How to Ask Users About What They Mean: Two Experiments & Results

Hervé BLANCHON
GETA-CLIPS
150, rue de la Chimie
BP 53
38041 Grenoble Cedex 9, France
herve.blanchon@imag.fr

Laurel FAIS
ATR-ITL
2-2 Hikaridai
Seika-cho, Soraku-Gun
619-02 Kyoto, Japan
fais@itl.atr.co.jp

Abstract

We report on two experiments we carried out at ATR-ITL evaluating the understanding of disambiguation questions which are produced automatically.

A pilot experiment was carried out during the summer of 1995 [3]. Even though the results were equivocal, we gained experience concerning how to design this kind of experiment.

The second experiment was carried out in April, 1996 [4], incorporating what we learned from the pilot experiment, and the results are far better.

Keywords

interactive disambiguation, user studies, understandability, multimodal interface

I. Introduction

I.1. Situation

Natural language (spoken or written) is an attractive modality for human-machine interaction. Speech is attractive because, as stated in [13, pp. 110-111]: speech requires no training; speech is fast; and speech requires little attention. Text also can be attractive when the utterances are short, when speech is not mandatory, and when the use of speech is annoying to those surrounding the user. Currently foreseeable applications using natural language interface include multi-modal drawing tools [6, 12, 15], on-line travel information [10] and more generally, on-line information retrieval [11], oral control systems, and finally Interpreting Communication systems [13, 14].

I.2. Interest

Natural language input has always been, and will continue to be, handled with great difficulty by computers. At the very least the correct words, syntactic structures and surface semantic features used in the input must be recognized, but natural language, either spoken or written, is highly ambiguous, and highly creative[1], even in restricted domains. This makes natural language difficult to process accurately.

There is a real need to fill the gap between a toy and a real-scale application overcoming those difficulties. Interactive disambiguation of the input is proposed as a reliable solution, which aims to produce more robust, fault-tolerant, and user-friendly software integrating with natural language processing components [5].

The interactive disambiguation process is then a crucial part of the system. The ease, and naturalness of the disambiguation process are the preconditions to the success of this idea.

There is, thus, a real need to experiment with the design of such a process to be able to propose a labeling of the questions understandable to users. The parameters to be taken into account are: the user expertise with the environment, the user expertise with the disambiguation process, the modalities to be used, and the ambiguities to be solved.

As a first step toward this long-term goal, we began to experiment with interactive disambiguation dialogues and we report the results from two experiments.

1 In the literature we often read about “ill-formed” input, but we should probably say “unexpected” input as what humans produce has to be called natural language.

I.3. Presentation

In the next part of this paper we give an account of the pilot experiment and discuss what we learned from it. In the third part, we will describe the second experiment and give our results. In conclusion we discuss the results of the second experiment and draw some implications.

II. Pilot experiment

II.1. Setting

1.1. Experimental conditions

For this experiment, the workstations of the subject and the experimenter were back-to-back (Fig 1).

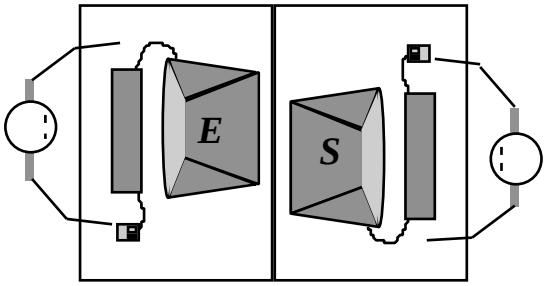


Figure 1. Experimental setting.

The subjects were first asked to read to themselves the text they were to answer questions about. The text was then displayed inside a text window on the subject's workstation screen. The subjects were asked to read the text aloud slowly and carefully and pause between the sentences. The scrolling of the text window was controlled by the subject.

The experimenter controlled the presentation of the questions to the subjects.

1.1.1 Presentation of the question by the experimenter

The presentation of the questions was controlled through a HyperCard stack. There was one stack per subject. All the cards in this stack had the same mode of presentation (Fig. 2). On the top part of each card was displayed a part of the text with the ambiguous sentences bolded. On the lower part was:

- a set of buttons (e.g., **traveling**, **exitout**, **trainticket**), each one activating the display of a dialogue box on the subject screen.
- a set of textual fields, used to record automatically the answer of the subject to the appropriate question,
- a set of two buttons allowing the experimenter to go to the previous or next card (the arrows).

Figure 2. A control card for the experimenter

On this card, which corresponds to the beginning of the text for subject-1 with the human-like set of questions, we can see that the subject has chosen: answer 1 for the question about **traveling**, answer 2 for the question about **exitout** and answer 1 for the question about **trainticket**.

On the first card is a prologue button used to play a speech synthesized message asking the subject to start reading slowly and carefully. On the last card is an epilogue button used to play an acknowledgment message.

1.1.2 Presentation of the questions to the subjects

The questions were displayed in a dialogue box presenting an ambiguous utterance and two possible interpretations (Fig. 3). The dialogue box appeared in the middle of the textual window. The special feature of this dialogue box was that there was no choice selected by default. We chose to do that so as not to lead the subjects toward a particular item.

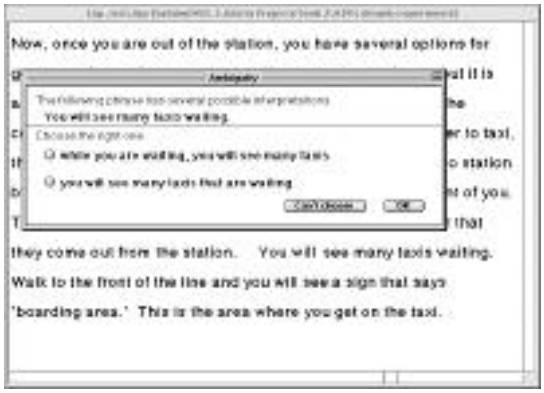


Figure 3. Subject screen & a dialogue box

1.2. Experimental materials

Two classes of dialogues were used. This required two groups of 12 subjects each. The text and the ambiguities to be solved were the same for each group.

1.2.1 Text

We designed a text that contained a set of 35 ambiguous sentences. The ambiguities in the sentences were selected from naturally occurring ambiguities in a corpus of spontaneous conversation collected at ATR [7, 8, 9]. The text itself was made up of two different stories (Appendix I). The 35 ambiguities were distributed evenly over the seven categories of ambiguities described in Table 1, i.e., five examples of each category.

Of the five examples in each category, there were two sentences with easy interpretations and three sentences with hard ones. That is, "easy" interpretations corresponded to the most frequent or most salient interpretation of a given sequence of words and "hard" interpretations corresponded to an unusual, though possible interpretation of a given sequence of words. The "easy" interpretation tended to be the sense that would pop up first in someone's mind for that sequence of words; the hard one was a much less likely interpretation. For example, the easy interpretation of "I want to check in to the hotel" is "I want to register at the hotel;" the hard one is "I want to investigate the hotel."

The codes found in the text (Appendix I) give the abbreviation for the ambiguity type followed by **H** for hard interpretation or **E** for easy interpretation. The abbreviations can be described as follows:

D	Decoration	"please exit **by** Exit 14." – exit through Exit 14 – exit in proximity to Exit 14.
PH	Phrasal Verb	"Go over it carefully." – pass over, – review.
CO	Coordination	"Western bed and bath." – western bath, – not western bath.
S	Subordination without a verb	"a train ticket vendor." – train ticket, – ticket vendor.
P	Polysemy	"story." – narrative, – floor.
SV	Subordination with a Verb	"You will see many taxis waiting." – the taxis are waiting, – You are waiting.
SC	Syntactic class	"You can take a bus or taxi." – You can taxi, – You can take a taxi.

Table 1. Description of the abbreviations for the ambiguity types

The subjects were given a hard copy of the text beforehand. They were first asked to read it to themselves, trying to get as clear an understanding of the stories as possible. They were then asked to read the text aloud.

When the subject read a sentence that contained an ambiguity, the experimenter caused a dialogue box to appear on the subject's screen. In the dialogue box was a question about that ambiguity which the subject had to answer before moving on. The subjects were invited to read the text aloud slowly and carefully, trying to understand and answer the questions whenever they appeared. The experimenter controlled the timing of the presentation of the questions to the subjects.

