Working while Driving:
Corpus based language modelling of a natural English Voice-User Interface to the in-car Personal Assistant

by

Michael Schillo

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The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

Abstract

This Thesis presents a pilot study of a potential industrial application of Natural Language Processing (NLP). An industrial sponsor is providing access to hardware and a practical application: the in-car "Intelligent Personal Assistant" system for travelling executives. The in-car application involves a Psion hand-held computer ("Personal Organiser"), including diary, databases of addresses, appointments, etc. and a portable PC-based commercial Speech Recognition system.

Our long-term aim is: to add a computer system that can access the information in the Psion personal organiser and the connected cellular telephone via a Voice-User Interface (VUI), i.e. via a speech recognition system, so that it is possible to access any desired information via natural audio language input; furthermore, to extend this computer system beyond an interface, to include some of the "intelligence" and organisational functionality expected of a human personal assistant. The Thesis focuses specifically on the modelling of an English-like sublanguage for the in-car personal assistant and pinpointing constraints on the feasibility of the project.

Ideally we would like to allow an unconstrained range of possible utterances; but a fully-comprehensive language model that would cover all possible spoken English would force the Speech Recogniser's performance to be very low. So a central issue is the design of a Voice-User Interface (VUI) sublanguage, a subset of English which will allow users of a speech interface to issue commands in a reasonably 'natural' way while achieving acceptable speech recognition accuracy. The sublanguage should be tailored to cover the underlying functionality of the software system being interfaced to, but less constrained than a menu-keyword system. This would simplify the syntax and increase the speech recogniser's accuracy and overall performance.

Our approach involved a survey of potential users and the Psion itself to elicit the desired functionality. Then an experiment was designed to elicit samples of natural English as it would be used in such a setting covering the whole functionality as found earlier. The experiment was

partially conducted in an office setting and a driving simulator to guarantee both good sound quality and natural environment for the recording and provide more background for the progress of the project. The samples taken in this experiment form our corpus. Furthermore, we analysed the corpus of the spoken interactions to point out general properties (the complexity of the language) and some specific problems with regards to the needs of the application. Last but not least, the corpus was used in evaluating a very simple language model with a state-of-the-art speech recogniser, to estimate an upper limit on the accuracy of recognition. We conclude that even an apparently simple command-and-control application can correspond to a complex natural English sublanguage, which casts doubt on the feasibility of a natural English Voice-User Interface.

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Note:

1. Some of the information gathered was found on the World Wide Web. To give reference in an adequate way, a section 'WWW references is included after the bibliography section. A reference looks like (Amalgam WWW), meaning it is referring to the WWW section and the reference can be found under 'Amalgam'.
2. Throughout the thesis I used the female alternative of he/she, him/her when addressing. This is not to offend the reader, it was just a choice made in order not to have to use the less elegant he/she, him/her.

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Chapter 1 Introduction

1. Context of the thesis

This thesis presents a pilot study of a potential industrial application of Natural Language Processing (NLP). An industrial sponsor, Visionair, are providing access to hardware and a practical application: the in-car "Intelligent Personal Assistant" system for travelling executives. The in-car application involves:

- a Psion hand-held computer "Personal Organiser", including diary, databases of addresses, appointments, etc.
- a portable PC-based commercial Speech Recognition system and development environment; currently we have a Speech Systems PE500, but we envisage that a more powerful system will be needed for the longer-term application.

Our long-term aim is: to add a computer system that can access the information in the Psion personal organiser (including access to connected cellular telephone) via a Voice-User Interface (VUI), i.e. via a speech recognition system (such as PE500), so that it is possible to access any desired information via natural audio language input; furthermore, to extend this computer system beyond an interface, to include some of the "intelligence" and organisational functionality expected of a human personal assistant (PA).

Visionair are developing the application: software systems on the Psion which the VUI will access, we focus on enhancing the speech recognition and an ergonomic interface by delivering constraints of the possible language used in this environment.

2. Aims and Objectives

When reading the thesis, the reader might get the impression that the thesis is rather destructive in the sense that it excludes certain methods for solving a problem. This however must be looked at in the light of the fact that the project was started with this work, so many decisions had to be made and it was found useful to consider different approaches and justify why a certain approach was chosen and others not. It was considered valuable for those who continue the project to be able to have evaluations of methods ready, in case the frame of resources changes.

The project is long-term and it is of special interest to explore the relationship between feasibility and desired functions. The thesis will try to deliver milestones that will guide future decisions for the project. Therefore a range of possibilities will be addressed and evaluated in this thesis.

Chapter two describes the background necessary for our research and gives an overview on similar products, existing as well as in development. Also, it hammers out the basic procedure of the thesis: we are trying to find a model of the subset of natural language with more constraints. This would simplify the syntax and increase the speech recogniser's accuracy and overall performance. The fundamental base of such a model is a study of the possible utterances that occur.

Further on, chapter three describes the findings of a survey of potential users to elicit desired functionality. We divide the desired functionality by to their feasibility according to a time frame. This will give the first pinpoints for the pilot study and will influence the following chapters.

As no corpus existed for this specific domain, an elicitation experiment to collect a corpus of expected typical spoken interactions was designed, which is described in Chapter four. The chapter also describes the necessity for developing an icon language that covers the functionality of the domain and justifies the various design decisions that had to be made. Finally, it describes the conduct of the experiment.

The analysis of the corpus and the modelling of the sublanguage will be undertaken in chapter five. It starts by providing some necessary theoretical background and then gives a comprehensive description of the complex sublanguage that has been collected in the corpus.

Chapter six derives a prototype with a primitive sublanguage model from the previous chapter and with its help, evaluates an upper bound of speech recognition accuracy for the in-car personal assistant voice user interface.

Chapter 2 Related research and theoretical background

The overall aim of our project is to explore the feasibility of an in-car automated intelligent personal assistant. The aim of this particular chapter is to gather information on past and present research in the field and deliver a survey on different aspects of our overall project. Especially, this chapter provides the theoretical background for the next step in the project: the collection of possible queries to the system. For easier reading the information will be presented in the following way.

First I will give a brief report on the existing commercial products of in-car applications in our field. From here I want to establish the need for sophisticated strategies in Natural Language Processing (NLP). I will give references to current speech recognisers. A look at their performance shows that speech recognition is not yet fully satisfactory. A second problem of Natural Language Interfaces (NLIs) dealing with semantics has already been encountered in research and will be demonstrated in the third section.

Then I will give an overview of how to increase performance by reducing the accepted language. Care will be taken not to reduce “too much”. This will be accompanied by considering alternatives that have been studied and be accompanied by a survey of existing work in the field.

In the last section, I will explain how the ergonomic performance of an existing system could be increased by the use of convergence in dialogues.

In the appendix C ‘Corpora’ the reader will find introductions to a selection of corpora mentioned in this chapter.

1. Which in-car Natural Language Interfaces exist already?

One problem here is that most of the companies do not want to talk about the products they are trying to develop, or if so, they do not want to talk about specifications, before the product is on the market.

The following lists a series of products that are already available. However, these are very limited in their ability of actually recognising unconstrained language.

1. Delco's concept car (the ASR brand),

The "Delco concept car" seems to be in development, as Delco themselves do not have any exact information on it. They expect a product with NL (Natural Language) speech input in the next 5 to 15 years.

2. Amerigon's vehicle navigation system (Lernout & Hauspie)

The Amerigon is one of the few NLP applications that does restrict itself to using a cellular phone. Amerigon created a navigation system with an isolated word, speaker dependent recogniser (provided by L&H) that they have tried (very enthusiastically) to sell. The vocabulary appears to be under 50 words (digits 0-9, letters A-Z, and a few command words) with street names spelled out one letter at a time. (comp.speech WWW).

L&H web page describes the same product from their point of view:

> "L&H has developed and implemented a small vocabulary, Isolated Word recognition, Keyword Spotting and Alphabet recognition engine that uses a propriety environment adapting algorithm to accommodate the noisy environment. The recogniser can stay idle until activated by voice"

3. Vodis in-car NLI

This product is produced in co-operation of the Universitaet Karlsruhe, bosch, Multicom Research Inc., Volkswagen, and again Lernout & Hauspie Speech Prod. Bosch delivers one of the platforms, namely the Berlin RCM303A in-car navigation system. Also included is a traffic-messaging system (RDS/TMC), a mobile telephone and more conventional equipment as car radio and audio/video entertainment sources (Vodis WWW).

4. Apart from the above mentioned, apparently every major car company offers a cellular phone with NL input (Mercedes-Benz with Voice Control systems, Cadallac with Hughes and VCS, Ford, Peugeot, Hyundai). Hyundai's system which will be released by the end of 1997 will control air, lights, audio, power windows and wipers. This seems to be the aim of most car companies for the short-term. The long-term research usually involves also a navigation system (such as the Vodis project). The products as they are today, however offer only small vocabulary recognition and do expect that the user learns this specific vocabulary. They cannot be compared to the product aimed at by this project, as it is one of the intentions that the user is unconstrained in the language she uses.

Also, every big telecommunications company is interested in developing NL interfaces. They can be divided into two groups. The ones that have a speech interface to the telephone (Motorola,

Sanyo, Nokia) and those who offer dial-in information servers with speech interfaces. In the US there is a big trend towards such systems, the most outstanding one probably being the Wildfire system, as it has finished the development phase and is already in use.
Its functionality covers the following:

> "Screens, routes, and announces your incoming calls, regardless of your location.
> Maintains your contact list and lets you "voicedial" all your outgoing calls.
> Schedules and reminds you of all your follow-up calls and action items.
> Handles all your messaging, giving you an advanced set of voicemail features.
> Creates on-the-fly conference calls from any phone, anywhere. "
>
> (Wildfire WWW)

Especially the function 'schedule and remind you of all your follow-up calls and action items' is much closer to the work aimed at as the above systems. However, one has to note that here again the user is strictly constrained in what will be accepted as a command.
Equally interesting is the recently announced new product of Apple, called the Voice Organizer, apparently using speech recognition to classify a voice recording. i.e. you say for example "on the 10th of 11th" (this will be recognised as the date) " I have to write a letter to Tom" (this will be digitised and recorded, and can be played back later). As a remark I would like to add that this does not affect our project in so far that we plan to use the information that is recorded in the Apple application on the Psion. Therefore we need a machine readable version of the speech input. It remains remarkable that Apple has solved the problem to spot the date in the utterance.

Instead of giving a survey on today's commonly used speech recognisers (for dictation, navigation in operating systems, etc.) that will be out of date soon, I would like to point to "Frequently asked Questions" of the newsgroup comp.speech (comp.speech WWW). The development of speech recognisers (SRs) is continuing on a large scale, as can be estimated from the above list and the obvious commercial interest in an ergonomic interface to computers, as opposed to the time-consuming keyboard input. Learnout + Hauspie Belgium are said to be one of the leading researchers on the in-car application of SRs.

2. Which other comparable interfaces do exist or are being worked on?

As no system as proposed already exists, the approach will be broadened to the variety of dial-in information systems. A great variety of such systems are being built. However, few are already in use (see the 'Wildfire' system above). In the following, two example systems will be described.

2.1. The SCHISMA system

As described in (van de Burgt et al. 96) this system is 'an evolving system-in-the-loop on the domain of theatre performances'. Its purpose is to give information on the tickets that can be sold and eventually take orders and is at an early stage of development. The approach is based on a corpus which was collected in an elicitation experiment. A dialogue manager that is being developed is supposed to assist the caller in her queries and resolve ambiguities.

2.2. A dialogue guided payroll program

(Harelick et al. 96) propose a system that can be used by their client companies to enter and modify their payroll data via the telephone. So a central server has access to the data itself. Every subscriber to the service can now ring the server and can access the data via an NLI (Natural Language Interface). This NLI consists mainly of a dialogue manager in charge of providing a comprehensive menu structure and a speech recognition system that is specialised on recognising speech from a telephone.

All these Speech Recognisers (as far as they exist) are still very poor in transcribing utterances from the whole set of possible utterances of a particular language in a natural environment, as was observed in (ARPA 94), one of the rare tests that deliver comparable data. Additionally, it is not likely that a breakthrough will be reached in the near future.

3. Semantics: Why is it so hard for machines to "understand" natural language?

After tackling the problem of extracting the spoken text from the audio data, one might wonder why it is so hard to extract the contents from it. (Perrault & Grosz 86), offer evidence that it is not that easy. Ambiguities can arise on many different occasions. Here is a selection of examples that show how often these problems occurs in our language:

> "For example, in the request 'Give me all the employees in a division making more than $50.000, it is unclear whether the modifying phrase 'making more than 50,000$ 'is meant to apply to employees or divisions"

or

> "... in general 'making shoes' in the query 'give me all employees in division making shoes' could modify either 'employees' or 'division'. In a domain constrained by the information in our sample data base only divisions make shoes, not employees; thus the query in this specific case is unambiguous".

Or the ellipsis problem:

> "Query 1, below, can be followed by either of the elliptical queries, 2a or 2b, which should then be interpreted as 3a or 3b, respectively.
>
> 1.Who is the manager of the automobile division
>
> 2a. of aircraft?
>
> 2b. the secretary
>
> 3a. Who is the manager of the aircraft division?
>
> 3b. Who is the secretary of the automobile division?"

Pronouns are another difficult problem and show that context knowledge is important to be understood:

> "9a. Can you tell me which employees earn more than the sales division manager?
>
> 9b. How much do they earn?"

And not even a sentence like “What employee earns more than every division manager?” turns out to be as simple as one might think. For it “might be either a request to name the one employee whose salary exceeds that of any division manager or a request to name for each manager some employee who earns more than that manager”. (Gale 93) agrees that this is a problem and gives further examples for this problem from the automated translation viewpoint.

These issues will cause us to restrict the language applicable for our personal assistant interface.

In (Brunner 92) the authors claim that the increase of the user’s knowledge of the target data domain decreases the complexity of the dialogue. He used two groups of subjects, with the following difference:

> “The primer variable was controlled through selective distribution of a “Travel Service Information” pamphlet, with other experiment preparation materials, to half of the participants prior to their participation in the study. This was a three-page document describing (a) what kinds of travel services were covered by our databases and (b) for which parts of the world such information was available. Participants not receiving a primer prior to the session were given no prior information on areas of database coverage.”

And as a result, those people with a primer (more knowledge of the data domain):

> “... were able to accommodate and retrieve more information about more itinerary goals in conditions with a primer. Because users with advance information about the target data were constantly focusing on new itinerary goals, rather than pursuing details subordinated to an active itinerary goal, there was a primer-induced, upward displacement of GSSDs (Goal Specification Subdialogues), DISDs (Domain Information Subdialogues), and communication meta-dialogues in the subdialogue hierarchy, That this simplification of dialogue structure was the result of advance exposure to information, rather than some enhancement of motivation, is indicated by the fact that there were also 77% fewer system scope meta-dialogues in the conditions with a primer”

In this book we find evidence, that by using NL output and the primer, the span of anaphora can be narrowed to a certain extent. This makes resolving the anaphora easier as their type will be more predictable. However, we can not eliminate the occurrence of anaphora entirely and they are still difficult to resolve.

4. How can sublanguage modelling improve natural language computer interfaces?

If we can identify the subset of language that is used to address the computer interface then we can improve our performance, by restricting ourselves to just trying to recognise this subset. As we use the whole subset of language that is used to address the machine, we omit nothing necessary.

The sublanguage of the computer interface should be able to tackle all the possible queries to the computer. As long as we can expect users to word their statement in their language, it is obvious that a sublanguage exists, as the whole English language contains all queries. As stated in Section 2 however, the SR's performance will not be able to cope with the whole English language .
Thus, the intention is to find a sublanguage as small as possible (whilst still retaining acceptable performance), but as large as necessary (to please the user). In order to find all the utterances that should be part of the sublanguage an elicitation experiment is helpful. The recordings of such an experiment form the collected corpus. While looking for related research I did not find information on how to decide when the corpus is representative or sufficient. However, the methodology of Cognitive Psychology is of help when it comes to accurately conducting the experiment and recording its conditions.

4.1. Important notes on how to conduct an experiment

In Cognitive Psychology the experiments have to be very objective. As the variable to measure is sometimes very hard to spot, the experimental environment has to be carefully set up and described. I picked an example (Greene 76) which I find representative:

> "During the experiment S sat 0.3m in front of a .63 X .63-m wooden box which contained a .21X.23-m projection screen A response panel with two response buttons was mounted across the bottom of the wooden box. A light located directly below the rear projection screen indicated when S was to respond.... The projector lamp (GE ELH) had a rise time of 270 msec. The slides were constructed from red, blue and green theatrical gels, which appeared subjectively to be of equal intensity. A Tally tape reader recorded the stimuli..."

(Miller 75) discusses the crucial decision on how many subjects should be selected for an experiment. He does not draw any firm conclusions.

> "Unfortunately we are very unlikely to know, before the experiment, what value to place on the variability of the scores, or the probable difference in population means, thus we cannot actually calculate the sample sizes needed to stand a good chance of detecting significance. All that we can say is that the prospects grow better as the sample is increased. In practical terms this normally means that we should run as many subjects as our time and resources allow. At least this is so until we have established from past research the sort of distributions of scores that are likely to arise. With this knowledge one can develop a 'idea' for the number of subjects needed to produce significant results. A 'pilot' study can be immensely useful in this respect."

It may be useful to start with the experiment and decide after a few, how to proceed. (McGuigan 93) suggests to use a pilot study as a "dress rehearsal of the main performance" which I consider a very good idea.

In statistical theory, estimations for how big a corpus must be to be satisfactory can be given. They are usually based on the idea that the number of new words in the next sample decreases while the data collection proceeds. So while the collection continues a threshold is chosen to decide how many new words have to be in a new sample before the collection is stopped. However, there is no theoretical means to decide in advance how many samples have to be taken.
In the next paragraph, (McGuigan 93) deals with the problem of choosing the subjects.

> "A second point which must be decided is the method of selecting subjects for the experiment. In theoretical terms we should select our subjects randomly from the population of people or animals to which we intend to generalize our experimental findings. In practice, the choice of subjects is determined by the availability of particular individuals and perhaps also by decisions to reduce subject variability by holding a given characteristic constant. Hence we purchase practical *convenience* and increased *precision* at the expense of *random sampling* from the broad population of interest. This crucial decision influences our freedom to generalize from the experiment to a wider context ..."

This is a significant point, to which I will come back later.
(McGuigan 93) is a good guide on how to conduct an experiment, which I intend to use in my future work. For example he raises several questions which will be a good guideline:

> "In designing an experiment the researcher needs ingenuity to obtain data that are relevant to the hypothesis. This involves such problems of experimental technique as: What extraneous variables may contaminate the phenomenon of primary interest and are therefore in need of control? Which events should be observed and which should be ignored? How can the behavioral data best be observed, recorded and quantified?"

These ideas, of course have to be adopted to our less psychologically oriented subject area.

4.2. What does an elicitation experiment look like Or: How do you collect a corpus?

4.2.1. In general

Elicitation experiment in general means that subjects face a more or less complicated task which may relate to the researched phenomenon. In other experiments the mere dialogue or just the sound data is of interest ((Brown 94), see appendix C 'Corpora', ShATR). If you go to the extreme, you can record every day dialogues, as in (Schiffrin 95) and it still is a speech elicitation experiment.

BNC

This huge corpus is partially a collection of already existing data (like newspapers, etc.) and to some extent speech that was recorded by subjects themselves in their everyday lives:
"Recruits used a personal stereo to record all their conversations unobtrusively over two or three days, and logged details of each conversation in a special notebook. Those who took

part in the recordings were asked after the conversation to give permission for their speech to be included in the corpus."
For more details, see appendix C 'Corpora'.

PDS-Edinburgh

This is a collection of Patient Discharge Summaries described by (Mikheev 96), consisting of 500 PDSs of patients with heart disorders. He used this fairly restricted and already existing text source for his work on automatic text recognition (he constructed a system doing a semantic analysis of the NL texts).

The HCRC Map Task Corpus

The Map Task Corpus was collected in order to explore human dialogues and subdialogues when solving a task in co-operation with each other.
Therefore the Map Task was first designed. In an experimental environment one subject received a simple map with a few easy to recognise icons, for example "pine forest", "bakery", "cliffs", etc. A second subject received the same map including a tour. The task was to describe this tour to the first subject, so she could draw the same tour on her map. One half of the teams of subjects could see each other, the other did not. At no time could they see each others map. The whole conversation was recorded and is being tagged for the specific transactions committed during the task (Isard & Carletta 95).

TRAINS

As described in (Heeman 95), this corpus consists of task-oriented dialogues set in the TRAINS domain: a user collaborates with a planning assistant to accomplish some tasks, involving shipping goods in a railroad freight system.
For solving this task two subjects, called "system" and "user" used a map to solve the task of planning transport resources for a virtual railway system. Both could communicate with each other by microphones and headphones. An experimenter was present, but did not interfere. The "system" was encouraged to use paper to write down the solved subproblems, whereas the user was not allowed to use anything at all but the map.
The conversation was recorded on one channel of the stereo recorder for the 'system' and one for the 'user'. The experimenter was not recorded.

4.2.2. Wizard-of-Oz experiments

The general idea of a Wizard-of-Oz experiment is that subjects only see the facade and can not see behind it. For a computer experiment this means that subjects think they correspond with a computer, but the replies are sent by an experimenter. The advantage is that the experimenter can explore in a laboratory environment what the human-computer dialogue would be like, before she actually constructs the computer system.

Computer Based Learning Unit

A Wizard-of-Oz experiment was carried out by (Pilkington 92). Her subjects were asked to try to learn how to use the UNIX based vi text editor. For this purpose they could use a computer terminal. As assistance they could use a second computer terminal to contact an "expert software" for vi, which was in fact not a computer program, but a human vi "expert". So it was possible for the experimenter to log the dialogue that was requested by a novice in order to learn how to use the software and to find out what the desired capabilities of an on-line help system should be.

Convergence paper

In (Leiser 89), the subjects again were not told what the experiment was really about. They were told the object of the experiment was to find out whether the NLI of a database worked correctly.

Accordingly, the subjects were seated in front of a terminal, supposed to be their access point for the database. Then they were given an information sheet on how the system worked and a worksheet containing a simple table with blanks that should be filled in, using the database. It should be noted that for the purpose of elicitation it was important to use as few words on the sheet as possible. (The object of the experiment was to find out which words the subject would use by themselves.) Whenever the subjects typed a query, they received a reformulation of that query from a second experimenter from a different terminal, who used software to make the reply look machine-generated.

I will come back to this particular experiment in Section 5.1.

One might think that a Wizard-of-Oz experiment could be an ethical problem. And indeed, it is a problem that the experimenter deliberately lies to the subjects. In the latter experiment this problem was solved by informing them afterwards of the real nature of the experiment.

Finally, we thought that this kind of elicitation experiment may be suitable for our project. However, we have a different objective than the described experimenters. We do not want to explore the human-computer dialogue. We want to know how a human would like to address the computer system. This is, we want to know how one would like to address a human personal assistant. Consequently, we anticipate an experiment similar to (Heeman 95) used for the TRAINS domain, as described above, which involves a human to human dialogue method.

This decision was made in spite of the report of the work of (Morel 89). Here, an experiment was conducted with two groups of subjects: one talking to a human operator and one talking to a human operator whose voice was distorted to imitate a machine. The conclusion is that if humans are confronted with what they think is a computer, they change their language behaviour. I.e. a smaller and simpler vocabulary is used and the utterances are more concise and stereotyped (certain simple connectors become more frequent, etc.). This, however is based on data collected

in artificial experimental settings. People were asked if they agreed to talk to this (fake) computer programme. If the caller were in a hurry, she might not have agreed. We are not being told what the situation for a typical caller is and therefore cannot draw parallels to the typical situation a user of our proposed system is in. Assuming that subjects in Morel's work are relaxed, they have time to concentrate on the computer as a dialogue partner. It is doubtful that a user who is used to work with humans and under stress is just as willing to make it that easy for the speech recogniser. On the contrary, it can be expected that the user falls back into her usual pattern of communication, including anaphora and all kinds of (seemingly) unusual linguistic means. Morel's work did not include how this effect that is being observed changes through time, in other words what happens if users get used to this tool. Do they still happily conform to its limitations? Although it is obvious that this question should be object of a further investigation, it was beyond our means (it will be recommended as a future work) and somewhat missing the point. It was considered a more challenging aim to try to evaluate the feasibility of speech recognition in a most natural and unconstrained way, that forces the machine to adapt to the human and not the other way round. For now, therefore it will be assumed that for a long term research goal it is desirable to develop an interface that is capable of understanding a most natural and unconstrained sublanguage.

4.3. How can these experiments contribute to modelling the sublanguage ?

After the experiment has been conducted, i.e. sufficient utterances have been recorded, a sublanguage has been collected. As (Churcher 95a) showed, the sublanguage can be described by a grammar based on the corpus. Basically, however, there is no formal means to 'flesh out' this sublanguage without need for further experiments, where more details are collected.

5. Improving speech recognition: Exploiting Convergence in Dialogues

5.1. The evidence

Psycholinguists have long made the point that mutual adapting in human dialogue exists (Schenkein 80), (Levelt and Kelter 82). In his paper, (Leiser 89) reports evidence for the phenomenon that humans significantly adapt their way of talking even in a dialogue with a computer. He also claims that NL speech recognition can be improved by making people use a specified, small sublanguage.

His experiments were conducted as stated above. Further on, it will be explained how the convergence phenomenon was observed.

The reformulation of the query that was returned by the experimenter was constructed according to the following idea. Three syntactical and three lexical items were chosen to be replaced by their syntactical alternative or their synonym. An example for a lexical item is the use of 'males' and 'females' versus 'men' and 'women', an example for a syntactical item would be 'past perfect' versus 'past imperfect' tense of the verbs 'to do' and 'to take' a subject (e.g. 'how many students

did English?' versus 'how many students were doing English'). The subjects were divided into four groups each of which was chosen to replace one syntactical and one lexical item in their language. This provided control over accidental biases of the subjects. The reformulation had to be confirmed in any case, whether the subjects had used the same way of putting their query as the second experimenter or not. So if the subjects adapted, they did not adapt to save themselves efforts. The whole dialogue was recorded and analysed.

As a result, the number of times the subjects used the induced alternative, rose significantly towards the end of the experiment. This rise is quantified and illustrated in (Leiser 89).

5.2. The application

This idea, however gives us a means of increasing a speech recogniser's performance, by using two corpora in parallel. I suggest to collect the corpus as we planned (doing interviews, recording them and then transcribing). By looking at frequencies, we will find out which the most often occurring verb-noun combination for selecting a function is. The short forms of those will then be extracted from the collected corpus and will then form a new corpus. An SR will then return confidence rates of the recognition of an utterance for each corpus.

This will further decrease the size of a single corpus without decreasing the performance. In fact, it might even increase the performance. If the two corpora model returns poor ratings for an utterance, so would the single corpus model. The single corpus, however does not necessarily return as good a value as the two corpus model, because the two corpora will be disambiguated (they are disjoint) and it will be easier for the SR to make its choice.

