish one common type of nickname is constructed by doubling the final consonant of the stem syllable (if there is no consonant use s) and adding for the male e (Sven: Svenne, Bo: Bosse) for the female a(n) (Elisabet: Bettan). In the square where the person is both a superior and a friend the choice of the title and the last name is the rule in a formal situation, in private the first name around 1950.

If the person is not a superior and not a friend and if the name is known one used the last name alone, optionally with the title hr (Mr). If the last name is used by itself it might have a touch of superiority i e the person addressed is treated as an inferior, a case which is not covered by the present diagram. Extensions of the diagram are discussed below.

The situation around 1975 is shown in fig 5 (a,b). The most striking fact is that the use of the first name has spread to the situation when a person who is both a superior and a friend is being referred to officially. The spread of Du has been accompanied by a reference to a third person by his first name e g Olof, Bo. Nicknames such as Olle, Bosse are, however, hardley used in this situation. They are still reserved for privacy. The spread of the first name seems to have occurred some five years after the spread of Du (Sigurd, 1980).

a)



ca 1975

b)

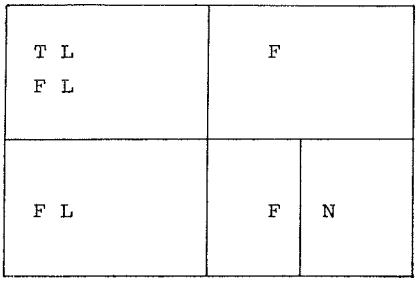


Fig 5 Reference to third person around 1975 demonstrated using the same symbols and example as in fig 4.

The increased use of first names also shows up in such official papers as testimonials, where the referee might have introduced the person to be commented on and evaluated by his full name but later refers to by his first name only, if he is a friend of the writer of the certificate. This is clearly a break with legal customs of the the 1950s.

The encreased use of first names can also be observed in board and committee meetings etc, where the chairman and members now quickly learn and use each other's first name. Such meetings are felt to be less formal nowadays. Around 1950 words such as the chairman, the speaker were the rule.

Expanding and interpreting the power-solidarity diagrams

Clearly, the dimensions power and solidarity allow a 9-square diagram (matrix) if they are both scaled in three steps (+1,0,-1), not only in two as demonstrated so far. Such a diagram is shown below (fig 6). So far we have only studied the top right four squares of the diagram and plotted Swedish terms in them.

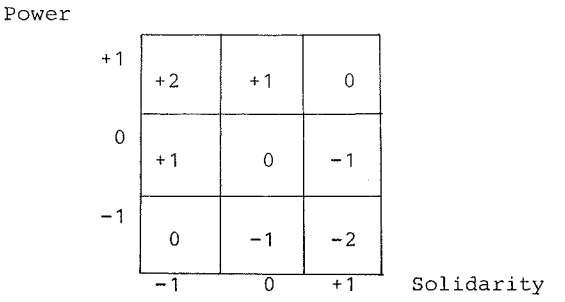


Fig 6 Power-solidarity diagram with 9 cells, established by assuming three values on each dimension. The figures in the cells are theoretical formality values calculated by subtracting the solidarity values from the power values.

The additional cells represent different combinations of values of power and solidarity, which may be identified and interpreted with more or less difficulty and more or less utility for linguistic description. The cell P:+1, S:-1 may be the situation when a powerful enemy is addressed. We may think of the address of mighty, unfriendly gods, devils. As is well-known from the anthropological literature such gods are often not mentioned by name (taboo, avoidance). The cell P:0, S:-1 may be interpreted as the situation where an enemy without power is to be addressed. The cell P:-1, S:-1 is the cell where an inferior enemy is being addressed, to be used for plotting the special expressions used for this situation. The cell P:-1, S:0 may be used for plotting the situation when an inferior person

who is neither an enemy nor a friend is at hand. The cell P:-1, P:+1 seems more interesting as it may be interpreted to cover the situation when an inferior friend is addressed, e g when a little child (baby) or a dear animal is to be addressed. Special nicknames, baby talk expressions, diminutives may be plotted in this cell.

The usefulness of the diagram, of course, rests on its potentialities for plotting linguistic distinctions. Typological studies are needed in order to determine which cells of the diagram are of primary interest. We must also note that the dimensions power and solidarity need concrete interpretation. The attributes of power and the meaning of friendship differ between cultures. Of course defining power and solidarity by verbal criteria would be circular. But, to be sure, verbal markers are important.

On the whole solidarity and power seem to draw in opposite directions. If we want to establish one dimension, e g called theoretical formality we might measure it using the following simple formula (1) where the value of S is deducted from P.
(1) F= P - S, where F is formality, P is power and S is solidarity, both measured on the scale -1,0+1. F varies between -2 and +2. These values are inserted in the diagram fig 6. As seen from the diagram, two squares get the value +1, two get the value -1 and three get the value 0. These values may be found to be useful in defining the use of terms of address and reference. It seems to be the case that title and first name, avoidance and taboo are used in particular when the formality value is +2. The most intimate and familiar terms, diminutives, baby talk, special nicknames etc are restricted to situations when the value of formality is -2. In many languages, in the cells with the value +1 a V pronoun and TL may be used, in the cells with the value -1 a T pronoun and first names. The cells where the formality value is 0 are of particular interest as the conflict between T and V may be solved differently in different languages.

