

# Ready for the Next Step? - Investigating the Effect of Incremental Information Presentation in an Object Fetching Task

Monika Chromik  
CITEC - Bielefeld University  
33615 Bielefeld, Germany  
mchromik@techfak.uni-  
bielefeld.de

Birte Carlmeyer  
CITEC - Bielefeld University  
33615 Bielefeld, Germany  
bcarlmey@techfak.uni-  
bielefeld.de

Britta Wrede  
CITEC - Bielefeld University  
33615 Bielefeld, Germany  
bwrede@techfak.uni-  
bielefeld.de

## ABSTRACT

In this paper we present a human-agent interaction study investigating the effect of incremental (just in time) information presentation on human task performance and the subjective ratings of the agent. On the one hand we show that the task of fetching ingredients and utensils for cooking is better performed in case of incremental information presentation. On the other hand it yields a negative effect on the subjective ratings of the agent.

## Keywords

incremental processing; dialog management; multi-modal systems

## 1. INTRODUCTION

Through their rich sensing and acting capabilities smart homes provide fundamentally new means of interaction that allow for semantically deep interpretations of the user's behavior in order to provide support exactly when it is needed. A first step towards this vision are assistive systems which support a user in daily activities such as packing a bag or fetching ingredients for a cake or a menu. While apps that support such activities on mobile devices by reading out lists already exist almost no integration of environmental or on-board sensors is foreseen that allow the system to adapt to the user's current activity.

In [3] it was shown that adaptation of an information providing app to the user's current activity yields better memory performance by interrupting the information presentation process during difficult phases. Interestingly, this positive memory effect could not be replicated in a smart home environment [2] where the system provided information and interrupted itself when the user was distracted by events in the environment. [5] investigated this relationship in more depth in a scenario where a robot dictated non-



Figure 1: Person interacting with the agent *Flobi*.

native (high difficulty) and native (low difficulty) sentences to a user whose task it was to write them down. In the easy task the users speeded up their activity in the adaptive condition while they used the adaptation capability in the difficult task to slow down between sentences. However, this study did not report any effects on errors.

The exact nature of the task thus seems to play an important role in determining in detail what kind of adaptation can be helpful for the user. In our study we therefore follow a two step approach in order to determine optimal adaptation strategies in the preparation phase of a cooking scenario: (1) we investigated how users would structure their information in a human-human interaction and (2) used the gained insights to model a (wizards) adaptive system behavior and compared it to a non-adaptive system behavior. Importantly, we not only looked at duration but also at errors as dependent variable. Results indicate that an adaptation strategy based on chunking the information into smaller packages with timing signals derived from the user's ostensive behavior yields objectively better performance but receives lower subjective evaluations especially wrt the timing behavior.

## 2. EXPERIMENT

### *Generation of Adaptation Strategy.*

In order to assess how users would structure the information in the preparation phase of a cooking scenario we carried out a human-human pilot study. In total 12 subjects took part in 6 trials with 2 subjects interacting with

each other per trial. One participant was asked to read out a list of ingredients, while the other one was asked to fetch these objects. The list was divided into four different kitchen locations (i.e. cupboards and drawers) and each location contained 7 objects. We observed that most of the subjects grouped the first and last 2 objects of each location together (i.e. 2 1 1 1 2) and read the next information as soon as their partner had put down the current object.

### Evaluation of Adaptation Strategy.

In order to evaluate the effect of incremental information presentation on task performance in a human-robot interaction scenario we realized a Wizard of Oz study. Again the participant's task was to fetch ingredients and utensils, this time read out by the agent *Flobi*, a simulation of an anthropomorphic robot head (cf. Figure 1). *Flobi* provided the information in chunks as derived from the pilot study (i.e. 2 1 1 1 2), either upon a signal from the participant (gaze or verbal feedback) or when the objects were put down. In the control condition all 7 objects were read out in one sentence.

The human's brain capacity allows us to memorize around 7 items [4]. However, this capacity can vary depending on individual differences or current condition. In order to evaluate whether such differences had an effect on the effect of the adaptation strategy we assessed the participants' memory performance on a memory test prior to the experiment.

After the interaction the subjects filled out a questionnaire about the subjective rating of the agent[1], the interaction with the agent and the information timing.

## 3. RESULTS AND DISCUSSION

In total 28 subjects took part in the main study. 15 participants (7 male, 8 female) were in the incremental condition and 13 (6 male, 7 female) in the control group. The average age of the subjects in the incremental condition were 23 years and 24 years in the control group. The human agent interaction in the incremental condition had a mean duration of 4:09 minutes and the average time in the non-incremental condition was 4:25 minutes. Overall, we did not find a significant effect on duration.

We first evaluated the task performance by counting the correct objects during the fetching phase and the correct locations when putting the objects back. The highest possible score was 84. The participants in the incremental condition performed better than those in the baseline condition: They achieved more points in average in both tasks (incremental condition: fetch=78, put back=75.47; baseline: fetch=72.85, put back=69.85), but only the difference of the achieved points for fetching the objects is significant [ $t(26)=-2.48$ ,  $p<0.05$ ]. We further evaluated the participants' subjective perception of the agent. In average the agent in the baseline condition received higher ratings than in the incremental condition, but this difference did not yield statistical significance. However, we found an effect on the perceived naturalness of the agent. The participants rated the agent in the incremental condition significantly less natural [ $M_{inc}=2,4$ ;  $M_{baseline}=3,5$ ;  $t(26)=2.66$ ,  $p=0.013$ ]. In addition the timing of the information presentation as well as the length of the information were assessed. The information in the baseline condition were rated significantly as too long and the information in the incremental condition as appropriate [ $M_{inc}=5,3$ ;  $M_{baseline}=2,9$ ;  $t(26)=-4.99$ ,  $p<0.001$ ]. The participants rated the timing of the incremental infor-

mation as too fast and timely less appropriate [ $M_{inc}=3,9$ ;  $M_{baseline}=4,7$ ], but this difference is not large enough for statistical significance. Although the robot behavior was based on a human-human experiment, the robot was controlled by a wizard, and the system response time was the same in both conditions, the timing in the incremental condition was perceived as timely less appropriate. That indicates that for smaller (incremental) information chunks the correct timing of the presentation becomes more important.

Overall, these result indicate that (1) the chunking of the information as derived from the pilot study was successful as this adaptation strategy yielded better performance wrt number of retrieved objects and (2) that the timing was not yet optimal as indicated by the subjective ratings.

## 4. CONCLUSIONS

We presented a human-agent interaction study investigating the effect of incremental information presentation on task performance and subjective user experience. The incremental information was presented based on the task progress of the human interaction partner. On the one hand, we were able to show that incremental information presentation can improve the task performance of the interaction partner. On the other hand, the correct timing of the presentation of incremental information chunks becomes more important and slight timing errors can be perceived as inappropriate, which requires further investigations.

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