With the convergence paper, we still have an idea up our sleeve. By means of asking for confirmation or simply stating the current system status with carefully chosen words, users will be made to use the utterances covered by the smaller corpus. As this corpus will be significantly smaller than the one collected, I expect performance to increase after some time of use. This is a very ergonomic way of using a small corpus and much better than telling the user that she is only allowed to use a clear cut and very small vocabulary.

For the future of the project this new idea means however that if Visionair wants to sell this product to people already using the Psion, there should be a significant part of Psion users among the interviewees and we rely on an SR that can process two independent corpora in parallel.

6. Conclusions

As (Wang 89) points out in his study on Computer Interfaces in working environments "... information-processing (EAT3), expectation (EAT10) and satisfaction (EAT14) (about work) are significant variables", which means they have significant influence on the organisational climate in the workplace. So after establishing that the SRs are not yet satisfactory, it follows that for a satisfactory application *theory*, *software* and *hardware* have to be developed.

(Leiser 89) gave us an important inspiration for the project with the idea of choosing two (maybe disjoint) corpora and compare the ratings of the SR.

The research for this survey also raised the question on how to decide when the corpus is representative or sufficient. A ‘dress rehearsal’ and decision on the data collected so far is considered a good answer, so this will make the next part of the work a bit easier.
Further on, an important decision was made during the reading as it was decided that a Wizard-of-Oz experiment is not suitable for our aim and will be replaced by an interview kind of experiment.
In any case, a task will be developed to be solved by the interviewees, which has to be, as (Brown 94) puts it, ”sufficiently absorbing”, because this will increase the naturalness of the utterances. Also I retrieved the important suggestion from (Leiser 89) to use pictorial information for collecting the corpus. This is that important, because this pictorial information elicits a wider range of lexical items than standard textual tasks.

Chapter 3 Study of the desired functionality

This chapter serves as the basis for the further work. It outlines the functionality that would be necessary for the system to have and gives a division into feasible and unfeasible aims.
The latter part helps define what the aims of the following work are and gives us a clearer picture of the topic we are dealing with as it discusses what is possible and what is not.

1. What might a travelling executive want from an intelligent personal assistant?

1.1. Features expected by current Psion users ?

To gather information, an article was posted to the newsgroup comp.sys.psion which is a place for vivid discussion on Psion related subjects. The following is a summary of the ideas people sent.

- read out appointments
- read out documents
- audio calculator
- search through a database
- let the machine read out a document, so you can check correctness

- information on car's status and its need for maintenance
- tell you about expected arrival time, warn if you might arrive late for an appointment
- help on in-town navigation
- have a route planner that can offer alternative routes

- establish connections to other machines and exchange data (Internet, read email, VCR?)
- read and send your email

- access all applications of the Psion via audio menu
- tell you about radio stations in the area

- access your own applications (CD player, radio, etc.)
- automatically dial your phone
- access your car phone answering machine

- enter your ideas in the appropriate application of the Psion: memos in word, to-dos and appointments in agenda

- provide mains supply
- mute radio, if phone is used
(See appendix B ‘User’s wishes’ for the whole text)

However, these people sometimes seemed to stick too much to the feasibility of the project. This restricted their imagination. In order to find people with broader expectations, I asked people who were not too much involved in using computers.

1.2. These are further features that are expected by non-users

I collected information from people (male/female) who did not work too deeply with their computer and therefore had not too much insight into feasibility. This includes a insurance investigator for false claims, a bank manager, etc.
Only information is listed that has not yet been included in the above section:
- check the car phone answering machine
- have access to the existing computer system/ data of the company (documents/information/etc.)
- using pronouns and anaphora for reference to commands and their arguments. For example, "do the same with the last appointment tomorrow", i.e. ‘cancel the appointment on November 16th starting at 10.00 p.m.’.

Apart from that there was only confirmation of the previously mentioned functions. This is why I am confident that I did not miss anything obvious.
An overall conclusion from both surveys was that the emphasis of the people interviewed was on the memo function, followed by the agenda.

1.3. Further expected features judging from today's functionality

These features are already in everyday use on a Psion and will therefore be expected by users of the intelligent personal assistant. I surveyed all the functions mentioned in the manual (Psion PLC 94) that might be relevant to an in-car environment (with a possible restriction: road safety, you do not want the Psion to monopolise visual perception). Then the previously-mentioned functions were eliminated leaving the further features:

- agenda:
    - read out, enter, change appointments

- to-do list:
    - modify
    - use another to-do list

- anniversaries:
    - read out names/dates within a specified range
    - enter name/date/age

- system:
    -specify where to read addresses/to-do list/agendas/etc. from

- database:
    - adding a phone number
    - read out addresses specified by name

- FindIt:
    FindIt is a product of Visionair. It is a navigation aid and can run on the Psion.

There are a lot of functions that are not in the above list that someone might like to use, but I tried to draw a reasonable line in order not to distract from the main issue.
(You might for example want to use the spell function of the Psion. But it just does not seem likely that you really need to use it, and furthermore it would take a lot of time to implement it.)

2. These features are feasible in 1 year's time

Provided a speech synthesiser (text to speech) and proper access from the PC system to the Psion data files are available, I think we could manage to solve some of the following problems.
Assuming we find a good speech recogniser and a good sublanguage the functions will be accessible by "a kind of" menu structure. At this point, I am thinking of a sublanguage model, where you first have to state an utterance with a keyword indicating which application you want to use and then use the constraints that are delivered by the functionality of the Psion. Judging from responses from Psion users, I do not have the feeling that this would be too inconvenient.
Provided we use the following functions:

word:
- enter new memo
- read out a document specified by a filename or by string matching

agenda:
- appointment:
    - read out appointment specified by date or relation (today/tomorrow/afternoon)
    - repeat appointment
    - skip -> difficulty of listening while speaking!
    - previous, last,
    - enter appointment
- to-do list:
    - add
        -text
        - priority
        - dated
        - alarm
    - modify
    - use another to-do list
- anniversaries:

- read out names/dates of specified range
- enter name/date/age

- system:
  -specify where to read addresses/to-do list/agenda/etc. from

we could use a mixture of menu traversing and free speech to increase the performance of a state-of-the-art speech recogniser. A request using this language model might look like this:

activate	-> activate speech recognition
open my diary	-> selection of the application by keyword diary
“what do you want to do with your diary?”	-> feedback and invitation for next function
read out my appointments for November 11th	-> function 'read out' and the date which is part of the text, are identified

(This is to show why it might be feasible in such a short period.)

If we use several levels, we gain performance, because we can enormously reduce the perplexity of the language on every level. Nevertheless other problems arise.
First, we need to know what the current level is. This is not obvious! The user might have been distracted by the traffic, but now she wants to state her request, but maybe she does not remember what she said last (and for example, she does not want to care! which is fair enough). If we want a visual output for the navigation system it might be too difficult to swap between the navigation output and a command level signal.
Second, we do not want the user to have to care too much about the levels anyway. So we do not want her to have to traverse every step back in the tree structure and then go back down a different branch again.
Here, a sensible compromise has to be found, depending on the specific speech recogniser.

If you look at the functionality as being a tree starting with Psion, followed by the applications, their functions and necessary specifications, it might be useful to consider the children of a tree most probable, followed by the children of the root and the root node of the application you are now using.

	Probability	of next utterance to be	
you are in level:	a) change application	b) select a function	c) specify parameters
A) Choose application	max.	zero	zero
B) Choose function	min	max.	zero
C) specify parameters	(*)	medium	max.

Table 1 Probability distribution for a proposed system

So in level A you need only accessibility to the applications. (restricted search space)
Level B provides the possibility to directly go to another application.
Level C is most sophisticated. The user might want to leave the application and may have found out that she chose the wrong function. (*) So I suggest introducing a keyword for resetting the system to level A instead of using the full lexicon A.
The PE500 is able to use different grammars for recognition. Therefore this is feasible.
It was hoped that there would be some sequences of work more probable than others. This would have offered the possibility of doing research on probabilities and eliciting constraints. However, research on Office Automation suggest that there will not be any way of predicting the next function in a sequence. The usual procedure for someone who wants to automate the processes of an office depends on looking for the individual's ways of working ((Pritchard 82) (Wainwright 84), (Willcocks 87)). You do not look at the business! So office automation will not deliver any standard sequences for our application, as we cannot even define a certain business as our target group.
The next idea could be thinking of a certain scenario, which is common to all our users. This could deliver constraints for our speech recogniser. For example, if someone just used the phone, she might then be more likely to use the memo function, because she wants to record the result of the phone call. But this again turns out to be fallible. The user might want to use the appointment function to change an appointment as well, because she learned about a new appointment. Or she might delete something from her to-do list, because this call was what she wanted to do at this particular time of day. Or she just got the wrong number and wants to use the phone again...
I can construct similar examples for any function, which proves that the idea of sequences of functions or applications will not help us.
Note that this chapter assumes that the system includes a speech synthesiser. The basic reason is, if there is no speech synthesiser, there can be no reading out of appointments, which is vital for the use of the system. And if the synthesiser is present it can easily be used for reading out other data as well (e.g. documents, feed back)
Reading out documents may still be inconvenient, because the system probably can not be interrupted, if it is PE500 based.

3. These features are feasible in 3 year's time

I consider that these features are not feasible in one year's time because they are too complex. However, we might cope with them in the short-term.

- depending on development of speech recognisers, easier access to features
- being able to interrupt the system while it is reading out something
- changing your database:
    - adding a phone number
    - read out addresses specified by name

because the language-model is run-time dependent; you would have to implement a learning dictionary.

- create a model that adapts to the user, for example an adaptive neural network that anticipates the next function because of an internal statistics of the last sequences of work.

4. These features are only feasible in the long run

I think the rest of the items of chapter one are too complex and have to be added to the long-term list of wishes:

- A link to the car status and, based on this, evaluation on remaining time, etc.
- a level-free structure of the different parts of the Psion/FindIt functionality.
- editing your data, instead of just entering or receiving data
- using references in the utterances
- Internet access
- bank account management
- route planning and navigation
- dictating a fax and letting the machine read out a received one

Chapter 4 Eliciting the Corpus: design and conduct of the experiment

1. The aim of the experiment

Our domain is best described as the queries and statements to an in-car Personal-assistant (PA) whose function is to assist the driver in managing her notes, appointments and her telephone number database. As no corpus of this domain exists, part of the work is to design an experiment that will elicit such a corpus. We wanted to collect a “natural English” corpus of utterances for our specific domain. We are aiming at a maximally ergonomic solution, so ideally there should be no difference in the responses of our system and a human personal assistant.

It is crucial for the success of the experiment that the utterances are as natural as possible. Also they should cover the whole functionality the project is aiming at. This corpus will be the basis

for further research in the project. We expect the analysis of the corpus to highlight the range and variety of language used in such a specific domain.

2. Design

2.1. Main criteria for the experiment

1. Aimed at an in-car unconstrained Speech Recognition (SR) application
2. Corpus is a means of guidance for further research
3. Technically simple

As stated above, naturalness of the utterances is most crucial to the results. We want to find out what people say to receive a certain piece of information or to use the phone so statistical methods must be applicable. Therefore a standardised design is necessary.
In order to make the briefing for the procedure uniform, a written briefing was found most appropriate. It was agreed that for additional data two questionnaires were included. One before the experiment, including general data and a second afterwards, where questions could be asked which would otherwise influence the data recorded.

2.2. Dependent and Independent variables

A first idea, to use a real car, was discarded due to it being too dangerous, time and money consuming. As it was not known in advance whether there would be any difference in the utterances if the setting were in a car or not, it was decided to conduct experiments in two locations: in a quiet room setting and in a driving simulator.
So we collected samples in two different settings:

1. quiet room:
   artificial setting; no distractions; no background noise
2. driving simulator
   more realistic setting; absorbing secondary task; background noise (artificial traffic)

As we have seen in the last chapter, the recognition rates of the SR can be expected to be less than perfect. So it is desirable to have “non-contaminated” speech material to evaluate results in the recognition tests later on.
As stated before, the aim of the experiment was to gather utterances from the PA domain. Thus, the elicited language should cover as much as possible of the functionality in that domain. Some specific aspects of the dialogue were focused on. One is how do the subjects refer to repetitions of subtasks and to information that was referred to just a few utterances ago. The subject of this study will be the repeated telephone task (task 6) and the information retrieval task (task 5) which is in real time just a few minutes after the first mention of the information. The same is valid for the task of arranging a date, where the more human way of interacting might be to refer to something someone has said before.

Also, it will be a goal to find out how tasks involving several subtasks may be summarised in the samples. This will throw light on a difficulty foreseen in the future of the project: the tendency of the human user to think in a higher degree of abstraction.

2.3. Decision: Dialogue failures or not?

Although it would have been interesting to study the human mechanisms dealing with misunderstandings and communication failure, it was found that this study is very ambitious and should be preceded by a more simple study to evaluate possible problems and give ideas on further research. Therefore it was decided to assume a perfect interaction.

2.4. Problem: How many subjects per experiment?

In order to increase the naturalness it was considered having two subjects per experiment interacting with each other. This would have increased the discourse character of the experiment. In the following the discussion is summed up.

On the one hand, in a two subject experiment, the experimenter who is biased is excluded from the experiment. Also the interactive moment is of immense importance for naturalness. Using two subjects increases the level of interaction. On the other hand, if the subjects misunderstood the instructions, the experimenter must interrupt the experiment. If the experimenter is part of the dialogue, it is easier to give the dialogue new directions without discouraging the subjects. Involving the experimenter as a partner in the experiment is contributing to the interactiveness, too. One might say, that not involving the experimenter is not a disadvantage, because ambiguities can be solved by an unambiguous pictorial briefing but it seems quite impossible to design a completely unambiguous briefing in advance for every imaginable subject. Besides, the subject can always ask if they encounter imprecision. Also doubling the number of subjects per experiment doubles the total number of subjects. It will be difficult to find so many people.

As the experimenter is not a native English speaker a further discussion topic occurs: The two subjects understand each other better, as they talk in their native tongue. However, as the experiment has a standardised procedure, the contents will be fairly predictable.

However, if the experimenter is not involved at all, he does not know if the subjects can fully imagine the suggested setting.

It was decided to use one subject and the experimenter as dialogue partner. This means the subject talks to the experimenter as if he were the subject's secretary. Although this is a highly contestable decision, it was made mainly for two reasons:

1. Feasibility:

Not all subjects turn up at agreed appointment times; A one subject experiment is not dependent as much on the turn-up of subjects as a two-subject experiment

2. Character of the Corpus

The Corpus was intended to be a guideline. It was never required or intended to be absolutely representative.

2.5. Problem: How to avoid prompting? The icon language

How can a natural utterance in this setting be elicited without prompting people and still being able to record a standardised sequence of utterances?

It was decided to create an icon language covering the whole functionality (as shown in appendix D 'Functionality'). Information concerning this functionality was either represented by icons or, as in the case of times and dates, in a standardised form. Dates were shown as 17/03/96, times as 15.00. This regulation was found to be not prompting during the test sessions.

More difficult was the briefing sheet (appendix E 'Material').This is where the icon language is introduced, so it is the point, where the transition from English language to the more abstract level takes place. Here either careful descriptions of the functions were used or deliberately vague language not including the keywords. Furthermore, information was left out, wherever possible. This lead to a certain ambiguity in the contents of the tasks.

The briefing sheet was also used for relaxing the atmosphere as far as possible by reassuring the subjects on their concerns about difficulty of the experiment in order to get natural utterances.

2.5.1. Problem: Indicating the next task

After having agreed on how to standardise the tasks and to represent them in the icon language it was necessary to find a way of showing the hint for the next task to the subject. It was found convenient to use common filing cards as a stiff back and to attach the icons. Thus, the material would be reusable and have a neutral background. Also it would be easily editable (adding, ordering, exchanging).

Those cards would each contain the piece of icon language needed for the next utterance (subtask).

In order to have the subject's attention available for the recognition of the actual subtask, every card contained all the information that was necessary to perform this subtask. Thus, at no stage was it necessary for the subject to remember information from an earlier stage. Care was also taken that no piece of information was on the card that was not necessary for the current subtask and would therefore be distracting. At no time should the subject see more than one card.

2.5.2. The icon language

As it was impossible to use the medium that was to be recorded (English spoken language) as the medium for starting the elicitation of the utterances, other media had to be used. Otherwise, all kinds of effects would have contaminated the data (Convergence in lexicon and grammar). One alternative, briefing in another language (e.g. German) was considered, but this idea was discarded as it would have made another study necessary: which effects might take place in such an environment (speaker being "caught" in the background of the foreign language, consequently

not being able to utter free English, or being prompted by words that sound similar: For example, German “Kalender” for English “diary” but not the same connotation as “calendar”). The idea of supportive sounds was found not to be contributing enough to the solution to be worth following up its value for this specific problem. It may however, be a solution for design problems in other settings.

Developing a series of photographs of a person conducting the specific tasks was considered too difficult and time-consuming. The problem here is that it is hard to design the setting of the photograph so that the information content is low enough not to overload the recognition resources of the subjects, while still providing the information necessary.

A good compromise appeared to be to design an icon language representing the different tools and actions of a PA.

Eight icons were used in the experiment. One icon for each of the to-do list, the diary and the telephone. The note pad function was split into two icons, one for information retrieval and one for information storage. Three icons were designed for indicating certain modes. One for indicating that the subject will just receive information (“Listen”) and one for retrieving information from the functional icons (“Ask”). The last one (“Say”) was used for making the subject read out pieces of conversation to fill gaps in the dialogues and make them more smooth and cohesive. Figure 1 gives an example of how such a piece of icon language looks.

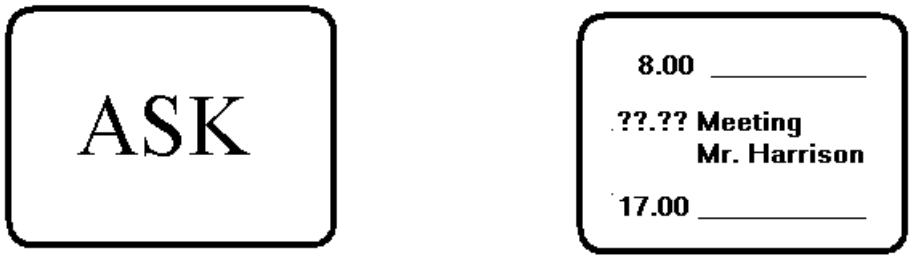

Figure 1.
Figure 1 Example of the icon language

In this example the subject is supposed to ask when the meeting with Mr. Harrison is scheduled.

Appendix E ‘Material’ shows the briefing sheets which contain the icons and their description, so the reader can refer to them if s/he wants to picture the language.

The design of the icon language proved to be very difficult and it had to be rearranged over and over again after each test session. Also, several alterations had to be made after consulting a cognitive psychologist. We are grateful for the advice of Dr. J. Denis McKeown on experimental design methodology in cognitive psychology. This includes the change from an example sheet, which was the first design to a practice session. The practice session is conditioning to a greater extent, as it involves interaction.

2.6. Problem: Frame of Mind

In order to help subjects to understand even though the actual material was supposed to lack information we tried hard to provide indirect information.

First of all, the tasks themselves were chosen to be as natural as possible. They should resemble a set of tasks that could be observed in everyday use of such an imagined intelligent in-car personal assistant. The choice of tasks and interactions based on sequences were based on observations in interviews as summarised in chapter 3.

Furthermore, an elaborate description of the situation which was supposed to be at least distantly familiar, was given. After subjects had read the written description the experimenter checked whether the setting was understood and if subjects could imagine the situation. He used the same terms as in the introduction to the experiment the subjects were given, which did not contain keywords crucial for the experiment. The environment contributed to this aim, particularly in the driving simulator experiment.

Virtual dialogue partners who were interacting with the subject through the experimenter were used to provide as much context as possible. Thus it was possible to describe more exactly which kind of action was required just by giving a context instead of giving too many instructions. All the actions were interwoven, in the sense that later actions referred to earlier ones and using the results of earlier for subsequent tasks, again saving the design from having to provide additional information. The storyline of the whole interaction is given in the appendix F ‘Storyline’.

3. Subjects

Thirteen Males and three Females acted as subjects. They were mostly students, but included also university staff , an officer worker and a company director. The students and the office worker were paid a small reimbursement by the experimenter. The subjects were asked to name their accent. These ranged from Northern and Yorkshire to Southern and London. Also, some subjects spoke with RP and one with a Canadian accent.

Although most of the subjects were familiar or very familiar with computers, except for one subject all the others were unfamiliar with a Psion and its functionality and the related terms.

All subjects but one were not familiar with palmtop computers and their functionality. Many were used to using a personal organiser or a diary.

One subject had to be told the term “to-do list” as he was too nervous to think of an equivalent.

4. Equipment

4.1. Recording Equipment

A Sony DAT Recorder type TCD-D7 with noise cancelling microphone Sony ECM-909A was used for the recording. Two 180 minutes tapes were required for recording approximately 4:20 hours of test and data samples.

4.2. Driving Simulator

The following is take from (Jamson 96) and describes the apparatus used for this experiment:

> "The simulator resides in its own dedicated laboratory space within the Department of Psychology of Leeds University. The simulator itself is currently based on the following major elements:
> - a Rover 216GTi.
> - a purpose-built projection screen allowing up to 120 degrees field of view and projector suspension system.
> - a Silicon Graphics 4D/440 Reality Engine graphical workstation.
> - a Sony VPH-1270QM video projector giving 50 degrees field of view.
> - an Elonex 386 IBM clone PC with two I/O cards.
>
> The "driver" sits in the complete Rover with all its basic controls and dashboard instruments still fully operational. He "drives" the car completely as a road vehicle, even down to "starting the engine" with the ignition key. On the screen in front of him is projected a real-time, computer generated 3-D graphical scene of the "outside world" from the single projector aligned with the driver's seat. Although the simulator is fixed-base, i.e. he receives no inertial force cues from the car's behaviour, feedback is given via simulated steering forces at the steering wheel. "

5. Material

Appendix E 'Material' is related to this section and contains all the material described here, except the ca. 100 Cards, which would have been just too much to include here.

5.1. Briefing Questionnaire

Contains slots for general information on name, profession, age group and gender. The experimenter added the subject's label and the tape counter for start and end of recording.

5.2. Briefing Sheets

Two sheets which contain an introduction to the situation. They explain that the subject is supposed to act as a travelling salesman and talk to the experimenter as if he were the secretary. Furthermore, these sheets contain the explanation of the invented icon language and an invitation to ask the experimenter for a practice session as soon as the subjects have finished reading.

5.3. Cards

The filing cards used here are approximately A5 size. The printouts of the subtasks were stuck onto the cards. In total, the subjects were presented about 100 cards, comprising nine tasks. First little sections of tasks were created and later on these sections were put into a sensible order. The order of task is:

2-6-1-3-9-5-4-7-8

This sequence is determined by a few constraints. For example, in task 7 the word “telephone” is used on one of the cards. Therefore, no card which was to elicit a term for “telephone” must follow task 7. Another example is the sequence of the three memo actions. Task 5 which contains the information retrieval must be preceded by tasks 2 which contains the real information that is being searched for and task 1 which contains a similar but different piece of complex information. This piece of information was designed to justify the need for the memo function to the subject and make it more realistic to use such a function and to distract the subjects, so they did not remember by themselves what the required information was. Having the information retrieval task in a later part of the experiment served the same purpose.

Task 1 was used for the practice session and afterwards reinserted into the experimental material.

It was intended to create a simulated conversation with husband or wife, but that would have brought up the difficulty of producing two sets of cards, one for each gender. So the design was changed to a conversation with “son” (task 8) and “daughter” (task 9).

5.4. Debriefing Questionnaire

Here subjects were asked to state their accent and rate their familiarity with computers in general, a palmtop computer and the “Psion” computer in particular. Subjects were also requested to state how often they use a personal organiser or work as/together with a secretary. To get general feedback on the experiment itself they rated the difficulty level of the icon interpretation.

6. Procedure

We discussed beforehand whether people should be told what the aim of the experiment is or not; in the end it turned out that most of the subjects were not interested or did not ask before the end of the experiment. Those who asked were informed that the experiment was a psycholinguistic experiment to find out about the range of language used in a certain domain. They were told that they were not asked to use correct grammar or words, but that emphasis was on naturalness of the utterances.

After the experiment, subjects would get more detailed information on the experiment itself if they wished so.

The sessions lasted between 20 and 50 minutes

6.1. Quiet room

A table and two chairs were required. The microphone was mounted, the recording level adjusted.

6.1.1. Briefing questionnaire

To start, subjects were given the Briefing questionnaire to fill in. This was easy and subjects got used to the situation.

6.1.2. Briefing Sheets

After this, the subjects received the briefing sheets. The subjects were not addressed until they said they were ready to start with the practice session.
The imagination of the subjects was appealed to, to get themselves into the frame of mind of the travelling salesman.
To avoid discouragement during the experiment, it was found useful to check whether subjects had a basic understanding of the four more complex icons on the second page before the start. These icons represent the central functions: memo, the to-do list and the diary.

6.1.3. Practice Session

This was conducted just as the recording session, task one was used as practice material. As the experimenter did not prompt subjects during this session the material could be used again and was to contribute to the confidence of the subject as soon as they found out that they already had solved a part of the experiment, it would advance the learning curve. Subjects were told that this part of the experiment was not recorded so that they could freely react to the procedure and get acquainted with it.

6.1.4. Recording Session

As soon as the subjects agreed that they would like to go on with the experiment, the recorder was turned on and they were given the first card. Whenever they finished a subtask they were given the next card, except for the simple cards that represented replies from virtual dialogue partners and had to be read out by the experimenter.

6.1.5. Debriefing questionnaire

To receive feedback, subjects were asked to fill in the Debriefing questionnaire.

6.2. Driving Simulator

In the driving simulator the microphone was mounted on the dashboard, the experimenter was seated in the passenger seat. A light in the back ensured the cards were visible.

6.3. Practice drive

Firstly, to get subjects accustomed to the driving simulator they had a practice drive in an urban setting. This made sure they were acquainted with the steering, the different feeling of a driving simulator and the attention would be available for the experiment itself.

6.3.1. Briefing questionnaire

Just as in quiet room setting. (The driving simulator was turned off)

6.3.2. Briefing Sheets

Just as in quiet room setting.

6.3.3. Practice Session

Just as in quiet room setting.

6.3.4. Recording Session

A motorway track was chosen to deliver the secondary task. This track did not contain any exits, so the only distraction was the traffic on the road. Apart from that we proceeded as in the quiet room setting.

6.3.5. Debriefing questionnaire

Just as in quiet room setting.

7. Discussion

Whether the tasks are really natural could be debated, as they were made up by a single person. However, the author designed the tasks after having studied the application, having held interviews with people of the target group of the computer PA and every subject gave feedback on the experiments.

