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The importance of “who” and “what” in Interruption Management: *Empirical Evidence from a Cell Phone Use Study*

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ABSTRACT

Interruption management in technology mediated communication is a key concern in collaborative work and social environments. Previous empirical and theoretical work in predicting interruptibility predominantly focuses on interruptee’s local context namely identifying cognitively and socially intruding contexts such as mental work load levels, activity, place of activity. They largely ignore the relational context namely “who” the interruption is from or “what” it is about. This paper addresses this issue by systematically investigating the use of the various contextual factors in interruption management practices of everyday cell phone use. Analysis of 1201 incoming calls from our experience sampling method study of cell phone use, shows that “who” is calling is used most of the time (87.4%) by individuals to make deliberate call handling decisions (N=834), in contrast to the interruptee’s current local social (34.9%) or cognitive (43%) contexts. We present implications of these findings for the design of interruption management tools for communication media.

Keywords (Required)

Interruption, Interruptibility, Availability, Management, Communication, Design, Mobile, Phones.

INTRODUCTION AND MOTIVATION

A recent national survey (Pew Research, 2006) found that 24% of respondents feel the need to answer the phone when interrupted in a meeting/meal and 22% report that they believe too many people try to reach them because they know they have a cell phone. Clearly, the value of the increased ability to communicate and be contacted as afforded by cell phone and other technologies comes with a price of inappropriate interruptions. The fact that so many individuals feel compelled to take calls may suggest that one’s tolerance to interruptions from interpersonal communication may be beyond what they are doing and where they are. Research on interruptibility to date has primarily been from two perspectives that are localized to the person being interrupted: 1) cognitive context which looks at cognitive level of involvement in tasks and its effects on task performance (Adamczyk and Bailey, 2004; Iqbal and Bailey, 2005); and 2) social context that looks at local environmental factors such as the type and place of activity (Fogarty, Hudson and Lai, 2004; Ho and Intille, 2005). These localized perspectives treat all interruptions in a generic manner by failing to incorporate a fundamental aspect of communication namely *who* the interruption is from and *what* it is about. Work place studies show that interruptions are often sought and even desired due to factors such as interdependencies of work activities, cooperation and sociality of work, crisis resolving organizational culture, and reward system based on individual heroics (O’Conaill and Frohlich, 1995; Hudson, Christensen, Kellogg and Erickson, 2002; Perlow, 1999). In such cases a person might be willing and open to be interrupted by a particular individual even if he/she is cognitively and socially overloaded. Therefore, if we are to gain an understanding of real world interruptibility, over and above the cognitive and social context we need to gain a richer and deeper understanding of the impact of what we term as the ‘relational context.’ This context encompasses people’s preferences and biases in regards to the relationship between the interrupter and interruptee (who); and factors relating to the interruption that vary with each interrupter’s interruption (what, why).

In this exploratory study we aim to understand how incoming cell phone calls are currently managed with respect to personal interruptibility and the importance of the three contexts namely cognitive, social and relational in call handling decisions. The rest of the paper is organized as follows: we begin by discussing how interruptions and interruptibility are defined and understood in the literature. This is followed by a brief review of how interruption management tools in telephones that highlights the need for further research in this area. We then present specific questions and hypothesis that we aim to

understand in this study, followed by description of the study method. Finally we present our results followed by a discussion design implications of these findings for interruption management tools.

BACKGROUND

Defining Interruptions and Interruptibility

The Webster dictionary defines the verb “interrupt” as “to break the continuity or uniformity of an action or discourse”. McFarlane and Latorella (2002) identify eight characteristics of an interruption - source of interruption; individual characteristic of the person receiving the interruption; method of coordination; meaning of interruption; method of expression; channel of conveyance; human activity changed by interruption; effect of interruption. Researchers have incorporated one or more of these characteristics in defining interruptions within the scope of their studies. Fisher (1998) classifies interruptions as being external if they originate from the environment outside of the individual such as a telephone call and internal if caused by the individual itself such as wandering thoughts or deliberate actions that break the continuity of tasks. Most research on interruptions in Human Computer Interaction and Computer Supported Collaborative Work view them specifically as external. (Speier, Valacich and Vessey, 1997; Adamczyk and Bailey, 2004). Speier et al. (1997) define interruption as “externally-generated, randomly occurring, discrete event that breaks continuity of cognitive focus on a primary task” while Cooper and Franks (1993) define it as “any disturbance to the normal functioning of a process in a system.” Covey (1989) views it as an event that “requires immediate attention” and “insists on action” while McCrickard, Chewar, Somervell and Ndiwalana (2003) define it as “an event within the notification system prompting transition of attention focus from a primary task to a notification”.

