Not All Interruptions are Created Equal: Positive Interruptions in Healthcare

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Interruptions were studied extensively in the past but with a focus on their negative effects. Although many types of interruptions result in a break-in-task, in some cases interruptions communicate important information associated with patient's safety. The majority of previous interruption research use a reductionist approach to minimize or prevent interruptions, and minimal attention has been given to the differentiation between positive and negative interruptions. Through the analysis of relevant healthcare literature, this paper first identifies the inconsistencies in the way interruptions are defined, and then categorizes potential sources of negative and positive interruptions.

INTRODUCTION

Interruptions are widespread and frequent in modern healthcare environments. Coiera et al. (2002) and Brixey et al. (2007; 2008) reported around 11 interruptions per hour to emergency department physicians' and nurses' work. Similarly, Trbovich et al. (2010) reported up to 14 interruptions per hour to nurses' work during medication administration through intravenous infusion. According to their study, interruptions account for 22% of nurses' working time.

Negative effects of interruptions in modern work environments are also well documented. Interruptions cause increased task completion time, error rates, and job stress (e.g., Van Bergen, 1968; Cellier & Eyrolle, 1992; Czerwinski et al., 2000; Bailey & Konstan, 2006). Disruption of work in team-based activities can also lead to coordination problems, increased time pressure, and increased team member workload (Jett & George, 2000).

It is apparent that the literature largely associates interruptions with negative effects. According to Latorella (1998), there is a consensus among researchers that in tasks with high cognitive demand, interruptions have negative effects. In healthcare, this negative view of interruptions is also dominant. Several patient safety organizations acknowledge the potential effects of interruptions on medical errors. In the United States, the Agency for Healthcare Research and Quality (AHRQ) and The Joint Commission (formerly JCAHO) reported that interruptions could lead to medical errors (JCAHO, 2001; 2002). According to MEDMARX, the largest adverse drug event database in the United States, hospitals attribute 43% of medication errors to workplace interruptions (Stevenson, 2005). In addition, the Institute of Medicine's report titled, *To Err Is Human*, identified interruptions as a possible factor contributing to medical errors (Kohn et al., 2000). Interruptions were also listed as one of the top stressors by community psychiatric nurses (Leary et al., 1995).

Despite this negative connotation, interruptions in healthcare are sometimes sources of important information, and an integral part of safe decision-making for both the interrupted person and the interrupter. According to McGillis Hall et al. (2008), 11% of interruptions, which occurred in pediatric units in a teaching hospital, had positive effects such as helping the nurse, contributing to increased safety, improvements in patient comfort, and increased accuracy. In collaborative domains such as healthcare, communications are an integral part of the work and in some cases contain critical information that ensures patient safety. In the majority of previous interruption research in healthcare, such communications from co-workers or patients are considered to be interruptions. Interruptions may also improve performance by decreasing boredom or increasing arousal (Speier et al., 1997).

Although few researchers acknowledged the potential benefits of interruptions in healthcare (e.g., Brixey et al., 2003; MacGillis Hall et al., 2008; Rivera & Karsh, 2010), in general, interruptions are assumed to have negative effects, and the majority of previous interruption research follows a reductionist approach to prevent or mitigate them. Under such framing, some potentially valuable cues directly related to decision-at-hand or necessary for the execution of the task will be tagged as interruptions and might get blocked. A systematic approach to identify both the positive and negative effects of interruptions is missing from the previous approaches. In particular, previous research does not classify different characteristics of interruptions, which contribute to an interruption being adverse or helpful. Due to safety-criticality of operations in healthcare, it is important to understand such characteristics to inform the design of tools that mitigate negative interruptions while allowing positive ones.

This paper summarizes findings from healthcare literature with respect to the definitions of interruption and presents a classification of sources of interruptions. Articles published in English, in peer-reviewed journals, which investigated interruptions or distractions to nurses and physicians, were selected for review. First, inconsistencies in several definitions

 DOI 10.1177/1071181312561172

of interruptions will be discussed. Next, important sources of interruptions will be introduced and categorized as they relate to potentially negative or positive outcomes.

DEFINING INTERRUPTIONS IN HEALTHCARE

Healthcare literature defines interruptions in a variety of ways, very few of which explicitly differentiate between positive and negative interruptions (see Table 1). Such a lack of distinction potentially affects the type of information the researchers observe. Further, there are inconsistencies even across definitions which do not include this distinction. The use of inconsistent terminology potentially hinders knowledge accumulation in the field, making cross-examination and generalization of results difficult. For example the words "interruption", "distraction", and "break-in-task" were used to refer to the same phenomenon interchangeably. What Chisholm et al. (2000) or France et al. (2005) refer to as "interruption" (i.e., any event that briefly required the attention of the subject but did not result in switching to a new task" is defined as a "distraction" elsewhere (e.g., Hillel and Vicente, 2003; and Grungeiger et al., 2009). Others define interruption as a special case of distraction (e.g., Ebright et al., 2003; or Drews, 2007) or vice versa (e.g., Trbovich et al., 2010). In addition, some definitions associate interruptions with communications (e.g., Coiera et al., 2002; Spencer et al., 2004; Alvarez and Coiera, 2005; and Woloshynovich et al., 2007).