A contestable point on the experiment will always be the involvement of the experimenter. Involvement of the experimenter consists of him setting the pace of the experiment, manipulating the subjects as they get conditioned by his feedback. His involvement is putting pressure on the subjects. It was found that subjects waited for a nod or a sound expressing approval before they continued and it cannot be ruled out that in some cases the approval was expressed too fast. So we cannot be sure that there is no “experimenter effect” which means that the experimenter subconsciously influences the experiment to return the desired result, which does not necessarily have to resemble reality. However, it must be said that referring to the main criteria of the experiment the effect is not thought to nullify the results of the analysis. The lack of accuracy in the corpus can be tolerated as its purpose is essentially a guideline rather than a comprehensive dataset.

In hindsight it can be said that the choice of design was the right decision. Because of the short time between finishing the design and analysing the results it was impossible to guarantee subjects to turn up at the date arranged.

The question of whether it makes a difference to perform the interactions with the PA in the car or not, is not yet cleared up. Neither is the question on how the distractions influenced naturalness of the utterances.

8. Notes

The experiment was designed to show the variety of language that would be used in co-operation with a human assistant. This particular paragraph will be used for pointing out a few interesting things that occurred while analysing the data.

In the following utterance the information that is usually stored separately in the Psion is interwoven:

could you put down for the eighth of the tenth meeting at twelve o'clock with Bradford copy shop
specification of the date: ^^^^^^^^^^^^^^ ^^^^^^^^^^^^^
and the actual entry: ^^^^^^ ^^^^^^^^^^^^^^^^^^^^^

In the next example the reader can see how the subjects tended to complete several subtasks in one utterance by continuing a sentence even after the next card was presented. This is especially remarkable as the experimental design seemed to force the utterances in discrete pieces of speech.

Subtask 1: *can you put a note in the to do list to write a letter to paper international on Thursday*
Subtask 2 : *and after that make a note phone the boss to confirm that letter has been sent*
^^^^

This could be an interesting object of study.
After having worked with the data now for a long time it appears to me that there is an application for discourse analysis. For example, it is probable that the user will enter an appointment after searching their diary and finally finding an empty slot. Also, it is possible to exploit the information stored in the organiser: if the text in the Psion looks like 'ring X' it is likely that the next function requested is the telephone function. The following utterance shows another possible application of discourse analysis:
(57) [e5] what am i doing on the same day between T and T
^^^^^^^^

(at this stage of the dialogue the subject was trying to find a window for an appointment on a specific day)
Maybe there are more examples. Initial findings seemed to back up the fact that discourse theory can not be applied here, but already these few examples suggest the opposite. This shows that the work turned up interesting findings.

9. Results

A separate chapter will be dedicated to the analysis of the data itself, but a few preliminary results can already be summarised.
In a specific case, the phone usage, it can already be said that the experiment served its purpose, it delivered a range of different phrases that were all aimed at the same function.
The usage of cards proved to be a good idea in the respect that they resemble a medium that was easily editable. This helped a lot during the long stage of correcting the icon language.
After the experiment I think it would have been better to use a few sheets including the whole dialogue and the icon language material, so that the experimenter does not have to be that involved and that subjects can set their own pace. This would have improved the design as the

biased experimenter would not have been involved. Also, it would have improved the design to replace the times and dates by a clock and calendar icon presenting the corresponding information.

It was hard to choose a correct set of subjects due to the lack of time. For a complete survey of the field a preceding study on the subjects is necessary. It was found that a lot of test subjects were necessary, every test proved to introduce new aspects and made improvement necessary. Despite this, it was decided to continue with the experiment because of the need to get at least preliminary results.

The design and actual conduct of the experiment took approximately two months; this was found very time consuming and it must be said that the workload was underestimated. It has to be noted that for a correct corpus collection the expected design period will be longer. Also it was found that if the set of subjects was supposed to be a representative set of males and females it may be advisable to consult both male and female designers. A similar finding might be true for other independent variables.

Chapter 5 Analysis and modelling of the sublanguage

In this chapter the corpus that was collected as described in the last chapter will now be analysed. A first step will be to transcribe the audio data and translate it into a format that can be used for an automated processing. The aim of the analysis will be to discover the perplexity of the sublanguage recorded in the corpus. Also to look at different levels of language and give an idea on which level the highest perplexity can be found. This problem is a not clearly defined in the field. Thus, the chapter will provide the theoretical background followed by the analysis itself.

1. Preparing the data for an automated analysis

In order to have the data (see appendix G 'Data') in a format that is suitable for further analysis, transcripts (ASCII format) had to be made and edited.

1.1. Transcripts

It was agreed to give the recorded audio data to secretaries in order to obtain a transcription. Already at this stage it became clear that a range of things had to be handled with care. In order to run scripts on the data we needed a standardised way of transcribing. For example, numbers and dates had to be written out:

3.30 -> three thirty

£2 -> two pounds

15^{th} October -> fifteenth of October

However, due to misunderstandings, the transcripts turned out to be made in a summarising style. E.g.:

subject: can you get the office on the line please Transcript: can you phone the office please

subject: eighth of the tenth Transcript: 8th October

subject: four Transcript: four o'clock

and therefore had to be extensively re-edited. This, the time spent finding someone to do the transcripts and the return time, explains why it took five weeks to make the transcripts available.

1.2. Pre-editing

This was done to every single sample:

- delete any utterances that were explanations or where subjects were talking about the experiment during the experiment
- delete punctuation
- proof reading
- spell check
- drop case
- the speaker is indicated for every utterance
- for processing purposes, a '*' as first character was included
- independent proof-reading by a second linguistic researcher

1.3. Editing

Invalid utterances were marked by 'X', when it was obvious that subjects were prompted by the experimenter the utterance was marked with an 'X', too. Words without meaning that were just used to start a sentence like '*right*, can you ...' (right) or '*yes,* can you ...' (yes) were deleted. These "discourse markers" are distinctive characteristics of human-to-human dialogue. For example one of the main results of (Grierson 94) was to insert these into computer generated dialogue to make the computer generated text more human like. On the other hand one can look at these words as noise or relatively semantically empty and it was intended to find a lower bound for the complexity of this language. Thus leaving out a complex feature does not jeopardise further analysis.

The data contains a number of utterances that are not 'correct' in the sense that the parameters were not understood properly, e.g. "(13) [d4] can you put a note in my diary to call the office at ten o'clock" (it was supposed to be four o'clock).

There are some utterances that might not be naturally uttered. Therefore I will not use them for the actual prototype. For the more general analysis they are not a problem. For example:

(41) [e6] jot down that we have a meeting with mrs robinson between fifteen hundred and fifteen thirty

^^^^^^^^^^^^

Utterance 42 of e3 is incomplete, the end of it is unclear and will not be taken into account. The utterance marked with X2 seemed highly prompted:

[e1] can you cross off mrs robinson now from the priority list
^^^^^^^^

and was excluded.

In a range of utterances speakers used the term ‘to cross off’. This term is very likely to have occurred because of the design of the material used in the experiment (i.e. the prompt card icon used a cross).

Two subjects had to be told the term to-do list to be able to solve the tasks (d5, e4) another subject (e3) might have been prompted to use the verb ‘to remind’ by the experimenter using the verb ‘to remember’.

All the above criticisms will be taken into consideration during the statistical analysis.

The editing so far has produced two files ‘storylist’ and ‘wordlist’ (see next section 1.4.). The next step of editing was very difficult but nevertheless important. This was to remove all the language that was prompted directly by the material on the cards during the experiment. Take for example the utterance:

(25) [e1] could you make a note that paper international sells paper for two pounds per one thousand sheets

The utterance consists of two parts. First the part to address the function (‘could you make a note that’) and the second part which acts as an argument of the function (‘paper international sells paper for two pounds per one thousand sheets’). The first part is exactly the kind of data we hoped to collect, the second part is necessary for a natural collection of data. For the analysis however the second part is of no use. In fact it even is ‘noise’ to the actual data. Therefore, the next editing step was to replace all this noise by ‘noise tags’ (a list can be found in the appendix L “tags”). As many words as possible were replaced by a symbol as long as this did not affect the function language.

1.4. Processing

A program tool was created to produce a listing of all utterances, first sorted by their position during the experiment, then sorted by sample number (storylist_creator.main). The utterances are enumerated from 1 to 83. All the utterances that were prompted or done by the experimenter are being left out, so that only the free language is being analysed (see appendix G ‘data’). A second tool (wordlist_creator.main) was created to produce a word frequency list from the result of the first tool.

The next step was to prepare a file that excludes all words that are not specific to the command sublanguage, that is, words that were to be entered in the memo, diary, etc. or represented date and time. The file ‘revised_corpus’ contains exactly that information. After this the wordlist was extracted (by using the above tool), the output of this program can be found in the appendix H ‘Wordlist’.

1.5. Notes on the data

The reader of the data will find that the end of the dialogue is very abrupt, the dialogue suddenly stops. This could have been made a bit smoother, but it does not influence the data itself. All the transcripts are in the files d1-6 (driving simulator) and e0-e9 (experiment in the office environment). These contain only one utterance per subtask. In six cases subjects gave not only an utterance but also an alternative utterance that were considered worth adding to the corpus. These alternative utterances were included in the file 'x'. The appendix J "Alternative Phrasings" contains the information necessary to backtrack to their origin.

For convenience, "I'm", "I've", etc. are counted as tokens. We might change this according to future needs.

2. Analysis of the questionnaires

Sixteen samples were taken, three subjects were female, thirteen male. Nine subjects were aged 18-24, five 25 to 34 and one each 35-44 and older than 45. Professions ranged from a managing director to academics to students from a diversity of departments and an 'A' level student.

The following is a listing of all the questions that were asked in the debriefing questionnaire:

Questions

1	How familiar are you with computers?
2	How often have you used a palmtop computer?
3	How familiar are you with a Psion computer?
4	How often do you use a personal organiser (calendar, to-do lists, etc.)
5	How often do you work together with a secretary or as a secretary?
6	How difficult did you find it to interpret the icons?

Table 2 Debriefing questions

The results are shown in Figure 2. The columns show the number of ticks of the values 1 to 9 for the questions 1 to 6 (Q1 to Q6). Nine here represents high frequency or familiarity, one is a low frequency or familiarity.

In summary it can be said that although many of the subjects were used to a computer in general, they were not familiar with the concept of a palmtop computer and especially not with a Psion. Unfortunately, we were not able to convince anyone who is used to working with/as a secretary to take part in the experiment. One of the secretaries from the School of Computer Studies at first agreed to participate, but abandoned the experiment part-way through. From the experiment and the spoken feedback after the experiment it appears to the experimenter that subjects who where used to a personal organiser found it easier to conduct the experiment than others. The data is shown in Figure 2 and seems to support this correlation.

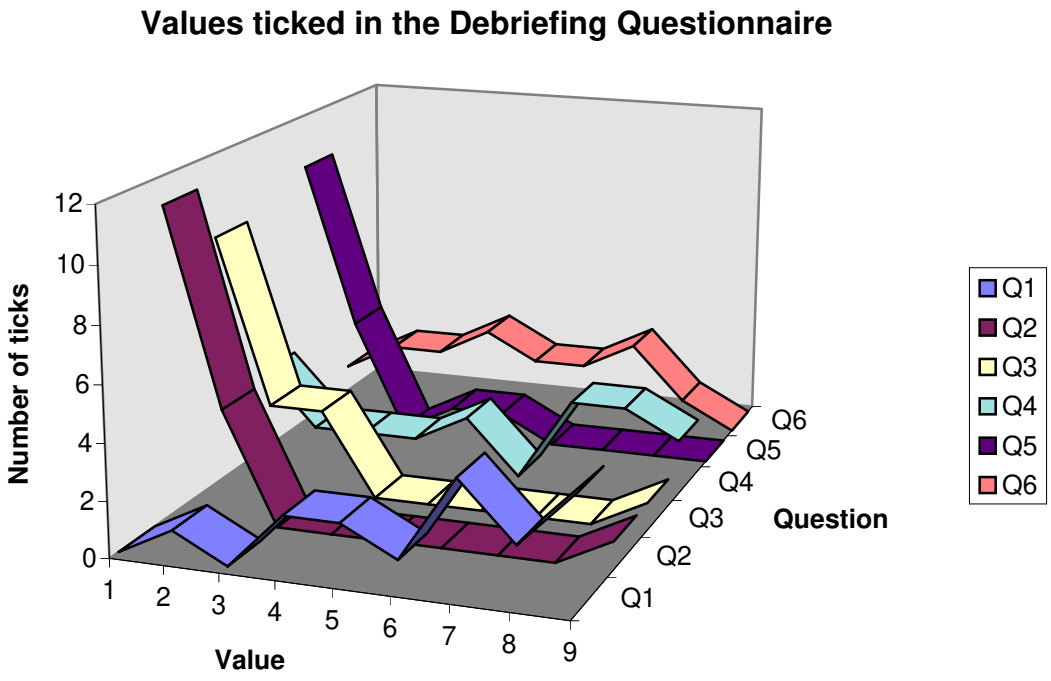

Figure 2 Debriefing questionnaire results

3. Analysis of the data

3.1. Terms

In the following the term language will refer to the language used to address the functions, not the more complex language for expressing the arguments of the functions. So for example:

Ring Mister Harrison

was analysed as:

ring Y

where Y is a symbol for the parameter who to call. Also, the term database will refer to the three databases, the to-do list, the memo and agenda function

3.2. Aim of the analysis

The aim of the analysis was to show the variety of the language used in the test settings. Most corpus collections tend to reveal a wider variety of expression than any individual's intuition is able to imagine. It was expected that the in-car setting is no exception. The analysis of the corpus should support or contradict this. In the long run this analysis will influence the project in the sense that the analysis will make predictions of feasibility possible. This includes preliminary evaluations of language models before they are fully developed and implemented.

3.3. Basics

This chapter will give an overview of the data that was collected and take a first step towards the analysis.

3.3.1. Figures

The Corpus consists of 16 samples, with a total of 495 valid utterances that are made up by 4843 word tokens (that is an average utterance length of 9.78 words). The lexicon consists of 229 words which are listed in the appendix H 'Wordlist' excluding 'parameter' vocabulary, e.g. 'Mister Harrison' types.

The corpus was divided into several sections representing the following different functions (more information on this can be found in the appendix K 'functions').

Function	Functionality	Example
1a	use the telephone	ring X
b	use the telephone again	ring X again
2a	retrieve a diary entry	when is my appointment with X
b	find a window for an appointment	when can I meet X
3	make a note in the diary	Note down that Y
4	delete diary entry	mark off Y from my diary
5	retrieve next item on to-do list	what is next on my to-do list
6a	add entry to the to-do list	write down in the to-do list that Y
b	and add entry to the to-do list	and write down ...
7	delete a to-do list entry	delete from my to-do list that Y
8	take a memo	take a note that Y
9	retrieve a memo	find the file on Y

Table 3 Functions and examples

The next table (Table 4) gives the number of valid utterances for every function. (Different weighting between the functions is intended.)

Function	1a	1b	2a	2b	3	4
number of valid utterances	78	16	120	15	47	31

Function	5	6a	6b	7	8	9
number of valid utterances	48	61	15	14	32	16

Table 4 Number of valid utterances per function

3.3.2. Utterance length analysis

Figure 3 shows the distribution of the length of the utterances. For every function the minimum, maximum and average number of words per utterance is given in Figure 3.

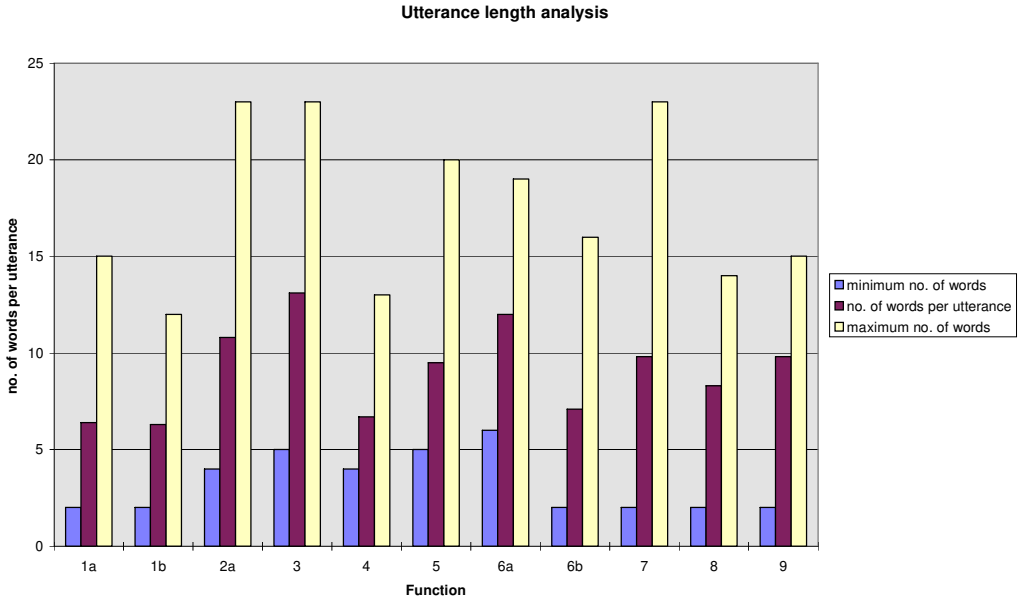

Figure 3 Utterance length analysis

This already shows that the language has some variety. Look for example at function 7. Maximum and Minimum are extremely distant from the average. That shows that there is no implicit rule about how to express this function.

3.3.3. Type-token-distribution

Figure 4 shows the Type-token-distribution as found in our data. It can be observed that this is a typical Zipfian distribution as described in (Zipf 36). Similar distributions can be found in (Hofland and Johansson 82) or (Hughes 94). Again, this shows that there is more to our language than what one would expect from a command language.

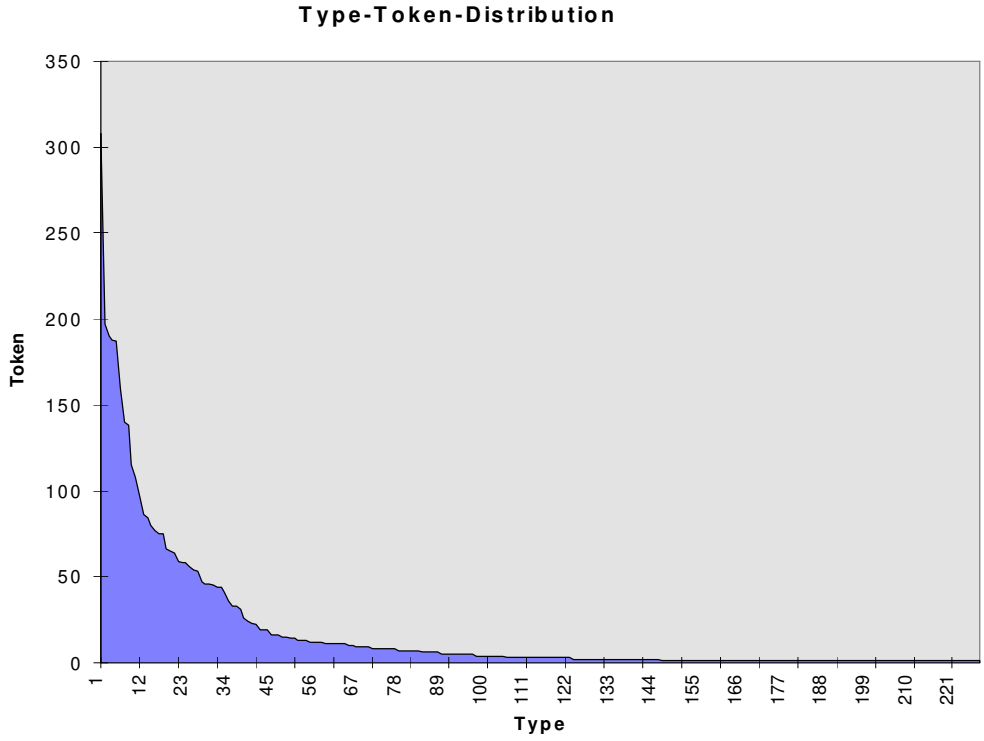

Figure 4 Type-Token-Distribution

3.4. Background of further analysis

After showing some intuitive evidence for the variety of our sublanguage, it is desirable to go on to find harder evidence. Below we consider various approaches to formally analysing the data.

We considered running a parser or a tagger on the corpus, then tagging/parsing the corpus by hand, and comparing the two results. This approach renders a measure of difficulty of the language. It may be assumed that, the more mistakes the tagger/parser makes, the more difficult the language must be. However, this is not necessarily true. A tagger or a parser is prone to have difficulties with certain language phenomena. Take for example the tagging of the word 'that'. Some taggers do have problems in deciding whether an item is a demonstrative pronoun or a relative pronoun. If one particular phenomenon is very frequent in the corpus then the measure will turn out to be biased by this one phenomenon. In our case the word "that" is very frequent (it occurs 97 times!). Therefore this method was not considered reliable. Also, as found in (Atwell 96) it is hard to compare parsers, because some parsers which have a very good parsing rate do not give much information on the text, whereas parsers that attempt a very detailed analysis often fail to give a parse for a sample. This makes choosing an off-the-shelf parser a research topic on its own.

Additionally, my personal intuition tells me that difficulty of language is not only a matter of using a difficult grammar. As a non-native speaker of English, my experience is that not only a complex grammar makes it hard to understand a sentence but also (and to no little extent) unknown words and idioms.

In the literature the problem of measuring the difficulty of language is known as the problem of perplexity. (Sharman 89b) for example takes a formal approach to measuring perplexity of language (based on (Sharman 89a)). The underlying idea is to measure the predictability of the next word (letter) of an utterance, knowing the beginning of it and the probabilities of occurrences of bigrams, trigrams, etc. The probabilities are calculated on the basis of a corpus. This is a fruitful approach, as it can be calculated by a machine and therefore is feasible for big corpora.

Soon, however, evidence was found that it cannot be applied in our case. (Gazdar 96) points out that "calculating such frequencies reliably requires enormous corpora even when the number of context words is restricted to two". Even for "very, very large corpora"(i.e. test data) this model has "important problems" (Jelinek 90). As we do not have a big corpus, bear in mind it was only intended to give us a guideline, an approach that relies only on statistical measures therefore is not applicable. This argument holds for both the tagger / parser idea and the n-gram frequency distribution.

Furthermore, as we are aiming at an application we also have to look at its requirements, in this case the specifications of the speech recogniser. Our Speech Recogniser, the PE500 is a black box. For the project itself this is appropriate as we want to create a generic model that can be applied to many different platforms and we even prefer to treat the PE500 as a black box in principle. For answering the question how the speech recogniser tries to match the phonetic transcription to the set of possible sentences this resembles a practical problem, as both relevant manuals (Speech Systems 94a) and (Speech Systems 94b) do not reveal any detail on this. The complexity of the problem however, suggests that the PE500 is not simply transcribing sequentially word by word. It seems likely that the possibility to backtrack after a part of the utterance has been transcribed is not neglected if it can improve the result of the analysis. Therefore a sequential "start to end" statistic would not return a good measure.

We did not see how a sequential "end to start" statistic used along with the "start to end" statistic could be used to make up for the above disadvantage of small test data. And as mentioned above, it was desired to have a generic model that does not depend on a specific speech recogniser.

As a consequence, it is sensible to look for other ways of discovering the entropy of the language used. For example the application of a conflating program which has already been developed at the School of Computer Studies (Souter 96). The program conflates two utterances into one as long as it can find a pair which is only different by one word. Its output is the list of the remaining rules (utterances).

A consultation of (Speech Systems 94b) shows that the PE500 expects an input similar to the above mentioned output. Internally, it then generates all the original utterances and uses them (not the rules) as a basis for the transcription. This means that the above analysis does not affect the number or the difficulty of different utterances that are being recognised by the machine. Consequently, this is a measure on how easily the utterance can be expressed by fewer rules and does not necessarily produce a good overview on the difficulty for the PE500.

Initial work with this algorithm showed no significant reduction of the language. The algorithm did not seem to be powerful enough to express clearly a measure of variety and it was not clear how to decide which other data would be appropriate to compare it with. On the other hand this approach does have the advantage that it works on the same type of units (namely sequences of english words, described by ASCII text) as are required as input for the PE500. Therefore, it was decided to develop a heuristic on the basis of this algorithm that will be described in Section 5.1. In order to further motivate this heuristic I would like to draw attention to a brief overview of the data in the following section.

3.5. Analysis based on a conflating heuristic

3.5.1. Motivation for the Heuristic

Already the first look at the statistics is a part of the analysis. The following table contains the number of unique utterances (or types) as compared to total number of utterances (or tokens) per function (the functions are described above and in the appendix K 'functions'). Note that the parameter language is regarded as noise in this case and is not taken into account.

Function	1a	1b	2a	2b	3	4
total	78	16	120	15	47	31
unique	46	16	112	15	47	29

Function	5	6a	6b	7	8	9
total	48	61	15	14	32	16
unique	48	59	15	14	28	16

Table 5 Number of valid and unique utterances per function

This already is an impressive result. Take for example function 1a. This is the function that addresses the telephone. There are 46 unique ways of expressing something like 'phone X'!
When surprised by these and similar figures one might want to have a look at what these utterances really look like. This then turns out to be surprising again, because many of the utterances seem to look very much like each other. For example:

can you telephone Y please
can you phone Y please
could you ring Y
can you telephone Y

(All have the same structure: Modal Subj Verb Obj (Itj))

Then the question comes up how much alike are they really? Is it enough to exchange just one or two words to obtain two identical phrases?

3.5.2. The Conflating Heuristic

In order to answer these questions the corpus was divided according to the semantics of the utterance (as described above or in the appendix K 'functions').
Then the following was applied to each sample separately:

> Step one: look at each utterance as a set of utterances that contains only that particular utterance
> Step two: pick an utterance
> Step three: compare this utterance with every member of every other set. If you find an utterance that can be translated into the chosen utterance by one of the following actions: introducing a word, deleting or replacing a word, then merge the two sets.
>
> Repeat steps two and three until every utterance of every set has been compared with every other utterance. (Remark: to indicate this, every utterance that has been looked at may be marked.)

In order to have a more graphic result, the same heuristic was run on the corpus with the merging condition "if you find an utterance that can be translated into the chosen utterance by any *two* actions of introducing a word, deleting or replacing a word, then merge the two sets".
Be aware of the fact that this heuristic is more powerful than the conflating program mentioned above! The heuristic merges two sets that contain a pair of similar wording. This does not necessarily mean, that every utterance in the set can be transferred by the merging condition into an utterance of the opposite set. Take for example:

1. can you phone Y
2. can you telephone Y
3. can you telephone Y please
4. could you ring Y

According to the heuristic with merging condition I these utterances will be merged into two clusters (utterances 1-3 in one cluster, the last utterance in a second). Imagine a fifth utterance is contained in the corpus:

5. can you ring Y

Then there is a link from number 4 to 5 and from 1 to 5. This means that all are collected in one cluster. It is possible to think of a number of sentence that form a chain in the sense that utterance 1 and 2 can be merged, 3 and 4, 5 and 6, and so on, but not 1 and 3, 2 and 4, 3 and 5, etc. As a

result, this heuristic collects the utterances in many different clusters if the words and their ordering are distinguished. If however the language used is very closely linked and it is possible to find connecting sentences, the result is a small collection of clusters. If the language is very varied these connectors will be missing!