While some externally generated interruptions are technology mediated reminders and notifications, others are technology mediated attempts at interpersonal communication such as phone calls, instant messages. In this paper we specifically look at technology mediated interruptions that are initiated by people but delivered by any of the myriad communication tools such as emails, instant messaging, beepers and cell phones.

Interruptibility can be viewed as the quality or state of being interruptible. Previous research has implicitly or explicitly defined the notion of interruptibility based on various factors such as task completion times, perceived costs/burden of interruption, cognitive limitations and disruptions at time of interruption, value of notification, unwanted distractions, and decision making ability (Ho and Intille, 2005). Interruptibility has been measured based on people’s perceptions of burden/cost, people’s perception of value, people’s quality of task performance and people’s willingness to be interrupted. Hudson et. al. (2002) measure interruptibility of managers based on their self reports of perceived burden. Horvitz, Koch, Sarin, Apacible and Subramani (2005) measure interruptibility based on people’s cost benefit analysis of value and burden of an interruption. Bailey, Konstan and Carlis (2001) measure interruptibility based on task completion times while Speier et. al. (1997) use quality of decision making. Ho and Intille (2005) base it on people’s self reports of receptiveness to an interruption of particular type (phone calls or reminders) at particular time.

Most of the above definitions of interruptibility are based how much an interruption negatively affects one’s cognitive and social state. However, how much it affects one’s cognitive/social state, and how willing people are to allow it to affect their cognitive/social state, are two different things. Interruptibility then becomes a conscious choice that people make about their willingness to be interrupted based on who an interruption is from and what they think it is about. While this definition of interruption is along the lines of the receptiveness dimension defined by Ho and Intille (2005), our definition goes one step further to show how this receptiveness to interruptions varies with and is relative to the source or the “who” and the “what” We will use this definition of interruptibility in the rest of the paper.

Interruptions Management in Telephones

Interruption management is a process of combining tools, social practices and policies to help organize and control various media that vie for our attention (Andrews, 2004). A number of research prototypes have been built to provide support for interruption management in telephones (Pedersen, 2001; Pering, 2002). Typically these prototypes provide support by: a) allowing users (interruptees) to set up manual/automated filtering rules to discourage unwanted interruptions (Pering, 2002); or b) displaying information on interruptee’s context to the interrupter either manually or automatically (Pedersen, 2001). These approaches are predominantly based on models of interruptibility that identify least intruding instances of the interruptee’s localized context namely: 1) cognitive/ personal context which looks at cognitive level of involvement in tasks and its effects on task performance (Adamczyk and Bailey, 2004); and 2) social context that looks at environmental factors such as the type and place of activity (Fisher, 1998; Ho and Intille, 2005). The third approach, of leveraging the relational context that comprises people’s preferences and biases in regards to the relationship between the interrupter and interruptee

(who) and factors relating to the interruption that vary with each interrupter's interruption (what, why), is utilized to a much smaller extent. Horvitz et. al. (2005) performed a cost benefit analysis in real time to evaluate the interruptibility based on calendar information of meeting attendance and pre defined interruptibility tags. Their interruptibility model uses relational context by allowing users to define callers based on organizational relationships, activities and ad hoc groups such as "critical associates" and "close friends". While this work breaks new ground by incorporating relational context that has so far been ignored by the other models of interruptibility, it leaves room for further research. Firstly, the scope of the study is limited to interruptibility in a narrow social context of being in a meeting. Secondly, relational context used is based on heuristics of broadly defined social/organizational groups that fail to capture the nuances of relationships within these broad groups.

Other researchers have shown that the relationship between the interrupter and interruptee influences one's interruptibility. Two separate studies of administrative assistants as mediators of interruptions show that importance of interruption was derived based on relationship between interrupters and interruptees (Dabbish and Baker, 2003; Szóstek and Markopoulos 2006). However, these studies are limited to a set of very specialized workers who mediate interruptions. They do not shed light on the nuances of how people use interpersonal relationships to manage their interruptions.

