심리학석사 학위논문

Effects of External and Internal Task-switching upon Idea Generation Performance

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2015년 12월

서울대학교 대학원
심리학과 인지심리학 전공
석 경 영

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ABSTRACT

Effects of External and Internal Task-switching upon Idea Generation Performance

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Multi-tasking pervades in our daily lives. We are handling more than two tasks at the same time. In a situation where more than two tasks are to be carried out within a set amount of time, there are mainly two reasons why a person switches from one task to another. In one instance, switching occurs because of external circumstances regardless of the intent of performers, such as the close of the set time. In the other, switching occurs because the performer gets bored or can no longer concentrate on the task. This study was carried out to examine how these two types of task switching affect idea generation. Two idea generation tasks were presented to different groups under various conditions. For each task participants were allowed to use for 12 min. In the control group (n=25), participants were instructed to tackle the two tasks one at a time (Task A then Task B). There were two experimental conditions: in the external task switching condition, participants were obliged to alternate the two tasks sequentially for 12 min each (Task A, Task B, Task A, Task B); In the internal switch condition, participants were allowed to switch the two tasks whenever they want to within 24 minutes for each task. The number and the quality of the ideas were rated by two graders who were not informed about the purpose of the study. The results showed that the quality of the ideas was lower for the external task switching condition than that for the control condition. However, the performance of the internal task switching group was superior to that of the control condition. Subsequent analysis showed that the increase in the number of switching resulted in lower performance even in case of the group who were given the choice when to switch. In conclusion, the results showed that performance improves when task switching choice is allowed but that too many switches have a negative influence on performance. Possible applications of these results were discussed.

Keywords: Externally-driven task switch, Self-initiated task switch, Idea generation.

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INTRODCTION

As technology becomes more pervasive, internet-based services (e.g., email agents, instant messages) and electronic devices (e.g., cell phones, laptops) provide people with more convenient access to information than ever before (Corbeil & Valdes-Corbeil, 2007; Czerwinski, Cutrell, & Horvitz, 2000b). However, they can also have the potential to reduce workers' productivity by distracting their attention away from the task at-hand (Del Rosario, 2009; Jin & Dabbish, 2009). Besides this, traditional factors such as hallway conversations, unexpected meetings, co-workers stopping by office are still common occurrences which can lead to workers losing focus in today's office environment (Kurke & Aldrich, 1983; O'Conaill & Frohlich, 1995). Therefore, it is not surprising to find that your work get interrupted many times every day (CubeSmart, 2006; O'Conaill & Frohlich, 1995). Instead of working on a project continuously until successfully completing it, in most occasions, people have to switch among tasks due to external annoyances (Chisholm, Dornfeld, Nelson, & Cordell, 2001; Czerwinski, Horvitz, & Wilhite, 2004; Jett & George, 2003).

Several studies have explored these two drivers of task switching: external interruptions from the outside environment, and internal decisions to no longer focus on the current task (Benbunan-Fich, Adler, & Mavlanova, 2011; Kushleyeva, Salvucci, & Lee, 2005; Mark, Gonzalez, & Harris, 2005). Correspondent to the different forms of task switching (Externally-driven task switching versus Self-initiated task switching), two types of experiment paradigms were developed to explore the task switching behavior (Hardy & Gillan, 2012; Monsell, 2003).

In the externally-driven task switching paradigm, individuals are compelled to switch tasks at predetermined moments, and the interleaving tasks are usually treated as interruptions (Jelmer P. Borst, Niels A. Taatgen, & Hedderik van Rijn, 2015; Chisholm et al., 2001; Czerwinski, Cutrell, & Horvitz, 2000a; Speier, Valacich, & Vessey, 1999). Results of these studies mostly suggested interruptions to be disruptive (Jelmer P Borst, Niels A Taatgen, & Hedderik van Rijn, 2015). Some major findings of interruptions are: 1) it takes time to resume the original task after an interruption, individuals need to spend more time on completing the whole work (Altmann & Trafton, 2004; Iqbal &

Bailey, 2006; Iqbal & Horvitz, 2007); 2) people make more errors after being interrupted (Bailey & Konstan, 2006); and 3) interruptions can bring individuals negative emotional statues, such as high level of stress and anxiety (Bailey & Konstan, 2006; Mark, Gudith, & Klocke, 2008).

Besides interruptions, people also switch tasks spontaneously (Adler & Benbunan-Fich, 2013; Dabbish, Mark, & González, 2011; Duggan, Johnson, & Sørli, 2013; Kessler, Shencar, & Meiran, 2009). Sometimes, employees realize that focusing on one task for a long time makes them feel bored, they need to shift attention to something unrelated to get rid of the negative mood and therefore to improve efficiency (Duggan et al., 2013; Fisher, 1998). In other cases, taking responsibility for more than one project at a time becomes a daily routine for some employees, high pressure and complex workloads drive them to interleave multiple works (Kerzner, 2013).

