
Combining Social Strategies and Workload: a New Design to Reduce the Negative Effects of Task Interruptions

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Abstract

Being interrupted by notifications and reminders is common while working. In this study we consider whether system politeness reduces (negative) effects of being interrupted by system requests. We carried out a 2 (polite vs. neutral system request) x 2 (high vs. low mental load) between-participants experiment. We measured annoyance, frustration and mental effort. Our results suggest that social strategies can mitigate some of the negative effects, but that this depends on the difficulty of the task. We discuss the implications of these results for the design of interruptive system messages and for further research into social computing.

Author Keywords

Task interruption; text message; social strategies; mental workload; social computing; cognitive overload;

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Human Factors; Design; Experimentation; Measurement;

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Introduction

Nowadays, news services, social networks, mobile devices and many more applications constantly ask for attention, regardless of one's current activities. These 'attention seeking' interruptions are likely to cause disruption of ongoing work tasks [13]. It is clear that there are numerous effects on a person's performance and emotion once interruptions occur. Most of these effects are of a negative kind, such as frustration, stress and diminishing performance [16], or increased annoyance, anxiety, error rate and bad decision making [1, 3].

Common solutions concentrate on the timing (when) of the interruption. Assuming that if the interruption could be deferred to a moment when one is less busy (low mental load), these effects will be reduced [1, 3, 12].

Fischer [9] distinguishes eight key characteristics of interruptions, namely 'who', 'says what', 'in which channel', 'to whom', 'when', 'where', 'with what effect' and 'how'. Positive results have been achieved by adapting these characteristics, such as the sender (who) [10], content (says what) [10], modality (in which channel) [2], recipient (to whom) and location (where) [8]. On the other hand, it is conceivable that there are situations where none of these characteristics can be altered. For example, in everyday office work an important message (says what) can often not be delayed (when), not be conveyed by someone else (who), only be conveyed by e-mail (in which channel), only be addressed to the manager (to whom), and only be delivered at work (where). As none of these aspects can be changed and the message needs to be delivered, it seems that only through changing the tone of an interruption (how; e.g. applying a social

strategy), the damaging effect of the interruption might be reduced (with what effect). A large body of work describes the use of social strategies in human-human and human-machine communication [5, 17] but few consider the interruptiveness of a given system. In this paper we look at how social strategies are used to reduce negative effects of interruptions on the task-performance of users.

Cramer et al. [7] showed that accurate empathy and situational valence could shape a person's attitude toward an embodied agent. From a longitudinal study, Bickmore [4] showed that embodied agents' politeness could have a strong effect on long-term compliance. Research on social strategies for non-embodied agents also focuses on empathy or politeness. Hone [11] confirmed that non-embodied empathic agents are able to reduce user frustration, but that embodied agents worked better. Nguyen and Masthoff [18] confirmed this finding, stating that empathy was the most important part of providing emotional support to users, but that adding embodiment improved it slightly. Klein et al. [15] showed that non-embodied agents that exhibit empathy could undo some of the negative feelings they caused.

Although it is clear from research that empathy is a potent social strategy, Cramer et al. [6] showed that displaying empathy while interrupting during a high mental load task (a search and recovery task modeling a crisis situation) could also be counter-productive. In this case the (over-)empathic condition was at times perceived as (more) irritating and superfluous than the neutral condition. This could mean that different social strategies should be applied when interrupting depending on the mental load that a task requires.

Research Question

We consider politeness as a form of empathy, i.e. the observance of and showing consideration for accepted socially normative patterns. We expect that using socially accepted forms of politeness reduces the negative effects of a system disruption during work. We expect that interrupting a simple task causes less detrimental effects than interrupting a difficult task that requires (more) concentration and mental effort. In the case of high mental load, Cramer et al. [6] discussed that using empathy may have adverse effects. This leads us to the following hypotheses.

- H1** People doing an easy task that involves a low mental load experience a polite interruption as less interruptive compared to a neutral interruption.
- H2** People doing a hard task that involves a high mental load experience a neutral interruption as less interruptive compared to a polite interruption.

Evaluation

We devised interruptive messages that adopted a social strategy (neutral, polite) in either task level (easy, hard). This resulted in interrupting a user with low or high mental load. Users were asked to perform four language correction tasks (per low or high load situation). The interruptions were timed at the 12th second of the second task and the 8th second of the fourth task for all conditions.