In addition, little work has been undertaken to understand how cognitive, social and relational contextual information together impact cell phone use. For example, we do not know how often people use relational context in their call handling decisions and how it compares in importance with cognitive and social context. This issue is more relevant in cell phones as the caller's context is limited to only the identity of the caller, when compared to other synchronous communications technology such as land phones where one could deduce place in which the caller is and/or her related activity the place. Milewski (2006) looked at interruption management practice of using call screening through answering machines and found that screened answered calls were less disruptive than unscreened answered calls due to the richness of interruption information such as content, emotional impact and urgency of the caller. Beyond the fact that people use practices such as turning off the phone/ringer, ignoring calls and using caller ID to decide on response strategy, we have very little knowledge on what motivates people's call handling decisions.

RESEARCH QUESTIONS AND HYPOTHESIS

This study extends prior work in two unique ways: 1) we use an experience sampling methodology with questions triggered on the cell phones on the arrival of each call that allows for more accurate capture of all events; and 2) we obtain users perceived level of influence of the three contextual factors (cognitive, social and relational) on their call handling decisions that allow us to look for individual impacts as well as correlations

There are two broad questions we wanted to explore in our study. First, we wanted to know how and when people use relational, cognitive and social context in cell phone interruptibility decisions, and what is the relationship between these three contexts? Second, we wanted to examine how important relational context is in cell phone interruption management? To address these questions we hypothesize the following use of three contexts in cell phone interruptibility decisions:

Hypothesis 1: Relational context will influence people's call handling decision more than cognitive context.

Hypothesis 2: Relational context will influence people's call handling decision more than social context.

Anecdotal incidents suggest that one might be open to interruptions from a particular individual even if cognitively and socially overloaded. This leads to our next two hypotheses.

Hypothesis 3: The influence of relational context on call handling decisions will not correlate strongly with that of the cognitive context.

Hypothesis 4: The influence of relational context on call handling decisions will not correlate strongly with that of the social context.

METHOD

Study Procedure

The most popular assessment instruments in use today for studying people's activities in natural settings are self report recall surveys, time diaries, direct field observation, and experience sampling methodology (ESM) (Barrett, L.F., Barrett, D.J 2001). We opted to use ESM a popular method in ubiquitous computing, to capture people's responses *in situ* as we were interested in understanding people's use of various contextual factors in their call handling decisions.

Over a 3 month period participants were each given a Qtek 9100 Windows Mobile Pocket PC cell phone to use for a week with their own SIM cards and service plans. The phones were loaded with the survey that consisted of 4-13 questions which varied based on the way an incoming phone call was handled. We differentiated between three types of incoming calls a) answered calls b) ignored calls (missed intentionally) and c) missed calls (missed unintentionally).

The surveys were triggered and administered as follows: a) immediately after the end of the call for answered calls; or b) immediately after a call that was missed; or c) immediately after user hit ignore/silence button for an incoming call. If the survey was not immediately answered due to reasons such as a missed call or other tasks, the survey was programmed to provide audible alert and a visual display of an icon suggesting pending incomplete surveys. In case of multiple missed surveys due to multiple missed calls, the surveys were queued and administered in the order of triggers detected.

The limitation of the ESM technique is that questionnaires have to be limited to 1 or 2 minutes so as to not burden the participants, and are typically presented to the subjects a number of times. As a result, we adopted a qualitative approach to ESM survey validity, using pretests, and experts' opinion to ensure that a single item scales measure what we wanted to. Further, subjects were trained and briefed on every single survey question, so that there was no ambiguity in their understanding and responses. Pre-tests showed that our survey took 20-30 seconds to complete for each incoming call. Subjects were trained and briefed before participating in the study on how to operate the phone and how to adhere to study requirements in providing data, and who to reach in case of problems.

Subjects

A total of 40 subjects were recruited for the ESM study and belong to two major groups: 1) 20 students of a research university and 2) 20 full-time employees of a fortune 500 company. Majority of the subjects (37) had used cell phones for at least 3 years or more

1) The student group consisted of 8 undergraduate and 12 graduate full time students who volunteered solely because of their interest in the study. They received no course credit or other reward for participation, other than the chance to use a Pocket PC phone for a week. Nineteen of the subjects were 18-25 years of age and 1 was 36-50 years of age. Eight lived on campus, one held a full-time job while another eight held part-time jobs. Jobs profiles included nurse, research assistants, tutors and desk assistants.