1.2.2 Questions

There were two groups of subjects, each group receiving a different type of disambiguation question. The labeling of the questions is given in Appendix II. One type of question had human-like or natural phrasing and the other, more "machine-like" phrasing. The human-like questions were couched in a natural, relatively verbose style, and the machine-like ones were patterned on the type of phrasing that we would be able to produce using the disambiguation methodology proposed in [1, 2]. Thus they were more compact, somewhat more abstract, and less descriptive. Both types of questions concerned the same ambiguities and intended meanings.

II.2. Analysis

2.1. Statistical analysis

Recall that each class of ambiguity was represented in the experiment by five examples each. These examples had both easy and difficult interpretations. Figure 4 illustrates the difference between the two types of questions; subjects gave significantly more correct answers in the case of the easy examples.

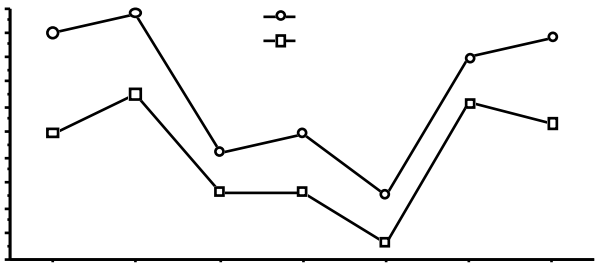


Figure 4. Average number of correct answers per ambiguity category, for easy and hard interpretations.

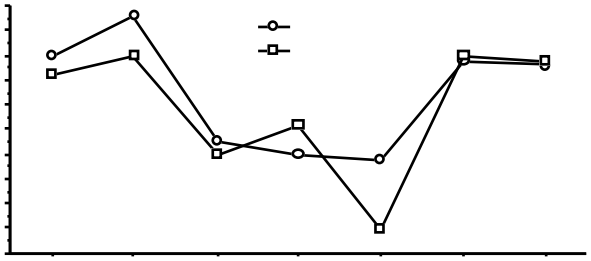


*Figure 5. Average number of **correct** answers per ambiguity category, for "wordy" and "system" choices.*

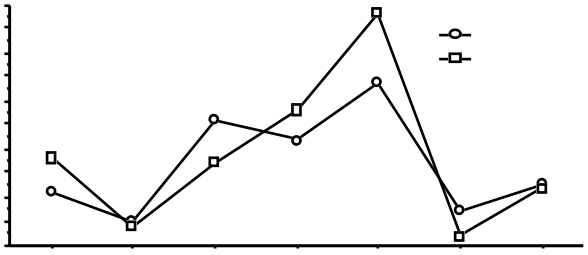


*Figure 6. Average number of **incorrect** answers per ambiguity category, for "wordy" and "system" choices.*

Since subjects had the options both to make a definite choice or to choose "no answer," we looked at the results for all three possible outcomes: the subject chose the correct response; the subject chose the incorrect response ; and the subject did not choose any response ("no answer"). The results for each case are described below.

The main point of Figure 4 is that we were, in fact, correct in our assessment of how difficult or easy the interpretations were. Our intuitions that subjects would be able to answer the easy interpretations more accurately were borne out.

Figures 5 and 6 give us some insight into how subjects reacted to the two different types of disambiguation dialogues. First of all, the only ambiguity class for which there was a clear difference between the two types of wording was Syntactic Class. These ambiguities were more difficult to resolve given the "system" or machine-like dialogue. We can see this not only in the fewer correct answers given for Syntactic Class ambiguities (Figure 5), but also in the greater number of incorrect answers (Figure 6).

The ambiguity classes seemed to fall into two categories depending upon how accurately subjects were able to interpret the intended senses. Subordination involving the Verb (SV), Phrasal Verb (PH), Decoration (D), and Polysemy (P) ambiguities seemed to group together, receiving a relatively high number of correct (and low number of incorrect) answers. On the other hand, subjects seemed to be less accurate in resolving Subordination (S), Coordination (CO), and Syntactic Class (SC). These received a relatively lower number of correct answers and higher number of incorrect answers. These results give us a rough indication of which types of ambiguities are most accurately resolved by subjects.

The "no answer" case is also interesting. Figure 7, which illustrates these results, shows a difference between the "wordy" and "system" dialogues for the Phrasal Verb, Subordination, and Coordination categories of ambiguity. In the first two cases, the "system" dialogues were more difficult to resolve; subjects had a greater number of "no answers" in those cases. For Coordination ambiguities, however, the "wordy" dialogue was more difficult to

respond to; subjects had greater number of "no answers" in that case.

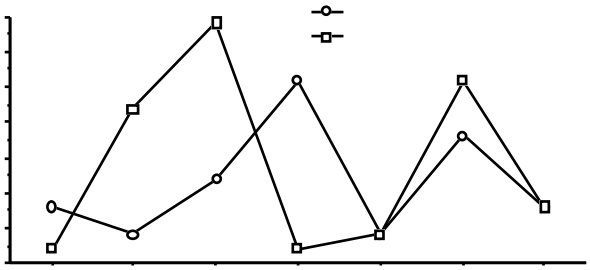


*Figure 7. Average number of **"no answer"** responses per ambiguity category, for "wordy" and "system" choices.*

In summary, then, only in the case of Syntactic Class ambiguities was there a real difference in subject performance depending upon dialogue type; in this case only, subjects responded to the human-like dialogues more accurately. Overall, subjects were able to respond relatively more accurately to Subordination involving the verb, Phrasal verb, Decoration and Polysemy ambiguities, and less accurately to Subordination, Coordination and Syntactic class ambiguities (regardless of dialogue type). Subjects seemed somewhat more confident in their ability to respond to the human-like or "wordy" phrasings (as measured by the number of "no responses" given) with the notable exception of Coordination ambiguities, which exhibited the opposite trend.

2.2. Questionnaire

Subjects, as shown in Appendices III & IV, were asked to rate how easy it was to answer the questions and to comment on their choices for each type of ambiguity to be solved. To remind them of the kind of question they had been asked, two example dialogue boxes were provided for each type. They were also asked to make general comments about the disambiguation dialogues, the interruptions, resuming the task after interruption and anything else they wanted to point out.

Subjects almost always responded to the particular examples we gave them; they could not generalize to the class of ambiguities. In a way, this is natural; there were often big differences among the ambiguous sentences in terms of how difficult they were.

Subjects often responded that being interrupted was not a problem. We suspect this was because being interrupted was the point of the experiment. They had agreed to do the experiment, so they weren't bothered by the interruptions. This doesn't tell us much about what their reactions would be in a "real life" situation.

II.3. Lessons learned & recommendations

3.1. Lessons learned

In the course of conducting the pilot experiment and discussing their impressions with subjects afterwards, we learned a number of things that affected the design of the next experiment.

Subjects frequently commented on how unnatural the text seemed to be. There were three reasons why the text sounded unnatural. First, it included actual spoken English examples in written form, surrounded by (made up) written context. Transcriptions of spoken English often sound unnatural, especially embedded in written text. Second, some of the "hard" interpretations were ones that, in real life, only a computer would have trouble understanding. In trying to motivate these difficult interpretations, unnatural text was produced. And third, there was a much higher density of ambiguous sentences in the text than would be found in real text or speech.

3.2. Recommendations

We made a number of changes to the experimental format for the second experiment based on our experience in the pilot experiment. We realized that using hard interpretations in the pilot experiment was a mistake. It made the text sound unnatural and made the task more difficult for the subjects, clouding the real issue: how well they could respond to the different wordings of the dialogues.

We also changed the arrangement of the screen so that subjects could check back to the text to confirm their understanding of the ambiguity involved. Subjects complained that they could not do this in the pilot; this was also an unnecessary obstacle to the accomplishment of the task.

While the "no answer" option gave some interesting results, it also made it difficult to see trends in answering the questions clearly. For that reason, we designed the next experiment to be forced choice.

III. Second experiment

III.1. Setting

1.1. Experimental conditions

For this experiment, the experimenter and the subjects were separated, sitting on either side of a partition. They communicated through head sets (microphone, headphones).