The other experiment paradigm is self-initiated task switching paradigm, in which individuals are allowed to switch between tasks at their personal discretion (Adler & Benbunan-Fich, 2013). Prior study have observed that nearly 40-50% of the task switching was initiated by individuals themselves

(Czerwinski et al., 2004; González & Mark, 2004). While research on how self-initiated task switching affects task performance is limited. In most studies, individuals were not allowed to switch or only allowed to switch on specific conditions (Duggan et al., 2013; Schneider & Logan, 2007; Sohn, Ursu, Anderson, Stenger, & Carter, 2000). For instance, some research claims task switching was permitted in their experiment, but instead of switching whenever they want, participants were only given the options to decide whether to switch or not at certain moments (Rogers & Monsell, 1995).Thus, one purpose of this paper is addressing this literature gap, providing a general study to examine how self-initiated task switching influences task performance when compared to interruptions.

The remainder of this paper is organized as follows. Section 2 reviews relevant literature on task switching, both from the lab and the field. First, the reasons why externally-driven task switching (interruptions) are normally regarded as disruptive are presented. Then, based on a selective body of research, we find evidence supporting the idea that task-switching provides an opportunity for incubation effect to emerge. Incubation is a process which is believed beneficial to idea generation. This brings the issue of why self-initiated task switching was found to facilitate task performance while externally-driven task switch was mostly disruptive if both of them are different forms of ‘incubation time’. We will discuss this in detail in section 2. Section 3 presents an experiment design to test these hypotheses. A general discussion summarizes the experiment results and their implications. Limitations and several directions for future research work will also be discussed.

Interruption and Switch Cost

Research on task switching has been focused primarily on task switching initiated by external circumstance (Altmann & Trafton, 2007; Chisholm et al., 2001; Jett & George, 2003). In a typical external-driven task switching experimental paradigm, individuals are often required to perform the same tasks repeatedly or switch between different tasks (Monsell, 2003; Payne, Duggan, &

Neth, 2007). During experiments, individuals are not allowed to switch at their own discretion. Instead, they were asked to shift tasks either at predetermined moments (Dodds, Ward, & Smith, 2004), or when instructions imply to switch were given (Rogers & Monsell, 1995).

Task switching caused by external factors was referred to as "interruption" in previous studies (Fisher, 1998; Speier, Vessey, & Valacich, 2003). Most of these studies have examined the disruptive effects of interruptions. They are often found to be time consuming (Jelmer P. Borst et al., 2015). The notion of "switch cost" (Monsell, 2003; Rogers & Monsell, 1995) or "resumption lag"(Altmann & Trafton, 2004) is mostly used to describe the time interval needed for individuals to resume the original task after performing an interrupting task. Studies have proved the existence of "switch cost"(Czerwinski et al., 2000a; Horvitz, 2001). For instance, Rogers and Monsell found individuals' responses apparently slower after being interrupted, even when these switches are completely predictable (Rogers & Monsell, 1995). Besides this, interruptions also lead to more errors and arouse negative feelings, such as annoyance and anxiety (Bailey & Konstan, 2006; Mark et al., 2008). In the research undertaken by Bailey and Konstan (2006), individuals committed doubled errors when got interrupted. In their another study, the results showed that in an effort to cope with interruptions, individuals have to experience increased stress levels.

Although the large proportion of articles have revealed that interruptions cause a deterioration of working efficiency (Jelmer P. Borst et al., 2015; Mark et al., 2008), studies in which simple tasks were undertaken indicate that interruptions could improve task performance (Speier et al., 1999; Speier et al., 2003). In addition, interruptions have found to be helpful in speeding up decision-making process (Speier et al., 1999). In a field study, 64% of the cases individuals reported that they had benefited from interruptions in their modern working environment (O'Conaill & Frohlich, 1995). One possible explanation for this plausible phenomenon is illustrated by the distraction conflict theory (Baron, Moore, & Sanders, 1978; Speier et al., 2003). The theory suggests that when an interruption occurs, it causes attentional conflict, resulting in an exclusion of unrelated information cues which in turn improves performance on simple tasks(Aiello & Douthitt, 2001; Speier et al., 2003).

To sum up, based on prior studies, even interruptions are often linked with a decrease of task performance, there is also evidence showing that interruptions could be beneficial in some cases. One purpose of current study was to investigate how interruptions affect the productivity of idea generation task. Before examining this question, the next section will outline related works on how task-switching, including self-initiated and external-driven task switching, affects idea generation tasks.

Task Switch and Incubation Effect

External interruptions such as text messages or email notifications are common triggers of task switching at office, while studies have observed task switching could also be the result of individuals' own choices (Adler & Benbunan-Fich, 2013; Dabbish et al., 2011; Jin & Dabbish, 2009). An observational study in real working environment revealed that almost 18% of the task switching were self-distractions. In the remaining part, 60% task switches were due to task competition, and only 22% of them were caused by external interruptions(Dabbish et al., 2011). In another diary study, 40% of the tasks switches were self-initiated (Czerwinski et al., 2004).

These data proved the prevalence of self-initiated task switching in our daily lives. But why do individuals choose to shift attention to another task so frequently? This action is rather irrational when we believe task switching normally leads to switch cost, which often characterized with a slower performance and a decrease in performance accuracy. What happened when individuals make the decision to stop performing one task and switch another one? Is this self-initiated task switching also as disruptive as interruptions?