The result of the application of this heuristic is shown in Figure 5. For every function there is one bar for the total number of utterance, the number of individual (unique) utterances and the number of sets after applying the conflating heuristic with one (I) and two (II) actions in the merging condition.

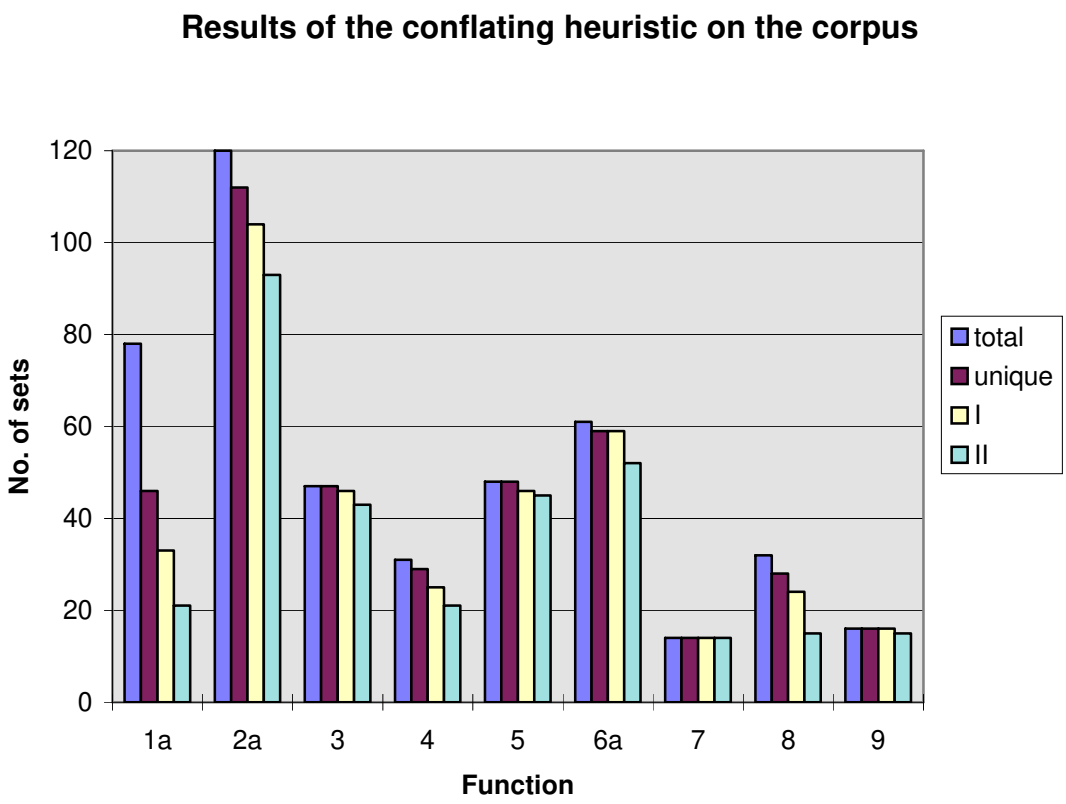

Figure 5 Results of the conflating heuristic on the corpus

Please note that the functions 1b), 2b) and 6b) are not included in Figure 5 as they served a different purpose than the above functions. 1b) is a function basically equal to 1a), its position in the dialogue however suggested a reference back to the earlier action. 2b) was included in order to find out how a very complicated action would be expressed. 6b) suggested a continuation of one subtask into a second one. The interest here lay in the linguistic means used to express this continuation or whether people would simply not express this continuation.

These three functions were all included as a matter of interest, to find out basic evidence. The number of utterances is too small to be suitable for the variety analysis. However, in order to make the complete information available a similar chart for these functions is inserted with Figure 6.

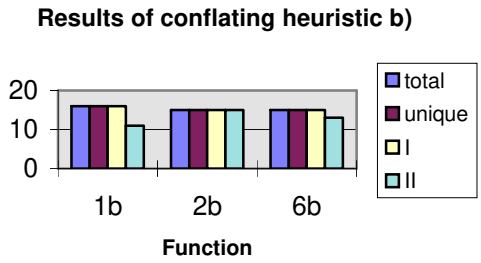

Figure 6 Results of the conflating heuristic on the corpus b)

3.5.3. Conclusion of the conflating

This analysis shows that the language used by the subjects is more complex than it looks at the first sight. It has been proven that utterances for simple actions such as "make an entry in my to-do list" (function no. 6a) are very diverse. Even the telephone action set that is most easily conflated, can only be compressed from 78 to 21 clusters. In other words, we have 21 sets with an average of 4 utterances that are very distant to all the other 20 clusters. Now the question arises, what makes them so different. Is it just a different word order, or are there more interesting phenomena hidden in the utterances? This leads to our second investigation.

3.6. The phrase tagging analysis

This second analysis is meant to be orthogonal to the previous one. In the last discussion it was shown how different the utterances can be if you allow for variation on the level of words, their order and occurrence. The second analysis should evaluate the previous findings by looking at how diverse the word choice is for a given semantic item. In other words, measure how many alternatives are for the verb for accessing the telephone function, how many alternative words for the diary function. etc. Later on, the conflating heuristic will be run on the tagged utterances. If the conflating result is very low this will show that the variation is not on that level. If however there will be a more than significant conflation this will tell us that as soon as the variation on the word level factored out, the language is a lot simpler.

In order to do this, the corpus is again being divided into the functions:

Function	Functionality	Example
1a	use the telephone	ring X
b	use the telephone again	ring X again
2a	retrieve a diary entry	when is my appointment with X
b	find a window for an appointment	when can I meet X
3	make a note in the diary	Note down that Y
4	delete diary entry	mark off Y from my diary

5	retrieve next item on to-do list	what is next on my to-do list
6a	add entry to the to-do list	write down in the to-do list that Y
b	and add entry to the to-do list	and write down ...
7	delete a to-do list entry	delete from my to-do list that Y
8	take a memo	take a note that Y
9	retrieve a memo	find the file on Y

Table 6 Functions and examples

3.6.1. The tagging scheme

In order to receive the different words and phrases for every slot of interest it was decided to name the slots and replace all the words and phrases by these tags. This procedure makes sure that all words are being replaced by a tag and we have an assignment for every word to a slot. Adequate sources were looked for and the corpus was consequently tagged by the AMALGAM multitagger (amalgam WWW) (Atwell et al. 94) that returned eight annotations according to eight different international tagging schemes.

These tagging schemes are all traditional tagging schemes and as (Atwell 96) concludes, every application has its own requirements that have to be taken into account while choosing a parser and therefore a tagging scheme. In our case this means that all the traditional syntactic word classes are insufficient for delivering insight in the perplexity of the language. It is necessary to have a more abstract scheme that tags whole phrases according to their semantics. As this is only a small corpus study with a very specific application, it seemed appropriate to not adapt a completely different parsing scheme but devise a new specially-designed one. First of all tags were designed for the particular objects of study: a noise tag for the parameter language, tags for phrases that addressed specific functions. Later on, the remaining text was divided in other semantic units: introduction, specifications, modifiers, etc. Note that these are not 'traditional' syntactic categories as used in parsers or large scale corpus annotation (see for example (Atwell 96)) and phrase boundaries do not correspond to standard syntactic phrase boundaries.

An example on how the utterances will be replaced by tags is the following:

can you

will be replaced by

IN

which is a tag for an introduction.

could you

is another example of an utterance for this category.

Here is Table 7 with a complete description of the tagging scheme:

Abbr.	Type description	No of types	Example
IN	introduction to a sentence	11	could you
MOD	modifies the verb	65	(write down)the fact that

Verbs:			
VND	used for expressing: Note down	19	write down
VPH	addressing the telephone	15	get Y on the line
VTL	for: written down in todolist	3	planned
VC	for expressing: cancel	12	mark off
VQU	for expressing the fact of a query	10	check to see
VM	for :take a memo	3	file (that information)
VRM	for: retrieve a memo	8	get back
Query beginnings:			
QUG	General query beginning	9	what have i got
QUF	Query if there is free time	16	am i free
QUT	Query what is on at that time	21	what am i am doing
QUY	Query for the TD of an item Y	14	what time is
QTL	query for the to-do list	6	what plans have i got
QDB	query to a database	19	what i have got to do
Parameters:			
SOU	specification of the source (database)	73	my notepad
Y	anything that is in the database	*	(phone) mr harrison or: british papers sell ... or: appointment with X etc.
TD	specification of Time and Date	97 (!)	tomorrow morning between T and T
IT	specification of an item in a database	1	after my Y
REFD	reference to a date mentioned earlier	5	same day
REFY	indirect reference to Y	9	(jot) that (down)
Various:			
PL	replaces "please"	1	please
ADD	not necessary for the function itself	20	thank you
TOO HARD		**	could you tell me please
if i			can make it home early today

(*) were deleted

(**) had only to be applied three times in the whole corpus

Table 7 Tagging scheme

The tagged corpus can be found in the appendix L 'tags'. The tags were carefully developed and the corpus was methodically tagged manually. However, three utterances did not fit into the scheme (**). It was decided not to force the scheme to fit to these utterances, as they referred to the semantics in a very abstract way. The Y tag (*) refers to any part of the utterance that is supposed to be part of the database. For example, it was not intended to look at 'mister harrison' or 'to write a letter to paper international' as part of the functional language, but as part of the language that describes the parameters to the functions.

3.6.2. Discussion

The following Figure 7 shows the above figures as a chart:

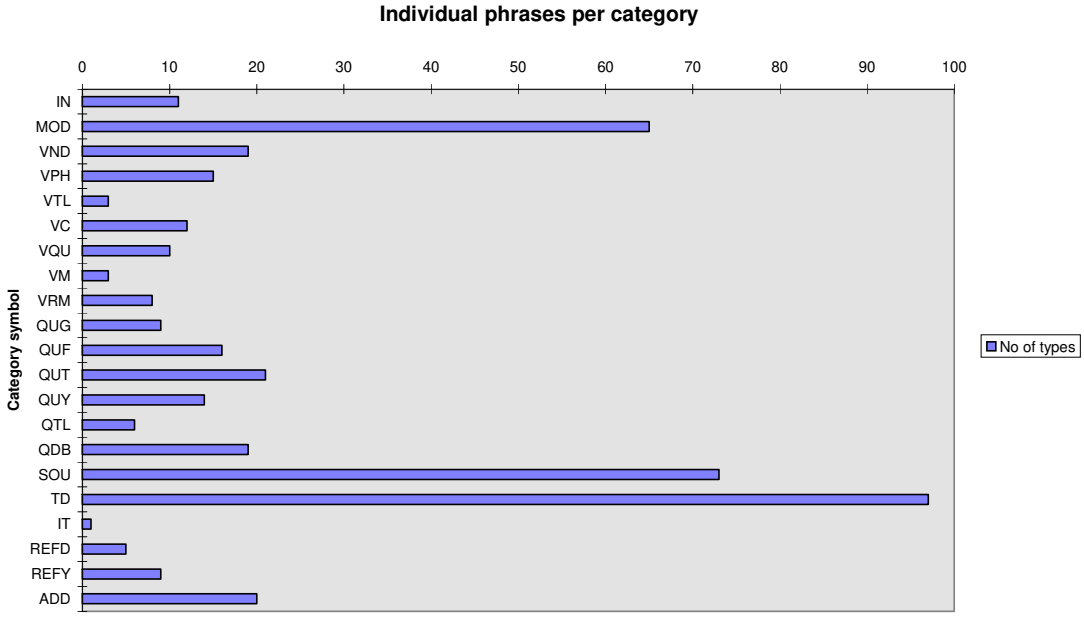

Figure 7 Number of individual phrases per category

The categories "modifier", the source specification (73) and the time and date specification do offer high richness in the sublanguage. The first can be expected to do so, as it is very general category. The two latter however are made up by a genuinely diverse sublanguage. Most surprising must seem the variety in the time and date category: there are 97 different ways of combining dates and times and this after numbers, weekdays and ordinals have been replaced by tags. The total number of different words plus the tags is forty.

A closer look at the source category reveals the different expressions used for defining which database is the object of a query or a modification:

Diary:	*agenda*
	diary
Memo:	*file note*
	notepad

	notes
To-do list:	*list*
	list of things to do
	plan
	planner
	priorities list
	things to do
	to-do list

This list makes the topic of identifying the database look easier to handle than it is. For example, the word agenda was used for the diary, as well as for the to-do list. Thus, there is still a problem of ambiguity on word level. Furthermore, some utterances clearly were aimed at the modification of a database, but did not contain a clear indication of which:

can you write down that british paper sells the cheapest paper

Others contained information on the source on the semantic level:

file the information

(Here the verb together with information may imply that the memo function is addressed.) Of further interest is the verb section in the above chart/table. The figures here represent the number of different lexical units. This means that there are for example 19 different verbs being used for saying “write down”. A similar finding is true for the simpler task of requesting a phone call (15 different lexical units).

This is evidence that we encounter a varied and sophisticated language. The next step was to run the conflating heuristic on the tagged corpus.

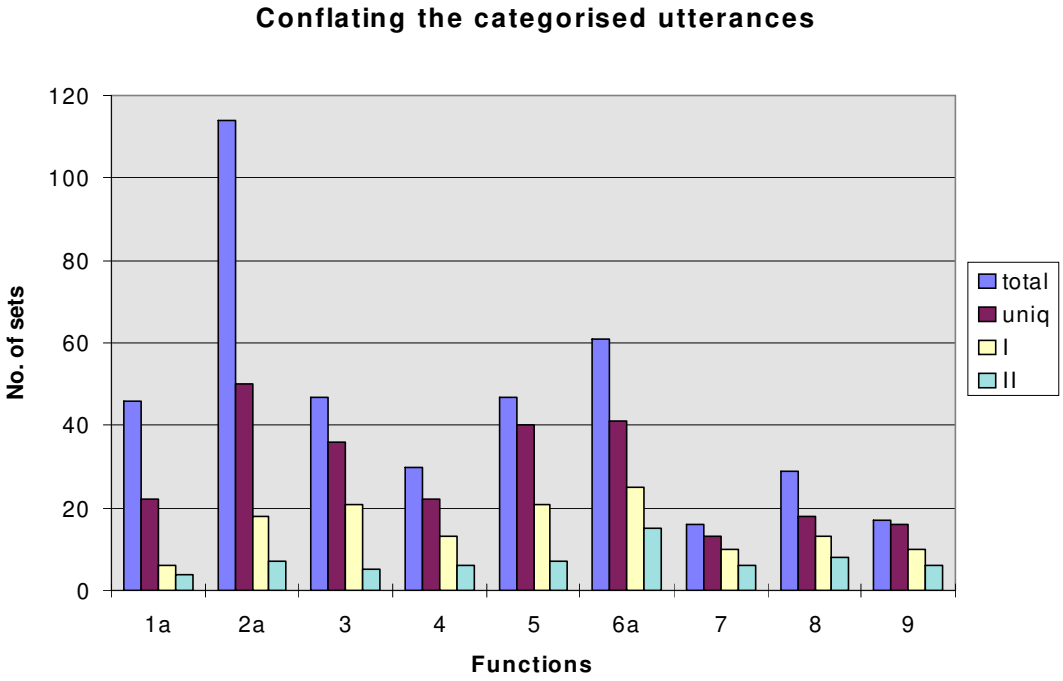

Figure 8 Conflating the categorised utterances

The heuristic was carried out in the same fashion as described in the above chapter. For every function there are four bars, one for the total of the phrases of this particular function, the second for the number of unique phrases, bar three and four are the results of conflating with merging condition I and II respectively.

It can easily be observed that conflating on this level returns highly conflated sets.

The following Figure 9 shows the result of the II conflation from a different point of view. It shows the percentage of the reduction, e.g. function 2a was reduced by 93.9 percent during the conflation.

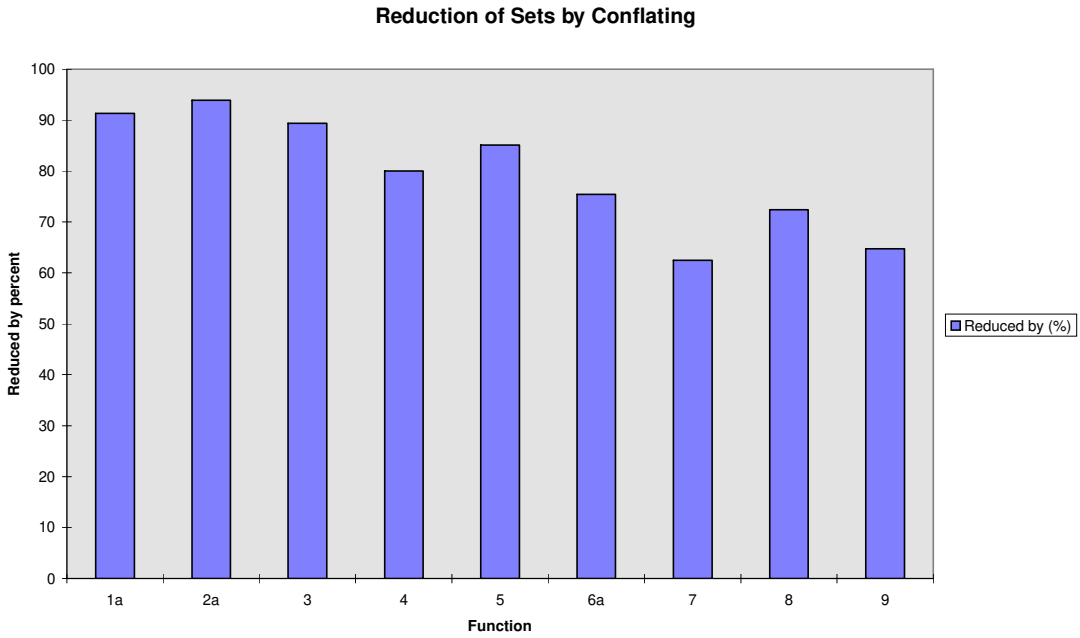

Figure 9 Reduction of sets by conflating

This delivers evidence that on the one hand the grammar of the tags is not as complex (it can easily be conflated) , the word level on the other hand is very difficult.

4. Conclusion

The data gathered gives strong evidence that the sublanguage encountered is of diverse nature at its lexical level. It consists not only of a complex grammar but also uses a wide range of words to express even simple functions. This in turn has consequences for our target application, in-car use of the Personal Organiser via speech recognition. Ideally we would like users to have no constraints on what they say to their Psion, to be allowed to express functionality in 'ordinary English' in whatever vocabulary and grammar 'comes naturally'. However, our evidence shows that 'naturalness' is far more complex than might be expected even for an apparently simple command and control sublanguage.

This finding is supported by the fact that we did restrict the language to the functionality part and left out the more complex part of the language that describes the parameters for example for the memo function, where the language is potentially completely unconstrained. And, what is more, dialogue specific features as in the utterances 'try again' (referring to telephone someone again) and 'and on the same day three to four' (querying the diary for a certain on a date mentioned in an earlier stage of the dialogue) will contribute to the complexity of the language used and have not been studied yet.

However, above the lexical level, there is far more homogeneity with respect to functional/semantic labelling.

The consequences of these results for the incorporation of the sublanguage with the PE500 are far reaching. As the PE500 transcribes on the lexical rather than the semantic level, exactly the variety of the lexical level will make the task seriously difficult.

Chapter 6 Evaluation of a simple language model with a speech recogniser

1. Aim of this experiment

This experiment was conducted in order to evaluate an upper bound on the recognition rate of a state-of-the-art speech recogniser, given a minimally simple language model on a typical personal assistant dialogue. The corpus collected in the earlier stage served as the source of this language model.

2. Method and Procedure

Speech System's PE 500 served as a platform for the experiment. The PE500's own speech collect mode was used and its parameter settings for the recognition were chosen according to (Churcher 95b), in order to reach optimal results. A more detailed description on how to use the PE500 can also be found in there. The experiment was supervised in order to make sure that subjects uttered the phrases correctly. If a mistake occurred, that particular phrase was recorded again. Five male and one female speaker served as subjects. Their task was to read out utterances that had been taken from the Corpus. This set of utterances consisted of four utterances from each function 1a, 3, 4, 5, 6a, 7, 8 and 9 and 6 utterances from the bigger set of utterances from function 2a, which gives us a total of 38 utterances. For reference here is Table 8 with a listing of the functions.

Function	Functionality
1a	use the telephone
2a	retrieve a diary entry
3	make a note in the diary
4	delete diary entry
5	retrieve next item on to-do list
6a	add entry to the to-do list
7	delete a to-do list entry
8	take a memo
9	retrieve a memo

Table 8 Functions

The samples were given the initials of the subjects as names. For recognising speech with the PE500 it is necessary to identify a grammar that describes all possible utterances. To estimate an upper bound of the results, it was decided to use just those 38 utterances as rules in the grammar. The utterances were chosen from different sets that resulted from the conflating heuristic level 2. Remember this conflating heuristic divides the corpus into sets of mutually distant utterances.

All this was to ensure that the task is as simple as possible for the PE500.

3. Results

Figure 10 displays the result of this minimum test on the PE500. Ninety percent of the 228 utterances were correctly transcribed. In 5 percent of the cases the PE500 selected the right function but failed to name the right rule for doing so. Another three percent failed to be assigned to the right rule and for the remaining two percent the SR was found incapable of assigning the utterance to any rule at all.

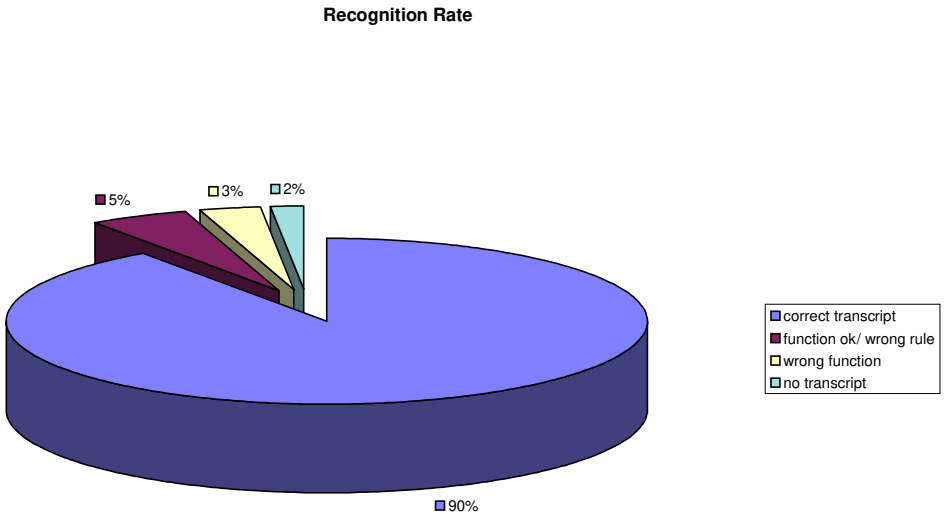

Figure 10 Recognition Rate

In order to illustrate this, examples for each of the three error categories will be given. The first line is the utterance as it was uttered, the second is the transcription that is returned by the SR.

- for this utterance of the sample 'jsh' the correct function was selected, but the rule that is returned for justifying the choice is wrong:

  can you tell me what i am doing at four please
  what do we have to do at four o'clock today

- here not only the wrong rule was selected, but also the wrong function, taken from sample 'gec'

  can you make a note in my notepad that mr harrison does the cheapest paper
  could you tell me which company does the cheapest paper

  (uses the query function instead of the function for taking a memo)

- the following utterance of sample ‘esa’ was not recognised, i.e. not a single word could be transcribed:

  can you get me the file on the cheapest paper please

4. Conclusion

From this experiment it follows that the performance of the speech recogniser is unacceptably low. Several reasons lead to that conclusion.

The language model that was used here was very simple. Furthermore, subjects were reading from a script which made them speak very slowly and clearly. As noticed by the transcribers of the Polytechnic of Wales Corpus (Fawcett and Perkins 80), subjects tend to be aware of the special situation of being recorded and therefore tend to speak unnaturally. A similar tendency has been reported in (Roach 90), who found that in experiments of speech recognition there is a degradation in speech over time.

As said before, the language model here is very simple. Only 38 rules existed for the PE500. However our corpus exists of more than 400 mutually different utterances. It seems sensible to assume that the overall performance will drop if the whole set of rules were implemented. In particular the category ‘number of function correct but utterance wrong’ is worrying. Here the speech recogniser selected the right function, but it uses the wrong rule for justifying its choice. Subsequently, when the complexity rises, this may well be looked at as a failure of correctly recognising speech. In short, we have ten percent failure of recognition. This is a more than significant error rate for such a simple task. As (Johnson 85) argues, such an error rate will soon be discovered by potential users and the product will most likely be rejected. He writes: “a system has to be at least 90% successful in parsing queries from users to be acceptable, but even so there is still an element of uncertainty”. How bad user’s response to a less successful product can be, was shown by the ridiculing in the computer press of Apple’s ‘Newton’ handwriting recognition system ((Johnson 94) for example calls it the ‘widely-lampooned Achilles heel’). In our case, we can just about offer a 90% accuracy rate, but this is the absolute upper bound. For every further sentence that has been uttered during the corpus collection experiment and gets included in the grammar of the PE500, the recognition will more and more deteriorate, as the search space gets more and more ambiguous.

In summary, it appears that with a small grammar it is possible to create the proposed system. Still, it will be making crucial mistakes even in the simplest case and we expect worse accuracy in more complex contexts. We can argue here, just as (Churcher, 96) did for the air traffic control domain, even if this is not a safety critical application that state-of-the-art speech recognition in as much as it is represented by the PE500 is making unacceptable mistakes for the personal assistant domain when it comes to unconstrained language recognition.

Chapter 7 Conclusion

1. Achievements

We started off with a very difficult task: free unconstrained speech recognition in the in-car personal assistant domain. It was shown by a survey on current speech recognition work that natural language interface technology does have a future in the area and is worth pursuing.

The approach of this thesis is corpus based. As no corpus for this domain previously exited, an elicitation experiment was designed and a corpus collected. The data collected is very interesting and delivers substantial information that will be used for deciding questions crucial to the project. For example, the data can be used for solving questions like how consistently did subjects use certain terms for certain functions (compare the numbers of uses of 'call' to uses of 'ring').

What is most important the data gives strong evidence that the sublanguage encountered is of diverse nature at its lexical level. It consists not only of a complex grammar but also uses a wide range of words to express even simple functions. The evidence shows that 'naturalness' is far more complex than might be expected even for an apparently simple command and control sublanguage.

During the discussion on the experiment, possible applications for a discourse management that would further improve the speech recognition were given.

Finally, a prototype was implemented to demonstrate and evaluate the application. It was found that without further enhancement of the product (as for example with discourse management) the performance of the speech recogniser is unacceptably low. In short, we have ten percent failure of recognition. This is a more than significant error rate for such a simple task. As (Johnson 85) argues and which is still valid today, such an error rate will soon be discovered by potential users and the product will most likely be rejected. Additionally, in our case we have to expect that the error rate when working with a more complex language model will even increase.