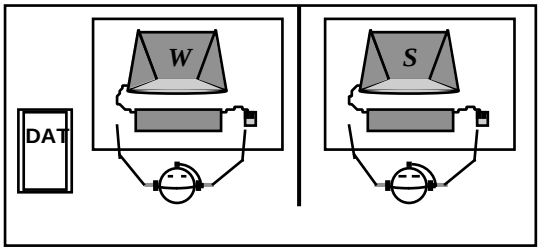


Figure 8. Experimental setting.

The subject was asked to read aloud, slowly and carefully, a text displayed inside a text window (Fig. 9), and pause after each sentence. The scrolling of the text window was controlled by the experimenter (i.e. the text windows of the subject and the experimenter were synchronized).

The experimenter controlled

- the recording, on a DAT tape, of the subjects' reading,
- the scrolling of the text windows for himself and the subject,
- the setting the subject participated in:
  - Speech, Human (spoken, human-like dialogues),
  - Speech, Machine (spoken dialogues that could have been generated automatically),
  - Text, Human (human-like text dialogues),
  - Text, Machine (text dialogues that could have been generated automatically).
- the presentation of the questions, written or spoken.

1.1.1 Presentation of the questions by the experimenter

The presentation of the questions was controlled through a palette made of buttons. There was one button per question to be asked. Once a button was released the corresponding question was asked (spoken or displayed in text on the subject screen).

With the text questions, the answers were recorded in a text file. A button at the top of the button palette was used to create and open this file (one per subject). A button at the bottom of the palette was used to close the file.

In the case of the spoken questions, the answers were recorded on tape. Thus the experimenter only had to present the questions.

1.1.2 Presentation of the questions to the subject

The written questions were displayed in a dialogue box presenting an ambiguous utterance and two possible interpretations. When a question was presented to be answered, the background color of the text turned from white to gray, as shown in Figure 9.

The spoken questions were prerecorded on the subject workstation. When a question was to be asked, the corresponding sound file was played by the experimenter.

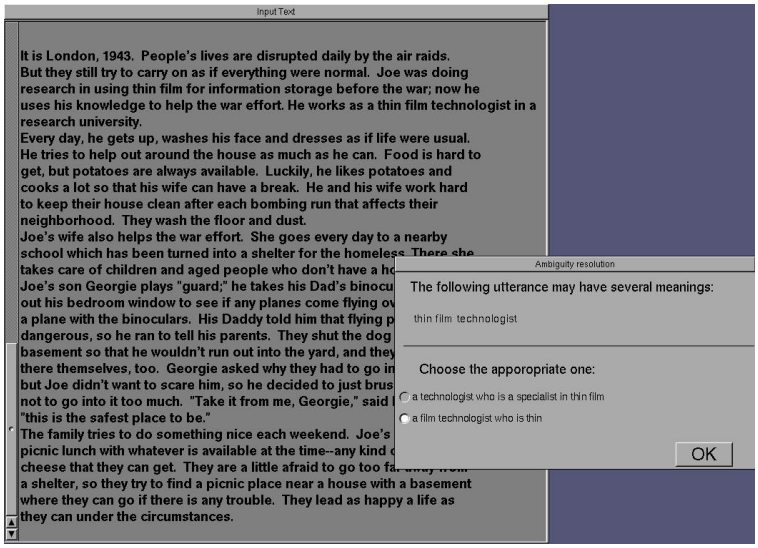


Figure 9. Subject's screen, text & dialogue box

1.2. Experimental materials

Two classes of dialogues and two modalities were used. This required four groups of subjects; there were fifteen subjects in each group. The text and the ambiguities to be solved were the same for each group.

1.2.1 Text

The text to be read was entirely made up, that is, it didn't contain examples from the "real" corpus as in the pilot experiment. It consisted of three different stories and contained 35 ambiguous sentences, five in each category of ambiguities described in the Table 1. The whole text is given in Appendix V where the ambiguities are boldfaced.

1.2.2 Questions

Two sets of questions were prepared: one human-like, i.e., as if a human were explaining the ambiguities, and one machine-like, i.e., as if the system were generating the explanations, similar to those in the pilot experiment. The contents of the textual and spoken dialogues were the same. The presented rephrasings are given in Appendix VI.

III.2. Results

The actual answers given by the subjects are shown in Appendix VII. Below we discuss the answers given for each dialogue type.

2.1. Textual human-like dialogues

We observed a high rate of success for the subjects, except for the question about the coordination phrase containing the word "children;" this received seven correct answers and eight wrong answers. It seems we have a case here in which subjects did not use the text to choose an interpretation but based their decisions on their own convictions. One subject said "of course you will be helping all the children." Moreover, the wrong answers were not affected by the gender of the subject (five males and three females).

2.2. Spoken human-like dialogues

The answers to the coordination ambiguity containing "children" were very good. This may have been because of the modality, which more or less obliges the subject to choose the right interpretation "on the fly." Once the first interpretation is chosen, the subject is less receptive to the second one.

The result for the question about "Tom telling Bill he had had a terrible time that day" is poor (eight correct answers and seven wrong). The results for the same question are excellent in the other settings. Maybe it was difficult to understand the difference between the rephrasings.

2.3. Textual machine-like dialogues

The ambiguities containing "taxi" and "professor" may have been a little difficult. On the other hand, we have a real problem with the ambiguities containing "school" and "apples". Almost all the subjects were asked by the experimenter about their understanding of these sentences and they all understood the intended meaning. Thus, the rephrasings did not effectively capture the intended meaning.

2.4. Spoken machine-like dialogues

The ambiguities containing "taxi" and "professor" seemed less difficult in the spoken machine-like dialogues than in the textual machine-like condition.

The responses to the ambiguities containing "school" and "apples" are also more accurate in this setting. For both questions almost all the subjects (except two) are in agreement with the intended meanings.

For the resolution of the ambiguity containing "school," the technique is the same as the one used for the other ambiguities of this type. The problem of interpretation of the wording used here may be linked with the representation people have of "the French style of cooking."

For the resolution of the ambiguity containing "apples" we used a slightly different technique than for the other ambiguity of the same kind, "Flying planes can be dangerous." For the "apples" ambiguity, the interpretations were labeled as follows: A – some eat apples, B – some are (eating apples). To be consistent with the interpretations for "planes," the labeling should have been: A – some are masticating apples, B – some are (eating apples). With this revised labeling the right interpretation may have been easier to understand. It should also be said that the

intonation of the second rephrasing for "apples" was similar to the natural intonation for saying that "people were eating apples." This is why this choice was unanimously chosen by the subjects.

III.3. Analysis

The analysis of the collected information is divided in three parts: statistical analysis, behavioral analysis, and the post-experiment questionnaire analysis.

3.1. Statistical analysis

3.1.1 Analysis of data actually collected

If we use the actual answers collected, the basic result is that the difference between the responses to the human-like dialogues and those to the machine-like dialogues is significant ($p<.05$; Figure 9). This is affected by the two questions (those with "school" and with "apples") which were problematic in the machine setting. We will see in another analysis below that the difference is not significant.

It appears that in both machine-like and human-like phrasings, the performance of the subjects tend to be better with text questions, but we can't draw any definitive conclusion since the differences between spoken and textual dialogues are not significant.

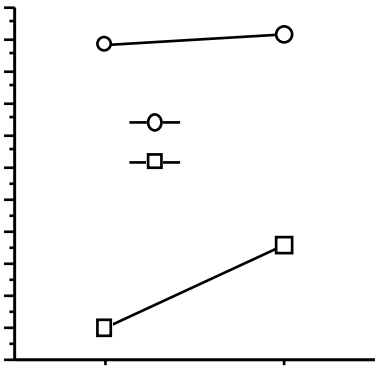


Figure 9. (Actual data) analysis

3.1.2 Filtered analysis: ambiguities containing "school" and "apples" excluded from machine-like dialogue results

Because of the questions raised above about the appropriateness of the dialogues for the ambiguities containing "school" and "apples," we also analyzed our results excluding the questions about those ambiguities from the results for the machine-like dialogues.

In this case there is no significant difference between the subjects' performance in the machine-like dialogue settings and in the human-like dialogue settings (Figure 10).