Few studies have explored the preceding questions (Kiesel et al., 2010).Except a recent research by Beeftink et al. (2008), the results indicated that individuals who can switch tasks at their own discretion outperformed those who were not allowed to switch. The authors contributed this result to an "incubation effect", that is, self-initiated task switching provides individuals a chance to take a break from the primary focus, which can help "incubation effect" to happen (Beeftink, van Eerde, & Rutte, 2008).

So, what happened when having an “incubation time”? The concept of “incubation effect” was first put forward by Wallas (1926). He suggested that creative problem-solving process includes four phases: preparation, incubation, illumination and verification. Among them, incubation stage happens when individuals feel being “stuck” during the process of problem solving, instead of struggling with the problem without any process, taking a break or switching to an irrelevant task can lead to a sudden insight occurs (Dodds et al., 2004; Segal, 2004).

One possible explanation for incubation effect is that if a person keeps fixating on one task while not being able to move beyond an idea or set of ideas to produce new solutions (Smith & Blankenship, 1991),they may experience a state of cognitive exhaustion(Sedek & Kofta, 1990). Segal (2004) described this experience as individuals will “have cognitive blocking, stop thinking, and are not likely to be engaged in further activity on the task.” In other words, this state may lead to non-productive time and decrease creativity for the later work(Sedek & Kofta, 1990). While taking a relatively short break enable individuals stop consciously thinking about the dead end of the primary task and have an opportunity to get rid of cognitive exhaustion by involved themselves in a new project(Dijksterhuis, 2004; Dijksterhuis & Meurs, 2006; Finke, Ward, & Smith, 1992; Segal, 2004).Besides, shifting attention also helps the unconscious to work. After taking a short break, individuals are able to go back to the task later with a fresh mind, which might stimulate incubation to happen.

Therefore, taking some time away from the task may eventually help to get out of the box and lead to greater creativity (Segal, 2004; Van Eerde, Beeftink, & Rutte, 2015). A long time attention focusing may not necessarily enhance the possibility for the generation of more creative ideas and would even be expected to be detrimental. From this point of view, both self-initiated task switching and interruptions should facilitate idea generation performance, considering both of them provide the chance to incubate. Previous research confirmed the idea that individuals who are allowed to switch tasks at their own discretion did perform better than individuals who had to solve tasks sequentially (Beeftink et al., 2008). However, the result did not show the same benefits of interruptions. The author interpreted the results as interruptions force individuals divide their cognitive resources, or incubation effect is stronger when given the option to take a break. Thus, only incubation effect cannot completely account for the different effects of task switching. An embedded analysis on the difference between self-initiated task switching and interruptions are discussed in the next section.

Switch Cost and Problem State

An alternative explanation for the different effects of task switching proposes that the moments individuals choose to switch will generate different switch cost. Research shows that when individuals are allowed to switch between tasks, the switch cost is smaller than when being interrupted. Researches on interruptions also indicate that timing is an important factor for the disruptiveness of interruptions (Jelmer P. Borst et al., 2015; O'Conaill & Frohlich, 1995; Speier et al., 2003). Interruptions lead to either negative or positive effects on performance due to whether they happened at a high or a low workload moment (Iqbal, Adamczyk, Zheng, & Bailey, 2005). Compared to being interrupted between subtasks, interruptions in the middle of a subtask cause more time to resume the primary task (Monk, Boehm-Davis, Mason, & Trafton, 2004).

A memory-for-problem-states theory developed by Borst and his colleagues explained how this mechanism works (Jelmer P. Borst et al., 2015). The whole idea of this theory is as follows: When individuals work on a task, task related information need to be stored in the problem state temporarily. Since the problem state can only maintain information for one single task, it usually serves as a bottleneck in multitasking. When individuals' attention shift to a new task at higher workload moment, problem state for primary task and the interrupting task both have to be stored, they will competing for the limited cognitive resources. When task switching happens during a lower workload moment, no problem state is needed to be maintained and less time is required to return to the primary task(CubeSmart, 2006). Therefore, switching timing is the determining factor for the disruptiveness of interruptions.

So how do individuals perform when they are allowed to switch freely, do they usually switch at a high or a low workload moment? Previous studies confirmed that individuals know when the right moment to switch is. In Salvucci and Bogunovich's (2010) research, individuals were required to perform a mail-browser task while being interrupted by a chat task occasionally. Individuals were allowed to deal with the chat task at their preferred moment. The results summarized that in94% of the cases, individuals did not respond to the message immediately. Instead, they delayed to switch the chat task at a low-workload moment. In an empirical study, individuals are often observed to switch after completing a subtask (Iqbal & Horvitz, 2007).

In summary, self-initiated task switching allows individuals to switch at their own discretion, and individuals often chose to switch at the low-workload moment, which eventually helps to reduce the switch cost. In contrast, being forced to switch in the middle of a task, individuals may switch at higher workload moments, experience more time pressure and consequently feel more frustrated and bored.

Switch Frequency

We discussed several findings on how task-switching influences idea generation performance and why self-initiated task-switching and interruptions generate different effects on creativity thinking process in former part, the following part will address the topic of how switch frequency affect task performance.