2) The full-time working group consisted of 20 adults from diverse professional backgrounds including research scientists, programmers, project managers, system administrators, software engineers, developers, business analysts, network engineers, computer scientists and purchasing staff. Subjects were given raffle tickets for an MP3 player in return for their participation. One subject was 18-25 years of age, 4 were 26-35 years of age, 8 were 36-50 years of age and 6 were 51-65 years of age.

Survey Instrument

The ESM survey consisted of 3 versions for the three call handling outcomes namely missed (unintentional), ignored (intentional), and answered. Survey versions for answered and ignored calls varied slightly from each other to reflect how the call was handled and were divided into 5 subsections described below. The survey version for missed calls however covered only relevant items in subsection (b) and (d).

- a) Identity of the caller: This contained questions regarding their identification of the caller/number.
- b) Reasons for call handling outcome/decision: This contained questions regarding their reasons for answering or missing or ignoring a call. Participants were also explicitly asked to rank reasons pertaining to relational (caller), cognitive/personal (mental state of mind) and social contexts (activity/place/people around) in terms of the level of influence they had in their call handling outcome/decision.
- c) Call handling decision in case of a different caller ID: This contained questions how they would have handled the call if it were from somebody else and the reasons influencing the decision.
- d) Satisfaction with call handling outcome/decision: This contained questions on participant's satisfaction with the way the call was handled and how they would have liked to handle it if they were dissatisfied with the current choice.

RESULTS

Our phones recorded a total of 1201 incoming calls for which ESM surveys were answered. The number of incoming calls that went directly to voicemail (typically received when the phone was switched off) is unknown.

Data were collected from participants for an average of 6 days as phone use varied from one person to another. One subject reported not using the phone at all after the first day and another subject was unable to send us the data due to his current location constraints. We thus dropped these two subjects and used the data from the remaining 38 subjects.

Current Interruption Management Practices

All calls resulted in three categories of call handling outcomes: 65.6% of the calls were answered, 13.6% were ignored intentionally and 20.8% were missed unintentionally. Majority of the calls (79.1%) were intentionally handled while 20.8% of the calls were handled unintentionally.

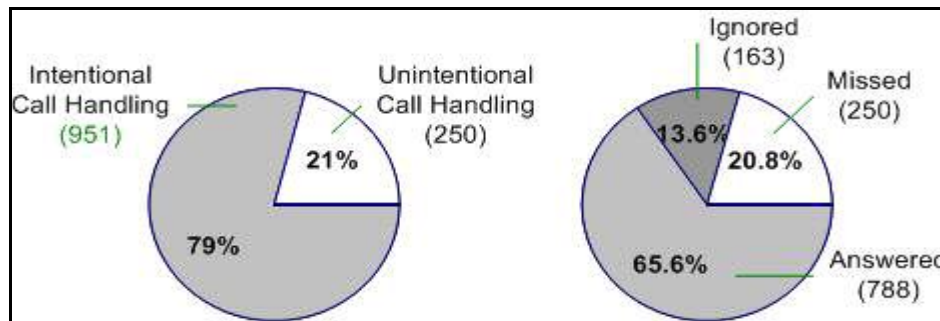


Figure 1: Interruption Management Practices in Cell phones

Of the calls answered, 92.5% (729) of the callers were identified. Participants reported answering the calls for the following reasons: 1) expecting the call 42.2%; 2) wanting to know why they were called 35.4%; 3) 16.5% of the time they reported having answered because they had some idea of what the call was about, 4) obligation 7.4%; and 5) closeness to the caller 24.7%. Other reasons included the caller's call patterns such as time, length of calls, frequency etc.

Participants reported being happy with the way the calls were handled 86% of the time. Specifically, with regards to intentional call handling decisions, participants reported being happy 96.7% of the times they answered calls and 97% when they ignored them. However when the call handling outcome resulted in missed calls (unintentional), they reported being unhappy 52.4% of the time. This shows that participants were largely unhappy when decision was not deliberate.