Subjects seem to show better performance for textual dialogues over spoken dialogues for the human-like phrasings; however, there is no difference at all between text and speech for the machine-like phrasings. Again, the differences are not significant so no definitive conclusion can be drawn.

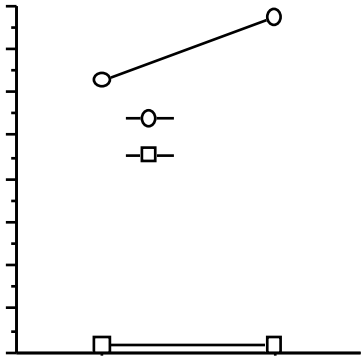


Figure 10. (Filtered Data) analysis

3.1.3 Projected analysis: ambiguity containing "school" excluded from machine-like dialogue results and results for ambiguity containing "apples" corrected

In this third way of looking at the data, we excluded results for the ambiguity containing "school" from the results for the machine-like dialogues and adjusted the answers to the question about "apples" according to what we conjecture the answers would have been if the question had been labeled correctly. In this third case, there is again no significant difference between the results in the machine-like and human-like dialogue settings (Figure 11).

In this analysis, the results for spoken and textual dialogues were different for the machine-like and human-like phrasings. The difference is again not significant; thus no definitive conclusion can be drawn.

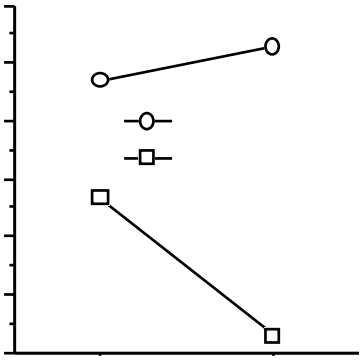


Figure 11. (Projected data) analysis

3.2. Behaviors

The behavior of the subjects can be evaluated according to several parameters that were pertinent to the task.

3.2.1 Lecture speed and pause length

The subjects' reading speed and pause duration between the sentences differed widely from one subject to another.

The experimenter did not explicitly ask the fast subjects to slow down but rather let them realize that they were reading too fast for the system by presenting the disambiguation question after the beginning of the sentence following the ambiguity. Subjects eventually accommodated slightly by reducing their speed somewhat.

There was marked accommodation and slowing down of the speech of the subjects in the spoken settings. The slow speed of the speech used in the spoken disambiguation questions may have influenced the subjects.

3.2.2 Use of the "repeat" option

In the spoken settings, subjects were able to ask for the disambiguation question to be repeated. However, the repeat option was very infrequently used:

- 17 times in the spoken human setting over 525 questions, namely 3.24%;
- 19 times in the spoken machine setting over 525 question, namely 3.6%.

3.2.3 Answer time

The time that subjects took to answer the questions was very different from one subject to another. The tapes have not been analyzed yet so no specific data are available at this time.

3.2.4 Comfort with the task

The subjects were very comfortable with the task and self-confident about their answers. They reported that the task was easy to carry out.

3.3. Questionnaires

Each subject was asked to answer a post-experiment questionnaire (cf. Appendix VIII). Here are some of the results, with short comments. The abbreviations in the first column of the Tables are as follows: TH, "textual, human-like;" SH, "spoken, human-like;" TM, "textual, machine-like;" SM, "spoken, machine-like."

3.3.1 About the ease of answering

	Very Easy	Quite Easy	Easy	Fairly Easy	Confusing
TH	2	2	4	8	1
SH	6	3		7	
TM	4	3	4	3	6
SM	3	3	3	8	2

Table 2. The ease of answering

The questions were thus easy to answer. Only 15% of the subjects felt that the answers were difficult.

3.3.2 Recommendations to make the questions easier to understand

	Proposal	Num.
TH	More context in the question	1
	Better distinction between items	2
SH	Less monotonous voice	1
	Shorter questions	5
	Written choices	1
	Be asked about my own text	1
TM	More context	3
	Wordier choices	2
	Brackets + bold for emphasis	1
	User-proposed meaning	1
	Grammar markers	1
SM	Example sentences instead of intonation & pauses	1
	Shorter questions	3
	Use of intonation	1
	More detailed explanation available	2
	C**hoice on the screen with brackets**	2

Table 3. Proposals from the user

In the spoken situations, several subjects (three) felt that they would have preferred to be asked questions in a written setting. That is a small number, but it shows that several settings could be available for the user to choose among.

In the spoken situation the meta-labeling to present the question should be as short as possible and intonation may be used more.

In the text machine situation, typography may be used as a complement to the bracketing to show the emphasis.

3.3.3 Strategies

	Strategy	Num.
TH	– Use of the context	8
	– Substitution in the sentence	4
SH	– Use of the context	7
	– Substitution in the sentence	2
TM	– Use of the context	9
	– Substitution in the sentence	3
SM	– Use of the context	4
	– Substitution in the sentence	2

Table 4. Strategies used by the subjects

Substitution and use of the context are the most used techniques in all settings.

3.3.4 Predictability & recognition of patterns

	Predictability & recognition
TH	3
SH	3
TM	2
SM	5

Table 5. Predictability of the questions

Some of the subjects were able to tell us how predictable the questions were, according to several syntactic patterns. We would have liked their number to be bigger but this does indicate that there are discernible patterns in the disambiguation process.

IV. Conclusion & perspectives

If we allow for the problematic questions concerning items with "school" and "apples," we see that there were no significant differences according to the style (machine, human) of the presentation of the disambiguation dialogues, and no significant differences according to the modality (spoken or textual). The former result is essential to the success of an automatic interactive disambiguation program. We have seen that subjects are able to interpret the dialogues when presented in human-like, i.e., natural, phrasing, but it is not likely that automatically generated dialogues can be so natural. Therefore, it is critical that users be able to interpret the type of dialogues that machines are likely to be able to generate. The results reported here show that this is indeed the case.

We also investigated whether spoken or textual dialogues would be easier to understand. This is a design question; it affects how an automatic system will be designed, but is not crucial to the system. The results found here, as well as comments made by some of the participants about wanting to have text instead of speech, suggest that one design feature for an interactive disambiguation system should be the option for users to choose in which modality they would like to have the dialogues presented. According to our results, both modalities are understandable.

Although the "repeat" option was not extensively used in the spoken setting, it is still necessary to include it for cases where users cannot understand the dialogue after the first hearing. Other suggestions made by the subjects can be easily implemented. For example, more of the context of the ambiguity can be included in the dialogue; this would also support the most frequent strategy used by the subjects in determining their responses, i.e., the use of context. In addition, spoken utterances can be made shorter and faster. How best to use intonation in the spoken presentation of disambiguation dialogues is an open and interesting question.

It will be also necessary to run an experiment using as a textual support a text provided by each subject himself. This may be the only way to have a better analysis of the interactive disambiguation methodology we have proposed.

Acknowledgment

The authors would like to acknowledge Dr. Yamazaki and Dr. Morimoto for their kind invitation of H. Blanchon in the framework of the joint MIDDIM project between ATR-ITL and the GETA-CLIP laboratories. They are very grateful to Dr Loken-Kim who gave them access to the experiment room equipment. They finally want to thank Mr. Kurihara who programmed the actual setting and set up the experiment.

References

[1] **Blanchon, H.**, (1992). *A Solution to the Problem of Interactive Disambiguation.* Proc. Coling-92. July 23-28, 1992. vol. **4/4** : pp. 1233-1238.

[2] **Blanchon, H.**, (1995). *An Interactive Disambiguation Module for English Natural Language Utterances.* Proc. NLPRS'95. Dec 4-7, 1995. vol. **2/2** : pp. 550-555.

[3] **Blanchon, H. & Fais, L.**, (1995). *Pilot Experiment on the Understandability of Interactive Disambiguation Dialogues.* Rap. ATR-ITL. Technical report. n° TR-IT-0177. September, 1995.

[4] **Blanchon, H. & Fais, L.**, (1996). *A Second Experiment on the Understandability of Interactive Disambiguation Dialogues.* Rap. ATR-ITL. Technical Report. n° TR-IT-0167. April, 1996.