Although there are differences between these views, most of these definitions acknowledge four properties of interruptions:

1. Interruptions are generally caused by external events. All of the definitions except Anthony et al.'s (2010) exclude the case in which people interrupt themselves (i.e., self-interruption).

Table 1. Definitions of interruptions in healthcare literature (expanded from Grundgeiger & Sanderson, 2009, p.296)

Citation	Interruption Definition
Chisholm et al. (2000)	"An *interruption* was defined as any event that briefly required the attention of the subject but did not result in switching to a new task." "A *break-in-task* was defined as an event that not only required the attention of the physician for more than 10 seconds, but subsequently resulted in changing tasks."
Coiera et al. (2002)	"A communication event in which the subject did not initiate the conversation, and which used a synchronous (i.e., two-way) communication channel."
Ebright et al. (2003)	"Distraction from the immediate task or issue-at-hand"
Hillel & Vicente (2003); Ginsburg (2004)	"An external event resulting in switching tasks"
Spencer et al. (2004)	"A communication event that was not initiated by the observed party and occurred using a synchronous communication channel such as face-to-face conversation or the telephone."
Alvarez and Coiera (2005)	"A *conversation-initiating interruption* is a communication event that is not initiated by the observed subject, and occurs using a synchronous communication channel such as face-to-face conversation or the telephone." "A *turn-taking interruption* occurs within an individual communication event, when one individual begins speaking before the other finishes. Two criteria: (a) the interrupter does not allow the other speaker to finish his/her utterance, (b) the interrupter was able to finish or continue his/her utterance."
France et al. (2005)	"A *temporary interruption* was an interruption that momentarily diverted the physician's attention away from the task at hand but did not result in a break-in-task." "A *break-in-task* was a type of interruption that pre-empted one task, resulting in another task being performed."
Potter et al. (2005)	"Activity that stops nurses from performing their task"
Healey et al. (2006)	"An *interruption* is a distraction resulting in a break in primary task activity." "*Distraction* was defined as observed behavior such as orienting away from a primary task or verbally responding to a secondary task."
Brixey et al. (2007)	"A break in the performance of a human activity initiated by a source internal or external to the recipient with occurrence situated within the context of a setting or location. This break results in the suspension of an initial task to perform an unplanned task with the assumption that the initial task will be resumed."
Collins et al. (2007)	"Cessation of productive activity before the current task was completed for an externally imposed reason"
Drews (2007)	"Event that required an attention shift from the primary task towards some external event"
Fairbanks et al. (2007)	"The initiation of a synchronous communication event when either a synchronous or an asynchronous communication event was already in progress"
Wiegmann et al. (2007)	"'*Extraneous interruptions* are distractions which occurred during a procedure that did not directly pertain to the treatment of the patient and resulted in disruption of surgical flow."
Woloshynowych et al. (2007)	"Communication that was not initiated by the person being observed when having a synchronous communication."
Grungeiger et al. (2008)	"An external intrusion of a secondary, unplanned, and unexpected task, which leads to a discontinuity in task performance"
Anthony et al. (2010)	"A break in continuity of complete focus on the task of preparing medication"
Relihan et al. (2010)	"An external factor causing the cessation of productive activity before a current task is complete"
Trbovich et al. (2010)	"Any externally initiated event (e.g., question from patient, telephone call, infusion pump alarm) that caused the nurse's attention to be diverted from a primary task"
Westbrook et al. (2010)	"*Interruptions* were defined as situations in which a nurse ceased the preparation or administration task in order to attend to an external stimulus." "A *distraction* was defined as a stimulus from an external source that resulted in an observable response, but not the cessation of activity."
Periera et al. (2011)	"*Distraction* was defined as the behavior observed when there was diversion of attention during the execution of a primary task and/or a verbal response to a secondary task related or not related to the activity performed."
Persoon et al. (2011)	"An *interruption* was defined as when a distraction leads to a break in main task activity." "A *distracting stimulus* was defined as any event that can cause diversion from the task at hand, and a *distraction* was any observed behavior indicating orientation away from the main task."