Task switching is ubiquitous in our life. Gonzales and Mark (2004) found an office worker usually works on a task for just over 3 minutes, after that they switch to another task. A manager gets interrupted every 8 minutes (CubeSmart, 2006). An online investigation found that individuals could not stop switching even when required not to do so, and the median number of their switches was 6 during a 32 minutes period experiment (Gould, Cox, & Brumby, 2013). These data reveals task switching is not only a prevalent phenomenon, but also a relatively high-frequency occurrence.

No straight forward research has examined the correlation between the overall task performance and the times individuals chose to switch between tasks. While several previous studies have revealed that the mean reaction time to the primary task getting longer as task-switch frequency increased in the interruption condition (Schneider & Logan, 2007). Results also suggested that switch cost will be reduced when individuals are allowed to switch (Barber, 2007; Rogers & Monsell, 1995). Thus, we assume that conducting a high-frequency of switches would not help to improve idea generation performance.

Current Study

Research on task switching has concentrated mainly on externally-driven task switching, limited literature explored self-initiated task switching. The main purpose of this study is bridging the gap by conducting an experiment to distinguish the different effects on idea generation tasks of self-initiated and externally-driven task switching. We propose a task switch process mode (see Figure 1) based on the integration of the interruption process model developed by

Franck Tétard and the memory-for-task-state theory by Borst and his colleagues (CubeSmart, 2006). The mode was proposed to support our assumptions on self-initiated and externally-driven task switching.

In summary, the current study draws on the following questions:

Although externally-driven task switches are found to be interruptive in most cases, sometimes they are also proved to be beneficial. How do they affect the productivity of idea generation tasks?

Compared to working on tasks sequentially or forced to switch between different tasks, will individuals be more effective on idea generation tasks when allowed to switch between tasks freely?

When allowed to switch between tasks freely, how often do individuals choose to switch to another task and what is the relationship between the switch frequency and task performance?

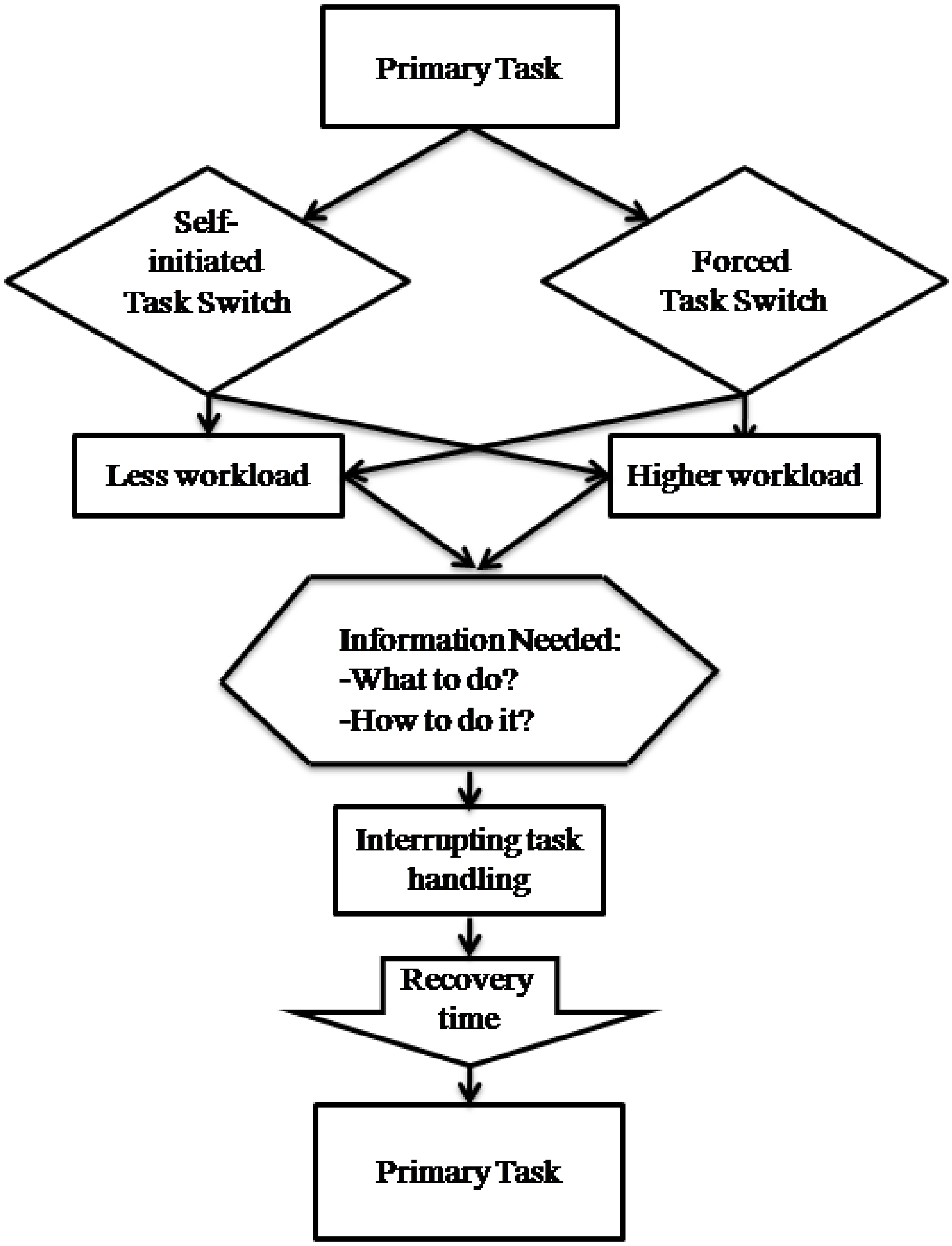

Figure 1 Task switching process model

METHOD

Participants

A total of 80 students from Seoul National University participated in this experiment. Participants were aged from 21 to 33 years (M = 23.75, *SD* = 4.09), and twenty-seven of the participants were female. They were all recruited via campus website and paid for their participation. They were randomly assigned to one of the three groups.