[5] **Blanchon, H. & Loken-Kim, K.-H.**, (1994). *Towards More Robust, Fault-Tolerant and User-Friendly Software Integrating Natural Language Processing Components.* Rap. Institute of Electronics, Information and Communication Engineering. Technical Report. n° SP94-65, NLC94-34. December, 1994.

[6] **Caelen, J.**, (1994). *Multimodal Human-Computer Interaction.* in Fundamentals of Speech Synthesis and Speech Recognition. John Wiley & Sons. New York. pp. 339-373.

[7] **Fais, L. & Loken-Kim, K.-H.**, (1994). *Effects of communicative mode on spontaneous English speech.* Rap. Institute of Electronics, Information and Communication Engineers. Technical Report. n° NLC94-22. Oct. 94.

[8] **Fais, L. & Loken-Kim, K.-H.**, (1995). *Lexical Accommodation in Human-interpreted and Machine-interpreted Dual Language Interactions.* Proc. ESCA Workshop on Spoken Dialogue Systems. May 30-June 2, 1995. vol. **1/1** : pp. 69-72.

[9] **Fais, L., Loken-Kim, K.-H. & Park, Y.-d.**, (1995). *Speakers' responses to requests for repetition in a multimedia cooperative dialogue.* Proc. International Conference on Cooperative Multimodal Communication. May 24-26, 1995. vol. **1/1** : pp. 129-144.

[10] **Goddeau, D., Brill, E., Glass, J., Pao, C., Philips, M., Polifroni, J., Seneff, S. & Zue, V.**, (1994). *GALAXY: a Human-Language Interface to On-Line Travel Information.* Proc. ICSLP 94. September 18-22, 1994. vol. **2/4** : pp. 707-710.

[11] **Haddock, N. J.**, (1992). *Multimodal Database Query.* Proc. Coling-92. 23-28 juillet 1992. vol. **4/4** : pp. 1274-1278.

[12] **Hiyoshi, M. & Shimazu, H.**, (1994). *Drawing Pictures with Natural Language and Direct Manipulation.* Proc. Coling-94. August 5-9, 1994. vol. **2/2** : pp. 722-726.

[13] **Kay, M., Gawron, J. M. & Norvig, P.**, (1994). *Verbmobil: A Translation System for Face-to-Face Dialog. CSLI lecture note no 33.* Center for the Study of Language and Information, Stanford, CA. 235 p.

[14] **Morimoto, T., Suzuki, M., Takezawa, T., Kikui, G., Nagata, M. & Tomokiyo, M.**, (1992). *A Spoken Language Translation System: SL-TRANS2.* Proc. Coling-92. 23-28 juillet 1992. vol. **3/4** : pp. 1048-1052.

[15] **Nishimoto, T., Shida, N., Kobayashi, T. & Shirai, K.**, (1994). *Multimodal Drawing Tool Using Speech, Mouse and Key-Board.* Proc. ICSLP 94. September 18-22, 1994. vol. **3/4** : pp. 1287-1290.

Appendix I: Text read by the subjects in the pilot experiment

I will be giving you information about traveling to the conference center and about various sightseeing spots in Kyoto. First, I will tell you about travel options and later I'll tell you about sightseeing. So let me **tell you what to do about traveling now**. **SVE** If you will be coming by Shinkansen, please be sure you have all your luggage with you and check your seat number before you leave the train. Then **exit out from the Shinkansen**. **PHH** Once you do that, you will walk down the platform toward the exits. On your left will be the offices where you can buy tickets for the special express trains, the bullet train, or tourist charter trains. Walk past that **train ticket vendor**. **SE** Then look for your exit. The exits have either names, such as South Central, or numbers, such as Exit 3. They are clearly marked above the exit door. So you should be able to see the sign saying the **exit with the number, or the name. COH** Follow the signs for Exit 14. At this point, you are on the lowest level of the station. Please take the escalators up. As you go up, you will reach one level that is built like a set of bleachers, in steps, and then two platforms that are level. You can **catch a taxi at the second level platform. SCH** When you arrive at this level, there will be additional signs for Exit 14. The exit you want to take is the South Central, right next to Exit 14. So, please **exit by Exit 14**, through South Central. **DH** Once you are at this platform, please continue through the main doors of the station which should be directly in front of you. At this point, you must be careful of your luggage. If you have a large suitcase, **it may be difficult to get out of Kyoto Station. PHH** If you have trouble getting through the door with any large luggage, there is a special luggage exit, one door to your left. You should have no trouble with your luggage if you just **take that one door to your left**. **SCE** You will have to go over a drainage conduit cover embedded in the floor of the station just past the exit. It is a little bumpy, and your luggage wheels may get caught, so you may want to be sure to **go over it carefully**. **PHH** Now, once you are out of the station, you have several options for getting to the conference center. You can take a subway, but it is a bit complicated. Most of our customers prefer to taxi to the conference center. I will assume that you would also prefer to taxi, though **you could take a bus or taxi. SCH** Once you have left Kyoto station by Exit 14, you should see the taxi stand directly in front of you. The taxis wait here in line to take each customer in the order that they come out from the station. **You will see many taxis waiting**. **SVE** Walk to the front of the line and you will see a sign that says "boarding area." This is the area **where you get on the taxi. PHE**. There are a number of different kinds of taxis and they will be different colors. The red ones are taxis from the conference center. Just tell the driver of a red cab where you want to go, and the trip should take you five minutes **by taxi from the conference center**. **SH** Be sure to take a red cab. Once taxis get to the conference center, all other taxis must turn left and stop in a lot that is a little far from the center entrance. However, the red taxis don't have to turn left, they come **right,** to the front of the center. **PH** Because these are special conference center taxis, the conference center will pay part of the cost of the taxi. Please inquire at the conference information desk to find out the cost of the taxi to you and **the cost of the taxi to the conference center. DH** The conference information desk can also help you with information about your return. Please consult them to help you make reservations to **take the taxi back. PHE**

The area around the conference center is rich with cultural sights. There are numerous shrines and temples and the famous castle, Nijo Castle. The conference information desk can also help you with transportation to **these temples or castles like Nijo. COH** Most conference goers will not leave immediately after the conference. If you are free on the day after the conference, perhaps you would like to join the sightseeing tour arranged especially for conference participants at that time. Please notify the desk if you would like to take part in this **tour the day after the conference before you leave. SE** Or you might like to arrange your own sightseeing. Although many taxi drivers in Japan speak English, not all of them do. Therefore, you may require help with communicating with your taxi driver. Please just ask anyone at the conference information desk. They know what to say and can help you with **where you should tell the taxi to go. DE**

If you do not wish, for some reason, to come to the center by taxi, please refer to the conference packet you received when you sent in your pre-registration. In it you will find a brochure. Consult it if you want to **look at** another method of travel. **PH** There are trains from the eastern terminal of the subway, or buses from Kyoto Station itself which can get you to the conference center. Please read the brochure concerning taking **a train or bus from the Station. COH**

I represent a travel service company. We specialize in helping visitors to Kyoto make arrangements for their stay here. We understand that you are coming to Kyoto for a conference. And **we'd also like to make such arrangements for you. DE** We have a number of agents, both human and mechanical. Our mechanical agents, or robots, can only display information for you graphically. Among our speaking agents, we have some who are French, some who are German and some who are English. I am an **English speaking agent. SCH**

To begin with, you have several options for making your arrangements. You can make a reservation through a foreign travel agency, a Japanese travel agency or by calling the hotel itself. However, out of all these options, **the most efficient one will be calling us to make your arrangements. SCE** Of course you may be calling some other places to help you as well. We would like to know who else you are calling after you call us so that we can know who our competitors are. .For that reason, we'd like to know **where you are calling, from now. SVH** The information I will give you may be rather complex. We want to be sure that you fully understand it. So, please feel free to ask any questions you might have so that you can be sure to **get it down correctly**. **PE** Now I'd like to give you some information about making reservations for your hotel. At most Japanese hotels, you can make a reservation for a night including breakfast or for a night not including breakfast. The price is thirteen thousand yen for a night not including breakfast and **fifteen thousand for a night including breakfast. SH** Of course, hotels have rooms in both Japanese and Western styles. You can reserve a Japanese room with either a Japanese-style or a Western-style bath. However, the western-style rooms only have western-style baths. If you reserve a western-style room, **it will have a regular western bed and bath. COE** There are deluxe Japanese rooms available as well. These look out on their own private gardens. Often these gardens have ponds with decorative carp. You could be **eating your Japanese style breakfast with fish** outside your window. **SVH** We have a number of sizes of rooms to choose from also. You can arrange to have a suite with one bedroom or a suite with two bedrooms. Just let us know if you'd like a single bedroom suite or a **double bedroom. SH** Some hotels have extensive recreational equipment. The Miyako, for instance, has an Olympic size swimming pool where many guests swim laps for exercise, and a gym complete with weights and exercise bicycles. You might enjoy staying at such a hotel where **there is a swimming pool and also a gym where you can train. COE**

