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**Research Article**

# The Effects of Fragmented and Continuous Interruptions on Online Task Performance

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**ABSTRACT**

This study examines the effect of online interruptions on task performance. Two hundred and eighty players played a game designed to simulate an online environment decision-making process. The manipulation was achieved through an intervention design. Participants were exposed to messages in six interruption conditions as they played: (i) slow-fragmented text, (ii) fast-fragmented text, (iii) slow-fragmented image, (iv) fast-fragmented image, (v) continuous text, and (vi) continuous image. We compared text-only interruptions and image interruptions within different rates of interruption. The results indicate that participants with continuous text interruptions display the same performance as those without interruptions; participants who experience fast text interruptions perform the best; participants exposed to slow text interruptions performed poorly on tasks. These results imply the conditions in which controlling the rate and richness of online interruptions could improve task performance.

**Keywords:** task performance, online interruption, information richness theory, experiment

## INTRODUCTION

The scholarly study of interruption has focused on interruption on multiple factors. For example, studies have inspected the timing of interruptions (Bailey et al., 2001; Feldman & Greenway, 2021), interruption length and its similarity to the main task (McFarlane & Latorella, 2002), social and cultural workplace norms (Alkahtani et al., 2020; Hudson et al., 2002), and managers' capabilities to multitask by switching among various tasks and communication with others (Grandhi & Jones, 2010; Russell et al., 2021).

Interruptions have been conceptualized as an event that violates the continuity of general activity or content (e.g., Bailey et al., 2001; Basoglu et al., 2009; McFarlane & Latorella, 2002). Mark and Harris (2005) defined work fragmentation as a break in continuous work activity. Boehm-Davis and Remington (2009) defined interruption as "the suspension of one stream of work prior to completion, with the intent of returning to and completing the original stream of work" (p. 1125).

Scholars have differentiated between external and internal interruptions (Adler & Benbunan-Fich, 2013; Mark & Harris, 2005). However, studies that examined the effects of external versus internal interruptions found mixed results. For example, Katidioti et al. (2016) found that internal interruptions made participants complete the main task slower than external interruptions but did not find a similar difference between the two interruptions in the time needed to renew the primary task.

### Online Interruption

McFarlane and Latorella (2002) claimed that an interruption is a disturbance in people's activities or a change in a process. Grandhi and Jones (2010) found that self-interruption occurs more often when

individuals who work in open office environments are in a central work area. People interrupt themselves to complete discrete tasks, such as answering a phone call or an e-mail (Dabbish et al., 2011) or using social media at work (Liu et al., 2021).

Empirical studies on interruption have attempted to identify the scope of interruption and its impact on task performance (Gonzalez & Mark, 2004), the effect of alternating tasks, and recovery from tasks after interruption (Czerwinski et al., 2004; Iqbal & Horvitz, 2007; Kalgotra et al., 2019). Heavy multitaskers in media technology environments tend to perform worse than others and are more prone to distraction (Ophir et al., 2009). Findings from various multitasking studies support the assumption that performing multiple tasks leads to fragmented and disseminated cognitive and motivational attention (Bowman et al., 2010; Lin et al., 2009).

The interruption phenomenon within online environments has sparked research interest in the 21st century (Addas & Pinsonneault, 2018; Bailey & Konstan, 2006; Fogarty et al., 2004). The effects of online interruptions vary among the conditions in which the interruption occurs. For example, Cutrell et al. (2000) found that interrupting users during a task's "planning phase" reduced completion time relative to interruptions during other tasks. Jackson et al. (2001) found that e-mail interruptions are less disruptive than phone calls. Therefore, one can presume that interruption will be considered a disturbance if it includes signals that distinguish it and break the continuity of the performed task.

Gonzalez and Mark (2004) found that managers interrupt themselves while working (internal interruptions) as much as they were interrupted by external influences (external interruptions). They found that managers switch tasks every three minutes and change the medium they use every two minutes on average (e.g., e-mail, mobile phones). Atchley and Chan (2011) found that switching between tasks improves alertness during monotonous task performance. On the other hand, switching between tasks can cause imprecise, slow performance, and stress. Nonetheless, the examination by Paul et al. (2015) of interruptive notifications implies that while their disruptive nature is well documented, they can also play a supporting role in users' task management activities in multiple-task environments.

