



# Interruptions, visual cues, and the microstructure of interaction: Four laboratory studies



Michael Weng<sup>a,\*</sup>, Stephan Huber<sup>a</sup>, Elizabeth Vilgan<sup>b</sup>, Tobias Grundgeiger<sup>a</sup>, Penelope M. Sanderson<sup>b</sup>

<sup>a</sup> Institute Human-Computer-Media, Julius-Maximilians-Universität Würzburg, Germany

<sup>b</sup> School of Psychology, The University of Queensland, Brisbane, Australia

## ARTICLE INFO

### Keywords:

Interruptions  
 Interruption management  
 Distraction  
 Visual cues  
 Soft constraints

## ABSTRACT

Visual cues relating to an interrupted task can help people recover from workplace interruptions. However, it is unclear whether visual cues relating to their next steps in a primary task may help people manage interruptions. In a previous intensive care unit simulation study, Grundgeiger et al. (2013) found that nurses performing equipment checks were more likely to defer an interruption from a colleague if they could see the next steps of their task on the equipment screen. We abstracted some elements of the simulation study into a controlled laboratory study to test whether visual cues support interruption management. Participants' primary task was to verify a set of linked arithmetic equations presented on a computer page. From time to time, an animated virtual character interrupted the participant to mimic a social interruption, and the participant chose whether or not to defer a response to the interruptions until they finished their page of equations. In four experiments, the independent variable was visual cue (cue versus no cue) and the primary outcome was the proportion of interruptions from the character that the participant deferred so that she or he could complete the page of equations. Experiment 1 (in English) suggested that the visual cue made participants more likely to defer the interruption. However, a potential confound noted in Experiment 1 was eliminated in Experiment 2 (also in English) and the effect of the visual cue disappeared. Experiment 3 (in German) tested a different way to remove the confound and replicated the results of Experiment 2. Finally Experiment 4 (in German) restored the confound and replicated the results of Experiment 1. Participants' decisions to defer interruptions can depend on apparently minor properties of their primary task.

## 1. Introduction

Interruptions are ubiquitous in modern society. Office workers are interrupted more than four times an hour (O'Connell and Frohlich, 1995) and managers use a PC barely two minutes before they switch their task or get interrupted (Gonzalez and Mark, 2004). Intensive care unit nurses are distracted about every three minutes and interrupt their task at hand almost seven times an hour (Grundgeiger et al., 2010). Interruptions have been associated with errors or degraded performance in healthcare (Westbrook et al., 2010), aviation (Loukopoulos et al., 2003), and human-computer interaction (Bailey and Konstan, 2006). In the literature, definitions of interruptions typically note the unexpected nature of the interruption and the prompt cessation of the task at hand due to the interrupting task (Brixey et al., 2007; Trafton et al., 2003). However, further studies report that participants use discretionary interruption management strategies; such strategies

include immediately engaging with the interrupting task, as described above, but also include deferring or blocking the interrupting task (Bogunovich and Salvucci, 2011; Colligan and Bass, 2012; Grundgeiger et al., 2010; Liu et al., 2009; Salvucci and Bogunovich, 2010). In the present paper, we investigated whether the presentation of subtle visual cues, emphasizing the remaining steps of a procedural task, can influence how humans manage interruptions.

### 1.1. Discretionary behavior in handling interruptions

In their model of the time sequence of an interruption, Trafton et al. (2003) suggest that an initial distraction alerts a person that an interruption may be imminent. The time between the initial distraction and the person attending to the interruption is the *interruption lag*. After the interruption lag, the person deals with the interrupting task. The time from the end of the interruption until the person resumes the

\* Corresponding author. Present address: Institut für Psychologie und Arbeitswissenschaft, Technische Universität Berlin, Sekr. MAR 3-2, Marchstr. 23, 10587 Berlin, Germany.  
 E-mail address: [michael@humanfactors-berlin.de](mailto:michael@humanfactors-berlin.de) (M. Weng).

primary task is the *resumption lag*. The duration of the resumption lag is used as an index of how cognitively demanding the task resumption process was. This framework has supported many empirical findings and has advanced our theoretical understanding of the effects of interruptions on cognition (Trafton and Monk, 2007).

Using the Trafton et al. (2003) framework, several studies have investigated the effect on task resumption of visual cues during different stages of the interruption sequence. For example, Hodgetts and Jones (2006) introduced interruptions to the execution phase of Tower of London problems. They found that contextual cues provided during the interruption lag gave participants the opportunity to prepare before the break-in-task, which reduced the time cost when participants resumed the primary task. Further studies found evidence that cues provided during an interruption can also help participants when they resume the primary task. Usually such cues contain contextual information about the interleaved primary task (e.g. Altmann and Trafton, 2004). For example, in an eye tracking study in an intensive care unit, Grundgeiger et al. (2010) observed that nurses used external cues to facilitate the task resumption, such as leaving work objects of the primary task in their hands when being interrupted. Finally, visual cues provided at the task resumption stage of an interruption can improve task resumption as well. In a laboratory study, Trafton et al. (2005) found that participants who received a blatant environmental cue (a red arrow) near their previous action after an interruption were able to resume their primary task faster than participants who received only subtle or no environmental cues. Taken together, the above findings underscore the effectiveness of providing visual cues before, during, and after an interruption. However most of the research about visual cues in the context of interruptions focuses on the task resumption stage. Less is known about how visual cues can influence interruption management strategies, such as during the interruption lag.