It appears that with a small grammar it is possible to create the proposed system. Still, it will be making crucial mistakes even in the simplest case and we expect worse accuracy in more complex contexts. We can argue here, just as (Churcher 96) did for the air traffic control domain, even if this is not a safety critical application that state-of-the-art speech recognition is making unacceptable mistakes, when it comes to unconstrained language recognition.

As a consequence this work expresses the need of further sophisticated means for language recognition on more abstract levels.

2. Limitations

In order to have a simple starting point the sublanguage that was researched on was restricted to the functionality part and left out the more complex part of the language that describes the parameters for a function, where the language is potentially completely unconstrained. And, what

is more, dialogue specific features as references and anaphora can contribute to the complexity of the language used and have not been studied yet for this specific problem.

Unfortunately, the subjects in the experiment are not fully representative for the target group. For future work, it might be necessary to rethink the procedure of research and it might become necessary to have a completely representative corpus.

It was not possible to take these three interesting phenomena into account: firstly, the fact that subjects do the same task a second time, the phrasing is not exactly the same. Quite the opposite is true, with a very high probability a completely different utterance will be the result. Secondly, what happens, if a task refers directly to a previous one? A variety of linguistic phenomena can be expected judging from the data in the corpus, but it was not possible to study them so far. Lastly, following many other researchers in the natural language interface field, attention should be paid to dialogue management. It would allow further restriction of the grammar for the speech recogniser and also provide a means for run-time disambiguation.

3. Suggested future work

This work is the starting point for more sophisticated language modelling and discourse management that might be able to cope with the low recognition quality. The convergence effect in human dialogues could be included in the dialogue manager as described earlier. Also it could help disambiguate the input by asking follow-up questions and narrow down the search space for the speech recogniser. Furthermore, it could improve the ergonomic quality and make the user more confident by giving appropriate feedback. To achieve this it should be able to handle misunderstandings and communication failures, which are in themselves an interesting object of study. The corpus and the work of this thesis will provide material to test the dialogue manager and evaluate it.

The question of giving feedback leads to a further topic that has not yet been covered: the role of speech output.

Still there remains the problem of people using full English language for appointments and memos which cannot be recognised so far. Therefore it is in our interest to find ways of coping with this. In the special context of the Psion, it should be considered to not recognise the speech that is being used for the parameter language, but find a way to transfer the audio data to the Psion and make it accessible from there, thus by-passing this problem.

Although it follows easily that the product will not be accepted by the user if it makes too many errors. Future work could include a survey on how many errors exactly are still acceptable.

In summary the positive contribution of this Thesis is to point out potential pitfalls to future researchers in this field. Natural Language Processing in the personal assistant domain turns out to be a very difficult task.

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(Willcocks 87) Willcocks, Leslie et al. *Computerising work.* Paradigm, London, pp 73. 1987.

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WWW references

This section will be used to give the URLs of the web pages that have been used for collecting information.

(amalgam)	http://agora.leeds.ac.uk/sean/amalgam/amalghome.htm
(comp.speech)	http://svr-www.eng.cam.ac.uk/comp.speech/
(vodis)	http://werner.ira.uka.de/VODIS
(Wildfire)	http://www.wildfire.com/

Appendix A Abbreviations used

NL	natural language
NLI	natural language interface
NLP	natural language processing
PA	personal assistant
SR	speech recogniser
VUI	voice user interface

Appendix B User's wishes

Here is an excerpt of the re-postings to the newsgroup comp.sys.psion to the query:
"what would you like to be able to do, if you could address your Psion in the car via a speech recogniser?"

I'd want to tell it about cost and quantity of fuel at fill ups, oil changes etc. and have it remind me of maintenance. I'd expect current and average fuel consumption values etc.

<snip>

How about some navigation software that says "next left" or "straight on at the traffic lights" whilst you're driving around in the car? :-)

Just the speech-synthesis side would be useful - the Psion could read out appointments at the appropriate times.

<snip>

If I were driving, I'd want to hear the directions, rather than see them. (Unless a map could be projected onto the windscreen.) So being able to navigate through an audio list of directions by voice control would be very useful. If this could be linked up to Autoroute, all the better.

<snip>

Read a document to me.

Ability to record memos, even in the middle of navigating.

Audio calculator - audio equivalent of the Eval function in Word etc.

Open a database and search through it.

Phone home and get the Psion to set up a video recording that I'd forgotten!

Get the Psion to say "mmm-hmm" in my voice whenever it thinks it hears a non-question. Then when I got bored with a phone call I could go off and do something else :-) (I guess, for most people that would apply to, just having it say "mmm-hmm" every few seconds without listening would be (a) sufficient and (b) just like me anyway!)

Perhaps, have the Psion in a more-or-less-off state where it's consuming little battery power, but monitoring the mike for a "turn on" signal. Difficult to see how this could be done with little power drain.

Many of these things would require tying the speech interface into
the standard apps, or the files that they use; I'd prefer not to have
to use (eg) a different database app, unless it could read the same
files as Data. This includes the System screen - some way to navigate
through apps, start them up, close them, ...
I'd also like to be able to work speech into my own apps; a trivial
and rather contrived example would be a "random CD selector".

I'm amazed to hear you say you're really doing this - voice
recognition is hard enough, without it being in a noisy environment
such as a car. Still, it's fun dreaming... and one day, it will happen.

<snip>

I'd like it to:

Read out directions.
Look up phone numbers (and dial them preferably).
Tell me my expected arrival time (if I shout out the mileage.
Warn me if I am going to be late.
Tell me what appointments I have later in the day.
Tell me the frequencies of the various radio stations in the area.
Allow me to shout out to-dos when I think of them.
Tell me how thin I'm looking at the moment.

<snip>

But talking into the Psion....It would not work in a car,
I think, as there is too much surrounding noise.

But it would be useful to be able to take down number plates
of bad drivers on the M25 so that they could be reported.

<snip>

I was just thinking about this on the way in to work today.

If I had a computer built into my car, I'd want it to have a heads-up display.
Next, I'd want it to be connected to my cellular phone for net access.

Ok, with the infrastructure in place, here's what I would want in the way
of software:

1) Email reader - it should read my email to me with a text -> speech
engine. The display should have a special large character mode so that
the words scrolled by at a readable size. Then I could by voice instruct
what should happen next "Delete message", "Refile to xxxx", "Reply to
at office", "Forward to xxxxx", etc.

2) Route planning. I give it an address, it plans my route based on road
conditions, traffic conditions, etc. It should contact some database to
get up to date information on traffic delays, speed limits, traffic light
information, etc.

3) Police scanning. I'd love it if my little computer could track where the
local policeman were sitting around (check the radio activity, know police
bands, radar scanning, etc.). Perhaps the local police supply this
information in a computerized format? :-)
4) Radio tuning guides. I'd like the computer to show me the channel number,

call letters, and a brief music type. It should then interface with my radio. For instance, I say "Jazz stations", the computer consults a little db and gives me a list of jazz radio stations.

5) Dial the cellular phone - I say "Dial Sam" and the little computer would dial Sam.

6) With all of this audio activity going on, the little computer should have and audio cross patch panel to make sure that only the relevant information was audible - for instance, it should mute the radio when giving route instructions, it should mute the radio when receiving a phone call, and if it cannot understand, it should mute the radio and politely ask "Say again, I could not understand your last comment".

<snip>

I like the idea if a gps thing attached to mapper3a.
It would be really easy to trace the roads as you go thus
updating the map - will this be done?

<snip>

I've had a couple of thoughts fairly minor though....

1) How about being able to turn the Alarm off by sound
ie shouting, clapping, talking.

2) Can the Psion be made to speak ie speech sythesis not recognition.
I use computers with Primary school children and a lot of word processors
come with a speech facility. This is extremely useful feedback for kids.
My thought was that if it could be done on a 32k BBC (I saw this 8 years ago)
why not a 1 or 2mb Psion ?
Perhaps the sound system isn't up to it ?

Appendix C Corpora

The following is a list of up-to-date corpora. It should give an impression of how varied the application of corpus research is by showing how different the corpora are that are available.

BNC

Excerpt from WWW:

> "British National Corpus:
>
> This corpus is the end-product of a unique three-year collaboration, involving Oxford University Press, Longman, Chambers-Harrap, Oxford University Computing Services, Lancaster University and the British Library, with funding from the DTI and SERC. It contains 100 million words, from over 4000 different texts carefully selected to give maximal coverage of the varieties of modern British English, both spoken and written. The corpus is automatically tagged for part of speech, using the CLAWS stochastic parser developed at UCREL, and marked up in SGML, following the TEI Guidelines for corpus encoding."

The written speech part of the corpus was collected by using the obvious resources (newspapers, books, speeches, etc.). More interesting is the way the spoken speech part was collected:

> "The Demographic part of the Spoken Corpus

A total of 124 volunteers were recruited by the British Market Research Bureau. The volunteers came from four social groupings (AB, C1, C2, and DE). There were male and female volunteers from a wide range of ages, and they lived at 38 different locations across the UK. Recruits were chosen in
such a way as to make sure there were equal numbers of men and women,
approximately equal numbers from each age group, and equal numbers from each social grouping.
Recruits used a personal stereo to record all their conversations unobtrusively over two or three days, and logged details of each conversation in a special notebook. Those who took part in the recordings were asked after the conversation to give permission for their speech to be included in the corpus.

The Context-governed part of the Spoken Corpus

The intention was to collect roughly equal quantities of speech recorded in each of the following four broad categories of social context:

Educational and informative events, such as lectures, news broadcasts, classroom discussion, tutorials. Business events such as sales demonstrations, trades union meetings, consultations, interviews. Institutional and public events, such as sermons, political speeches, council meetings, parliamentary proceedings. Leisure events, such as sports commentaries, after-dinner speeches, club meetings, radio phone-ins."

To be found at:
http://info.ox.ac.uk/bnc/

The BABEL project
This project is (as the ECI) an european one, but with links to the five eastern european languages Bulgarian, Estonian, Polish, Romanian, Hungarian. It was launched just recently.

To be found at:
http://midwich.rdg.ac.uk/research/speechlab/babel/

CHILDES
A collection of utterances of children of different age groups. The total size of the database is approximately 150 megabytes. The corpora are divided into six major directories: English data, non-English data, story-telling or narrative data, data on language impairments, data from second language acquisition, and data not transcribed. (MacWhinney, 1995)

ECI
Excerpt from WWW:
"The European Corpus Initiative (ECI) was founded to oversee the acquisition and preparation of a large multilingual corpus, and supports existing and projected national and international efforts to carefully design, collect and publish large-scale multilingual written and spoken corpora.

ECI has produced Multilingual Corpus I (ECI/MCI) of over 98 million words, covering most of the major European languages, as well as Turkish, Japanese, Russian, Chinese, Malay and more. The primary focus in this effort is on textual material of all kinds, including transcriptions of spoken material.
German newspaper texts from the Frankfurter Rundschau from July 1992 - March 1993. Provided by Universität Gesamthochschule, Paderborn, Germany. Approximately 34 million words.

French newspaper texts from Le Monde, consisting of material from September 1989, October 1989,and January 1990. Provided by LIMSI CNRS, France. Approximately 4.1 million words

Extracts from the Leiden Corpus of Dutch, consisting of newspapers, transcribed speech, etc. Provided by Instituut voor Nederlandse Lexicologie, Leiden, Holland. Approximately 5.5 million words

International Labor Organisation (ILO) "Official Bulletin, B Series". Vols. LXVII(1984) - LXXII(1989). Parallel texts in English, French and Spanish provided by the International Labor Organisation. Approximately 5 million words. "

To be found at:
http://www.cogsci.ed.ac.uk/elsnet/eci.html

HCRC Map Task Corpus
The HCRC Map Task Corpus was collected in order to explore human dialogues and subdialogues when solving a task in co-operation with each other. (HCRC: Human Communication Research Centre)
Therefore the Map Task was designed. In an experimental environment one subject received a simple map with a few easy to recognise icons, for example "pine forest", "bakery", "cliffs", etc. A second subject received the same map including a tour. The task was to describe this tour to the first subject, so she could draw the same tour on her map. One half of the teams of subjects could see each other, the other did not. At no time could they see each others map. The whole conversation was recorded and is being tagged for the specific transactions committed during the task (Isard & Carletta, 1995).

Marsec
The Machine Readable Spoken English Corpus is based on the SEC. The SEC is available in several versions, ranging from standard orthographic text to audio recording to prosodic transcription (Knowles, 1993). To get Marsec, a phonetic transcription with links to the digitised source was added.

ShATR
The Sheffield-ATR multiple-simultaneous speaker database is another corpus collected using a task. In (Brown, 1994) the authors describe the task as follows.
Two teams of two speakers had to solve crossword puzzles. One speaker of a team had the solution and the other was allowed to ask her questions. A fifth speaker had both solutions and was allowed to give hints. A total of eight microphones was used to record the conversations. This was essential, as the original aim was to record auditory scenes of multi-speaker environments
Now the Corpus is of linguistic and dialogue research interest, too.

TRAINS
As described in (Heeman, 1995), this corpus consists of task-oriented dialogues set in the TRAINS domain. A user collaborates with a planning assistant to accomplish some task involving manufacturing and shipping goods in a railroad freight system. Altogether, there are 98 dialogues included, collected using 20 different tasks and 34 different speakers. This amounts to six and a half hours of speech, about 5900 speaker turns, and 55000 transcribed words.
The VERBMOBIL Project
This project is concerned with collecting a new database of spontaneously spoken German.
The desired corpus contains recorded dialogues between two german speakers within a certain task. In this case the task was the planning of several business dates (meetings, dinner, business trip, etc.).
The orthographic transcription ('transliteration') of each dialogue is created by phonetically skilled listeners, including noise classification and all effects of spontaneous speech (e.g. hesitations, interrupts, ...). Up to now 6 CDROMs, each containing about 500 MB data were distributed. The corresponding transliterations are distributed on the official VERBMOBIL ftp server in Saarbrücken.
This database and the corresponding transliteration are the basis for the development of the speech recogniser and the research of dialogue handling, semantics and syntax of spontaneous speech within the VERBMOBIL project.

Appendix D The functionality covered

This appendix shows the functionality that was covered by the experiment. It will help in future work to determine the value of the samples.
After dividing the functionality in certain groups I listed typical examples that further divide the functionality on a more specific level.

1. Using the phone interface
ring X

2. looking for a memo

3. Querying for an appointment
what is the next appointment today?
appointment at 5.00 p.m.?
appointments tomorrow morning?
when is appointment with Mr. X?
appointments on May 22nd ?
what appointment at 12.00?

2 Enter appointment
remind me to meet X at Y at 7.00 today
remind me to ring X at 16.00

consult to-do list
first item ?

enter to-do list item
complete Task X by 22nd of June
ring X on Friday

Appendix E Material

The following pages include the pre-and post-experimental questionnaires, plus the two briefing sheets that were handed out to the subjects.

Sample No.:_____

Tape Counter:_____

Name : _____

Gender: ❑ male ❑ female

Age: ❑ 18-25
❑ 25-35
❑ 35-45
❑ 45-

Profession/Department:_____

What do we want you to do?

This experiment is basically about talking. We want you to imagine you are a travelling salesman for Paper Shop Leeds in his/her car, who is selling paper for photocopiers. To help you, you have a secretary sitting next to you. Instructions on what your work is about will be provided. Please take as much time as you need for this experiment, it is carefully planned, so you have plenty of time.
Please talk to the experimenter, as if he were your secretary. He will show you a set of cards sheet by sheet and we want you to look at them. On each sheet you will find an instruction. Please follow this instruction by co-operating with your pretend secretary.
In the following you will find the different kinds of icons representing the different tasks you will find on the instruction sheets.
Please feel free to refer to this introduction during the experiment, whenever you find it necessary. This is not complicated, there are only eight icons and the experimenter can explain anything, if you happen to encounter any problems.

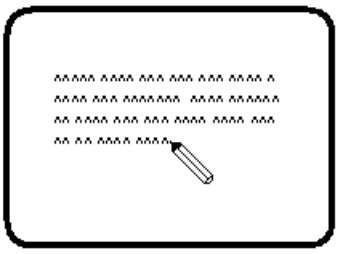
Whenever you see this sign, the pretend secretary will tell you some information. Please read the information on the card and say “o.k.” when you want to go on.

Whenever you see this sign, there are two possible tasks:
1.it is followed by a text: just read out the text
2. it is followed by an other icon: interpret the second icon and give your secretary an “appropriate” instruction.

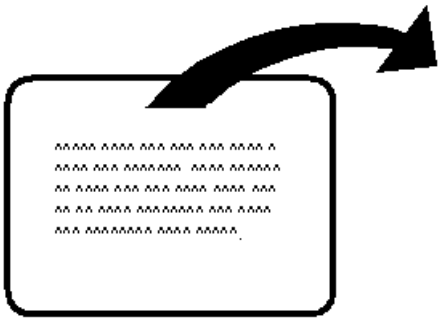
Whenever you need to talk to someone, say to your secretary that you need to use this!

Whenever you see this icon, please ask your secretary for a piece of information.
It will be followed by another icon or text containing question marks. The question marks represent the piece of information you should ask for.

The next four icons represent the different kinds of work your secretary can carry out for you. And here is the first thing we want you to do in the experiment: name them as you find appropriate!

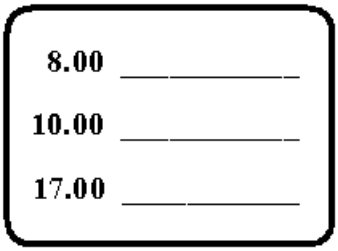


Whenever you see this sign, then you are being asked to store some information for a longer time. It will be followed by another icon or te specify the information you should store.

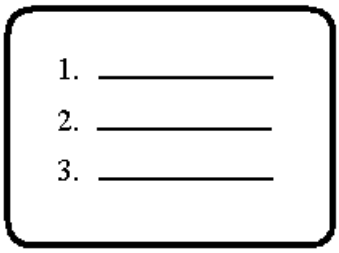


Whenever you see this icon, ask your secretary to get back some information that has been stored.

behaviour



Here you can keep information on important times you want to remember.



This is a summary of all the things you want to do in future.

In order to give you an idea on how the experiment will look like, you will have a practice session as soon as you tell the experimenter that you are ready.

Please answer the following questions by ticking a number.

How familiar are you with computers?

Little ❑1 ❑2 ❑3 ❑4 ❑5 ❑6 ❑7 ❑8 ❑9 Very

How often have you used a palmtop computer?

❑1 ❑2 ❑3 ❑4 ❑5 ❑6 ❑7 ❑8 ❑9

How familiar are you with a Psion computer?

❑1 ❑2 ❑3 ❑4 ❑5 ❑6 ❑7 ❑8 ❑9

How often do you use a personal organiser (calendar, to-do lists, etc.)

❑1 ❑2 ❑3 ❑4 ❑5 ❑6 ❑7 ❑8 ❑9

How often do you work together with a secretary or as a secretary?

❑1 ❑2 ❑3 ❑4 ❑5 ❑6 ❑7 ❑8 ❑9

How difficult did you find it to interpret the icons?

❑1 ❑2 ❑3 ❑4 ❑5 ❑6 ❑7 ❑8 ❑9

Do you think you have an accent? If so, which? _____

Appendix F Storyline of the experiment

The following is a listing of the expected utterances.
Italic lines are being uttered by the pretend secretary, not by subjects.

What is the first item on my to-do list
Find out which company does the cheapest paper and how much it is.
Ring the office for me
hello this is paper shop Leeds, what can I do for you?
"Which company does the cheapest paper?"
British papers sell 1000 sheets for one pound
Please make a note that British papers sell 1000 sheets for one pound
Office: I would like to talk to you, but I am very busy right now. Could we talk again later on?
What are my appointments for this afternoon?
None
"What about 16.00?"
Office: that's fine.
Note down that I have to ring the office at 16.00
Ring Mr. Brown for me
engaged
Ring Mr. Brown again.
Brown: I cannot talk right now and I am not in tomorrow, what about Friday?
"Fine, bye."
Put on my to-do list that I have to ring Mr. Brown on Friday.
When is my meeting with Mr. Harrison?
"O.k."
Ring Mr. Harrison
"I am sorry, I cannot make it today. What is it you wanted to tell me?
Mr. Harrison: Paper International sell paper for two pounds per 1000 sheets
Not down that Paper International sell paper for two pounds per 1000 sheets
"Thanks very much for that information
Mr. Harrison: bye
What is my next appointment?
"O.K."
Delete my appointment with Mr. Harrison
What is the first item on my to-do list
Ask Mrs. Robinson for an appointment this afternoon
Ring Mrs. Robinson for me
"Can you spare half an hour for me"
"O.K."
What am I doing at 16.30?
Meeting with boss at office
Where is a window for Mrs. Robinson?
"O.K."
"O.K."
Please make a note that I am meeting Mrs. Robinson at 15.00
Delete my first to-do list item
"O.K."

What am I doing on 15/10
Nothing so far
Tell Mrs. Stevens the company for the cheapest paper
Ring Mrs. Stevens
What can you tell me?
Look at my notes and tell me, who does the cheapest paper
British paper does the cheapest paper
"British paper does the cheapest paper"
Thanks, bye
"Bye"
"O.K."
What am I doing 08/10 11.00 - 13.00?
"O.K."
What am I doing 08/10/ 12.00-13.00?
"O.K."
"What about meeting at 12.00?"
"Yes that's fine"
Make a note that I am meeting copy shop Bradford on 08/10 at 12.00-13.00
Please tell us one day in advance, if you can still make it. Thanks, Bye.
Please put on my to-do list for 07/10 to confirm the appointment
"All right, Bye"
Your boss is on the phone: I cannot make it for the meeting today
cancel my meeting with my boss
"That's all right"
Boss: can we meet tomorrow
"I might be busy tomorrow morning. Let me see...."
What are my dates tomorrow morning?
No dates for tomorrow morning
"Let's meet tomorrow at 10.00"
Boss: That's fine
boss: Can you please write a letter to Paper international tomorrow and tell me as soon as you have finished it?
"I can do that"
put on my to-do list that I have to write a letter on Thursday
and that I have to ring my boss to confirm that the letter is sent
"o.k."
note in my to-do list that I have to finish the job for Bradford until Aug 21st
"See you then bye."
Your son: Can you come home early today
"Let me see..."
What is still on my to-do list for today?
There is nothing left to do, thank you very much.

Appendix G Data

This is the complete dataset after the pre-editing and editing phases described in **Preparing the data** in chapter 5. Note that 'parameters' of Functions are analysed as 'noise' and replaced with the tag Y. The numbers in round () brackets represent the number of the utterance, the square brackets [] are the separators (a, c), the title of the utterance (b) which is taken from the previous appendix storyline and the number of the sample (d1-6, e0-e9).

(1) []
(1) [a]
_____
(1) [b] What is the first item on my todolist
(1) [c] ----------
(1) [d1] what have i got scheduled for the first thing
(1) [d2] what is the first job on the list for today
(1) [d3] can you tell me what is first on my todolist today
(1) [d4] can you tell me what is top of my todolist please
(1) [d5] what am i doing today
(1) [d6] what's my first thing to do today please
(1) [e0] what do we have to do
(1) [e1] could you check to see what my first priority is
(1) [e2] could you tell me what i still need to do what i haven't had time for today
(1) [e3] what do i have on my agenda first today
(1) [e4] could you tell me please what i have planned for today
(1) [e5] can you tell me what the first thing is that i have to do
(1) [e6] what is the first thing we have to do today
(1) [e7] what have i got to do first
(1) [e8] what is the first thing i am doing today
(1) [e9] what is the first thing on my todolist today
(1) [x]
(2) []
(2) [a]
_____
(2) [b] Find out which company does the cheapest Y and how much it is.
(2) [c] ----------
(3) []
(3) [a]
_____
(3) [b] Ring Y for me
(3) [c] ----------
(3) [d1] can i ring Y
(3) [d2] could you phone Y
(3) [d3] i'd like to ring Y can you ring them for me
(3) [d4] can you phone Y please
(3) [d5] can you telephone Y
(3) [d6] can you get me Y on the phone please
(3) [e0] can you get Y on the line for me please
(3) [e1] could you put me through to Y on the phone please
(3) [e2] would it be possible for you to phone Y please
(3) [e3] can you please phone Y for me
(3) [e4] could you phone Y for me please
(3) [e5] can you phone Y please
(3) [e6] call Y for me
(3) [e7] can you telephone Y please
(3) [e8] could you ring Y for me
(3) [e9] can you telephone Y for me please
(3) [x]
(4) []

(4) [a]

---

(4) [b] hello this is Y shop Leeds what can I do for you?
(4) [c] ----------
(5) []
(5) [a]

---

(5) [b] "Which company does the cheapest Y?"
(5) [c] ----------
(5) [x]
(6) []
(6) [a]

---

(6) [b] British Ys Y for one Y
(6) [c] ----------
(7) []
(7) [a]

---

(7) [b] Please make a note that British Ys Y for one Y
(7) [c] ----------
(7) [d1] Y can you make a note of that please
(7) [d2] record Y
(7) [d3] can you make a note of that in my notepad please that Y
(7) [d4] can you make a note of that Y
(7) [d5] could you write down Y
(7) [d6] make a note in my notepad that Y
(7) [e0] could you file the information for me please that Y
(7) [e1] could you take note that Y
(7) [e2] would it be possible for you to note down that Y
(7) [e3] could you please write down that Y
(7) [e4] could you make a note of the fact that Y
(7) [e5] can you write down that Y
(7) [e6] Y can you write that down for me please
(7) [e7] could you make a note that Y please
(7) [e8] could you make a note of the fact that Y
(7) [e9] can you take a memo Y
(7) [x]
(8) []
(8) [a]

---

(8) [b] Office: I would like to talk to you but I am very busy right now. Could we talk again later on?
(8) [c] ----------
(9) []
(9) [a]

---

(9) [b] What are my appointments for this afternoon?
(9) [c] ----------
(9) [d1] yes what time can i make an appointment to talk to them
(9) [d2] could i just ask what appointments i've got from T till T
(9) [d3] can you tell me what i am doing in my diary this afternoon between T o'clock and T o'clock please
(9) [d4] can you tell me when i am free this afternoon or later today
(9) [d5] X
(9) [d6] can you find a slot when i can call them back please
(9) [e0] i am free at T o'clock could you make me an appointment for then please
(9) [e1] could you check my diary for this afternoon between T and T to see if i have any appointments
(9) [e2] X

(9) [e3] so what do i have on my agenda from T to T
(9) [e4] X
(9) [e5] can you tell me what time i am free to talk to Y
(9) [e6] what is the itinerary for today
(9) [e7] X
(9) [e8] could you tell me what my schedule is for today starting at T
(9) [e9] can you tell me when the best time would be between T and T o'clock
(9) [x]
(10) []
(10) [a]

---

(10) [b] no appointments
(10) [c] ----------
(11) []
(11) [a]