Arroyo and Selker (2011) discussed the discrepancies between interruptions, disruptions, and distractions. An interruption typically occurs in multitask environments as an unanticipated request for task switching. It escalates into a disruption when the interruption diverts the user into another task (action). Therefore, it should be considered a distraction when the individual considers this change in activity undesirable. Furthermore, Edwards et al. (2002) explain that the perceived intrusiveness of Internet pop-up ads is determined by the degree to which the advertisement conflicts with the users' goals.

Under certain conditions, interruptions can improve performance (Zijlstra et al., 1999). Interruptions may also function as relief from tedious tasks (Baethge et al., 2015). However, Puranik et al. (2020) claims that findings regarding the frequency of interruptions of tasks are inconsistent. For example, some scholars have found that the frequency of interruptions negatively impacts performance on interrupted tasks. In contrast, others have reported that it causes people to perform tasks faster but at the cost of their well-being. This study applied the measurement of perceived interruption through a self-reporting mechanism embedded in the research tool (a clickable button to denote the occurrence of interruption). Bailey and Konstan (2006) assert that several dependent variables have been continuously used to measure the effects of interruptions: accuracy, task completion times, and scores in affective states scales. This study utilized task performance score as the dependent variable.

Thus, we hypothesize the following:

**H1:** A negative correlation exists between the perceived interruption and task performance.

**H2:** There is a significant difference in task performance between the rate's types of interruptions.

## Information Richness

The media richness theory, also known as the information richness theory (emphasizing the content rather than the transmitter), is one of the most widely used yet controversial theories that has emerged in the computer-mediated communication field (Daft, 2013; Kahai & Cooper, 2003; Robert & Dennis, 2005). For example, Daft (2013) asserts that "there is confirming evidence that information media do fit a continuum of richness. Each major medium has a specific capacity for information processing. Moreover, the notion that

managers tend to choose a communication medium to fit message content is confirmed for the major media categories of face-to-face, telephone, electronic, and impersonal." Similarly, Trevino et al. (2000) argued that effective managers might make rational choices to match tasks to a richness-appropriate medium.

In recent years, researchers have investigated the predictive shortcomings of media richness theory in computer-mediated communication (Ishii et al., 2019). Criticism of media richness theory focuses on classifying media as rich or poor and the lack of distinction between the medium's technological suitability to the transmitted message. Robert and Dennis (2005) proposed the 'paradox of richness' model, in which a rich medium diverts attention from the task. When the medium is richer and increasingly capable of transferring substantial amounts of information, the recipient will require greater attention to ignore distracting information and focus on the message.

While early studies suggested that face-to-face communication is superior to computer-mediated communication, other models offered a more complex effect. For example, the hyper personal model (Walther, 2007) postulates that a textual medium might have fewer impediments to a rich social context's tailored conveyance. Walther et al. (2015) found that e-mail and chat may better suit social interaction than video conferencing or face-to-face interaction. Walther and Whitty (2021) argue that studies within the hyper personal model repeatedly discounted text-based messaging in favor of multimodal communication. Additionally, despite their empirically demonstrated success, people underestimate their ability to affect others' behaviors via text-based messaging platforms compared to voice and face-to-face interaction. The social information processing model (Walther & Parks, 2002) assumes that face-to-face communication differs from computer-mediated communication due to the time accounted for comparing the two environments. According to this model, face-to-face and computer-mediated communication differences blur over time. Computer-mediated communication is slower than face-to-face communication; thus, the type and number of messages transmitted are a product of duration.

Thus, closely related models met the criticism of media or information richness theory concerning the lack of distinction between the medium's technological suitability and the information it transmits. Thus, investigating the information richness theory, information transmitted as the text is defined as lean information. On the other hand, information transmitted as a picture and text (i.e., an image banner) is defined as rich information. Therefore, in the present study, participants were exposed to two types of information while playing a computerized simulation game: text information and an image combined with text.