Once you have chosen the hotel you'd like to stay in, we will handle your reservation, but we require a deposit. The deposit must be in yen, and it *must* be made by postal money order or by bank transfer. No cash or credit cards, please. Although you cannot make the deposit with a credit card, you can pay the final bill with a credit card. If you would like to pay the final bill with your credit card, we will need to see your credit card before you register. For that reason, please let us have the **deposit with your credit card. DH** Because we are particular about our clients, we assume our clients are particular, too. For that reason, you will have an opportunity to check out the hotel and be sure that it is satisfactory before you register. Please let us know when you would like to check out your hotel. Most guests plan to **check out** the day before they register. **PH**

Or, if you would rather make your own reservation, you can do that, too. Right next to the conference center where your conference is being held is a Tourist Information and Hotel Reservation Office with a number of **stories**. **PE** They can help you make reservations for hotels anywhere in the city. So it is very easy for you to **make a reservation for a hotel near the conference center**. **SVH**

Appendix II: Labels of the dialogues presented in the pilot experiment

Ambiguous phrases (in bold) and proposed interpretations in both human-like and machine-like phrasings for the pilot experiment.

Human	Machine
let me tell you what to do about traveling now let me tell you now about traveling let me tell you about your forthcoming travel	**let me tell you what to do about traveling now** now, let me tell you what to do about traveling let me tell you what to do about (traveling now)
exit out from the Shinkansen to out of the Shinkansen area to exit the Shinkansen itself	**exit out from the Shinkansen** to leave from the Shinkansen to leave the shinkansen
that train ticket vendor someone selling train ticket someone selling tickets to buy a train	**that train ticket vendor** that vendor for train ticket that ticket vendor for train
the exit with the number, or the name the name the exit with the name	**the exit with the number, or the name** (the exit with the number) or (the name) (the exit with the number) or (the exit with the name)
level the platform is on the second level the platform itself is level	**level** a platform that is (second level) a (second platform) that is level
exit by Exit 14, through South Central get out near Exit 14 get out through Exit 14	**exit by Exit 14, through South Central** exit next to Exit 14 exit through Exit 14
to get out of Kyoto Station to get yourself out of Kyoto Station to take something else out of Kyoto Station	**to get out of Kyoto Station** to leave Kyoto Station to get (out of Kyoto Station)
that go through that door to your left take that through the door to your left	**that** take (that one door) to your left take (that) one door to your left
go over it carefully look it over and consider it carefully walk or move above and over carefully	**go over it carefully** to examine it carefully to go (over it) carefully
taxi you could take a bus or a taxi you could take a bus or you could taxi	**taxi** you could take a taxi you could taxi
you will see many taxis waiting while you are waiting, you will see many taxis you will see many taxis that are waiting	**you will see many taxis waiting** waiting, you will see many taxis you will see many (taxis waiting)
get on the taxi actually climb into the taxi arrive at somewhere on the taxi	**get on the taxi** board the taxi get (on the taxi)
by taxi from the conference center the trip is five minutes from the conference center the taxi is the conference center's property	**by taxi form the conference center** from the conference center, five minutes by taxi by (taxi from the conference center); five minutes
right on the right side, not on the left straight there; no detour	**right** opposite to the left directly
the cost of the taxi to the conference center the taxi is going to the conference center The conference center will pay for the taxi	**the cost of the taxi to the conference center** the cost of the taxi towards the conference center the cost of the taxi in case of the conference center
take the taxi back take the taxi and return it take the taxi and go back	**take the taxi back** return the taxi take the taxi (back)
these temples or castles like Nijo these temples these temples like Nijo	**these temples or castles like Nijo** (these temples) or (these castles like Nijo) (these temples like Nijo) and (these castles like Nijo)
the day after the conference before you leave it the day before you leave it the day after the conference which is right before you leave	**the day after the conference before you leave** (the day before you leave) after the conference the day after (the conference before you leave)
where you should tell the taxi to go where you should speak where the taxi should go	**where you should tell the taxi to go** at what place you should tell the taxi to go to what place you should tell the taxi to go
look at actually looking with your eyes think about or think over	**look at** to see to consider

a train or bus from the station the bus only is from the station the train and the bus are from the station	**a train or bus from the station** (a train) or (a bus from the station) (an train from the station) or (a bus from the station)
arrangements for you the arrangements are for you the arrangement are made on your behalf, possibly by someone else	**arrangements for you** arrangements appropriate to you arrangements instead of you
speaking someone who speaks English someone who is English and who is speaking	**speaking** an agent that is (English speaking) A (speaking agent) that is English
calling the most efficient option will be to call us to make the arrangement the most efficient person will be calling us to make the arrangement	**calling** the most efficient one (will call) us to make the arrangement the most efficient one (will be) calling us to make the arrangement
where are you calling from now where are you calling from at this point of time from now, where are you calling to	**where are you calling from now** now, where are you calling from from now, where are you calling
get down to make sure something is put down to get a complete understanding	**get down** to lower to understand
fifteen thousand for a night including breakfast fifteen thousand for a night which happens to also include breakfast fifteen thousand for a particular kind of night which includes breakfast	**fifteen thousand for a night including breakfast** including breakfast, fifteen thousand for a night for (a night including breakfast), fifteen thousand
a western bed and bath a bath a western bath	**a western bed and bath** (a western bed) and (a bath) (a western bed) and (a western bath)
You could be eating you Japanese style breakfast with fish outside your window your Japanese breakfast includes fish the fish are outside the window	**You could be eating you Japanese style breakfast with fish outside your window** outside your window, you could be eating you Japanese style breakfast with fish with fish outside your window, you could be eating you Japanese style breakfast
a double bed-room two bedrooms a room with a double bed	**a double bed-room** a double (bedroom) a (double bed) room
a swimming pool and also a gym where you can train a swimming pool a swimming pool where you can train	**a swimming pool and also a gym where you can train** (a swimming pool) and (a gym where you can train) (a swimming pool where you can train) and (a gym where you can train)
the deposit with your credit card use your credit card for the deposit let us have your deposit and your credit card	**the deposit with your credit card** the deposit using your credit card the deposit and your credit card
check out to settle the bill and leave the hotel to look into or investigate something	**check out** to pay and leave the hotel to verify
story like fairy tales or legends different levels or floors	**story** narrative floor
it is very easy to make a reservation for a hotel near the conference center the reservation takes place near the conference center the hotel is near the conference center	**it is very easy to make a reservation for a hotel near the conference center** near the conference center, it is very easy to make a reservation for a hotel it is very easy to make a reservation for (a hotel near the conference center)

Appendix III: Questionnaire for the human-like dialogue boxes, pilot experiment

Experiment with Disambiguation Dialogues: Evaluation questionnaire

Your name:

Below we've listed examples of each of the types of disambiguation you did. Please rate each type (one number only):

1 easy to answer
2 had to think, but then the answer was clear
3 had to think about it and was still unsure

4 really doubtful about the answer
5 completely impossible to answer

After each one rated 3 or over, please comment on why you think you had some difficulty (multiple answers are fine).