Sample

The sample contained 71 participants (39 male and 32 female). The study was conducted in Dutch. The

average age was 27 and the median 24. Nearly all participants finished a form of tertiary education (many university level), except for four. Participants were randomly assigned over the four conditions and not compensated for their participation.

Task workload manipulation

The tasks were created to be in line with previous work that manipulated workload with a broadly validated method by using a text correction task [1, 12].

In the *low workload condition*, the participants were presented with tasks consisting of a few sentences that contained minor grammatical errors. For each task, the participants were asked to correct the grammatical errors (ranging from two to six errors per task) by typing the correct words in a text box below.

In the *high workload condition* the participants were asked to correct difficult errors such as separating sentences, rewriting a sentence from past tense to present tense, changing the sequence of sentences to a logical order, and replacing certain adjectives with their opposites also typing them in a text box below.

Social (interruption) manipulation

The interruptions were messages to the user requesting information. The topic of the interruption message was completely different from the correction task and concerned requests from an environmental monitoring system. In addition, the interruption was clearly visible, i.e. full screen and in opposite color scheme (white on black, vs. black on white), to ensure that the visual onset was equivalent to the moment of interrupting.

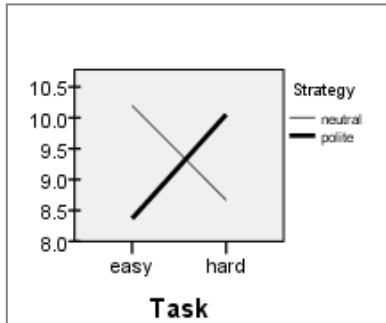


Figure 1: Mean of Interruptiveness divided by task and strategy condition.

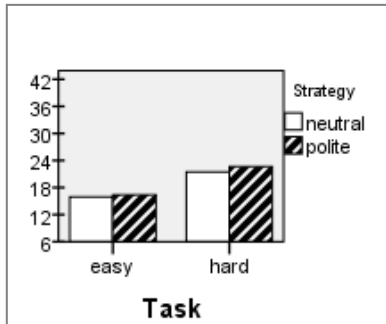


Figure 2: Mean of Cognitive Load divided by task and strategy condition.

In the *neutral interruption condition* the participants were presented with a simple interruption message like "Give an accurate description of the weather outside in three keywords (example keyword: foggy). Afterwards, you can proceed with your previous activity." The messages were translated from Dutch to English for this paper. The other message requested the participants to describe the scent they currently smelled by giving three (associative) keywords. The order of the interruptions was randomized.

In the *polite interruption condition* the participant was politely asked (not ordered) to describe the weather or the scent and a polite apology for the interruption was offered. This distinction was made by using the Dutch equivalent for words like 'sorry for' and 'could you please'. An example message is: "Sorry for disturbing you while you are busy. Could you please give an accurate description of the weather outside in three keywords (example keyword: foggy). Afterwards, you can proceed with your previous activity." The order of interruptions was again randomized.

Procedure

The experiment was programmed in WebExp [14] which has built-in functions to save log data and result files. The experiment was distributed through Facebook and e-mail during a period of three weeks. If participants were willing to take part, they went to the official instructions of the experiment. If they agreed to a consent form, the participants were randomly assigned to one of the four conditions. A session started with an example, an example answer and an explanation of the task that the participants were about to perform (e.g., correcting spelling errors or adjusting sentences from past tense to present tense). Once

participants confirmed they understood the task, the experiment began. Afterwards, the users were asked to fill out a questionnaire (including the manipulation checks).

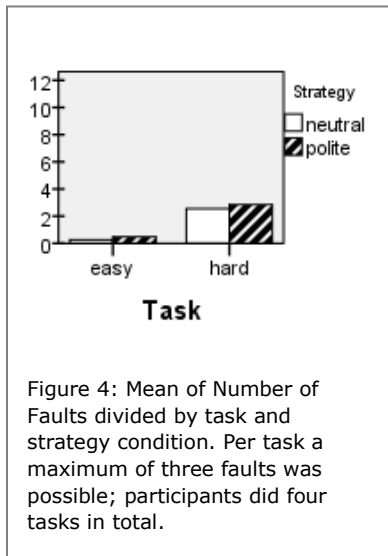
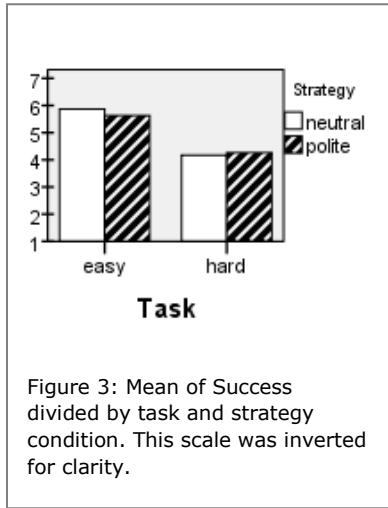
Measures