Thus, we hypothesize the following:

**H3:** There is a significant interaction between the richness of interruption and the interruption rate on task performance.

## METHODOLOGY

### Research Design

An experimental research design employing a computerized simulation game measured task performance. In the present study, we used the 'push' method to transfer text and image interruption scenarios to the experimental participants as a tool to generate external interruptions. In a 'push' environment, the system is used to push information while the user is passive and cannot control the resulting information (Rafaeli et al., 2003). In such a situation participant is unable to control the information he receives.

Couffe and Michael (2017) summarize interruptions effects in various studies and argue that these effects depend on when an interruption occurs during the primary task. Researchers have operationalized interruption at a task's beginning, middle, and end. There is no consensus on when the interruption will impact the resumption of the primary task. Nonetheless, there is an agreement that if the interruption lasts longer than 30 seconds, the schemata of one's primary task will not be active within working memory. Thus, this study operationalized interruptions several times throughout the task in three variations:

1. Slow-fragmented interruption–operationalized as five interruptions that were "pushed" to the participants' screen every five minutes within the twenty-minute task;

**Table 1.** The experimental conditions

| | | Rate of the interruption | | | |
|---|---|---|---|---|---|
| | | None | Slow-fragmented | Fast-fragmented | Continuous |
| Information richness of interruption | None | No interruption | | | |
| | Text | | Slow-fragmented & text | Fast-fragmented & text | Continuous text |
| | Image | | Slow-fragmented & image | Fast-fragmented & image | Continuous image |

2. Fast-fragmented interruption–operationalized by pushing twenty interruptions within the same period; and
3. Continues interruption–operationalized by pushing more than twenty interruptions.

The study tool was developed around an online game ("The Sea-Trader") in which the participant is required to make decisions while sailing in the sea. The online game simulates an international trade system that includes decision-making while increasing personal profit. The data was gathered automatically from the participants taking part in the game. Simulation has been shown to offer high external validity for predicting behaviors (Galizzi & Navarro-Martinez, 2019; Schmuck, 2021).

### *Participants*

Two hundred eighty participants were randomly assigned to seven groups; six experimental groups and one control group (**Table 1**). All participants were undergraduate students. Consistent with the gender distribution of academic institutions, 62% of the participants were female. All participants were 20 to 30 years old, with a mean age of 24.61 (SD=4.7).

The experimental scenarios were distinguished by the type of interruption received in the following scenarios. The first scenario was the slow-fragmented and text-interruption condition. This group received a slow-fragmented interruption during the game. The interruptions that the participants were exposed to were plain text advertisement messages without images or pictures. These interruptions appeared in the surrounded game screen frame and did not disappear from the game screen until the game ended. The frequency of these interruptions was one interruption per four minutes. The second scenario was the fast-fragmented and text-interruption condition. The interruptions to which the participants were exposed were identical in their content (plain text advertisement messages) and appeared more frequently, at one interruption per minute. The third scenario was the continuous text interruptions implemented through a textual chat. Participants were exposed to ongoing chat messages in a side window in this group. The fourth scenario was the slow-fragmented and image condition, while the fifth scenario received the fast-fragmented and image interruption scenario. The sixth scenario was the continuous image interruptions implemented through exposure to ongoing image messages in a side window. Finally, a control group had no interruption. The simulation mechanism was removed in this group, and no interruption scenarios were performed. The dependent variable was task performance (the score gained by the player in the game).

## Research Tools

The computerized game used in this study simulates an international trade system. Games have frequently been praised as a tool to overcome traditional training failures (e.g., Berg, 2021; Greitzer et al., 2007). The game's goal is to increase personal profit, including decision-making processes. The rules of the game are simple. Players may buy, sell, sail, go to the bank, or rest each trading day. At the top left of the computer screen, a timer is activated. Players are instructed to pay attention to the clock accompanying the whole game. As advertising is seen during play, players are instructed to press the "I was interrupted" key, which activates a timer. The timing of participants pressing the "I was interrupted" button allows measurement of whether participants noticed the interruption. Participants were instructed that their success would depend on the efficient use of time and high concentration.