Materials

Materials used in this experiment were two idea-generation tasks originally selected from those that are posted on InnoCentive home website (InnoCentive is a company that collects problems from different fields and later frames these as 'challenge problems' for anyone to solve). These problems are all concerned about reality problems. Contents of both tasks are provided in Appendix A. An example of the task is: "Thanks to the technology, the quality of the camera is so good on a smartphone today that many people don’t see the need for traditional cameras. Everyone in the digital camera industry can see that the marketplace has changed. The question is - if you were a digital camera designer or manufacturer, what would you want a digital camera to look like to save the market?”

For each task, participants were told to generate as many ideas as they can. Their performance will be assessed according to the quality and quantity of the answers they made. After the experiment, their performance were rated by two graders who were not informed about the purpose of the study.

Procedure

Individuals were assigned to sit in separate cubicles and then assigned to perform two computerized creative idea generation tasks. All instructions and tasks were given on the computer screens. The design consists of three groups. In each group, after reading the instructions and clicking the “Ready” bottom, individuals would then access to the task page. Two parallel task boxes were shown on the screen, while the contents were invisible until the task button on the screen is clicked. There is a timer on the top of the task box, which would remind individuals how many minutes left for the current task. Individuals were requested to enter their answers for the task via the keyboard.

Continuous Group. Participants in this group need to finish the two tasks in a sequential manner. They were not allowed to switch back and forth between the tasks, which implies that they worked for 12 minutes on task 1, and then 12 minutes on task 2. The “Task 2” button could not be activated until they spend the whole 12 minutes on task 1. A sample screen shot of the experimental window is given to show how the page appears before individuals start to solve the first task (see Figure 2).

Forced switch group (externally-driven task switch). Participants in this group were forced to switch after every 4minutes on each task. That is, once they click one of the task buttons, one task displays on the screen, and individuals are required to work on that task on exactly 4 minutes. Afterwards, that task windows closes and the other task window shows up. Answers are saved automatically.

Self-initiated switch group. In this group, participants were given the instructions that they could switch back and forth between the tasks at their own discretion. Whenever individuals want to switch, they just need to click the button, the other tasks would then appear on the screen and the answers for the previous task would be saved automatically. The computer is allowed to only restrict the total time spent on each task to 12 minutes. Answers are saved automatically and the times for which the individuals switched tasks are recorded.

At the end of the study, all participants completed questionnaires describe their feelings about the tasks and their performances. Contents of the questionnaire are provided in Appendix B.

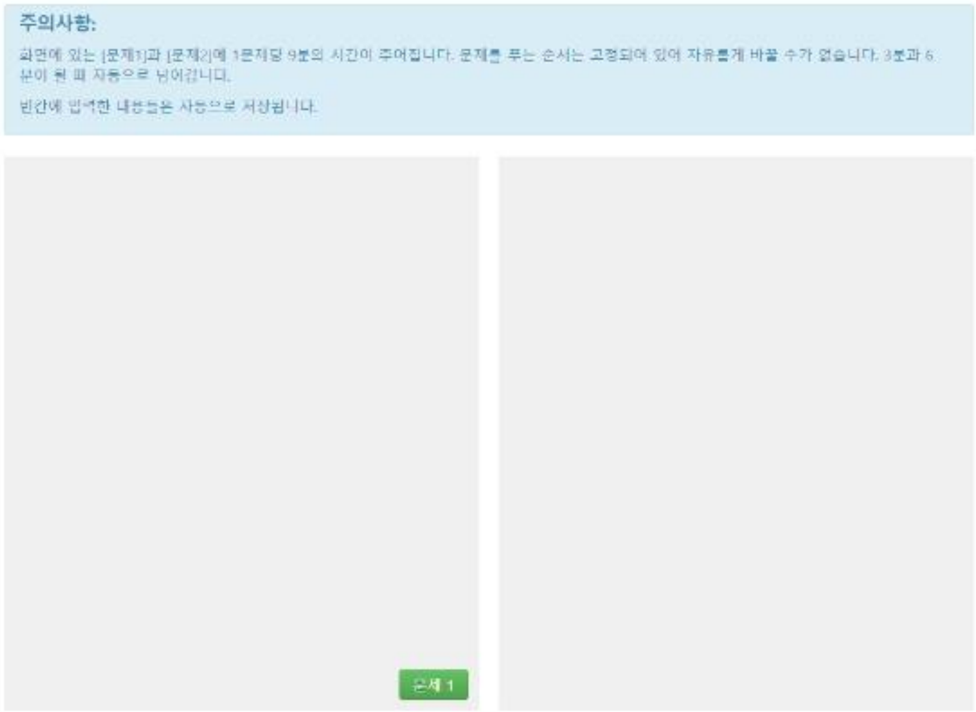

Figure 2 Sample screen shot of the experimental window.