2. Interruptions are usually unexpected events. Although only Grundgeiger et al. (2008) explicitly states this characteristic, unexpectedness is somewhat implicit in other definitions. However, literature does not differentiate between unexpected interruptions and interruptions that were expected by the interrupted person nor is there any investigation of the difference between their effects on cognition or performance.
3. Interruptions divert attention from a primary task to a secondary task (15 out of 21 definitions).
4. The secondary task could be related or unrelated to the primary task. All the definitions listed in Table 1, except the one given by Wiegmann et al. (2006), don't differentiate between the interruptions that are directly related to, and provide additional information for the primary task, or provide additional information to perform the primary task.

Based on these four characteristics, interruptions can be broadly defined as "*externally or internally generated, usually unexpected events that may cause a break in the primary task (if they don't, they are merely distractions), diverting attention to a related or unrelated secondary task, which can have both negative and positive effects on the interrupter's or the interrupted person's main task.*"

SOURCES OF INTERRUPTIONS

As discussed previously, interruptions are generally initiated by an external event but can also be induced internally. A necessary step in differentiating between negative and positive effects of interruptions is to classify these initiating events or sources of interruptions. Table 2 presents sources of interruptions identified in the reviewed literature, classifies these sources into five categories, and indicates their potential effects as being positive and/or negative. It is important to note that some of the identified sources may not necessarily result in task switching but may merely distract the person. In that sense, distractions were dealt with as potential sources of interruption. Although literature provides many time-motion studies which identify the rate and frequency of different interruptions, very little attention is given to the effects of different sources on performance.

Table 2. Summary of sources of interruption in healthcare literature

Category	Sources of Interruption	Effects
Environmental	• *Ambient and other external noise* (Pape, 2003; Hedberg & Larsson, 2004; Pape et al., 2005; Healey et al., 2006)	Negative
	• *Too many people around* (Brixey, 2008)	Negative
	• *External conversations* (Pape et al., 2005)	Negative
	• *Overhead pages* (Friedman et al., 2005)	Negative/Positive
	• *People's movements* (Healey et al., 2006, Periera et al., 2011)	Negative
	• *Other patients* (Relihan et al., 2010)	Negative
Patient-related	• *Communication initiated by patient* (Shvartzman & Antonovsky, 1992; Hedberg & Larsson, 2004; Friedman et al., 2005; Healey et al., 2006; Laxmisan et al., 2007; Trbovich et al., 2010)	Negative/Positive
	• *Communication initiated by patient's family/friends* (Hedberg & Larsson, 2004; Poter et al., 2004; Friedman et al., 2005; Tucker & Spear, 2006)	Negative/Positive
Organizational	• *Forms/prescriptions* (Dearden et al., 1996)	Negative
	• *Communication initiated by nurses* (Shvartzman & Antonovsky, 1992; Peleg et al., 2000; Hedberg & Larsson, 2004; Friedman et al., 2005; Pape et al., 2005; Healey et al., 2006; Laxmisan et al., 2007; Trbovich et al., 2009)	Negative/Positive
	• *Communication initiated by physicians/doctors* (Shvartzman & Antonovsky, 1992; Pape, 2003; Hedberg and Larsson, 2004; Friedman et al., 2005; Pape et al., 2005; Laxmisan et al., 2007)	Negative/Positive
	• *Communication initiated by other staff* (Friedman et al., 2005; Healey et al., 2006; Laxmisan et al., 2007)	Negative/Positive
	• *Procedures* (Poter et al., 2004; Healey et al., 2007)	Negative/Positive
	• *Missing medication/tools/staff* (Pape, 2003; Poter et al., 2004; Pape et al., 2005; Tucker & Spear, 2006)	Negative
	• *Emergency situations* (Relihan et al., 2010)	Negative/Positive
Technological	• *Beepers/pagers* (Blum & Lieu, 1992; Harvey et al., 1994; Weingart, 1996; Healey et al., 2006; Healey et al., 2007; Laxmisan et al., 2007; Brixey, 2008)	Negative/Positive
	• *Telephone* (Shvartzman & Antonovsky, 1992; Dearden et al., 1996; Paxton et al., 1996; Peleg et al., 2000; Pape, 2003; Poter et al., 2004; Healey et al., 2006; Healey et al., 2007; Laxmisan et al., 2007; Brixey et al., 2008)	Negative/Positive
	• *Device/display failures* (Friedman et al., 2005; Pape et al., 2005)	Negative
	• *Device/display alerts* (Healey et al., 2006; Healey et al., 2007)	Negative/Positive
	• *Device/display noise*	Negative
Internal	• *Stress*	Negative
	• *Cognitive fatigue* (Periera et al., 2011)	Negative
	• *Other thoughts (e.g., daydreaming)*	Negative
	• *Recent errors* (Pape, 2003; Pape et al., 2005)	Negative