## Procedures

In total, 240 participants participated. They were placed randomly in six groups of one trial scenario, which included varying rates of interruptions and types of interruption richness. The participants played the game in a computer lab. Each participant was seated in a chair at a personal computer desk and played for 20

**Table 2.** Perceived interruption values for the experimental group

| Perceived interruption | N | Mean | SD |
|---|---|---|---|
| Slow-fragmented with text interruption | 41 | 1.475 | 1.43 |
| Fast-fragmented with text interruption | 39 | 2.825 | 4.34 |
| Slow-fragmented with image interruption | 41 | .450 | 1.08 |
| Fast-fragmented with image interruption | 40 | 1.025 | 2.31 |
| Continuous interruption (textual) | 39 | .750 | 1.03 |
| Continuous interruption (image) | 42 | .844 | 1.13 |

Note. $F(1, 238)=8.95$, $p<.001$, $\acute{\eta}^2=.261$

minutes. All interruptions (advertising messages) were identical in their content. All participants saw the same presentation before starting to play. They were given instructions on playing the game and played a demo version of the game for 15 minutes before starting to use the game. The participants were instructed that their success in the game would depend on the efficient use of time and their final game score.

## FINDINGS

Participants in the six groups participated in the game's different conditions. In addition, six groups received text or image interruptions of different interruption rates, and the impact on the participants' task performance was assessed. First, a manipulation check was performed to examine the correlation between interruption rate and perceived interruption level. A Spearman rank-order correlation coefficient test revealed a significant positive relation ($r=.442$, $p<.001$). Thus, there is a tendency to perceive the situation as more interruptive when the interruption is more intense. **Table 2** displays the perceived interruption values of the experimental group. A Pearson correlation test was conducted to examine the first hypothesis between the perceived level of interruption and task performance. We found no significant relationship between the variables ($r=.08$, $p>.05$). Thus, the first hypothesis is not supported. Similarly, a partial correlation test that controlled for the experimental group (interruption type) yielded equivalent results (zero-order $r=.15$, $p>.05$; partial $r=.13$, $p>.05$). The second hypothesis was evaluated using an analysis of variance (ANOVA) to compare the effects of different interruption rates on task performance. The analysis showed that the effect of the interruption rate on task performance was statistically significant ($F[6, 227]=2.182$, $p<.05$). Thus, the second hypothesis was supported. A Scheffé post hoc test of all groups indicated a significant difference.

**Figure 1** shows that fast-fragmented interruptions achieved the highest value of task performance: for text interruptions (M=51,292, SD=21,442) and for image interruptions (M=50,393, SD=20,006) compared to