Measures

After the experiment, the number and the quality of the ideas were rated by two graders who were not informed about the purpose of the study.

Task Performance. A creative idea is normally considered should at least consist of two main qualities: appropriateness and originality(Howard-Jones &

Murray, 2003). Thus, the criteria applied here also involve two elements: Practicality and Originality. For each element, the score ranges from 1~10 (1 is bottom and 10 is top). Individuals' overall performance will be the mean score of individuals' total score for task 1 and task 2.

Switch Frequency. For switch frequency, system records each time when individuals open the task box. Since the two task boxes were designed to show alternatively, every single click on the bottom be regarded as a shift to that task. How many times they clicked on the task buttons were calculated.

RESULTS

Task Performance

A one-way ANOVA was performed to analyze the task performance on these three groups, using a significance level of $p < .05$. Performance was measured as the mean score of the two idea generation tasks. The performance by task switching group can be seen in table1.

Mean score of the sequential group, forced switch group and self-initiated switch group (with standard deviations in parentheses) were 12.6 (.84), 11.8 (1.74) and 13.2 (.93), respectively (see Table 1). There is a statistically significant difference between groups as determined by one-way ANOVA ($F(2,77) = 9.656$, $p < .001$).

A Games Howel post-hoc test indicated that the performance is statistically significantly better when allowed to switch freely, compared to the sequential group and forced switch group, $p = .03$, $p < .001$, respectively. The table of the means indicates that having discretion to switch tasks appears to be best for creativity. In the self-initiated switch condition, individuals usually started with working on one of the tasks, after some initial attempts they may stop and jump to the other task, and go back to the primary task later. The results indicate that participants in this group statistically generate more high quality creative ideas among these three groups.

Results also indicated that a marginally significant better performance in sequential group (M = 12.61, SD = .84) over forced switch group (M = 11.77, SD = 1.74), $p = .09$. Interruptions were found to be most disruptive across three groups.

Table 1 Means and Standard Deviations of Task Performance

	Task Performance		
	N	Mean	SD
Continuous	25	12.6	.84
Forced Switch	25	11.8	1.74
Self-initiated Switch	30	13.2	.93

Switch Frequency and Task Performance

The total times of individuals click on the task bottom were counted. The result indicates that individuals almost clicked about 6 times during the experiment. We further examined the correlation between the individuals' performance on the idea generation tasks and total times of task switches. A scatter plot of this measurement is shown in *Figure* 3. Pearson's *r* were calculated, which shows that there is a significant negative correlation between the individuals' performance and the total times they switched, r (30) = -.420, *p*<.05.

In other words, the score of individuals who switch less were relatively higher than individuals who switch more often. Therefore, it appears that when working on a task with the option to switch between tasks but do not switch frequently is better for individuals to gain more creative ideas.

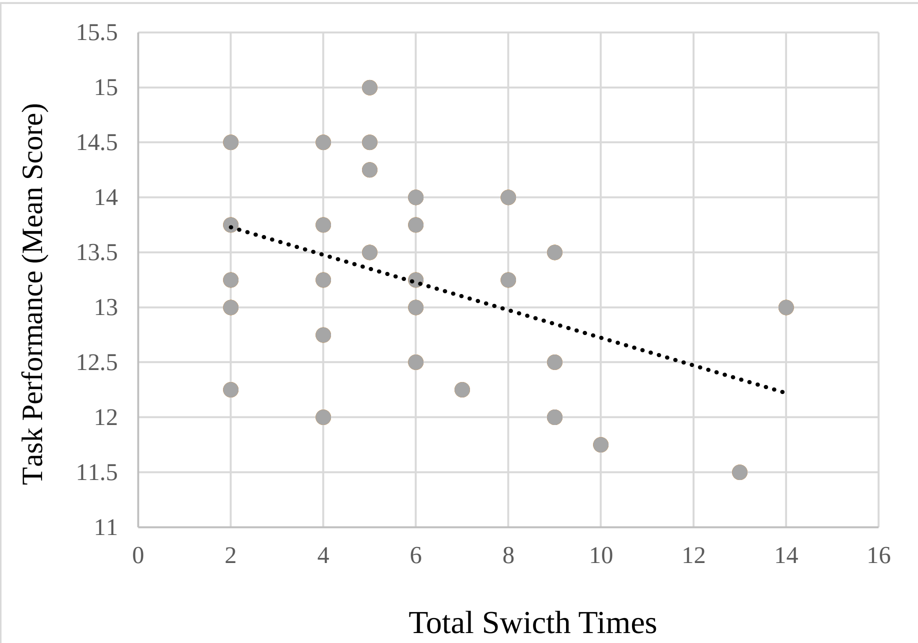

Figure 3 Scatter plot showing a negative correlation between individuals' performance and task switch frequency.