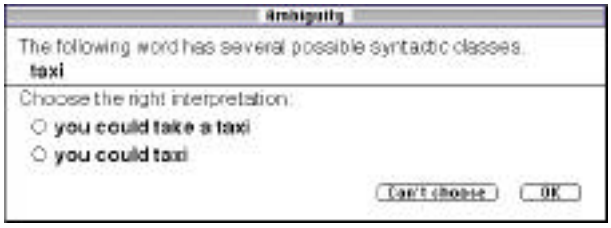
A couldn't tell from the text which meaning was intended
B couldn't understand the meaning of the choices in the dialogue box
C both choices in the dialogue box seemed the same
D could understand the dialogue box, but couldn't see how it related to the example
E other (please explain)

For each question, please, circle your choice.

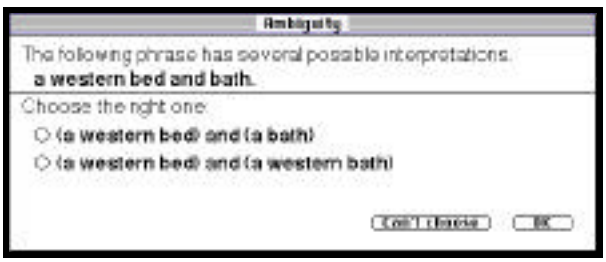
Polysemy

Phrasal verb

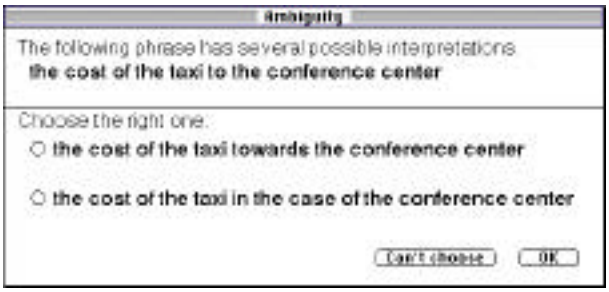
Syntactic class



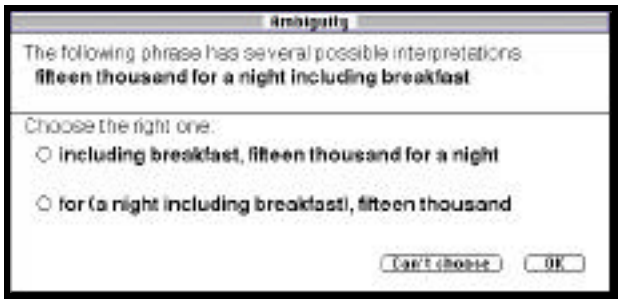
Coordination



Decoration



Subordination without verb



Subordination with verb

Other questions

In general, how did you feel about the following (answers might be like "fine," "irritated," "confused," etc., with elaboration if possible):

- The disambiguation dialogues:
- Being interrupted to disambiguate:
- Resuming the task after disambiguation:

Do you have any more comments or suggestions about the design of a disambiguation module? (you can use the back of the sheet)

Appendix IV: Questionnaire for the machine-like dialogue boxes, pilot experiment

Experiment with Disambiguation Dialogues: Evaluation questionnaire

Your name:

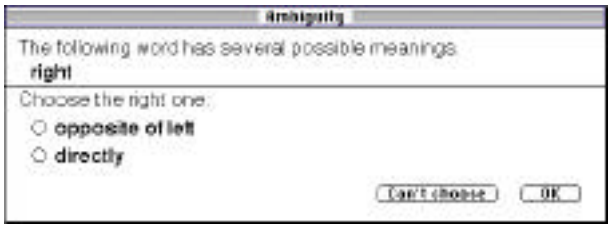
Below we've listed examples of each of the types of disambiguation you did. Please rate each type (one number only):

1 easy to answer
2 had to think, but then the answer was clear
3 had to think about it and was still unsure
4 really doubtful about the answer
5 completely impossible to answer

After each one rated 3 or over, please comment on why you think you had some difficulty (multiple answers are fine).

A couldn't tell from the text which meaning was intended
B couldn't understand the meaning of the choices in the dialogue box
C both choices in the dialogue box seemed the same
D could understand the dialogue box, but couldn't see how it related to the example
E other (please explain)

Polysemy

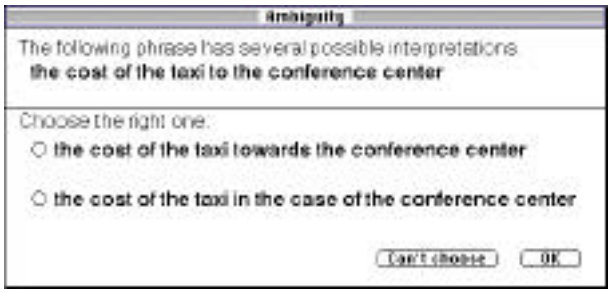


Phrasal verb

Syntactic class

Coordination

Decoration



Subordination without verb

Subordination with verb

Other questions

In general, how did you feel about the following (answers might be like "fine," "irritated," "confused," etc., with elaboration if possible):

- The disambiguation dialogues:
- Being interrupted to disambiguate:
- Resuming the task after disambiguation:

Do you have any more comments or suggestions about the design of a disambiguation module? (you can use the back of the sheet)

Appendix V: Text read by the subjects in the second experiment

Bill had to go to the library to get a book. But he didn't want to have to pay **the cost of the taxi to the library.D** So he decided to drive himself. However, he wasn't sure how to get there, so he called his friend Tom. Tom gave him the directions over the telephone and told Bill to **take them down PH** carefully. Tom told Bill to **go by the highway D,** and then get off at the Charles Street exit. But Bill told Tom that he hated taking the highway; the cars and the trucks drove so quickly and made so much noise. He especially didn't like all the **noisy cars and trucks CO**. So Tom gave him different directions, using a much longer route so that he could avoid the highway. The directions were so complicated that they had to **go over them PH** twice before Bill understood. They **talked about an hour D** before they were finished.

The next day, Bill drove to the library. He found the sign Tom had told him about--the sign **in front of the gas station with the red roof. S** He looked to the left, as Tom had told him to, and there he saw the library building with a number of **stories P**. On the third floor, he found the book that he wanted, but the librarian was nowhere to be seen. Bill decided to go

home, but he **met the librarian as he was leaving SV.** He signed out the book and took it home with him. The trip took him all day, and he was exhausted when he got home. He called Tom and **told him he had had a terrible time that day SV.**

There was going to be a big Medieval Arts festival that night in the nearby city of Newton, and Susan really wanted to go. She didn't **have a date P** to go to the festival, though, so she wondered what to do. Finally she thought she might call up her **Old English professor S** and see if he wanted to go with her. He hadn't heard about the festival and told her that he would **look into it PH**. He called back an hour later to say that he had talked to a friend about it and that it sounded quite interesting. He heard that everything there would be medieval: medieval entertainment and **medieval food and drink CO**. He agreed to pick her up at 8:00, so she started getting ready.

She searched through her closet for something appropriate to wear. She found a cape, but she also wanted a long dress that would match it. Finally she found a dress that would **go with P** the cape. They both were made from velvet and the cape had a feather collar. She put on **the dress and the cape with the feather collar CO** and waited for her professor. He arrived with a **bottle of wine from France SV**, so they had a glass of wine before they left.

The festival was easy to find--the area it was in was brightly lit and the music could be heard from a long way off. It was a warm night, so she **deposited her cape with the coat check clerk D** and she and the professor went to see what there was to eat. The food stalls were lined up along the river under a string of white lights, so they headed for the **bank P**. There they found a wide variety of foods available. It was early, so some of the stalls weren't quite open, but they found one that advertised a special French style of mutton. The professor admitted that he was quite fond of **the French school of cooking S** and so they went to see if they could get some mutton stew. The **lamb did look ready to eat D,** so they ordered a dish to share between the two of them. The stew also contained chestnuts and cranberries, and was delicious. They enjoyed walking along the river **eating their mutton stew with cranberries. SV**

They were still hungry, so they continued to wander among the food stalls. Other people were also strolling along the river. Some were eating cakes and **some were eating apples SC**. But soon they got tired, so they walked back to the entrance, picked up her cape, and went home.

It is London, 1943. People's lives are disrupted daily by the air raids. But they still try to carry on as if everything were normal. Joe was doing research in using thin film for information storage before the war; now he uses his knowledge to help the war effort. He works as a **thin film technologist S** in a research university.