Hostile and guest languages

The distinction between ergative and non-ergative (nominative) languages is based on the identification of subjects of intransitive verbs with the agent or patient (object) of transitive verbs. If the subject is identified with the object of transitive verbs (by using the same morphological marker) the language is called ergative. If the subject of intransitive verbs is identified with the agent of transitive verbs (as in English) the language is termed non-ergative (nominative). A similar approach can be taken in other areas of languages. We will here distinguish between hostile and guest languages on the basis of the identification of the terms of address and third person reference in certain choice situations. The two terms hostile and guest are to be associated with the semantic not the phonetic development of the common indoeuropean word underlying both the word host(ile) and guest.

As was observed by Brown & Gilman many languages have a binary choice between terms which may be symbolized T and V. T is roughly speaking the informal address V the formal address.

If we take the address to strangers as a test situation we may distinguish between languages and cultures which identify strangers with friends and those which identify strangers with enemies. The first type may be called guest languages and the second type hostile languages. In a guest language the same term of address is used about friends and strangers, in a hostile language the same term is used for enemies and strangers. Swedish, then, has clearly changed from a hostile to a guestile language. German and French are hostile languages. For English the distinction is irrelevant as you is used in both cases; we may, however, take a second criterion into account.

There is clearly a choice of terms in the reference to a third person who is both a superior and a friend. A language where speakers take their own point of view a friend is referred to in the same way whether he is without power or if he is in some

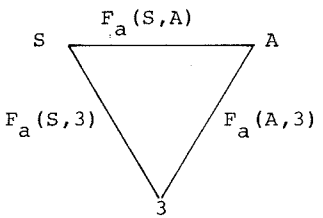
way superior. We may take this as an additional criterion of guest languages. A language, where the person who is a superior and a friend is referred to by the term used about superiors, may be called hostile. Clearly English is a guestile language from this point of view, as the use of first names even in formal situations referring to superiors is wide spread. Swedish has changed into a guest language even from this point of view as was observed earlier.

We may thus give the following definition of guest hostile languages.

Definition: A language (society) is guest if it identifies strangers and friends by its use of terms of address (T pronoun) and/or if it refers to friends who are superior in formal situations in the same way as friends in private (by first name). A language which is not guest is called hostile.

The effect of the relations between the speaker, the addressee and the third person

The relations between the three persons involved in the speech act (the speaker, the addressee, the third person) may have an influence on the choice of 3rd person expressions (cf Erwin-Trip, 1971). Graphically the situation may be represented by a triangle as below. (S:speaker, A:addressee, 3:third person).



In this triangle formal expressions (matrix expressions) have been written beside the lines connecting different parties. The expression $F_a(S,A)$ represents the formality value when the speaker is addressing the addressee. The formality value may e g be computed as indicated below from the values of solidarity

and power. $F_a(A,3)$ is the formality value which would be used if the addressee was to address the third person, and $F_a(S,3)$ represents the formality value used if the speaker was to address the third person.

The speaker has a choice when referring to a third person. He may base his choice of verbal expression on his own relations, to the third person or on the addressee's relations to the third person. If the speaker's relations to the third person are less formal (more familiar) than the addressee's relations, the addressee might feel like an outsider (alien) or unduly intimate and according to several sources of etiquette this way of referring is not good manners. A lady may e g not call a friend by her first name, when speaking about her to a servant. Sometimes using first names seems to be a way of showing off and indicating important acquaintanceships.

If, on the other hand, the speaker uses an expression which is less formal than he himself would use if addressing the third person but in accordance with the relations between the addressee and the third person, the addressee might think of him as being conceited, taking the role of the addressee. This happens sometimes, by accident, in conversation when the speaker forgets to change from the perspective of the addressee to his own. It is quite common when speaking to children and referring to their daddy as daddy (pappa in Swedish).

There are conventional ways of avoiding uneasiness in talking about the third person. One general rule "the politeness rule of third person reference" is the following. "Follow the formality level of the addressee towards the third person only when it is higher than your own".

This may be expressed more formally using the expressions presented above and a BASIC if .. then expression.

If $F_a(A,3) > F_a(S,3)$ then $F_3(S,3) = F_a(A,3)$ ELSE $F_3(S,3) = F_a(S,3)$

where F_3 is the formality level to be used in selecting the proper third person expression.

The rule prohibits the speaker from using a formality level which is below the one the addressee would use and also a formality level which is lower than his own relations to the third person suggest. This rule is discussed in Sigurd (1980) at some length.

The spread of first name usage may be seen as breaking this rule and certainly many people react as if they considered the new official use of first names about persons they don't know as improper. These people are the ones who do not use Du to everybody.

Vocative terms

In Latin a person, who is called upon, is marked morphologically. But only in the third declension is the case ending (vocative) unique. The stock example is Brute! (Nominative:Brutus). In the other declensions the ending coincides with the nominative. One may well ask whether the category vocative can be distinguished in languages such as Swedish and English, where there is no overt morphological marker. We think the answer is yes. Forms in the vocative are to be distinguished functionally from third person reference and address.