DISCUSSION

The results revealed two major findings: When individuals are permitted to switch at their own discretion between different tasks, (a) they generate the most creative ideas compared to the other two groups and (b) their task performance drops as switching frequency increases.

Regarding to the first finding, previous studies assumed that both externally-driven and self-initiated task switching can be considered as taking sometime away from a task. In another word, both interruptions and breaks can provide a chance to incubate and thus facilitate productivity. The results in prior research have partially support this prediction. Experiment data indicated the positive effect of self-initiated task switching but failed to prove that interruptions could also help individuals to solve more insight problems (Beeftink et al., 2008). Findings of current study are consistent with previous research on this point. Participants perform better than the other two groups when giving the discretion to switch back and forth between tasks. Interruptions do not facilitate creativity. Previous study proposed two explanations for this effect: 1) forcing individuals to switch may divide their cognitive resources; or 2) when individuals are allowed to switch between tasks, incubation effect is stronger. Based on this assumption, a more detailed interpretation is discussed.

The different effects of externally-driven and self-initiated task switching can be depicted as an outcome of the interplay between task switch cost and incubation effect. Switch cost theory demonstrates that extra time and effort is needed to activate a task-set when returning to a primary task after an interrupting task (Barber, 2007). Externally-driven task switching and self-initiated task switching should both produce switch costs, since both of them are switches from one task to another. The difference stems from the moment individuals switch. Task switching is actually breaking a whole task into multiple short periods of time. Self-initiated switch enable individuals to switch at their preferred moments, while interruptions may happened at a higher workload moment. Therefore, even cannot be totally eliminated, switch costs are at least be mitigated in self-initiated task switching condition.

In general, there are two major effects of task switching. The positive effect offers individuals a chance to incubate and improving their task performance consequently. The negative effect is the potential switch cost they may bring. Self-initiated task switching does not produce high switch costs since individuals often switch at a lower workload moment. Thus, the performance is better than that of individuals who are forced to switch between tasks.

The second finding of this study is when allowed to switch freely, high-frequency switching will lead to a reduction in performance. This could also confirm the idea that switch costs are reduced but not completely eliminated when task switching was initiated by individuals themselves. The lower performance on the high-frequency switching group thus could be explained by the existence of switch cost. Further research is required to replicate this results and investigate a more compelling and comprehensive explanation.

Limitations and Future Direction

One limitation of the current study is that in the forced switch group, we restrict individuals to switch at predetermined moment and these switches are irresistible. While most interruptions in the real life are more unpredictable, workers never known when their colleagues will come into their office or share a talk. Similarly, interruptions can be delayed, people do not have to reply an e-mail once they receive it. Thus, a more considerable laboratory experiment condition need to be adopted if we want obtain more insight to how task switch affects task performance.

The reasons why self-initiated task switch facilitates idea generation while externally-driven task switching had a negative effect on task performance remained unclear. Even though we adopted a memory-for-problem-state theory to explain the distinctive effects between externally-driven and self-initiated task switch, neither a systematical theory nor in-depth analysis were available to account for this phenomenon. In this study, we presume this distinction may derive from the moment effects of task switch. In another words, switch at a rather lower workload moment may not result in a poor performance. Individuals are observed knowing when is the right moment to switch in most cases. Thus, self-initiated task switching provides an environment where individuals can switch at the right time. Based on this assumption, future research may further distinguish how individuals perform at different points during the idea generation process.

Finally, individuals were required to work on idea generation tasks in the current study. We know little about the extent to which our findings generalize to tasks that are more complicated or realistic. Prior research had found interruptions to be helpful on simple tasks while inhibiting performance on complex problem (Speier et al., 2003)s. Future research should examine whether this effect can extend to different types of tasks.

Implications

The findings have practical implications for working management. The results imply breaks help workers from getting bored and focus more intently. While working continuously on a single task did not bring such benefits for idea generation. To keep focusing on the task, individuals have to complete the task at the expense of personal well-being and sometimes the quality of their work. Therefore, an important approach to enhance productivity is to promote individuals' self-management skills. Knowing when to keep pursing the task, and when to shift attention can save our efforts. Taking a short break or switching to another task may be considered as a good option after fulfilling a subtask or getting exhausted by one task.

Whereas, frequent switching may reflects a limited cognitive control. Taking switches at an appropriate level of frequency is an important predictor for work efficiency. Because switch cost is only reduced but not eliminated when discretionary switching between tasks are allowed. This suggests that switching between tasks too often will not contribute to tackle the problem. For instance, when an individual finds himself checking various emails, replying Facebook messages or switching from one browser tap to another, this does not mean that he has paid attention everything around and got things done effectively. Rather, he had already lost focus on the work and been distracted by himself. Thus, staying with the current tasks for a period of time before deciding to switch immediately and constantly is important to achieve better performance.

Interruptions can raise a lot of issues that lead to poor performance. To help workers avoid frequent distractions in the workplace, companies should provide a less-interruptive working environment to undermine interruptions from both realistic world and the increasing influential electrical world, such as control of noise in open cubicle, avoiding unscheduled meeting and last minute requests, setting the frequency of email notifications at an appropriate level (Henning, Jacques, Kissel, Sullivan, & Alteras-Webb, 1997).