Many laboratory studies of interruptions do not explore interruption management strategies, which is a shortcoming. Participants are frequently forced to interrupt their primary task almost immediately; no other means are given them to manage the interruption as might be the case in everyday life. However, more natural interruption management strategies can be observed in the laboratory if participants are free to engage in discretionary behavior. For example, in a study on informative cues for interruption management, Hameed et al. (2009) observed that participants preferred to engage with important interruptions and blocked unimportant interruptions (see also Ho et al. (2004)). In a further study by Salvucci and Bogunovich (2010), participants were required to work on a task which alternated between high and low mental workload. When faced with an interruption, in 94% of all cases participants switched to the interrupting task during a phase of low mental workload (see also Lenox et al. (2012)).

Field studies in different domains report that humans manage interruptions in different ways. In an early study, Zeigarnik (1927) reported that participants refused to accept interruptions from an experimenter so that they could first finish their task. In a field study of office work, Zijlstra et al. (1999) observed that office workers who were interrupted by a phone call while working on a text editing task let their phone ring for some time until they had completed a sub-step of their primary task. Finally, in a critical care context, Grundgeiger et al. (2010) observed that in about 19% of cases, intensive care unit nurses finished their primary task before turning to the interrupting task. However, the latter study was observational and it remained unclear why nurses sometimes finished the primary task and sometimes not.

In a further study, Grundgeiger et al. (2013) provided a possible reason that nurses sometimes finished their primary task. The Grundgeiger et al. study is described in some detail here, because certain aspects of it guided the studies reported herein. Grundgeiger et al. examined whether visual cues would improve nurses' memory for future tasks (prospective memory). The study was conducted in an intensive care unit (ICU) in an isolation room with a patient manikin,

real ICU equipment, and ICU nurses as participants. The prospective memory events and visual cues were carefully controlled; however, the scenario was open-ended in terms of how nurses could behave, meaning that naturalistic, discretionary behavior was captured.

In one part of the Grundgeiger et al. (2013) study, the participating nurse was conducting a bedside safety check, which is a routine task at the beginning of a shift that includes, for example, checking running medications, checking alarm limit settings on the vital sign monitor, and checking alarm limits on the mechanical ventilator. A colleague (actor) at the other side of the room interrupted the nurse just as the nurse was about to start checking the alarm limits on the mechanical ventilator. In the 'visual cue' condition, the ventilator's display screen was open at the page showing the alarm limits, very clearly displaying the upcoming task. In the 'no visual cue' condition, however, the ventilator's display screen did not show the alarm limit page – the participant had to click on a tab to open it. The original hypothesis was that nurses in the visual cue condition would more frequently resume the unfinished primary task at the end of the interruption than would nurses in the no visual cue condition. However, some nurses deferred attending to the colleague's interruption and finished the alarm limit check (primary task) before attending to the interruption. This behavior occurred significantly more often in the visual cue condition than in the no visual cue condition. Grundgeiger et al. suggested that "for the interrupted alarm limits task, nurses frequently avoided the anticipated memory demand of resuming the interrupted task by asking the interrupting nurse to wait until they had finished the alarm limits check," (p. 586).

The above finding from Grundgeiger et al. (2013) is interesting from both a practical and theoretical perspective. From a practical perspective, it suggests that visual support provided as part of a primary task display, highlighting the next steps of a task, may actually encourage people to use a deferral interruption management strategy and thereby avoid the prospective memory demand of needing to return to the primary task. Such a principle could be of interest for the design of any graphical user interface. From a theoretical perspective, the finding contributes empirical evidence to the under-studied area of discretionary interruption management. Furthermore, the findings may also contribute to the development of theoretical models of multitasking (Wickens and Gutzwiller, 2015).

However, the Grundgeiger et al. (2013) study has several shortcomings. First, the results regarding interruption deferral were observed post-hoc. Second, the analysis regarding this result included only 18 participants. Third, the behavior observed may be specific to an interruption-driven critical care environment. Healthcare staff may be aware that they are less likely to resume the task after an interruption and therefore tried to avoid any prospective memory demands. In sum, it is premature to conclude that visual cues of task steps encourage people to complete their primary task before they attend to an interruption. In the present study our goal was to provide an initial further test of the conjecture arising from the Grundgeiger et al. study—that visual cues encourage participants to defer an interruption.

## 1.2. The present study

A key motivation for the present study was the findings of Grundgeiger et al. (2013). We investigated whether the use of subtle visual cues emphasizing the task structure can influence how humans manage interruptions. To this end, we extracted some characteristics of the interruption event in Grundgeiger et al.'s simulation study and constructed a laboratory study that could be used to investigate interruption management in a controlled setting.

We preserved certain aspects of the Grundgeiger et al. (2013) simulator study when designing the interruptions for the laboratory study. The purpose of doing so was to capture some of the conditions underlying the nurses' interruption management strategies. First, we used an animated virtual character to interrupt the participant in order

Download English Version:

<https://daneshyari.com/en/article/4945800>

Download Persian Version:

<https://daneshyari.com/article/4945800>

[Daneshyari.com](https://daneshyari.com)