It seems reasonable to take the vocative as a special kind of speech act on a level with statements, questions and directives, although its function is very restricted and its manifestions very special. It is generally manifested in both verbal and non-verbal signals. Vocative forms occur rather freely. They may occur alone or with other utterences, typically after or before. Some examples are: Bo!, Hovmästarn! (Waiter!), Herr ordförande! (Mr chairman!), Hallå där! (Hallo there, I say!), Du (där)! (you (there)!)

The vocative often occurs before or after a question or an imperative, Bill, kom här! (Bill, come here!), Stängde Du dörren, Bo? (Did you shut the door, Bo?) A better way to use punctuation would perhaps be to write both question and exclamation marks: Stängde Du dörren? Bo! As pointed out to me by Elisabeth Engdahl a Swedish NP in the vocative, e g Kära syster is special by showing definiteness only in the adjective. The imperative example

Försvara Dig, Bo! (Defend yourself, Bo!) where the form of the reflexive pronoun is dig not sig shows that it is not governed by the vocative third person form Bo. We suggest that the vocative is not the subject, although it might look like it, in the case where the vocative form is Du (you), e g Försvara dig, Du (Bo). It is more reasonable to consider both Du and Bo as vocatives (double vocative). With this analysis it is true that differences in formality do not show in English address where you is the only alternative. But they show in the vocative where Sir is inserted as a marker of formality e g in Did you ring, Sir? In both English and Swedish a personal pronoun in the vocative may be supplemented with a noun as in Du, Berg (you, Berg), Du, dåre (you, fool) Ni pacifister (you pacifists) which may be analyzed as an apposition. Swedish is peculiar in also allowing a possessive pronoun in this situation e g Din dåre, Era pacifister, but generally only with evaluative nouns (cf Kjellmer, 1976). The construction is to be found in English only in petrified phrases, such as Your (Royal) Highness, Your Majesty, Your Grace.

Vocatives are quite common with greetings and leavetaking expressions, e g Hej, Bo! (Hi, Bo!), Vi ses, Bo! (Be seeing you, Bo!), Adjö, direktörn! (Good-Bye, Mr director! Sir!) The addition of the use of the vocative seems to have increased with the increased use of first names in the 1970s.

Below we list some questions where the vocative expression occurs after the questions. The examples chosen to illustrate that the expressions used in the vocative slot are very much the same as those used as address and third person reference.

Adress	Vocative
Vad vill Du ha?	Bo, Bosse, Du (där), Berg, *Ers Majestät!
Vad vill Ni ha?	Dr Berg. Fru Larsson, Ni (där), Ers M, *Bosse!
Vad vill Ers majestät ha?	?Ers Majestät, *Ni!
Vad vill frun ha?	?frun, *professorskan, *Ni, *Du!
Vad vill doktorn ha?	?doktorn!

In all the examples the address and vocative terms are coreferential. It is clear that some of the terms of address and third person reference may also occur as vocatives, but there are certain cooccurence restrictions, which are probably best handled as textual rather than (sentence) syntax. The use of the same word both as address and vocative seems grammatical, although not acceptable. Pronouns can only be used as vocatives if they are also used for address. A well-known slang example, exceptional because of its repeated occurences of vocative du, is Hör du, du du! (Do you hear, you, you?)

We will not investigate these problems further here, but we will note that expressions of vocative follow the same degrees of formality as terms of address and third person reference.

Summary and conclusions

The terms of address, third person reference and the vocative be derived with reasonable success from the dimensions of power and solidarity, and the overall pattern can be displayed by power-solidarity diagrams. The dimensions and their combinations have to be made concrete and interpreted for different languages and cultures.

A scale of formality with five steps (+2,+1,0,-1,-2) can be derived from the dimensions of power and solidarity and the steps seem to correspond to important linguistic distinctions. The step +2, the highest formality is found only with very important persons (gods, devils, royalty) and generally manifested in very special ways including taboo and avoidance. The level +1 is found in normal polite and respectful behaviour. The level -1 corresponds to friendship, and -2 to behaviour with small dear friends, such as children and pets. V is the general pronoun of plus values, T the pronoun of minus values. If the formality value is 0, hostile languages would substitute +1 and use V, while guest languages would substitute -1 and use T. The handling of strangers is crucial for the distinction between hostile and guest languages.

The terms of address, reference and the vocative are not just passive reflexes of the attitudes of society. They may be used

actively to promote certain values such as solidarity and equality, respect and individuality (inequality). The effect of intentional reforms in the address or reference system may, however, fade away when the contrasting situation is forgotten. The use of Du will only be felt as a token of equality and friendship as long as it contrasts with previous usage and is not available for everybody.

Levelling in the terms of address in a language, e g in English you, should not be taken as evidence of equality and lack of formality. Differences may instead be reflected in the vocative (as in the English use of sir) and third person reference. The two underlying factors power and solidarity seem to be fundamental to society and language must be expected to offer means of showing the existence or non-existence of power and solidarity, but these means may differ.

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