We collected a total of four measures from nine questions with a 7-point scale. The first measure was *Cognitive Load* (6 items: Mental Demand, Temporal Demand, Effort, Frustration, Annoyance and Resumption, $\alpha = 0.85$) for which we used an adapted version of the NASA-TLX measure with a simplified scale and extended questions. Similar research adopted a partial NASA-TLX [1]. The other measures were *Interruptiveness*, to see to what extent the interruption was perceived as disruptive (2 items: Interruptiveness and Annoyance of Interruption, $\alpha = 0.832$); *Success*, to assess how people perceived their own performance on the task (1 item) and the counted *Number of Errors in Task*, to measure users' actual performance.

Manipulation checks

The first manipulation check, *Difficulty of Task* (1 item) had a statistically significant difference between the easy and the hard task ($F(1,67) = 9.497, p = 0.003$). The hard task ($M = 3.76, SD = 1.50$) was perceived as being harder than the easy task ($M = 2.53, SD = 1.96$).

The second manipulation check, *Politeness of Interruption* (1 item) shows a significant difference in politeness ($F(1,67) = 4.570, p = 0.036$). The polite interruption ($M = 4.45, SD = 1.80$) was perceived as politer than the neutral interruption ($M = 3.61, SD = 1.50$).



Results

A two-way between-participants analysis of variance was conducted to evaluate the effects of the social interruption strategies and the task levels.

Interruptiveness

An interaction effect was found for Interruptiveness ($F(1,67) = 4.382, p = 0.040$). Figure 1 shows that for the easy task, the system request was experienced as less interruptive in the polite condition ($M = 8.37, SD = 3.35$) than in the neutral condition ($M = 10.20, SD = 3.34$). And in the hard task the system request was found less interruptive in the neutral condition ($M = 8.67, SD = 3.27$) compared to the polite condition ($M = 10.05, SD = 2.93$). These findings support both our hypotheses H1 and H2.

Cognitive Load

The task had a significant main effect on Cognitive Load ($F(1,67) = 11.329, p = 0.001$). Figure 2 shows that this effect was due to higher experienced Cognitive Load for the hard task ($M = 22.05, SD = 6.61$) in comparison to the easy task ($M = 16.18, SD = 7.88$). This result is in line with the manipulation check Difficulty of Task.

Success

A main effect was found for Success ($F(1,67) = 11.257, p = 0.001$). The participants judged themselves to be more successful in the easy task ($M = 5.74, SD = 2.11$) than in the hard task ($M = 4.22, SD = 1.67$) (Figure 3).

Number of Faults

Figure 4 shows that Number of Faults was higher for the hard task ($M = 2.70, SD = 1.75$) than for the low task ($M = 0.38, SD = 0.65$). Respectively, participants got 22.5% (hard) and 3.17% (easy) of the task wrong.

Discussion and Conclusion

The results show a number of significant effects. First, the modeling of tasks that differed with respect to difficulty and the modeling of a more polite versus a neutral interruption were successful, leading to a significant difference between the conditions.

As hypothesized, it seems that social strategies can mitigate negative effects of task interruptions. Here, the negative effects or 'Interruptiveness' were based on the severity of feeling interrupted and annoyed with the interruption. Results show that the interruptiveness was reduced when a polite interruption was applied in a low cognitive load condition and a neutral interruption was applied in a high cognitive load situation confirming our hypotheses (H1 and H2). Our thoughts are that *a polite message is more costly in terms of mental load than a neutral one and this in turn adds to the negative effects when experiencing a situation of high cognitive load*. However, in a situation of low cognitive load, enough capacity would be available to address and acknowledge the politeness, in effect mitigating some of the negative feelings by being polite.

Also, there are several limitations to this study. The sample may be biased due to distribution through Facebook and e-mail, the online nature could affect the results and the interruptions were not of equal length.

Applying social strategies to interruptive systems turned out to be very promising. Future research will have to investigate this new perspective on interaction design with different types of social strategies. Moreover, the strategies should be tested in the real world in order to deepen our understanding of the influence of social strategies in more complex settings.

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