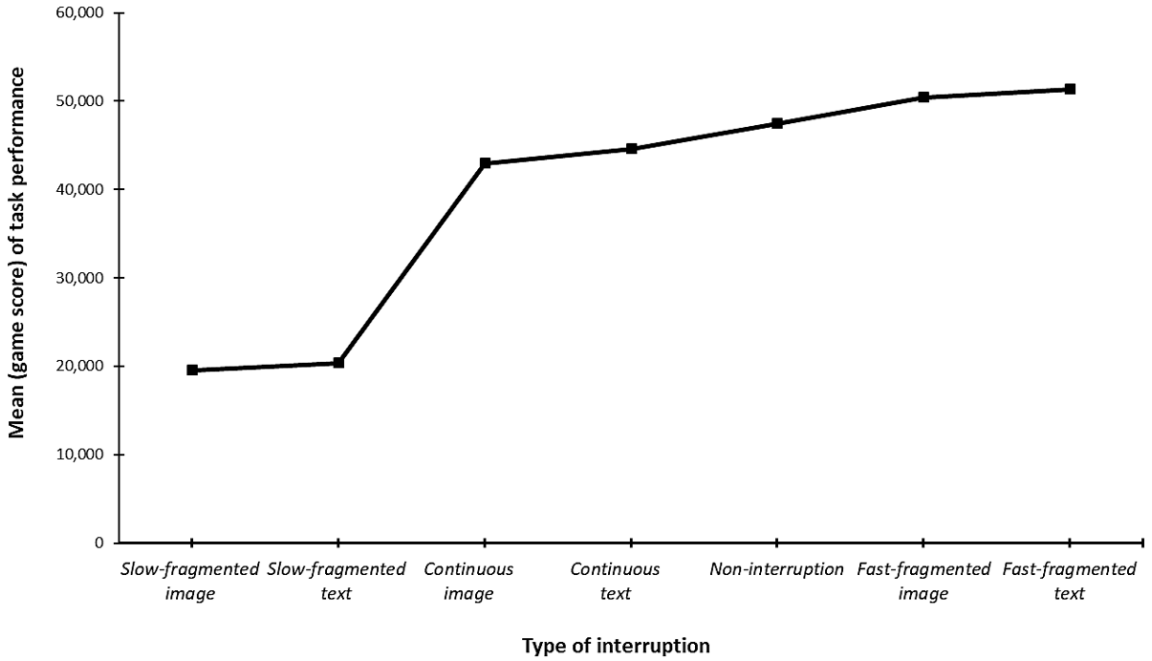


**Figure 1.** The impact of interruption type on task performance

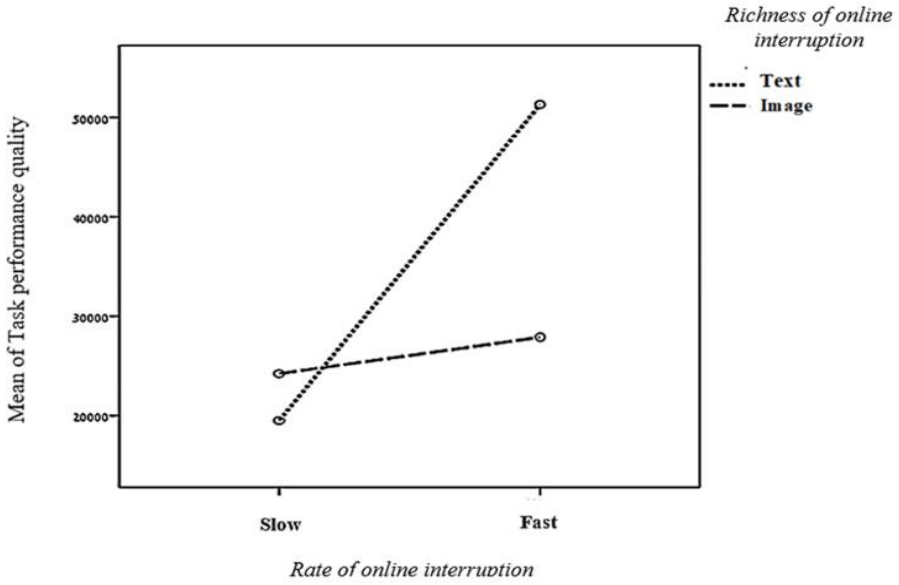


**Figure 2.** The impact of information richness and interruption rate on task performance

the other interruption conditions; non-interruption also achieved high values (M=47,441, SD=24,992) and was closely followed by continuous text interruption (M=44,553, SD=16,018) and continuous image interruption (M=42,941, SD=26,022). Slow-fragmented interruptions achieved the highest value of task performance: for text interruption (M=20,311 SD=12,051) and for image interruption (M=19,491, SD=13,284).

To evaluate the third hypothesis, a two-factor analysis of variance (two-way ANOVA) was conducted among the participants who experienced fragmented interruptions. The independent variables were information richness and interruption rate. Neither interruption richness (F[1,156]=1.76, p .05) nor interruption rate (F[3, 220]=1.05, p>.05] had a statistically significant impact on task performance. However, the interaction effect was statistically significant (F[3, 156]=5.216, p<.05). Thus, the third hypothesis was supported.