Since 52.4% of the missed calls resulted in participants being unhappy, we decided to look at the reasons provided for having missed a call unintentionally. Participants reported that 32% of unhappy missed calls resulted due the ringer being turned off, 52.4 due to not hearing the ring or feeling the vibration. Other reasons reported included hanging up accidentally, away from the phone, unable to reach the phone on time, calling party hanging up, currently on another call and driving.

When asked how they would have liked to have handled these missed calls, they wished to have been notified of the incoming call 83.2% of the time, wished it went to the voice-mail 9.2% of the time and wished they had known who the caller was but not have to pick up 5.3% of the time. They almost never (0.8%) wished they could have blocked it completely. Other reasons included better physical access to cell phone such a convenient place to hold the phone, and have an easier way to pull out phone from holder without hanging up.

Use of Relational, Cognitive and Social Context

When participants made an intentional call handling decision to either answer or ignore a call, we asked them to what level their decision was influenced by (0- no influence, 1-least and 3-most influence) the three factors representing the three contexts namely:

- 1) Caller (relational);
- 2) My mental state of mind (cognitive); and
- 3) My activity/place/people around me (social).

Figure 2 shows the significant difference in strength of influence of these three factors, with relational context being most twice as important as either social or cognitive factors.

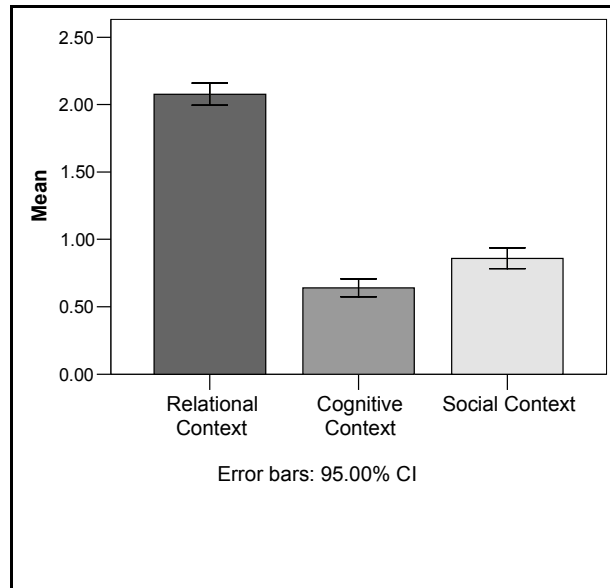


Figure 2: Mean Strength of Influence

Of the 951 intentionally handled calls, 117 calls were reported to have no influence from any of these factors. For the remaining 834 calls, participants reported that the caller influenced their decisions 87.4%, their mental state of mind influenced 34.9% and the place/activity/people around 43%¹. Clearly the caller played a very important role in their call handling decisions. Further, 49.5% of the time participants reported the caller alone influenced their call handling decisions. In contrast, the level of influence cognitive and social factors on their own was limited to only 1.8% and 9% respectively. These results are shown in Figure 3. In particular, 51.9% of the times caller alone influence the decision to answer a call and 37% of the time in the decision to ignore a call. For answered calls: cognitive context was used in isolation 0.7% of the time and social context 6.3%. For ignored calls: cognitive context was used in isolation 7.4% of the time and social context 23%.

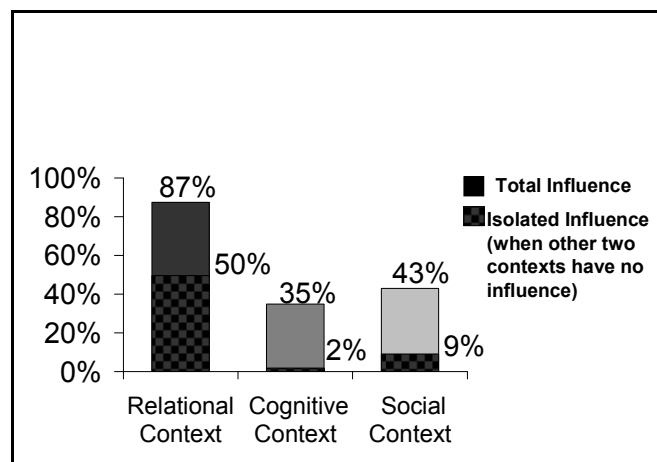


Figure 3: Influence¹ of context on call handling decisions (N=834)

¹ Since participants were asked to rate the influence of each context, percentages do not add up to a 100%.