---

(11) [b] "What about 16.00?"
(11) [c] ----------
(11) [x]
(12) []
(12) [a]

---

(12) [b] Office: that's fine.
(12) [c] ----------
(13) []
(13) [a]

---

(13) [b] Note down that I have to ring Y at 16.00
(13) [c] ----------
(13) [d1] can you make a note that Y at T o'clock
(13) [d2] schedule at T AP to Y
(13) [d3] can you put in the diary to Y at T o'clock
(13) [d4] can you put a note in my diary to Y at T o'clock
(13) [d5] can you write down in the diary at T o'clock to Y
(13) [d6] make an appointment in my diary to Y at T o'clock please
(13) [e0] could you make an appointment in my diary to Y at T o'clock please
(13) [e1] could you note in my diary at T o'clock to Y
(13) [e2] would you remind me at T o'clock to Y please
(13) [e3] could you please remind me that i have to Y at T o'clock
(13) [e4] could you make a note in my diary that i need to Y at T
(13) [e5] can you put in the diary that i have to Y at T o'clock please
(13) [e6] write down that we have an appointment at T at Y
(13) [e7] can you put it in the diary to Y at T o'clock please
(13) [e8] can you remind me to Y at T
(13) [e9] can you remind me to Y at T o'clock please
(13) [x]
(14) []
(14) [a]

---

(14) [b] Ring Mr. Brown for me
(14) [c] ----------
(14) [d1] can i speak to Y
(14) [d2] phone Y
(14) [d3] can you ring Y for me please
(14) [d4] call Y please
(14) [d5] i'd like to telephone Y
(14) [d6] can you get me Y on the phone please
(14) [e0] i need to phone Y can you get him on the line please
(14) [e1] could you get me Y on the phone please

(14) [e2] could i have the phone please i want to speak to Y
(14) [e3] i would like to talk to Y now could you please phone him
(14) [e4] can you telephone Y please
(14) [e5] can you phone Y please
(14) [e6] call Y for me
(14) [e7] can you telephone Y please
(14) [e8] could you ring Y
(14) [e9] can you telephone Y
(14) [x]
(15) []
(15) [a]

---

(15) [b] it is engaged
(15) [c] ----------
(16) []
(16) [a]

---

(16) [b] Ring Mr. Brown again.
(16) [c] ----------
(16) [d1] can you try again please
(16) [d2] phone Y
(16) [d3] try again
(16) [d4] call Y again
(16) [d5] i'd like to try again
(16) [d6] try Y again on the phone please
(16) [e0] i need to phone Y can you try again please
(16) [e1] could you get me Y on the phone please
(16) [e2] would it be possible to put me through to Y again please
(16) [e3] could you please try again
(16) [e4] could you try him again
(16) [e5] can you phone Y again please
(16) [e6] give him another ring in a couple of minutes
(16) [e7] can you telephone Y please
(16) [e8] can you keep trying to get through to Y
(16) [e9] can you try again to phone Y
(16) [x] can you ring Y again
(17) []
(17) [a]

---

(17) [b] Brown: I cannot talk right now and I am not in tomorrow what about Friday?
(17) [c] ----------
(18) []
(18) [a]

---

(18) [b] "Fine bye."
(18) [c] ----------
(18) [x]
(19) []
(19) [a]

---

(19) [b] Put on my todolist that I have to ring Mr. Brown on Friday.
(19) [c] ----------
(19) [d1] can you make a note that i am to Y first thing on F please
(19) [d2] schedule first job F Y
(19) [d3] can you put in my todolist to Y on F please
(19) [d4] could you add to my todolist to Y on F please
(19) [d5] can you write in my list to Y on F
(19) [d6] can you make a note to Y on F as an urgent thing on my todolist
(19) [e0] please make a note in my diary to Y on F

(19) [e1] could you make a note that first priority is to Y on F
(19) [e2] could you jot down that i need to Y on F please
(19) [e3] could you remember to tell me that i have to Y on F
(19) [e4] can you take a note i need to Y on F
(19) [e5] can you put in my task list that i have to Y on F
(19) [e6] write down an appointment with Y first thing on F
(19) [e7] could you put a note in the things to do to Y on F please
(19) [e8] can you make a note to Y on F
(19) [e9] can you put in my todolist for F that i must Y
(19) [x]
(20) []
(20) [a]

---

(20) [b] When is my Y with Mr. Harrison?
(20) [c] ----------
(20) [d1] what time am i supposed to Y
(20) [d2] what time am i Y
(20) [d3] what time's Y today between T and T o'clock please
(20) [d4] can you tell me what time Y is
(20) [d5] what time do i have to Y today
(20) [d6] can you tell me when Y is please
(20) [e0] what time is Y
(20) [e1] could you tell me what time Y is please
(20) [e2] could you tell me what time Y is please
(20) [e3] what time am i Y
(20) [e4] what time do i have Y
(20) [e5] can you tell me what time i have my Y today please
(20) [e6] what time is Y
(20) [e7] what time is Y
(20) [e8] what time am i Y
(20) [e9] when is my Y
(20) [x]
(21) []
(21) [a]

---

(21) [b] it's at Y o'clock ->"O.k."
(21) [c] ----------
(21) [x]
(22) []
(22) [a]

---

(22) [b] Ring Mr. Harrison
(22) [c] ----------
(22) [d1] can i have the phone to ring Y please
(22) [d2] phone Y
(22) [d3] can you ring Y for me please
(22) [d4] call Y please
(22) [d5] i'd like to telephone Y
(22) [d6] please can you get me Y on the phone
(22) [e0] i need to phone Y can you get him on the line please
(22) [e1] could you get me Y on the phone please
(22) [e2] could i phone Y please
(22) [e3] can you please phone Y now
(22) [e4] could you please phone Y
(22) [e5] can you phone Y please
(22) [e6] give Y a call for me
(22) [e7] could you phone Y please
(22) [e8] could you ring Y for me please
(22) [e9] can you phone Y

(22) [x]
(23) []
(23) [a]

---

(23) [b] "I am sorry I cannot make it today. What is it you wanted to tell me?
(23) [c] ----------
(23) [x]
(24) []
(24) [a]

---

(24) [b] Mr. Harrison: Paper International Y for two Y per Y
(24) [c] ----------
(25) []
(25) [a]

---

(25) [b] Note down that Paper International Y for two Y per Y
(25) [c] ----------
(25) [d1] Y can you make a note of that for me please
(25) [d2] record Y
(25) [d3] can you make a note then please of the fact that Y please
(25) [d4] can you make a note of that Y
(25) [d5] can you note that down that Y
(25) [d6] michael can you make a note in my notepad that Y
(25) [e0] could you please make a file note that Y
(25) [e1] could you make a note that Y
(25) [e2] would you be able to make a note of the fact that Y please
(25) [e3] so could you please write down that Y
(25) [e4] could you make a note that Y
(25) [e5] can you write down that Y
(25) [e6] Y can you jot that down and put it aside please
(25) [e7] could you make a note that Y
(25) [e8] can you make a note of the fact that Y
(25) [e9] can you make a note Y
(25) [x]
(26) []
(26) [a]

---

(26) [b] "Thanks very much for that information
(26) [c] ----------
(26) [x]
(27) []
(27) [a]

---

(27) [b] Mr. Harrison: bye
(27) [c] ----------
(28) []
(28) [a]

---

(28) [b] What is my next appointment?
(28) [c] ----------
(28) [d1] after Y what have i got on in the afternoon after T o'clock
(28) [d2] have i got any appointments scheduled after Y
(28) [d3] what am i doing this afternoon after Y after T o'clock
(28) [d4] can you tell me what i am doing the rest of the day after Y
(28) [d5] what am i doing after Y
(28) [d6] michael can you tell me what i have got to do this afternoon after Y
(28) [e0] what am i doing after my Y
(28) [e1] could you tell me what i am doing this afternoon after Y
(28) [e2] could you tell me what i am doing after Y please

(28) [e3] X
(28) [e4] do i have any Y after T
(28) [e5] can you look in the diary and tell me what i am doing after my Y please
(28) [e6] what do we have to do after Y
(28) [e7] what time is my next Y
(28) [e8] can you tell me what i am doing after Y
(28) [e9] what am i doing after my Y at T o'clock
(28) [x]
(29) []
(29) [a]

---

(29) [b] no appointments -> "O.K."
(29) [c] ----------
(29) [x]
(30) []
(30) [a]

---

(30) [b] Delete my appointment with Mr. Harrison
(30) [c] ----------
(30) [d1] can you cancel the T Y please
(30) [d2] cancel Y T
(30) [d3] will you cancel Y at T then please
(30) [d4] can you cancel that Y please
(30) [d5] can you cross out Y at T please
(30) [d6] can you cancel Y because i have got Y later
(30) [e0] could you please cancel the appointment with Y at T
(30) [e1] can you cancel Y at T please
(30) [e2] could you cancel Y please
(30) [e3] X
(30) [e4] could you cancel Y at T
(30) [e5] can you cancel Y in the diary please
(30) [e6] cancel Y then
(30) [e7] could you cross Y out of the diary
(30) [e8] can you cancel Y please
(30) [e9] can you cancel my Y at T please
(30) [x] can you cancel Y at T with Y please
(31) []
(31) [a]

---

(31) [b] What is the first item on my todolist
(31) [c] ----------
(31) [d1] what have i got scheduled for first thing today please
(31) [d2] what is the first job i have listed
(31) [d3] can you tell me what's first on my todolist please
(31) [d4] tell me what's top of my todolist please
(31) [d5] what plans have i got for today
(31) [d6] what is the first thing i have got to do (unclear)
(31) [e0] what am i doing first on my plan
(31) [e1] what is my first priority at the moment
(31) [e2] could you tell me what i have still got to do what else i have still got to do please
(31) [e3] what's on my agenda first thing today
(31) [e4] do i have anything scheduled today
(31) [e5] what is my first task today
(31) [e6] what is the first we have to do
(31) [e7] what have i got to do
(31) [e8] can you tell me what the first thing i am meant to be doing today is
(31) [e9] what is the first thing to do on my todolist today
(31) [x] what is the first thing on my todolist
(32) []

(32) [a]

---

(32) [b] Ask Mrs. Robinson for an appointment this afternoon
(32) [c] ----------
(33) []
(33) [a]

---

(33) [b] Ring Mrs. Robinson
(33) [c] ----------
(33) [d1] can you get me the phone to ring Y please
(33) [d2] phone Y
(33) [d3] can you ring Y then
(33) [d4] call Y please
(33) [d5] i'd like to telephone Y
(33) [d6] can you phone Y please
(33) [e0] please can you get Y on the line
(33) [e1] could you get me Y on the phone please
(33) [e2] could you put me through to Y please then
(33) [e3] please ring Y for me
(33) [e4] could you telephone Y please
(33) [e5] can you phone Y please
(33) [e6] give Y a call
(33) [e7] could you phone Y please
(33) [e8] could you ring Y for me please
(33) [e9] can you phone Y please
(33) [x]
(34) []
(34) [a]

---

(34) [b] "Can you spare T an hour for me"
(34) [c] ----------
(34) [x]
(35) []
(35) [a]

---

(35) [b] she says: what about Y at 16.30 ?->"O.K."
(35) [c] ----------
(35) [x]
(36) []
(36) [a]

---

(36) [b] What am I doing at 16.30?
(36) [c] ----------
(36) [d1] what have i got on for T today
(36) [d2] do i have anything scheduled for T this afternoon
(36) [d3] what am i doing at T this afternoon please
(36) [d4] can you tell me if i am free at T
(36) [d5] what am i doing at T today
(36) [d6] michael can you check if i am doing anything at T today please
(36) [e0] what am i doing at T
(36) [e1] am i doing anything at T this afternoon
(36) [e2] can you tell me what i am doing at T this afternoon please
(36) [e3] have i got anything at T in my agenda
(36) [e4] could you tell me what i have scheduled at T please
(36) [e5] can you tell me what i am doing at T please
(36) [e6] what do we have to do at T
(36) [e7] X
(36) [e8] what am i doing at T today
(36) [e9] what am i doing at T this afternoon

(36) [x]
(37) []
(37) [a]

---

(37) [b] Meeting with boss at Y
(37) [c] ----------
(38) []
(38) [a]

---

(38) [b] Where is a window for Mrs. Robinson?
(38) [c] ----------
(38) [d1] can i Y before T
(38) [d2] what times are available to Y between T and T this afternoon
(38) [d3] so what have i got on between T this morning and T when i could see Y
(38) [d4] can you find me another slot for Y
(38) [d5] what time do you think i can Y
(38) [d6] can you check if there is another slot in the day before Y
(38) [e0] what time should i see Y between T and T
(38) [e1] do i have anything between T and T in my diary
(38) [e2] could i Y in-between T o'clock and T would it be possible for me to fit in Y then
(38) [e3] X
(38) [e4] when would it be possible to have Y
(38) [e5] is there a time available today between T and T that i could see Y
(38) [e6] find a more appropriate time to schedule Y
(38) [e7] what time can i Y then
(38) [e8] can you reschedule Y for some other time between T and T please
(38) [e9] when can i arrange Y
(38) [x]
(39) []
(39) [a]

---

(39) [b] 15.00 is a window -> "O.K."
(39) [c] ----------
(39) [x]
(40) []
(40) [a]

---

(40) [b] 15.00 is ok for her -> "O.K."
(40) [c] ----------
(40) [x] ok
(41) []
(41) [a]

---

(41) [b] Please make a note that I am Y Mrs. Robinson at 15.00
(41) [c] ----------
(41) [d1] can you put in that i am Y between T and T today please
(41) [d2] schedule T till T Y
(41) [d3] can you put in my diary that i Y between T and T
(41) [d4] would you put in my diary Y at T till T
(41) [d5] can you write down in the diary Y at T o'clock
(41) [d6] can you schedule Y at T o'clock till T please
(41) [e0] could you please put in an appointment in my diary for T to Y
(41) [e1] could you note in the diary that between T and T Y
(41) [e2] could you note down that i need to Y from T to T please
(41) [e3] put down that i have got Y between T and T
(41) [e4] could you make a note that i am Y at T
(41) [e5] can you write down that between T and T i have got Y please
(41) [e6] jot down that we have Y between T and T
(41) [e7] could you put Y at T o'clock

(41) [e8] can you make a note that i Y between T and T
(41) [e9] can you make a note that i want to Y between T o'clock and T this afternoon
(41) [x]
(42) []
(42) [a]

---

(42) [b] Delete my first todolist item
(42) [c] ----------
(42) [d1] and cancel the appointment for first thing today Y
(42) [d2] first job ask Y is done
(42) [d3] can you take off my todolist that Y
(42) [d4] could you cancel my action to Y
(42) [d5] and cross out in the planner to Y
(42) [d6] you can cross off Y at T o'clock off the list of things to do
(42) [e0] can you please cross through on the plan to Y
(42) [e1] X2
(42) [e2] i have Y so that piece of information is done so can you tick that off my list of things to do please
(42) [e3] could you please cancel that Y from my agenda
(42) [e4] X3
(42) [e5] and cross off the task list that i've got to Y
(42) [e6] mark off the todolist that we have made Y
(42) [e7] please cross off the todolist Y
(42) [e8] cancel Y
(42) [e9] can you remove from my todolist that i was to Y
(42) [x]
(43) []
(43) [a]

---

(43) [b] can you spare some time on 15/10? ->"O.K."
(43) [c] ----------
(43) [x]
(44) []
(44) [a]

---

(44) [b] What am I doing on 15/10
(44) [c] ----------
(44) [d1] on the O of M what have i got timetabled in after T o'clock
(44) [d2] what do i have scheduled from T AP onwards on the O of the O
(44) [d3] what have i got lined up in my diary for the O of M after T o'clock please
(44) [d4] could you tell me if am i doing anything on the O of the O this year
(44) [d5] what am i doing on the O of M
(44) [d6] can you check what i am doing on the O of M it's my daughter's birthday
(44) [e0] what am i doing on the O of M please
(44) [e1] could you tell me what i am doing on the O of M
(44) [e2] could you tell me what i am doing on the O of M J please
(44) [e3] could you please tell me if i have any free time after T o'clock
(44) [e4] could you tell me if i have anything scheduled for the O of M
(44) [e5] can you tell me what i am doing on the O of M
(44) [e6] so on the O of M at T o'clock what do we have to do
(44) [e7] what am i doing on the O of the O for the whole day
(44) [e8] what am i doing on the O of M after T o'clock
(44) [e9] can you tell me what my agenda is for the O of M please
(44) [x] could you check my diary for the O of M please
(45) []
(45) [a]

---

(45) [b] Nothing so far
(45) [c] ----------

(46) []
(46) [a]

---

(46) [b] Tell Mrs. Stevens the company for the cheapest Y
(46) [c] ----------
(47) []
(47) [a]

---

(47) [b] Ring Mrs. Stevens
(47) [c] ----------
(47) [d1] can you give me the phone so that i can ring her please
(47) [d2] phone Y
(47) [d3] can you ring Y
(47) [d4] call Y please
(47) [d5] i'd like to telephone Y
(47) [d6] can you phone Y please
(47) [e0] could you please get Y for me
(47) [e1] could you get me Y on the phone please
(47) [e2] could you put me through to Y please i want to give her some information
(47) [e3] ring Y please
(47) [e4] could you telephone Y please
(47) [e5] can you phone Y please
(47) [e6] ring Y for me
(47) [e7] could you phone Y please
(47) [e8] could you ring Y for me
(47) [e9] can you phone Y please
(47) [x] please can you get Y on the phone for me
(48) []
(48) [a]

---

(48) [b] What can you tell me?
(48) [c] ----------
(49) []
(49) [a]

---

(49) [b] Look at my notes and tell me who does the cheapest Y
(49) [c] ----------
(49) [d1] can you get me the file on Y please
(49) [d2] retrieve Y
(49) [d3] can you get out of my notepad what Y is please
(49) [d4] could you retrieve that information we stored about Y
(49) [d5] can you look in the notes to find out what Y is
(49) [d6] michael can you get from your records Y please
(49) [e0] could you please get back the information about Y for me
(49) [e1] could you check in the file for the Y quote please
(49) [e2] could you get back the information i told you to write down about Y please
(49) [e3] please tell me which is the Y you have got written down i told you
(49) [e4] could you tell me which company does Y
(49) [e5] can you get me information about who does Y
(49) [e6] can you dig out the file on Y for me
(49) [e7] could you get from the file which is Y please
(49) [e8] could you tell me what Y was
(49) [e9] what is it i told you was Y
(49) [x]
(50) []
(50) [a]

---

(50) [b] British Ys do the cheapest Y
(50) [c] ----------

(51) []
(51) [a]

---

(51) [b] "British Ys do the cheapest Y"
(51) [c] ----------
(51) [x]
(52) []
(52) [a]

---

(52) [b] Thanks bye
(52) [c] ----------
(53) []
(53) [a]

---

(53) [b] "Bye"
(53) [c] ----------
(53) [x]
(54) []
(54) [a]

---

(54) [b] "O.K."
(54) [c] ----------
(54) [x]
(55) []
(55) [a]

---

(55) [b] What am I doing 08/10 11.00 - 12.00?
(55) [c] ----------
(55) [d1] can you tell me on the O of M have i got anything timed in for Y to T o'clock please
(55) [d2] am i free from T till T on the O of M
(55) [d3] what have i got on the O of M between T and T o'clock please
(55) [d4] am i busy at T o'clock on the O of M
(55) [d5] what am i doing between T and T on the O of M
(55) [d6] can you check on the O of M what i am doing from T to T please
(55) [e0] what am i doing T till T on the O of M
(55) [e1] could you check in the diary for the O of M and see if i am free between T and T
(55) [e2] could you tell me what i am doing T till T on the O of M J please
(55) [e3] on the O of the O have i got anything on T to T in my agenda
(55) [e4] could you tell me what i'm doing on the O of M between T o'clock and T o'clock
(55) [e5] what am i doing on the O of M between T and T
(55) [e6] can you check the itinerary for the O of M J and tell me what i am doing between T and T please
(55) [e7] what have i got in my diary on the O of the O between T and T o'clock
(55) [e8] can you tell me tell me what i am doing at T o'clock on the O of the O please
(55) [e9] am i free at T o'clock on the O of M
(55) [x]
(56) []
(56) [a]

---

(56) [b] busy -> "O.K."
(56) [c] ----------
(56) [x]
(57) []
(57) [a]

---

(57) [b] What am I doing 08/10/ 12.00-13.00?
(57) [c] ----------
(57) [d1] what about T to T on the same day
(57) [d2] am i free between T and T on the O of M

(57) [d3] what have i got then on the same day between T and T
(57) [d4] am i free at T o'clock
(57) [d5] what am i doing between T and T on the O of M
(57) [d6] can you check in the diary to see what i am doing from T to T on the same day
(57) [e0] what am i doing T till T on the O
(57) [e1] could you check in diary for the O of M between T and T
(57) [e2] could you tell me what i am doing on the O of M T till T o'clock please
(57) [e3] on the O of the O is there anything down between T and T o'clock
(57) [e4] could you tell me what i'm doing on the O of M between T o'clock and T o'clock
(57) [e5] what am i doing on the same day between T and T
(57) [e6] what about between T and T
(57) [e7] how about T to T o'clock on the O of the O
(57) [e8] same day what about T o'clock to T o'clock
(57) [e9] am i free between T o'clock and T o'clock on the O of M
(57) [x]
(58) []
(58) [a]

---

(58) [b] nothing -> "O.K."
(58) [c] ----------
(59) []
(59) [a]

---

(59) [b] "What about Y at 12.00?"
(59) [c] ----------
(59) [x]
(60) []
(60) [a]

---

(60) [b] Yes that's fine
(60) [c] ----------
(61) []
(61) [a]

---

(61) [b] Make a note that I am Y copy shop Bradford on 08/10 at 12.00-13.00
(61) [c] ----------
(61) [d1] can you put in that on the O of M i am Y at roughly T to T please
(61) [d2] schedule T till T Y O of M
(61) [d3] can you put in my diary for the O of M that i am Y between T and T thanks
(61) [d4] can you put in my diary T o'clock Y with for an hour
(61) [d5] can you write down in the diary on the O of M T o'clock till T Y
(61) [d6] can you book me Y T till T on the O of M with Y
(61) [e0] please make an appointment for the O of M T till T Y
(61) [e1] could you make a note in the diary between T and T on the O M Y
(61) [e2] could you write down that i am Y T till T on the O of the O J please
(61) [e3] could you please put down for the O of the O Y at T o'clock Y
(61) [e4] could you make a note that i am Y at T o'clock
(61) [e5] can you put in the diary that on the O of M between T and T o'clock i've got Y
(61) [e6] so make an appointment between T and T on the O of M J for Y
(61) [e7] could you put in the diary Y between T to T on the O of the O please
(61) [e8] X
(61) [e9] can you put in my diary that i have got Y with Y between T and T o'clock on the O of M
(61) [x]
(62) []
(62) [a]

---

(62) [b] Please tell us one day in advance if you can still make it. Thanks Bye.
(62) [c] ----------

(63) []
(63) [a]
---
(63) [b] Please put on my todolist for 07/10 to confirm the appointment
(63) [c] ----------
(63) [d1] can you make a note on M the O first thing i've got to confirm the date with Y please for the next day
(63) [d2] schedule job O of M Y
(63) [d3] can you put in my todolist then that on M the O i need to Y
(63) [d4] can you put a note on my todolist to confirm that Y on the O
(63) [d5] make a note that on M the O to Y
(63) [d6] can you make a note in my todolist for M the O to Y
(63) [e0] please can you make a note in my plan to Y on the O of M
(63) [e1] can you make a note first priority O M to Y
(63) [e2] would you note down please that we have got to Y on the O of M to Y please
(63) [e3] put down on my agenda that i have to Y on the O Y
(63) [e4] X
(63) [e5] can you put on the task list for M the D i have got to Y
(63) [e6] jot down to make sure that Y on M the O for Y
(63) [e7] can you put a note in the todolist to Y on M the O
(63) [e8] X
(63) [e9] can you put in my diary for the O of M that Y
(63) [x]
(64) []
(64) [a]
---
(64) [b] "All right Bye"
(64) [c] ----------
(64) [x]
(65) []
(65) [a]
---
(65) [b] Your boss is on the phone: I cannot make it for the Y today
(65) [c] ----------
(66) []
(66) [a]
---
(66) [b] cancel my Y with my boss
(66) [c] ----------
(66) [d1] can you cancel Y today please
(66) [d2] cancel Y at T AP
(66) [d3] can you cancel Y
(66) [d4] can you cancel Y in my diary
(66) [d5] can you cross out in the diary Y
(66) [d6] can you cancel Y today thank you
(66) [e0] please could you cancel Y today in my diary
(66) [e1] could you cancel Y at T Y in the diary
(66) [e2] could you cancel Y this afternoon please
(66) [e3] please cancel my Y on my agenda
(66) [e4] cancel my Y please
(66) [e5] can you put in the diary for today that Y has been cancelled
(66) [e6] cancel Y today
(66) [e7] could you cross out Y at T please
(66) [e8] can you cancel Y please
(66) [e9] cancel Y today
(66) [x]
(67) []
(67) [a]
---

(67) [b] "That's all right"
(67) [c] ----------
(67) [x]
(68) []
(68) [a]

---

(68) [b] Boss: can we meet tomorrow
(68) [c] ----------
(69) []
(69) [a]

---

(69) [b] "I might be busy tomorrow morning. Let me see...."
(69) [c] ----------
(69) [x]
(70) []
(70) [a]

---

(70) [b] What are my dates tomorrow morning?
(70) [c] ----------
(70) [d1] can you tell me what i've got booked for tomorrow morning between T and T please
(70) [d2] what do i have scheduled tomorrow morning between T and T
(70) [d3] what have i got on tomorrow please between T o'clock and T o'clock
(70) [d4] can you tell me if i am free tomorrow morning
(70) [d5] what am i doing between T and T tomorrow
(70) [d6] can you check what i am doing tomorrow morning
(70) [e0] what am i am doing tomorrow morning
(70) [e1] could you check my diary for tomorrow between T and T
(70) [e2] could you tell me what i am doing tomorrow please
(70) [e3] have i got anything on tomorrow morning
(70) [e4] can you tell me what i am doing tomorrow morning
(70) [e5] what am i doing tomorrow between T and T o'clock
(70) [e6] can you check what i have scheduled for tomorrow please
(70) [e7] what time am i free tomorrow morning
(70) [e8] can you tell me what i am doing tomorrow morning
(70) [e9] do i have any slots free tomorrow morning between T and T
(70) [x] could you please see if i got any Y tomorrow morning
(71) []
(71) [a]

---

(71) [b] No dates for tomorrow morning
(71) [c] ----------
(72) []
(72) [a]

---

(72) [b] "Let's meet tomorrow at 10.00"
(72) [c] ----------
(72) [x]
(73) []
(73) [a]

---

(73) [b] Boss: That's fine and write a letter to Paper international tomorrow and tell me as soon as you have finished it?
(73) [c] ----------
(74) []
(74) [a]

---

(74) [b] "I can do that"
(74) [c] ----------
(74) [x]