**Figure 2** shows that fast-fragmented and text interruption achieved the highest values (M=51,296, SD=71,441) compared to the other conditions. Fast-fragmented and slow interruption (M=27,882, SD=15,368) was lower, followed by slow-fragmented and rich interruption (M=24,211, SD=24,827) and slow-fragmented and text interruption (M=19,494, SD=13,294).

## DISCUSSION

This study examined the effects of fragmented and continuous interruptions on task performance using a game that involved various manipulations of external interruptions. Previous studies have shown that individual awareness of the potential costs or benefits of interruptions increases the effectiveness of their decisions regarding their active responses to the interruption (Arroyo & Selker, 2011; Iqbal & Bailey, 2010).

Ishii et al. (2019) reviewed information richness literature and stated that "... we acknowledged the limitations of the theory developed in the 1980s, yet we believe that media richness theory remains the landmark foundation of studies on continuously evolving communication technology and media use behavior" (p. 129). As suggested by critics of media richness theory and supported by our findings, the richness level is not dictated by the medium's properties, suggesting that richness is a matter of subjective interpretation. For example, recovering task implementation following rich message interruption may require more time. Furthermore, a message containing a picture combined with text contains poorer cues than a message comprising only text.

A potential explanation of our findings can lean on Trafton et al.'s (2003) notion of 'interruption lag' and 'resumption lag.' While the first term, 'interruption lag,' represents the time before the occurrence of the interruption (between the initial distraction from current activity to dealing with interruption itself), the second term, 'resumption lag,' represents the time from the end of the interruption to the renewal of former activity. Iqbal and Bailey (2005), the period between sub-tasks requires a low mental workload. Thus, fast-fragmented

interruptions may be mentally considered a sub-task since their occurrence in this experiment is expected and rapid enough to meld with the primer task. Future studies could manipulate time lags between interruptions to investigate the correlation between 'interruption lag'/'resumption lag.' And task performance. We presume that the lowest task performances stemmed from the slow-fragmented interruptions due to their renewed attempts to coordinate abrupt change in the primer activity; thus, continuous, and fast fragmented interruptions are more integrated into the whole cognitive activity.

## CONCLUSION

In an information technology-based environment, this study contributes to our understanding of managing information overload and making it more effective. Furthermore, this study contributes on both a theoretical and practical level to a technological environment, providing insight into interruptions in a computer-mediated environment and their impact on decision-making processes in such an environment.

The current study has several limitations. Mark et al. (2008) suggested that an uninterrupted group required more time to perform the task than interrupted groups because the uninterrupted participants were not expecting a disturbance and extended the task execution period. Thus, it is possible that other elements of perceived interruptions may not have been adequately considered. Leroy et al. (2020) suggest that scholars should acknowledge the subjective nature of interruptions, which has been overlooked in previous studies. Rather than observing a situation from the perspective of an observer, they emphasize the importance of taking the position of the person who has been interrupted.

Running the experiment in a different setting may be informative. Speier et al. (2003) argue that interruptions facilitate simple tasks' performance but hinder their complex tasks. Thus, a more profound examination of the cognitive abilities or skills employed in the online business game needs to be examined. Before the experiment, we conducted a pilot to assess participants' ability to use the simulation game and understand the rules.

Continued studies may confirm the observed effects of interruptions in other multitasking environments by employing similar online simulation designs. The nature of this experimental design has disadvantages as well as advantages. This study performed a substantial and complex series of trials. The disadvantage of conducting a laboratory study is its low external validation level. Despite this disadvantage, simulation can be used as a research tool to analyze complex processes and compensate for the disadvantage. Furthermore, an online game can have high external validity when predicting behaviors (Feinstein & Cannon, 2003; Vissers et al., 2001).

Finally, scholars have stated (e.g., Liu & Gu, 2020) that studies on fragmentation focused on multitasking due to people's engagement in multiple information processing activities. The time has come to move fragmentation and continues beyond the wonder of multitasking nature to the unique ways people manage online interruptions in various configurations.

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