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Appendices

[Appendix A] 실험에서 사용하는 자극

Task A: 최근에는 사람들은 카메라보다는, 사진이나 비디오를 더 빨리 찍을 수 있는 휴대폰을 더 즐겨 사용한다. 디지털 카메라 업계 사람들이라면 누구나 다 시장의 변화를 체감할 정도이다. 만약 당신이 카메라 디자이너 혹은 제작자라면, 어떤 디지털카메라나 기기를 만들어서 이 시장을 살릴 수 있을 것인가?

Task B: 예전과 달리, 점점 더 많은 사람들이 직장 밖에서도 많은 지식을 습득하고 싶어 한다. 그런데 직장인들은 일도 많고, 공부하는 시간과 장소도 많은 제한을 받고 있다. 만약, 당신이 직장인 학습자들을 위한 방법을 찾는다면, 어떤 방법으로 직장인들이 더 쉽고 오래 공부하도록 도울 수 있습니까?

[Appendix B] 설문지

[A] 아래의 질문들을 읽어보시고, 해당되는 사항에 √로 표시해 주시기 바랍니다.

문제 푸는 시간은 충분했습니까?

문제 1: 아주 부족-----부족----적당-----충분----아주 많음

문제 2: 아주 부족-----부족----적당-----충분----아주 많음

문제 풀 때 계속해서 집중하셨습니까?

문제 1: 집중 못함-----자주 다른 생각-----가끔 다른 생각-----집중-----계속 집중

문제 2: 집중 못함-----자주 다른 생각-----가끔 다른 생각-----집중-----계속 집중

문제를 풀 때 다른 생각을 했다면 주로 어떤 생각을 했습니까?

3-1. 문제 1을 풀 때

다른 생각을 전혀 하지 않았음

문제 1과 관련된 다른 생각 (혹은 상상)

문제 2에 대한 생각

개인적인 문제

기타 (   )

3-2. 문제 2를 풀 때

다른 생각을 전혀 하지 않았음

문제 2과 관련된 다른 생각 (혹은 상상)

문제 1에 대한 생각

개인적인 문제

기타 (   )

문제의 난이도를 평가해주세요.

문제 1: 아주 쉬움-----조금 쉬움----적당-----어려움----아주 어려움

문제 2: 아주 쉬움-----조금 쉬움----적당-----어려움----아주 어려움

문제가 얼마나 재미있는지 혹은 지루한지 평가해주세요.

문제 1: 아주 재미있었음-----조금 재미있었음----적당-----조금 지루했음 ----아주 지루했음

문제 2: 아주 재미있었음-----조금 재미있었음----적당-----조금 지루했음 ----아주 지루했음

Abstract in Korean

멀티태스킹은 우리의 일상 생활에 산재한다. 우리는 동시에 둘 이상의 어떤 일들을 하게 된다. 둘 이상의 과제를 동시에 수행해야 하는 상황에서, 한 과제를 하다가 다른 과제로 옮아가게 되는 이유는 크게 두 가지이다. 그 하나는 정해진 시간이 종료되는 경우에서처럼, 과제 수행자의 의도와 상관없이 외적인 요인으로 인해 일어나는 전환이다. 다른 하나는 과제 수행자가 지루하거나 혹은 집중할 수 없어서 스스로 한 과제에서 다른 과제로 전환하는 경우이다. 본 연구는 이 두 가지 과제 전환상황이 아이디어 생성에 어떤 영향을 주는 지를 알아보기 위해 수행되었다. 이를 위해 두 개의 다른 아이디어 산출 과제를 서로 다른 집단에게 제시하되 다양한 조건하에서 수행하도록 하였다. 각 과제에 주어진 시간은 12 분이었다. 통제 집단(n=25)에서는 두 개의 과제를 하나씩 차례로 풀도록 하였다. 실험 조건은 두 가지였는데, 그 중 외적 과제 전이 조건(n=25)에서는 두 과제를 번갈하가면 하되 각 과제에 주어진 시간은 12 분이었다 (과제 A, 과제 B, 과제 A, 과제 B). 내적 과제 전환 조건(n=30)에서는 각 과제에 주어진 시간 내에서는 실험

참여자가 원하면 언제라도 두 과제 중 하나를 선택하여 과제를 수행할 수 있었다. 생성된 아이디어의 수와 질은 연구 목적을 모르는 두 명의 평가자에 의해 평정되었다. 그 결과 아이디어의 질은 통제 조건에 비해 내적 과제 전환 조건에서 더 높았지만, 외적 과제 전환 조건에서는 오히려 더 낮았다. 추가 분석에서 스스로 과제를 바꾸는 집단에서도 바꾸는 횟수가 많아지면 그에 비례해서 수행이 떨어짐을 확인하였다. 이상의 결과는 과제 선택의 자유가 주어지면 더 나은 수행을 보일 수 있지만 실제로 너무 많이 과제를 변경하면 오히려 수행에 악영향을 미칠 수 있음을 보여준다. 논의에서는 이상의 결과가 어떻게 활용될 수 있는 지에 대해 탐색하였다.

주요어: 외적 과제 전이, 내적 과제 전이, 아이디어 생성.

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