Broadly stated, interruptions reported in the literature can be classified as coming from five sources: Environmental, Patient-related, Organizational, Technological, and Internal. Environmental sources are usually those related to visual and auditory noise in the work environment (e.g., people's movements). Patient-related interruptions are those initiated by the patient or patient's visitors such as questions and conversations. Organizational sources relate to procedures and other personnel (e.g., doctors, nurses, and management). Technological interruptions are those initiated by medical tools or telecommunication devices such as phones, pagers, or medical device alarms. Finally, internal sources include cognitive or

physical factors such as stress or fatigue. The relationship between internal sources and interruptions are seldom studied in healthcare due to limitations associated with the objective measurement of internal sources.

As shown in Table 2, some interruptions can have positive effects. It is notable that the majority of environmental and all of internal sources likely have only detrimental effects on performance. While overhead pages might distract the nurses/physicians from their main task, they were identified as the only environmental source that could have a positive effect on other patients' safety. For example, nurses/physicians may be paged to attend to another patient in a critical condition. On the other hand, the majority of organizational, technological, and patient-related sources could have positive effects on the main task and eventually patient safety. All of the patient-related sources (i.e., communication initiated by the patient or patient's visitors) as well as several organizational sources (e.g., communications initiated by nurses, physicians, and other staff) are associated with face-to-face communications. Such interruptions could convey important information from other observers to help the nurse or physician, or could warn the nurse or physician of an error (e.g., setting a wrong dosage for an IV pump), both of which contribute to patient safety. Similarly, technological sources of interruption such as device/display alarms, telephone, and pager/beepers could communicate important information that could contribute to patient safety.

Finally, an important source of positive interruptions is procedures. These are sets of actions that are expected to be followed in certain situations (e.g., anesthetist leaves to get provisions from anesthetic room (Healey et al., 2007)). Similarly, in an emergency situation, nurses and doctors might be interrupted to attend to an urgent secondary task. Although these types of interruptions will result in a break in the primary task, the secondary task followed by the interruptions is usually of high priority with regard to a patient's safety.

DISCUSSION AND CONCLUSION

Through the analysis of relevant healthcare literature, a classification of sources of interruptions in healthcare was introduced that differentiates between the sources that could have positive and/or negative effects. Such a categorization is a necessary step in implementing interruption-handling methods that mitigate or prevent negative interruptions (i.e., most internal and environmental) while inviting positive interruptions (i.e., some patient-related, organizational, and technological) at an opportune time.

The majority of the reviewed literature (43 out of 48) consisted of observational studies. Out of the other six studies, two used analysis of daily intern logs (Blum and Lieu, 1992; Harvey et al., 1994) and one utilized surveys (Sevdalis et al., 2008). The remaining three studies utilized case-control methodologies (e.g., Peleg et al., 2000; Pape et al., 2005; and Relihan et al., 2010). Overall, most of these studies reported on the frequency and sources of interruptions. It appears that additional research is needed to answer questions related to interruption mitigation techniques, the effects of interruptions on cognition and task flow, and interruption recovery.

Furthermore, some of the inconsistencies in defining interruptions were discussed as a barrier for knowledge generation in this field. In addition, studies have been conducted in different environments (e.g., operating rooms, wards, offices, etc.) with different personnel (e.g., nurses, physicians, technicians, etc.). These differences in the design of studies coupled with inconsistent working definitions adopted by the researchers make it challenging to transfer knowledge across studies.

It was discussed that some interruptions may have positive effects. Although some of the reviewed healthcare literature acknowledges this fact, the majority does not. Definitions of interruptions in the literature are somewhat biased toward negative interruptions and do not explicitly differentiate between positive and negative interruptions. This lack of distinction in definitions may have limited previous observations to only consider negative interruptions. Rigorous methodologies to differentiate between negative and positive interruptions are currently missing.

Finally, another important gap in the reviewed literature was the lack of plausible theoretical models that can explain the cognitive processes involved during healthcare interruptions. Although literature generates quality evidence to support categorization of different types/frequency of interruptions (e.g., Healey et al., 1994, Chisholm et al., 2000, Harvey et al., 2007, and Brixey et al., 2008) and different types of activities performed (Chisholm et al., 2000, Trbovich et al., 2010, and Kosits et al., 2011), the effect of interruptions on cognition have not been studied in healthcare. Furthermore, plausible interruption models, concepts, and theories from other domains (e.g., aviation, transportation, and nuclear) generated by the likes of McFarlane (2002), Latorella (1998), and Altman and Trafton (2003) should be examined further for their applicability to healthcare.

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