(75) []
(75) [a]

---

(75) [b] put on my todolist that I have to write a letter on Thursday
(75) [c] ----------
(75) [d1] can you make a note that Y first thing on F please
(75) [d2] schedule tomorrow first job Y
(75) [d3] put in my todolist to Y on F
(75) [d4] can you put a note in my todolist to Y tomorrow
(75) [d5] can you write in my planner Y on F
(75) [d6] can you make a note to Y on F
(75) [e0] please can you make a note in my plan to Y on F
(75) [e1] can you put first priority on things to do is to Y on F
(75) [e2] could you write down that i need to Y on F please
(75) [e3] can you please remind me to Y on F
(75) [e4] could you remind me that i have to Y on F
(75) [e5] can you write down that i've got to Y on F
(75) [e6] so put on the todolist the first thing for F is to Y
(75) [e7] can you put a note in the todolist to Y on F
(75) [e8] can you make a note that i need to Y on F
(75) [e9] can you put in my todolist for F to Y
(75) [x]
(76) []
(76) [a]

---

(76) [b] and that I have to ring my boss to confirm that the letter is sent
(76) [c] ----------
(76) [d1] and after that to Y
(76) [d2] schedule second job Y
(76) [d3] and put second on the todolist to Y
(76) [d4] can you add a note to my todolist to Y
(76) [d5] and also to Y
(76) [d6] and also make a note in my todolist to Y
(76) [e0] and the next note to Y
(76) [e1] and secondly to Y
(76) [e2] yes could you note down that i need to Y please
(76) [e3] and also write down that i have to Y
(76) [e4] and could you remind that i have to Y
(76) [e5] and Y
(76) [e6] and Y
(76) [e7] and after that make a note Y
(76) [e8] also i need to Y
(76) [e9] can you put in my todolist that Y as well
(76) [x]
(77) []
(77) [a]

---

(77) [b] remember to end work for Y on Aug 21 -> "o.k."
(77) [c] ----------
(77) [x]
(78) []
(78) [a]

---

(78) [b] note in my todolist that I have to finish the job for Bradford until Aug 21st
(78) [c] ----------
(78) [d1] can you make a note that on M O is Y please
(78) [d2] schedule first job M O Y
(78) [d3] can you put in my todolist on M the O to Y
(78) [d4] can you make a note in my todolist that Y M the O

(78) [d5] can you put in the planner on M the O Y
(78) [d6] make a note that by M O i've got to Y
(78) [e0] please can you make a note on my plan on the O of M that Y
(78) [e1] can you make a note on the priorities list that M the O is Y
(78) [e2] could you make a note that Y on M O please
(78) [e3] can you also put down that on M O Y
(78) [e4] could you make a note that Y on M O
(78) [e5] can you put on the list of things to-do that on M O Y
(78) [e6] so jot down on the O of M Y
(78) [e7] put a note in the todolist Y on M O
(78) [e8] X
(78) [e9] can you record for the entry M O that Y
(78) [x]
(79) []
(79) [a]

---

(79) [b] "See you then bye."
(79) [c] ----------
(79) [x]
(80) []
(80) [a]

---

(80) [b] Your son: Can you come home early today
(80) [c] ----------
(81) []
(81) [a]

---

(81) [b] "Let me see..."
(81) [c] ----------
(81) [x]
(82) []
(82) [a]

---

(82) [b] What is still on my todolist for today?
(82) [c] ----------
(82) [d1] what have i got scheduled for today
(82) [d2] what jobs do i have scheduled for today
(82) [d3] what is on my todolist please
(82) [d4] can you tell me if i have got anything urgent to do
(82) [d5] what have i got planned
(82) [d6] have i got anything else left today to do
(82) [e0] what am i doing for the rest of the day
(82) [e1] could you tell me what things i have to do today
(82) [e2] have i got anything to do please today
(82) [e3] could you tell me if i have got anything on
(82) [e4] could you tell me please if i can make it home early today please
(82) [e5] can you tell me what i have got to do today
(82) [e6] can you check what we have to do for the rest of the day
(82) [e7] what have i got on my todolist
(82) [e8] can you tell me what i have scheduled for today
(82) [e9] have i done everything i was meant to do today
(82) [x]
(83) []
(83) [a]

---

(83) [b] There is nothing left to do thank you very much.
(83) [c] ----------
(84) []

(84) [a]

---

(84) [c] this is the end of the dialogue

Appendix H Wordlist

This is a list of the word-types sorted by frequency, excluding the ‘parameter’ vocabulary.

308 you
197 can
192 i
188 the
187 please
159 to
140 on
138 what
115 could
108 me
97 that
85 my
84 have
80 of
79 am
75 in
75 for
66 note
65 and
64 a
59 tell
58 o'clock
58 at
56 make
54 doing
47 phone
47 between
46 put
46 got
45 today
44 is
44 do
41 diary
36 first
33 todolist
33 down
31 cancel
26 time
23 get
22 after
20 ring
19 write
19 tomorrow
19 thing
16 this
16 check
16 anything
15 afternoon
14 till
14 free
13 telephone
13 scheduled
13 need
13 if

12 we
12 morning
12 again
11 would
11 schedule
11 from
11 day
11 appointment
11 an
10 then
10 so
10 call
9 list
9 it
9 cross
9 agenda
8 when
8 try
8 see
8 out
8 job
8 be
8 about
7 with
7 remind
7 off
7 like
7 information
7 i've
6 through
6 things
6 i'd
6 file
6 any
5 same
5 priority
5 possible
5 plan
5 jot
5 him
5 give
5 fact
5 also
4 what's
4 was
4 task
4 take
4 notepad
4 michael
4 line
4 find
3 which
3 want
3 told
3 there
3 them
3 talk
3 still
3 slot

3 rest
3 record
3 planner
3 next
3 done
3 back
3 appointments
3 another
2 yes
2 urgent
2 top
2 speak
2 some
2 second
2 retrieve
2 planned
2 now
2 meant
2 look
2 later
2 itinerary
2 her
2 else
2 does
2 confirm
2 before
2 available
2 ask
2 as
2 add
1 your
1 year
1 written
1 will
1 whole
1 who
1 well
1 up
1 trying
1 to-do
1 timetabled
1 times
1 timed
1 time's
1 tick
1 think
1 thanks
1 thank
1 sure
1 supposed
1 stored
1 starting
1 slots
1 should
1 secondly
1 roughly
1 reschedule
1 remove
1 remember

1 records
1 quote
1 priorities
1 plans
1 piece
1 other
1 or
1 onwards
1 notes
1 must
1 more
1 moment
1 minutes
1 memo
1 mark
1 made
1 listed
1 lined
1 left
1 keep
1 just
1 jobs
1 it's
1 in-between
1 how
1 hour
1 home
1 haven't
1 has
1 had
1 fit
1 everything
1 entry
1 early
1 dig
1 daughter's
1 date
1 couple
1 company
1 cancelled
1 by
1 busy
1 booked
1 book
1 birthday
1 best
1 been
1 because
1 aside
1 arrange
1 are
1 appropriate
1 action
1 able

Appendix I Parsed Corpus

This is the corpus, divided into Functions, annotated with phrase labels, as described in **Analysis of the data**.

Function 1a

<w call > <t VPH > <t Y> <w for > <t MOD > me
<w call > <t VPH > <t Y> <w please> <t PL>
<w can i > <t IN > <w have the phone to > <t ADD > <w ring > <t VPH > <t Y> <w please> <t PL>
<w can i > <t IN > <w ring > <t VPH > Y
<w can i > <t IN > <w speak to > <t VPH > Y
<w can you > <t IN > VPH (Y) <w for me > <t ADD > <w please> <t PL>
<w can you > <t IN > VPH (Y) <w please> <t PL>
<w can you > <t IN > <w get me the phone to ring > <t VPH > <t Y> <w please> <t PL>
<w can you > <t IN > <w phone > <t VPH > Y
<w can you > <t IN > <w phone > <t VPH > <t Y> <w please> <t PL>
<w can you > <t IN > <w please> <t PL> <w phone > <t VPH > <t Y> <w for > <t MOD > me
<w can you > <t IN > <w please> <t PL> <w phone > <t VPH > Y now
<w can you > <t IN > <w ring > <t VPH > Y
<w can you > <t IN > <w ring > <t VPH > <t Y> <w for me > <t ADD > <w please> <t PL>
<w can you > <t IN > <w ring > <t VPH > Y then
<w can you > <t IN > <w telephone > <t VPH > Y
<w can you > <t IN > <w telephone > <t VPH > <t Y> <w for me > <t ADD > <w please> <t PL>
<w can you > <t IN > <w telephone > <t VPH > <t Y> <w please> <t PL>
<w could i > <t IN > <w have the phone > <t ADD > <w please> <t PL> i <w want to speak to > <t VPH > Y
<w could i > <t IN > <w phone > <t VPH > <t Y> <w please> <t PL>
<w could you > <t IN > VPH (Y) <w please> <t PL>
<w could you > <t IN > <w phone > <t VPH > Y
<w could you > <t IN > <w phone > <t VPH > <t Y> <w for me > <t ADD > <w please> <t PL>
<w could you > <t IN > <w phone > <t VPH > <t Y> <w please> <t PL>
<w could you > <t IN > <w please> <t PL> <w get > <t VPH > <t Y> <w for > <t MOD > me
<w could you > <t IN > <w please> <t PL> <w phone > <t VPH > Y
<w could you > <t IN > VPH (Y) <w please> <t PL>
<w could you > <t IN > <w put me through to > <t VPH > <t Y> <w please> <t PL> i want <w to > <t MOD > give her some information
<w could you > <t IN > <w put me through to > <t VPH > <t Y> <w please> <t PL> then
<w could you > <t IN > <w ring > <t VPH > Y
<w could you > <t IN > <w ring > <t VPH > <t Y> <w for > <t MOD > me
<w could you > <t IN > <w ring > <t VPH > <t Y> <w for me > <t ADD > <w please> <t PL>
<w could you > <t IN > <w telephone > <t VPH > <t Y> <w please> <t PL>
give Y a call
VPH (Y) <w for > <t MOD > me
IN (Y) <w can you > <t IN > <w get > <t VPH > <w him > <t REFY > on the line <w please> <t PL>
IN (Y) <w could you > <t IN > <w please> <t PL> <w phone > <t VPH > <w him > <t REFY >
<w i'd like to > <t IN > <w ring > <t VPH > <t Y> <w can you > <t IN > <w ring > <t VPH > <w them > <t REFY > <w for > <t MOD > me
<w i'd like to > <t IN > <w telephone > <t VPH > Y
<w phone > <t VPH > Y
<w please> <t PL> <w can you > <t IN > VPH (Y)
<w please> <t PL> <w can you > <t IN > <w get > <t VPH > me Y on the phone
<w please> <t PL> <w ring > <t VPH > <t Y> <w for > <t MOD > me
<w ring > <t VPH > <t Y> <w for > <t MOD > me
<w ring > <t VPH > <t Y> <w please> <t PL>
<w would it be possible for you to > <t IN > <w phone > <t VPH > <t Y> <w please> <t PL>

Function 2a

TD (Y) <w what have i got on > <t QUG > <w in the afternoon after T o'clock > <t TD >
<w am i busy > <t QUF > <w at T o'clock on the O of M > <t TD >
<w am i doing anything > <t QUF > <w at > <t MOD > T this afternoon
<w am i free > <t QUF > <w at > <t MOD > T o'clock
<w am i free > <t QUF > <w at T o'clock on the O of M > <t TD >
<w am i free > <t QUF > <w between T and T on the O of M > <t TD >
<w am i free > <t QUF > <w between T o'clock and T o'clock > <t TD > <w on the O of M > <t TD >
<w am i free > <t QUF > from <w T till T on the O > <t TD > <w of > <t MOD > M
<w can you > <t IN > VQU (SOU) <w what i am doing > <t QUT > TD (REFD)

<w can you > <t IN > <w check > <t VQU > <w on the O of M > <t TD > <w what i am doing > <t QUT > <w from T to T > <t TD > <w please> <t PL>
<w can you > <t IN > <w check > <t VQU > <w the itinerary > <t SOU > <w for the O of M > <t TD > J and <w tell me > <t VQU > <w what i am doing > <t QUT > <w between T and T > <t TD > <w please> <t PL>
<w can you > <t IN > <w check > <t VQU > <w what i am doing > <t QUT > <w on the O of M > <t TD > it's <w my > <t MOD > daughter's birthday
<w can you > <t IN > <w check > <t VQU > <w what i am doing > <t QUT > <w tomorrow > <t TD > morning
<w can you > <t IN > <w check > <t VQU > <w what i have scheduled for > <t QUT > <w tomorrow > <t TD > <w please> <t PL>
<w can you > <t IN > <w look > <t VQU > <w in the diary > <t SOU > and <w tell me > <t VQU > <w what i am doing > <t QUT > IT (Y) <w please> <t PL>
<w can you > <t IN > <w tell me > <t VQU > <w if i am free > <t QUF > <w at > <t MOD > T
<w can you > <t IN > <w tell me > <t VQU > <w if i am free > <t QUF > <w tomorrow > <t TD > morning
<w can you > <t IN > <w tell me > <t VQU > <w on the O of M > <t TD > <w have i got anything > <t QUG > timed in <w for Y to T o'clock > <t TD > <w please> <t PL>
<w can you > <t IN > <w tell me > <t VQU > tell me <w what i am doing > <t QUT > <w at T o'clock on the O of the O > <t TD > <w please> <t PL>
<w can you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > TD (Y)
<w can you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > <w at > <t MOD > T <w please> <t PL>
<w can you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > <w at T this afternoon > <t TD > <w please> <t PL>
<w can you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > <w in my diary > <t SOU > <w this afternoon between T o'clock and T o'clock > <t TD > <w please> <t PL>
<w can you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > <w on the O > <t TD > <w of > <t MOD > M
<w can you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > TD (Y)
<w can you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > <w tomorrow > <t TD > morning
<w can you > <t IN > <w tell me > <t VQU > <w what i've got booked for > <t QUT > <w tomorrow morning between T and T > <t TD > <w please> <t PL>
<w can you > <t IN > <w tell me > <t VQU > QUT (SOU) <w for the O of M > <t TD > <w please> <t PL>
<w can you > <t IN > <w tell me > <t VQU > <w what time Y is > <t QUY >
<w can you > <t IN > <w tell me > <t VQU > QUF (Y)
<w can you > <t IN > <w tell me > <t VQU > <w what time i have my Y > <t QUY > <w today > <t TD > <w please> <t PL>
<w can you > <t IN > <w tell me > <t VQU > <w when Y is > <t QUY > <w please> <t PL>
<w can you > <t IN > <w tell me > <t VQU > <w when i am free > <t QUF > <w this afternoon > <t TD > or later today
<w can you > <t IN > <w tell me > <t VQU > <w when the best time would be > <t QUF > <w between T and T > <t TD > o'clock
<w could i > <t IN > <w just > <t ADD > ask QUT (SOU) <w from T till T > <t TD >
<w could you > <t IN > VQU (SOU) <w the O of M > <t TD > between T and T
<w could you > <t IN > VQU (SOU TD) <w if i am free > <t QUF > between T and T
<w could you > <t IN > VQU (SOU TD) if i have any appointments
<w could you > <t IN > VQU (SOU) <w tomorrow > <t TD > between T and T
<w could you > <t IN > <w please> <t PL> <w tell me > <t VQU > <w if i have any free time > <t QUF > <w after T > <t TD > o'clock
<w could you > <t IN > <w tell me > <t VQU > <w if am i doing anything > <t QUF > <w on the O of the O > <t TD > this year
<w could you > <t IN > <w tell me > <t VQU > <w if i have anything scheduled > <t QUF > <w for > <t MOD > the O <w of > <t MOD > M
<w could you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > <w T till T > <t TD > <w on the O of M J > <t TD > <w please> <t PL>
<w could you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > TD (Y) <w please> <t PL>
<w could you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > <w on the O > <t TD > <w of > <t MOD > M
<w could you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > <w on the O of M J > <t TD > <w please> <t PL>
<w could you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > <w on the O of M T till T o'clock > <t TD > <w please> <t PL>

<w could you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > <w this afternoon > <t TD > after Y
<w could you > <t IN > <w tell me > <t VQU > <w what i am doing > <t QUT > <w tomorrow > <t TD > <w please> <t PL>
<w could you > <t IN > <w tell me > <t VQU > <w what i have scheduled > <t QUT > <w at > <t MOD > T <w please> <t PL>
<w could you > <t IN > <w tell me > <t VQU > <w what i'm doing > <t QUT > <w on the O of M > <t TD > between <w T o'clock > <t TD > and T o'clock
<w could you > <t IN > <w tell me > <t VQU > <w what my schedule is for > <t QUT > <w today starting at T > <t TD >
<w could you > <t IN > <w tell me > <t VQU > <w what time Y is > <t QUY > <w please> <t PL>
<w do i have any Y > <t QUY > after T
<w do i have any slots free > <t QUF > <w tomorrow morning > <t TD > between T and T
<w do i have anything scheduled > <t QUT > <w for T this afternoon > <t TD >
QUT (SOU) TD (Y)
<w have i got anything > <t QUG > <w at > <t MOD > T in <w my > <t MOD > agenda
<w have i got anything > <t QUG > on <w tomorrow morning > <t TD >
<w how about > <t QUF > <w T to T > <t TD > o'clock <w on the O > <t TD > <w of > <t MOD > the O
<w michael > <t ADD > <w can you > <t IN > <w check > <t VQU > <w if i am doing anything > <t QUT > <w at T today > <t TD > <w please> <t PL>
<w michael > <t ADD > <w can you > <t IN > <w tell me > <t VQU > <w what i have got to do > <t QDB > <w this afternoon > <t TD > after Y
<w on the O of M at T o'clock > <t TD > what do <w we have > <t MOD > <w to > <t MOD > do
<w on the O of M > <t TD > <w what have i got > <t QUG > timetabled in <w after T > <t TD > o'clock
<w on the O of the O > <t TD > <w have i got anything > <t QUG > on <w T to T > <t TD > in <w my > <t MOD > agenda
<w on the O of the O > <t TD > <w is there anything down > <t QUF > <w between T and T o'clock > <t TD >
<w same day > <t REFD > <w what about > <t QUT > <w T o'clock to T o'clock > <t TD >
<w what about > <t QUT > <w T to T > <t TD > on the same day
<w what about > <t QUT > between T and T
<w what am i am doing > <t QUT > <w tomorrow morning > <t TD >
<w what am i doing > <t QUG > <w T till T on the O > <t TD >
<w what am i doing > <t QUG > <w T till T on the O of M > <t TD >
<w what am i doing > <t QUG > after Y
<w what am i doing > <t QUG > after <w my > <t MOD > Y
<w what am i doing > <t QUG > IT (Y) <w at T o'clock > <t TD >
<w what am i doing > <t QUG > <w at > <t MOD > T
<w what am i doing > <t QUG > <w at > <t MOD > T this afternoon
<w what am i doing > <t QUG > <w at T this afternoon > <t TD > <w please> <t PL>
<w what am i doing > <t QUG > <w at > <t MOD > T today
<w what am i doing > <t QUG > <w between T and T > <t TD > <w on the O > <t TD > <w of > <t MOD > M
<w what am i doing > <t QUG > <w between T and T on the O of M > <t TD >
<w what am i doing > <t QUG > <w between T and T > <t TD > <w tomorrow > <t TD >
<w what am i doing > <t QUG > <w on the O > <t TD > <w of > <t MOD > M
<w what am i doing > <t QUG > <w on the O of M > <t TD > <w after T > <t TD > o'clock
<w what am i doing > <t QUG > <w on the O of M > <t TD > between T and T
<w what am i doing > <t QUG > <w on the O of M > <t TD > <w please> <t PL>
<w what am i doing > <t QUG > <w on the O of the O > <t TD > <w for > <t MOD > the whole day
<w what am i doing > <t QUG > on the <w same day > <t REFD > between T and T
<w what am i doing > <t QUG > TD (Y) <w after T > <t TD > o'clock
<w what am i doing > <t QUG > <w tomorrow between T and T > <t TD > o'clock
<w what do i have on > <t QUG > <w my agenda > <t SOU > from T <w to > <t MOD > T
<w what do i have scheduled > <t QUT > from T AP onwards <w on the O > <t TD > <w of > <t MOD > the O
<w what do i have scheduled > <t QUT > <w tomorrow morning > <t TD > between T and T
<w what do we have to do > <t QDB > after Y
<w what do we have to do > <t QDB > <w at > <t MOD > T
<w what have i got > <t QUG > <w in my diary > <t SOU > <w on the O of the O > <t TD > <w between T and T > <t TD > o'clock
<w what have i got > <t QUG > lined up <w in my diary > <t SOU > <w for the O of M after T o'clock > <t TD > <w please> <t PL>
<w what have i got on > <t QUG > <w for > <t MOD > T today
<w what have i got > <t QUG > <w on the O of M between T and T o'clock > <t TD > <w please> <t PL>

<w what have i got on > <t QUG > <w tomorrow > <t TD > <w please> <t PL> between <w T o'clock > <t TD > and T o'clock
<w what have i got > <t QUG > <w then > <t ADD > on the <w same day > <t REFD > between T and T
<w what is > <t QUG > <w the itinerary > <t SOU > <w for > <t MOD > today
<w what time > <t QUY > am i Y
<w what time am i Y > <t QUY >
<w what time > <t QUY > <w am i free > <t QUF > <w tomorrow > <t TD > morning
<w what time > <t QUY > am i supposed <w to > <t MOD > Y
<w what time > <t QUY > <w can i > <t IN > VND (SOU) <w to > <t MOD > talk <w to > <t MOD > them
<w what time do i have Y > <t QUY >
<w what time do i have to Y > <t QUY > <w today > <t TD >
<w what time is Y > <t QUY >
<w what time > <t QUY > <w is > <t MOD > <w my > <t MOD > Y
<w what time is my next Y > <t QUY >
<w what time's Y > <t QUY > <w today between T and T o'clock > <t TD > <w please> <t PL>
<w when is my Y > <t QUY >

Function 3

<w can you > <t IN > <w book me > <t VND > <t Y> <w T till T on the O of M > <t TD > <w with > <t ADD > Y
<w can you > <t IN > <w make a note > <t VND > <w that > <t MOD > <t Y> <w at > <t MOD > T o'clock
<w can you > <t IN > <w make a note > <t VND > <w that i > <t MOD > <t Y> <w between T and T > <t TD >
<w can you > <t IN > <w make a note that i want to > <t VND > <t Y> <w between T o'clock and T this afternoon > <t TD >
<w can you > <t IN > VND (SOU) Y <w at T o'clock > <t TD >
<w can you > <t IN > <w put > <t VND > <w in my diary > <t SOU > <w T o'clock > <t TD > <t Y> <w with > <t ADD > <w for > <t MOD > an hour
<w can you > <t IN > <w put > <t VND > <w in my diary > <t SOU > <w for the O of M > <t TD > <w that i am > <t MOD > <t Y> <w between T and T > <t TD > thanks
<w can you > <t IN > <w put > <t VND > <w in my diary > <t SOU > <w that i > <t MOD > Y between T and T
<w can you > <t IN > <w put > <t VND > <w in my diary > <t SOU > <w that i have got > <t MOD > <t Y> <w with > <t ADD > <t Y> <w between T and T o'clock > <t TD > <w on the O > <t TD > <w of > <t MOD > M
<w can you > <t IN > <w put in that > <t VND <w that > <t MOD > > <w i am > <t MOD > <t Y> <w between T and T > <t TD > <w today > <t TD > <w please> <t PL>
<w can you > <t IN > <w put in that > <t VND <w that > <t MOD > > <w on the O of M > <t TD > <w i am > <t MOD > <t Y> <w at roughly T to T > <t TD > <w please> <t PL>
<w can you > <t IN > <w put > <t VND > <w in the diary > <t SOU > <w that i have to > <t MOD > <t Y> <w at T o'clock > <t TD > <w please> <t PL>
<w can you > <t IN > <w put > <t VND > <w in the diary > <t SOU > <w that > <t MOD > <w on the O of M between T and T o'clock > <t TD > <w i've got > <t MOD > Y
<w can you > <t IN > <w put > <t VND > <w in the diary > <t SOU > <w to > <t MOD > <t Y> <w at T o'clock > <t TD >
<w can you > <t IN > <w put it > <t VND > <w in the diary > <t SOU > <w to > <t MOD > <t Y> <w at T o'clock > <t TD > <w please> <t PL>
<w can you > <t IN > <w remind me to Y > <t VND > <w at > <t MOD > T
<w can you > <t IN > <w remind me to Y > <t VND > <w at T o'clock > <t TD > <w please> <t PL>
<w can you > <t IN > <w schedule > <t VND > <t Y> <w at T o'clock till T > <t TD > <w please> <t PL>
<w can you > <t IN > <w write down > <t VND > <w in the diary > <t SOU > <t Y> <w at T o'clock > <t TD >
<w can you > <t IN > <w write down > <t VND > <w in the diary > <t SOU > <w at T o'clock > <t TD > <w to > <t MOD > Y
<w can you > <t IN > <w write down > <t VND > <w in the diary > <t SOU > <w on the O of M T o'clock till T > <t TD > Y
<w can you > <t IN > <w write down > <t VND > <w that > <t MOD > <w between T and T > <t TD > <w i have got > <t MOD > <t Y> <w please> <t PL>
<w could you > <t IN > <w make a note > <t VND > <w in my diary > <t SOU > <w that i need to Y > <t MOD Y > <w at > <t MOD > T
<w could you > <t IN > <w make a note > <t VND > <w in the diary > <t SOU > <w between T and T > <t TD > <w on the O M > <t TD > Y
<w could you > <t IN > <w make a note > <t VND > <w that i am > <t MOD > <t Y> <w at > <t MOD > T