Every day, he gets up, **washes his face and dresses SC** as if life were usual. He tries to help out around the house as much as he can. Food is hard to get, but potatoes are always available. Luckily, he **likes potatoes and cooks SC** a lot so that his wife can have a break. He and his wife work hard to keep their house clean after each bombing run that affects their neighborhood. They **wash the floor and dust. SC**

Joe's wife also helps the war effort. She goes every day to a nearby school which has been turned into a shelter for the homeless. There she takes care of **children and aged people who don't have a home. CO**

Joe's son Georgie plays "guard;" he takes his Dad's binoculars and watches out his bedroom window to see if any planes come flying over. Once he saw a **plane with the binoculars SV**. His Daddy told him that **flying planes can be dangerous SC**, so he ran to tell his parents. They **shut the dog up P** in the basement so that he wouldn't run out into the yard, and they all went down there themselves, too. Georgie asked why they had to go into the basement, but Joe didn't want to scare him, so he decided to just brush it off and not to **go into it PH** too much. "**Take it from me PH**, Georgie," said his father, "this is the safest place to be."

The family tries to do something nice each weekend. Joe's wife makes a picnic lunch with whatever is available at the time--any kind of **bread and cheese that they can get CO**. They are a little afraid to go too far away from a shelter, so they try to find a picnic **place near a house with a basement S** where they can go if there is any trouble. They lead as happy a life as they can under the circumstances.

Appendix VI: Labels of the dialogues presented in the second experiment

Human	Machine
the cost of the taxi to the library the cost of the taxi that is going to the library the cost of the taxi that will be paid by the library	**the cost of the taxi to the library** the cost of the taxi towards the library the cost of the taxi for the library
take down record in writing move something to a lower level	**take down** record take downwards
go by the highway take the highway to go there go by the side of the highway	**go by the highway** go via the highway go next to the highway
noisy cars and trucks noisy cars and not necessarily noisy trucks noisy cars and noisy trucks	**noisy cars and trucks** (noisy cars) and trucks noisy (cars and trucks)
go over pass or move over do again for practice	**go over** pass over review
talked about an hour the discussion concerned an hour the discussion took an hour	**talked about an hour** (talked about) an hour talked (about an hour)
the sign in front of the gas station with the red roof the sign has a red roof on it the gas station has a red roof on it	**the sign in front of the gas station with the red roof** the sign with the red roof the gas station with the red roof
stories floors in a building tales or narratives in books	**stories** floors narratives

he met the librarian as he was leaving Bill was leaving when he met the librarian the librarian was leaving when Bill met him	**he met the librarian as he was leaving** Bill was leaving the librarian was leaving
he told him he had had a terrible time that day he told him on the same day, that he had had a terrible time he told him that that day had been terrible	**he told him he had had a terrible time that day** that day, he told him he had had a terrible time he told him (he had had a terrible time that day)
date day on the calendar social engagement with someone	**date** day engagement
Old English professor a professor who teaches Old English an English professor who is old	**Old English professor** (Old English) professor old (English professor)
look into try to find out about look into the inside of	**look into** investigate look inside
medieval food and drink medieval food and not necessarily medieval drink medieval food and medieval drink	**medieval food and drink** (medieval food) and drink medieval (food and drink)
go with match or suit color or style go somewhere in the company of	**go with** match accompany
the dress and the cape with the feather collar the dress with the feather collar and the cape with the feather collar the dress with no feather collar and the cape with the feather collar	**the dress and the cape with the feather collar** the dress and (the cape with the feather collar) (the dress and the cape) with the feather collar
he brought a bottle of wine from France he brought a bottle of French wine he himself brought some kind of wine from France	**He brought a bottle of wine from France** He brought a bottle of (wine from France) from France, he brought a bottle of wine
she deposited her cape with the coat check clerk she deposited her cape and the coat check clerk together somewhere she gave her cape to the coat check clerk to take care of	**she deposited her cape with the coat check clerk** she deposited her cape and the coat check clerk she deposited her cape to the coat check clerk
bank the land along the side of a river a place where people deposit and borrow money	**bank** river side financial institution
French school of cooking cooking in the French style the school of cooking located in France	**French school of cooking** (French school) of cooking French (school of cooking)
The lamb did look ready to eat The lamb is going to eat The lamb is going to be eaten	**The lamb did look ready to eat** The lamb eats The lamb is to eat
eating their mutton stew with cranberries eating their mutton stew that has cranberries in it eating their mutton stew in the company of cranberries	**eating their mutton stew with cranberries** eating (their mutton stew with cranberries) with cranberries, eating their mutton stew
some are eating apples some are consuming apples some are the kind of apples that can be eaten	**some are eating apples** some eat apples some are (eating apples)
thin film technologist a technologist who is a specialist in thin film a film technologist who is thin	**thin film technologist** (thin film) technologist thin (film technologist)
he washes his face and dresses he washes his face and he washes his dresses he washes his face and he dresses	**washes his face and dresses** washes (his face and dresses) (washes his face) and dresses
he likes potatoes and cooks he likes potatoes and he likes cooks he likes potatoes and he cooks	**he likes potatoes and cooks** he likes (potatoes and cooks) he (likes potatoes) and (cooks)
They wash the floor and dust They wash the floor and they wash the dust They wash the floor and they dust	**They wash the floor and dust** They wash (the floor and dust) They (wash the floor) and (dust)
children and aged people who don't have a home children who don't have a home and aged people who don't have a home any kind of children, and aged people who don't have a home	**children and aged people who don't have a home** (children and aged people) who don't have a home (children) and (aged people who don't have a home)
he saw a plane with the binoculars using binoculars, he saw a plane he saw a plane that had binoculars on it	**he saw a plane with the binoculars** with the binoculars, he saw a plane he saw (a plane with the binoculars)
flying planes can be dangerous it can be dangerous to fly on or operate planes planes that are flying can be dangerous	**flying planes can be dangerous** using or operating planes can be dangerous (flying planes) can be dangerous

shut up to close something or someone into a room to make someone stop making noise	**shut up** close up make quiet
go into it explain it in more detail go inside of something	**go into it** explain it enter it
Take it from me take it away from me take my advice	**Take it from me** remove it from me believe me
bread and cheese that they can get any kind of bread but only cheese that they can get only bread they can get and cheese they can get	**bread and cheese that they can get** bread and (cheese that they can get) (bread and cheese) that they can get
a picnic place near a house with a basement the house itself has a basement the picnic place itself has a basement	**a picnic place near a house with a basement** a picnic place near (a house with a basement) (a picnic place near a house) with a basement

Appendix VII: Results of the second experiment

Question	Class	Number of good answers			
		TH	**SH**	**TM**	**SM**
taxi	D	15	13	10	13
takedown	PH	15	15	14	14
goby	D	15	15	15	15
noisy	C	15	15	15	14
goover	PH	15	13	15	15
talkabout	D	15	14	14	14
sign	S	15	15	14	15
stories	P	15	15	15	15
leaving	SV	15	15	15	15
told	SV	14	**8**	15	14
date	P	15	15	15	15
professor	S	12	12	10	11
lookinto	PH	15	15	15	15
medieval	CO	15	15	15	15
gowith	P	15	15	14	15
collar	CO	15	15	15	14
wine	SV	11	15	15	14
deposit	D	15	15	15	15
bank	P	15	15	15	15
school	S	15	15	**7**	**2**
lamb	D	15	15	15	15
cranberries	SV	15	15	13	13
apples	SC	15	15	4	**0**
technologist	S	15	15	15	15
face	SC	15	15	15	15
potatoes	SC	15	15	15	15
floor	SC	15	15	15	15
children	CO	**7**	13	13	13
binoculars	SV	15	15	15	15
flying	SC	15	14	14	15
shutup	P	15	15	14	15
gointo	PH	15	15	15	14
takefrom	PH	15	15	15	15
bread	CO	14	15	14	15
picnic	S	14	15	15	15

Table 6. Number of correct answers according to the question and the setting

Appendix VIII: Questionnaire for the second experiment

Post-Experiment Questionnaire

Please answer the following questions in as much detail as you can.

1. How hard or how easy was it to answer the questions?

2. Can you think of anything that would have made it easier to answer the questions?

3. What kinds of strategies did you use to answer the questions?