The correlations between the three contexts were examined for answered and ignored calls. For answered calls, the relational context did not correlate with either cognitive context (Spearman's $\rho=0.039$, $n=788$, $p=.27$) or social context (Spearman's $\rho=-0.17$, $n=788$, $p<.0001$). However, social and cognitive context correlated highly (Spearman's $\rho=0.584$, $n=788$, $p<.0001$). Similarly for ignored calls, the relational context did not correlate with either cognitive context (Spearman's $\rho=0.072$, $n=163$, $p=.36$) or social context (Spearman's $\rho=-0.26$, $n=163$, $p<0.001$). Contrary to the answered calls, social and cognitive context were not correlated (Spearman's $\rho=0.115$, $n=163$, $p=0.145$) in the case of ignored calls.

DISCUSSION AND IMPLICATIONS FOR INTERRUPTION MANAGEMENT TOOLS

First and foremost, this study confirms our hypotheses that relational context influences interruption management decisions more than the social and cognitive contexts. Our results confirm hypotheses 1 and 2 by showing that the mere identity of the caller plays an enormous role (87.4%) in call handling decisions and single handedly influences decisions to answer (51.9%) and ignore (37%) calls. Further our data suggests that social and cognitive factors are sparingly (less than 9%) used in isolation and are used in conjunction with the relational context. This is not surprising as people are fundamentally social beings and interruptions in the form of interpersonal communication are handled on relationship by relationship basis rather than the social and cognitive context one is in.

Further we also found that relational context had no strong correlation with cognitive and social context, thus supporting hypotheses 3 and 4. This indicates a clear disconnect between the influence of local interruptee-context and relational context in terms of call handling decisions. This support our argument that the localized cognitive and social context on their own lack in providing the necessary subtext to understand and predict people's willingness to be interrupted.

The findings of this study not only provide empirical evidence of how the cognitive and social interruptibility paradigms used in previous work underplay the role of the relational context (who is calling and about what) but revealed that relational context plays an enormous role in everyday interruption management practices as alluded by some of the previous researchers (Horvitz et. al. 2005; Dabbish and Baker, 2003). These results suggest that dramatic improvements in interruption management are likely to come from the provision of tools that leverage social relationship data rather than complicated inference from sensors about the social and/or cognitive context.

This study highlights the need for improved understanding of how relational context is used in interruption management is of particular relevance to mobile communication technologies. This is because 'communication tools' are also 'social relationship tools', information pertaining to the relational context (i.e. the caller id) is currently the only information available to the callee, and additional information about the caller can be provided relatively easily. Elaborating on the third point, we could provide additional relational context by leveraging social network and/or location data, or by providing mechanisms for the capture and presentation of reason and urgency of calls to the callee.

We found that majority (79%) of the calls were handled intentionally by answering or ignoring. On encountering unintentionally missed calls, participants reported being unhappy more than 50% of the time and expressed a desire to be made aware of an incoming call at the very least. This suggests that the users may prefer deliberation of costs and benefits of their call handling decisions rather than have an agent control or filter their incoming interruptions. Further it was seen that more than half these missed calls (54%) resulted from the not being able to hear/feel the vibration and more than one third (32%) from the ringer being turned off. Clearly interruption management practices in cell phones are a combination of synchronous and asynchronous settings. For example, one could turn off the ringer now but want it up at a later time or for a different call. These findings call for improved design of notification mechanisms in cell phones that currently fail to provide user satisfaction in call management. Current design of notification settings are manual and fail to remind users to switch to a different setting as required. This problem can be overcome if notification settings had an expiration time at which the user is alerted to remain in or change the current settings.

Finally, we saw that individuals engaged in the process of uncertainty reduction in call handling decisions where 35.4% ($N=729$) of identified calls were answered to find out what the call was about. Thus designing interruption management systems to provide richer information on the relational context to the interruptee can help reduce uncertainty of an incoming interruption and aid in satisfying call handling decisions. This warrants future research to see how relational context can be operationalized to support improved interruption management. In particular, what specific factors pertaining to relational context such as relationship type, communication histories, interrupter's context can be used to aid interruption management.

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