<w could you > <t IN > <w make a note > <t VND > <w that i am > <t MOD > <t Y> <w at > <t MOD > T o'clock
<w could you > <t IN > VND (SOU) <w in my diary > <t SOU > <w to > <t MOD > <t Y> <w at T o'clock > <t TD > <w please> <t PL>
<w could you > <t IN > <w note down > <t VND > <w that i need to Y > <t MOD Y > <w from T to T > <t TD > <w please> <t PL>
<w could you > <t IN > <w note > <t VND > <w in my diary > <t SOU > <w at T o'clock > <t TD > <w to > <t MOD > Y
<w could you > <t IN > <w note > <t VND > <w in the diary > <t SOU > <w that > <t MOD > <w between T and T > <t TD > Y
<w could you > <t IN > <w please> <t PL> <w put down > <t VND > <w for the O of the O > <t TD > <t Y> <w at T o'clock > <t TD > Y
<w could you > <t IN > <w please> <t PL> <w put in an > <t VND an > appointment <w in my diary > <t SOU > <w for > <t MOD > T <w to > <t MOD > Y
<w could you > <t IN > <w please> <t PL> <w remind me > <t VND > <w that i have to > <t MOD > <t Y> <w at > <t MOD > T o'clock
<w could you > <t IN > <w put > <t VND > <t Y> <w at T o'clock > <t TD >
<w could you > <t IN > <w put > <t VND > <w in the diary > <t SOU > <t Y> <w between T to T on the O of the O > <t TD > <w please> <t PL>
<w could you > <t IN > <w write down > <t VND > <w that i am > <t MOD > <t Y> <w T till T > <t TD > <w on the O of the O > <t TD > J <w please> <t PL>
<w jot down > <t VND > <w that > <t MOD > <w we have > <t MOD > Y between T and T
VND (SOU) <w between T and T > <t TD > <w on the O of M J > <t TD > <w for > <t MOD > Y
VND (SOU) <w in my diary > <t SOU > <w to > <t MOD > <t Y> <w at T o'clock > <t TD > <w please> <t PL>
<w please> <t PL> VND (SOU) <w for the O of M > <t TD > <w T till T > <t TD > Y
<w put down > <t VND > <w that i have got > <t MOD > Y between T and T
<w schedule > <t VND > <w T till T > <t TD > Y
<w schedule > <t VND > <w T till T > <t TD > Y O <w of > <t MOD > M
<w schedule > <t VND > <w at > <t MOD > T AP <w to > <t MOD > Y
<w would you > <t IN > <w put > <t VND > <w in my diary > <t SOU > <t Y> <w at T till T > <t TD >
<w would you > <t IN > <w remind me > <t VND > <w at T o'clock > <t TD > <w to > <t MOD > <t Y> <w please> <t PL>
<w write down > <t VND > MOD (SOU) <w at > <t MOD > T at Y

Function 4

<w can you > <t IN > <w cancel > <t VC > Y
<w can you > <t IN > <w cancel > <t VC > <t Y> <w at > <t MOD > T <w please> <t PL>
<w can you > <t IN > <w cancel > <t VC > Y because <w i have got > <t MOD > Y later
<w can you > <t IN > <w cancel > <t VC > Y in <w my > <t MOD > diary
<w can you > <t IN > <w cancel > <t VC > <t Y> <w in the diary > <t SOU > <w please> <t PL>
<w can you > <t IN > <w cancel > <t VC > <t Y> <w please> <t PL>
<w can you > <t IN > <w cancel > <t VC > <t Y> <w today > <t TD > <w please> <t PL>
<w can you > <t IN > <w cancel > <t VC > <t Y> <w today > <t TD > thank you
<w can you > <t IN > <w cancel > <t VC > <w my > <t MOD > <t Y> <w at > <t MOD > T <w please> <t PL>
<w can you > <t IN > <w cancel > <t VC > <w that > <t MOD > <t Y> <w please> <t PL>
<w can you > <t IN > <w cancel > <t VC > the T Y <w please> <t PL>
<w can you > <t IN > <w cross out > <t VC > <t Y> <w at > <t MOD > T <w please> <t PL>
<w can you > <t IN > <w cross out > <t VC > <w in the diary > <t SOU > Y
<w can you > <t IN > <w put > <t VND > <w in the diary > <t SOU > <w for today > <t TD > <w that > <t MOD > Y has been cancelled
<w cancel > <t VC > Y T
<w cancel > <t VC > <t Y> <w at > <t MOD > T AP
<w cancel > <t VC > Y then
<w cancel > <t VC > Y today
<w cancel > <t VC > <w my > <t MOD > <t Y> <w please> <t PL>
<w could you > <t IN > <w cancel > <t VC > <t Y> <w at > <t MOD > T
<w could you > <t IN > <w cancel > <t VC > <t Y> <w at > <t MOD > T Y in the diary
<w could you > <t IN > <w cancel > <t VC > <t Y> <w please> <t PL>
<w could you > <t IN > <w cancel > <t VC > <t Y> <w this afternoon > <t TD > <w please> <t PL>
<w could you > <t IN > VC (Y) the diary
<w could you > <t IN > <w cross out > <t VC > <t Y> <w at > <t MOD > T <w please> <t PL>
<w could you > <t IN > <w please> <t PL> <w cancel > <t VC > MOD (SOU) <w with > <t ADD > <t Y> <w at > <t MOD > T
<w please> <t PL> <w cancel > <t VC > <w my > <t MOD > Y on my agenda

<w please> <t PL> <w could you > <t IN > <w cancel > <t VC > <t Y> <w today > <t TD > in <w my > <t MOD > diary
<w will you > <t IN > <w cancel > <t VC > <t Y> <w at > <t MOD > T <w then > <t ADD > <w please> <t PL>

Function 5

<w can you > <t IN > <w check > <t VQU > MOD (SOU) <w for > <t MOD > the rest <w of > <t MOD > the day
<w can you > <t IN > <w tell me > <t VQU > <w if i have got anything > <t QUG > <w urgent > <t MOD > <w to > <t MOD > do
<w can you > <t IN > <w tell me > <t VQU > <w what i have got to do > <t QDB > today
<w can you > <t IN > <w tell me > <t VQU > <w what i have scheduled for > <t QUT > today
<w can you > <t IN > <w tell me > <t VQU > <w what is first on > <t QDB > <w my todolist > <t SOU > today
<w can you > <t IN > <w tell me > <t VQU > <w what is top of > <t QDB > <w my todolist > <t SOU > <w please> <t PL>
<w can you > <t IN > <w tell me > <t VQU > QDB (MOD SOU TD)
<w can you > <t IN > <w tell me > <t VQU > <w what the first thing is > <t QDB > <w that i have to > <t MOD > do
<w can you > <t IN > <w tell me > <t VQU > <w what's first on > <t QDB > <w my todolist > <t SOU > <w please> <t PL>
<w could you > <t IN > <w check to see > <t VQU > what MOD (SOU) is
<w could you > <t IN > <w tell me > <t VQU > <w if i have got anything on > <t QUG >
<w could you > <t IN > <w tell me > <t VQU > <w please> <t PL> if i can make <w it > <t REFY > home early <w today > <t TD > <w please> <t PL>
<w could you > <t IN > <w tell me > <t VQU > <w please> <t PL> <w what i have planned > <t QDB > <w for > <t MOD > today
<w could you > <t IN > <w tell me > <t VQU > <w what i have still got to do > <t QDB > what <w else > <t ADD > i have still got MOD (SOU) <w please> <t PL>
<w could you > <t IN > <w tell me > <t VQU > <w what i still need to do > <t QDB > <w what i haven't had time > <t QDB > <w for > <t MOD > today
<w could you > <t IN > <w tell me > <t VQU > <w what things i have to do > <t QDB > today
<w do i have anything scheduled > <t QUT > today
have i done everything i was meant MOD (SOU) today
<w have i got anything > <t QUG > <w else > <t ADD > <w left > <t ADD > <w today > <t TD > <w to > <t MOD > do
<w have i got anything > <t QUG > MOD (SOU) <w please> <t PL> today
<w tell me > <t VQU > <w what's top of > <t QDB > <w my todolist > <t SOU > <w please> <t PL>
<w what am i doing first on > <t QDB > <w my > <t MOD > plan
<w what am i doing > <t QUG > <w for > <t MOD > the rest <w of > <t MOD > the day
<w what am i doing > <t QUG > today
QUG (SOU) <w today > <t TD >
<w what do we have to do > <t QDB >
<w what have i got on > <t QUG > <w my > <t MOD > todolist
<w what have i got > <t QUG > planned
<w what have i got > <t QUG > <w scheduled > <t VTL > MOD (SOU) <w today > <t TD > <w please> <t PL>
<w what have i got > <t QUG > <w scheduled > <t VTL > <w for > <t MOD > MOD (SOU) thing
<w what have i got > <t QUG > <w scheduled > <t VTL > <w for > <t MOD > today
<w what have i got > <t QUG > <w to > <t MOD > do
<w what have i got > <t QUG > MOD (SOU) first
<w what is > <t QUG > MOD (SOU) <w at > <t MOD > the moment
<w what is > <t QUG > <w my first task > <t SOU > today
<w what is > <t QUG > <w on my todolist > <t SOU > <w please> <t PL>
<w what is > <t QUG > MOD (SOU) <w job > <t SOU > i have listed
<w what is > <t QUG > MOD (SOU) <w job > <t SOU > <w on the list > <t SOU > <w for > <t MOD > today
<w what is > <t QUG > MOD (SOU) <w i am doing > <t MOD > today
<w what is > <t QUG > MOD (SOU) <w i have got to > <t MOD > do (unclear)
<w what is > <t QUG > MOD (SOU) <w on my todolist > <t SOU > today
<w what is > <t QUG > MOD (SOU) MOD (SOU) <w on my todolist > <t SOU > today
<w what is > <t QUG > MOD (SOU) <w we have > <t MOD > MOD (SOU) today
<w what is > <t QUG > MOD (SOU) <w we have > <t MOD > MOD (SOU)
<w what jobs do i have > <t QTL > <w scheduled > <t VTL > <w for > <t MOD > today
<w what plans have i got > <t QTL > <w for > <t MOD > today
<w what's my first thing > <t QTL > MOD (SOU) <w today > <t TD > <w please> <t PL>

<w what's on my agenda first thing > <t QTL > today

Function 6a

<w can you > <t IN > <w also > <t ADD > <w put down > <t VND > <w that > <t MOD > <w on M O > <t TD > Y

<w can you > <t IN > <w make a note > <t VND > MOD (SOU) O M <w to > <t MOD > Y

<w can you > <t IN > <w make a note > <t VND > <w in my todolist > <t SOU > <w for > <t MOD > <w M the O > <t TD > <w to > <t MOD > Y

<w can you > <t IN > <w make a note > <t VND > <w in my todolist > <t SOU > <w that > <t MOD > Y M the O

<w can you > <t IN > <w make a note > <t VND > <w on M the O > <t TD > MOD (SOU) Y <w please> <t PL> Y

<w can you > <t IN > <w make a note > <t VND > <w on the priorities list > <t SOU > <w that > <t MOD > <w M the O > <t TD > <w is > <t MOD > Y

<w can you > <t IN > <w make a note > <t VND > <w that > <t MOD > Y MOD (SOU) <w on F > <t TD > <w please> <t PL>

<w can you > <t IN > <w make a note > <t VND > <w that i am to Y > <t MOD Y > MOD (SOU) <w on F > <t TD > <w please> <t PL>

<w can you > <t IN > <w make a note > <t VND > <w that i need to Y > <t MOD Y > <w on F > <t TD >

<w can you > <t IN > <w make a note > <t VND > <w that > <t MOD > <w on M O > <t TD > <w is > <t MOD > <t Y> <w please> <t PL>

<w can you > <t IN > <w make a note > <t VND > <w to > <t MOD > <t Y> <w on F > <t TD >

<w can you > <t IN > <w make a note > <t VND > <w to > <t MOD > <t Y> <w on F > <t TD > <w as an urgent thing > <t ADD > on <w my > <t MOD > todolist

<w can you > <t IN > <w please> <t PL> <w remind me to Y > <t VND > on F

<w can you > <t IN > <w put a note > <t VND > <w in my todolist > <t SOU > <w to > <t MOD > <t Y> <w tomorrow > <t TD >

<w can you > <t IN > <w put a note > <t VND > <w in the todolist > <t SOU > <w to > <t MOD > <t Y> <w on F > <t TD >

<w can you > <t IN > <w put a note > <t VND > <w in the todolist > <t SOU > <w to > <t MOD > Y on M the O

<w can you > <t IN > <w put a note > <t VND > <w on my todolist > <t SOU > <w to > <t MOD > <w confirm that Y > <t MOD MOD Y > on the O

<w can you > <t IN > <w put > <t VND > MOD (SOU) <w on things to do > <t SOU > <w is > <t MOD > <w to > <t MOD > <t Y> <w on F > <t TD >

<w can you > <t IN > <w put > <t VND > <w in my diary > <t SOU > <w for the O of M > <t TD > <w that > <t MOD > Y

<w can you > <t IN > <w put > <t VND > <w in my task list > <t SOU > <w that i have to > <t MOD > Y on F

<w can you > <t IN > <w put > <t VND > <w in my todolist > <t SOU > <w for F > <t TD > <w that i must Y > <t MOD MOD Y >

<w can you > <t IN > <w put > <t VND > <w in my todolist > <t SOU > <w for F > <t TD > <w to > <t MOD > Y

<w can you > <t IN > <w put > <t VND > <w in my todolist > <t SOU > <w on M the O > <t TD > <w to > <t MOD > Y

<w can you > <t IN > <w put > <t VND > <w in my todolist > <t SOU > <w then > <t ADD > <w that > <t MOD > <w on M the O > <t TD > i need <w to > <t MOD > Y

<w can you > <t IN > <w put > <t VND > <w in my todolist > <t SOU > <w to > <t MOD > <t Y> <w on F > <t TD > <w please> <t PL>

<w can you > <t IN > <w put > <t VND > <w in the planner > <t SOU > <w on M the O > <t TD > Y

<w can you > <t IN > <w put > <t VND > <w on the list of things to do > <t SOU > <w that > <t MOD > <w on M O > <t TD > Y

<w can you > <t IN > <w put > <t VND > <w on the task list > <t SOU > <w for M the D > <t TD > <w i have got to > <t MOD > Y

<w can you > <t IN > <w record > <t VND > <w for the entry > <t MOD > M O <w that > <t MOD > Y

<w can you > <t IN > <w take a note > <t VND > <w i need to Y > <t MOD Y > on F

<w can you > <t IN > <w write down > <t VND > <w that i've got to > <t MOD > Y on F

<w can you > <t IN > <w write > <t VND > <w in my list > <t SOU > <w to > <t MOD > <t Y> <w on F > <t TD >

<w can you > <t IN > <w write > <t VND > <w in my planner > <t SOU > <t Y> <w on F > <t TD >

<w could you > <t IN > <w add to > <t VND > <w my todolist > <t SOU > <w to > <t MOD > <t Y> <w on F > <t TD > <w please> <t PL>

<w could you > <t IN > <w jot down > <t VND > <w that i need to Y > <t MOD Y > <w on F > <t TD > <w please> <t PL>

<w could you > <t IN > <w make a note > <t VND > <w that > <t MOD > <t Y> <w on M O > <t TD >

<w could you > <t IN > <w make a note > <t VND > <w that > <t MOD > <t Y> <w on M O > <t TD > <w please> <t PL>
<w could you > <t IN > <w make a note > <t VND > <w that > <t MOD > MOD (SOU) <w is > <t MOD > <w to > <t MOD > Y on F
<w could you > <t IN > <w put a note > <t VND > <w in the things to do > <t SOU > <w to > <t MOD > <t Y> <w on F > <t TD > <w please> <t PL>
<w could you > <t IN > <w remember to tell me > <t VND > <w that i have to > <t MOD > Y on F
<w could you > <t IN > <w remind me > <t VND > <w that i have to > <t MOD > Y on F
<w could you > <t IN > <w write down > <t VND > <w that i need to Y > <t MOD Y > <w on F > <t TD > <w please> <t PL>
<w jot down > <t VND > <w on the O of M > <t TD > Y
<w jot down > <t VND > <w to make sure > <t MOD > <w that > <t MOD > <t Y> <w on M the O > <t TD > <w for > <t MOD > Y
<w make a note > <t VND > <w that > <t MOD > <w by M O > <t TD > <w i've got > <t MOD > <w to > <t MOD > Y
<w make a note > <t VND > <w that > <t MOD > <w on M the O > <t TD > <w to > <t MOD > Y
<w please> <t PL> <w can you > <t IN > <w make a note > <t VND > in <w my plan > <t SOU > <w to > <t MOD > <t Y> <w on F > <t TD >
<w please> <t PL> <w can you > <t IN > <w make a note > <t VND > in <w my plan > <t SOU > <w to > <t MOD > <t Y> <w on the O of M > <t TD >
<w please> <t PL> <w can you > <t IN > <w make a note > <t VND > on <w my plan > <t SOU > <w on the O of M > <t TD > <w that > <t MOD > Y
<w please> <t PL> <w make a note > <t VND > <w in my diary > <t SOU > <w to > <t MOD > <t Y> <w on F > <t TD >
<w put a note > <t VND > <w in the todolist > <t SOU > Y on M O
<w put down > <t VND > <w on my agenda > <t SOU > <w that i have to > <t MOD > <t Y> <w on the O > <t TD > Y
<w put > <t VND > <w in my todolist > <t SOU > <w to > <t MOD > <t Y> <w on F > <t TD >
<w put > <t VND > <w on the todolist > <t SOU > MOD (SOU) <w for F > <t TD > <w is > <t MOD > <w to > <t MOD > Y
<w schedule > <t VND > <w first > <t MOD > <w job > <t SOU > <w F Y > <t TD >
<w schedule > <t VND > <w first > <t MOD > <w job > <t SOU > M O Y
<w schedule > <t VND > <w job > <t SOU > <w O of M > <t TD > Y
<w schedule > <t VND > <w tomorrow > <t TD > <w first > <t MOD > <w job > <t SOU > Y
<w would you > <t IN > <w note down > <t VND > <w please> <t PL> <w that > <t MOD > <w we have got to > <t MOD > <t Y> <w on the O of M > <t TD > <w to > <t MOD > <t Y> <w please> <t PL>
<w write down > <t VND > MOD (SOU) <w with > <t ADD > Y MOD (SOU) <w on F > <t TD >

Function 7

and <w cancel > <t VC > MOD (SOU) MOD (SOU) <w today > <t TD > Y
and <w cross off > <t VC > <w the task list > <t SOU > <w that i've got to > <t MOD > Y
and <w cross out > <t VC > <w in the planner > <t SOU > <w to > <t MOD > Y
<w can you > <t IN > <w please> <t PL> <w cross through > <t VC > <w on the plan > <t SOU > <w to > <t MOD > Y
<w can you > <t IN > <w remove from > <t VC > <w my todolist > <t SOU > <w that i > <t MOD > was <w to > <t MOD > Y
<w can you > <t IN > <w take off > <t VC > <w my todolist > <t SOU > <w that > <t MOD > Y
<w cancel > <t VC > Y
<w could you > <t IN > <w cancel > <t VC > <w my action > <t MOD > <w to > <t MOD > Y
<w could you > <t IN > <w please> <t PL> VC (MOD Y) <w my > <t MOD > agenda
<w first > <t MOD > <w job > <t SOU > ask Y <w is > <t MOD > done
<w i have Y so that piece of information is done so > <t MOD MOD MOD ADD > <w can you > <t IN > VC (REFY) <w my list of things to do > <t SOU > <w please> <t PL>
<w mark off > <t VC > <w the todolist > <t SOU > <w that > <t MOD > <w we have made > <t MOD > Y
<w please> <t PL> <w cross off > <t VC > <w the todolist > <t SOU > Y
<w you can > <t IN > <w cross off > <t VC > <t Y> <w at T o'clock > <t TD > off the list <w of > <t MOD > things <w to > <t MOD > do
*

Function 8

Y <w can you > <t IN > VND (REFY) and <w put it > <t VND > aside <w please> <t PL>
Y <w can you > <t IN > <w make a note of > <t VND > <w that > <t MOD > <w for me > <t ADD > <w please> <t PL>
Y <w can you > <t IN > <w make a note of > <t VND > <w that > <t MOD > <w please> <t PL>
Y <w can you > <t IN > VND (REFY) <w for me > <t ADD > <w please> <t PL>
<w can you > <t IN > <w make a note > <t VND > Y

<w can you > <t IN > <w make a note of > <t VND > <w that > <t MOD > Y
<w can you > <t IN > <w make a note of > <t VND > <w that > <t MOD > <w in my notepad > <t SOU > <w please> <t PL> that Y
<w can you > <t IN > <w make a note of > <t VND > <w the fact that > <t MOD > Y
<w can you > <t IN > <w make a note > <t VND > <w then > <t ADD > <w please> <t PL> <w of > <t MOD > <w the fact that > <t MOD > <t Y> <w please> <t PL>
<w can you > <t IN > VND (REFY) <w that > <t MOD > Y
<w can you > <t IN > <w take a > <t VM > <w memo > <t SOU > Y
<w can you > <t IN > <w write down > <t VND > <w that > <t MOD > Y
<w could you > <t IN > VM (SOU) <w for me > <t ADD > <w please> <t PL> <w that > <t MOD > Y
<w could you > <t IN > <w make a note of > <t VND > <w the fact that > <t MOD > Y
<w could you > <t IN > <w make a note of > <t VND > <w the fact that > <t MOD > Y
<w could you > <t IN > <w make a note > <t VND > <w that > <t MOD > Y
<w could you > <t IN > <w make a note > <t VND > <w that > <t MOD > Y
<w could you > <t IN > <w make a note > <t VND > <w that > <t MOD > <t Y> <w please> <t PL>
<w could you > <t IN > <w please> <t PL> VM (SOU) <w that > <t MOD > Y
<w could you > <t IN > <w please> <t PL> <w write down > <t VND > <w that > <t MOD > Y
<w could you > <t IN > <w please> <t PL> <w write down > <t VND > <w that > <t MOD > Y
<w could you > <t IN > <w take note > <t VND > <w that > <t MOD > Y
<w could you > <t IN > <w write down > <t VND > Y
<w make a note > <t VND > <w in my notepad > <t SOU > <w that > <t MOD > Y
<w michael > <t ADD > <w can you > <t IN > <w make a note > <t VND > <w in my notepad > <t SOU > <w that > <t MOD > Y
<w record > <t VND > Y
<w would it be possible for you to > <t IN > <w note down > <t VND > <w that > <t MOD > Y
<w would you > <t IN > <w be able > <t ADD > <w to > <t MOD > <w make a note of > <t VND > <w the fact that > <t MOD > <t Y> <w please> <t PL>

Function 9

<w can you > <t IN > <w dig out the file on > <t VRM > <t Y> <w for me > <t ADD >
<w can you > <t IN > <w get me information about > <t VRM > Y
<w can you > <t IN > VRM (SOU) Y <w please> <t PL>
<w can you > <t IN > VRM (SOU) Y <w is > <t MOD > <w please> <t PL>
<w can you > <t IN > VRM (SOU) <w to > <t MOD > find out what Y is
<w could you > <t IN > <w check > <t VQU > <w in the file > <t SOU > <w for > <t MOD > MOD (Y) <w please> <t PL>
<w could you > <t IN > <w get back > <t VRM > <w the information > <t MOD > <w i told you to write down > <t MOD > <w about Y > <t MOD Y > <w please> <t PL>
<w could you > <t IN > <w get from > <t VRM > <w the file > <t SOU > <t Y> <w please> <t PL>
<w could you > <t IN > <w please> <t PL> <w get back > <t VRM > <w the information > <t MOD > <w about Y > <t MOD Y > <w for me > <t ADD >
<w could you > <t IN > <w retrieve > <t VRM > <w that information > <t MOD > <w we stored > <t MOD > <w about Y > <t MOD Y >
<w could you > <t IN > <w tell me > <t VQU > what Y was
<w could you > <t IN > <w tell me > <t VQU > Y
<w michael > <t ADD > <w can you > <t IN > <w get from > <t VRM > <w your records > <t SOU > <t Y> <w please> <t PL>
<w please> <t PL> <w tell me > <t VQU > <t Y> <w you have got written down > <t MOD > i told you
<w retrieve > <t VRM > Y
<w what is > <t QUG > <w it > <t REFY > <w i told you > <t MOD > was Y

Appendix J Alternative phrasings

As described under 2.4 of chapter 5 this appendix can be used to follow up the origin of the utterances of the x-file.

d3:[d3] can you ring mr brown again/ try again
e0:[e10] please can you get mrs stevens on the phone for me/ could you please get mrs stevens for me
e1:[e1] could you tell me what I am doing on the fifteenth of october / could you check my diary for the fifteenth of october please
e3:[e3] have i got anything on tomorrow morning / could you please see if i got any meetings tomorrow morning

e7:[e7] could you cancel the meeting that i had at eleven thirty with mr harrison/ could you cross the meeting with mr harrison out of the diary
e7:[e7] what have i got to do/ what is the first thing on my to do list

Appendix K Functions

These are the tables that show how the corpus was divided for the steps of analysis.. The first table gives examples for every function, the second displays the utterances that belong to every function respectively.

Function	Functionality	Example
1a	use the telephone	ring X
b	use the telephone again	ring X again
2a	retrieve a diary entry	when is my appointment with X
b	find a window for an appointment	when can I meet X
3	make a note in the diary	Note down that Y
4	delete diary entry	mark off Y from my diary
5	retrieve next item on to-do list	what is next on my to-do list
6a	add entry to the to-do list	write down in the to-do list that Y
b	and add entry to the to-do list	and write down ...
7	delete a to-do list entry	delete from my to-do list that Y
8	take a memo	take a note that Y
9	retrieve a memo	find the file on Y

Function	Functionality	Utterances no.
1a	use the telephone	3, 14, 22, 33, 47
b	use the telephone again	16
2a	retrieve a diary entry	9, 20, 36, 44, 55, 57, 70, 28
b	find a window for an appointment	38
3	make a note in the diary	13, 41, 61
4	delete diary entry	30, 66
5	retrieve next item on to-do list	1, 31, 82
6a	add entry to the to-do list	19, 63, 75, 78
b	and add entry to the to-do list	76
7	delete a to-do list entry	42
8	take a memo	7, 25
9	retrieve a memo	49

Appendix L Tags for semantic phrase categories

These are the tags used in the revised corpus and the following steps of analysis.

X	utterance does not refer to the task requested

During the analysis these were all replaced and included in the TD tag:

Noise tags:

AP	am or p.m.
T	time: but not o'clock midday one, two, ..twelve
D	day in a date: one, two, ... 31
O	ordinal numbers (range as D): first, second, thirty-first
J	number of the year: e.g. ninety- six

The following are the tags used for created the tagged corpus:

Abbr.	Type description	No of types	Example
IN	introduction to a sentence	11	could you
MOD	modifies the verb	65	(write down) the fact that
Verbs:			
VND	used for expressing: Note down	19	write down
VPH	addressing the telephone	15	get Y on the line
VTL	for: written down in todolist	3	planned
VC	for expressing: cancel	12	mark off
VQU	for expressing the fact of a query	10	check to see
VM	for :take a memo	3	file (that information)
VRM	for: retrieve a memo	8	get back
Query beginnings:			
QUG	General query beginning	9	what have i got
QUF	Query if there is free time	16	am i free
QUT	Query what is on at that time	21	what am i am doing
QUY	Query for the TD of an item Y	14	what time is
QTL	query for the todolist	6	what plans have i got
QDB	query to a database	19	what i have got to do
Parameters:			
SOU	specification of the source (database)	73	my notepad
Y	anything that is in the database	*	(phone) mr harrison or: british papers sell ... or: appointment with X etc.
TD	specification of Time and Date	97 (!)	tomorrow morning between T and T
IT	specification of an item in a database	1	after my Y
REFD	reference to a date mentioned earlier	5	same day
REFY	indirect reference to Y	9	(jot) that (down)
Various:			
PL	replaces "please"	1	please
ADD	not necessary for the function itself	20	thank you
TOO HARD		**	could you tell me please
if i			can make it home early today

(*) were deleted
(**) had only to be applied three times in the whole corpus