

Effects of Task Switching on Creativity Tests

Claudia Roda, Georgi Stojanov, Dana Kianfar

The American University of Paris

147 rue de Grenelle

75007 Paris, France

croda@aup.edu, gstojanov@aup.edu, dana.kianfar@gmail.com

Abstract

We analyze the results of an experiment where participants were asked to complete a set of creativity tests under various interruption conditions. The results indicate that interruptions hinder creativity. However, the extent by which creativity is thwarted depends both on the creative activity considered and the quality of the task interrupting it. These results suggest that a better understanding of how different types of interruptions interact with specific creative activities may help preventing some of the undesired effects. Unexpectedly, we found no evidence that interruptions may improve creativity but we believe that this effect may be possible under conditions that were not reflected by our experiment.

Introduction

The work described in this paper is part of an ongoing research exploring how modern working and studying environments, characterized by the availability of numerous devices that induce frequent interruptions and task switching, impact people's activity, learning, information management, and communication. We focus here on the effects of interruptions and task switching on creative activities as a way of gaining a better understanding of the relation between attention and creativity. We admittedly proceed in this endeavor with a completely exploratory approach as both the concepts of attention and, even more, creativity are still ill understood – for a review of the many areas of exploration of what creativity may be see (Runco 2004).

It has been widely reported that interruptions increase the load on attention and memory (Gillie and Broadbent 1989), may generate stress (Bailey, Konstan 2006; Bradley Morrison and Rudolph 2011), and compromise

the performance of the primary task (Franke, Daniels, and McFarlane 2002; McFarlane and Latorella 2002; Speier, Vessey, and Valacich 2003). As briefly reported below, several studies have revealed a strong connection between attention and creativity. However, while some research has tasked to apply finding of cognitive psychology and neuroscience in order to design systems capable of better adapting to human attention processes (Roda 2011; Wickens and McCarley 2008) relatively little is known on how such knowledge may inform the design of devices capable of supporting creative activity.

Within highly interactive environments where users are frequently solicited on subjects and at times that are not directly under their control, attention switches are frequent. The question we ask is whether such switches help or hinder creative production. The answer to this question is obviously very nuanced and it most likely depends on many variables such as the type of creative pursuit, the type of interruption, the task within which the creative activity takes place, as well as many other factors including individual differences and possibly even different kinds of creativity (Dietrich 2004). The experiment described here, however, didn't attempt to explore these nuances and only aimed at assessing whether two different types of interruptions may affect a very simple creative activity: completing a text based creativity test.

Attention and Creativity

Several researchers have explored the relationship between attention and creativity. Creative behavior has been connected with trait breadth of attention - see (Kasof 1997) for a short review of relevant studies. In general, wide attention deployment and defocused attention are considered to lead to greater creativity. Amongst the recent research, Friedman and his colleagues offer a set of

experiments showing that “broad or narrow scope of perceptual attention engenders an analogously broad or narrow focus of conceptual attention, which in turn bolsters or undermines creative generation.” (Friedman et al. 2003, 277) Vartanian explains that since many researchers see creativity as the ability to relate concepts previously considered as unrelated and “[b]ecause combining two or more concepts necessitates that they fall within the focus of attention, variations in the focus of attention can have a direct impact on one’s ability to engage in this combinatorial activity” (Vartanian 2009, 57). However, Vartanian continues to argue that such view of creativity being simply associated to attention breadth may not reflect reality, and an ability to apply wide attention breadth in an initial stage of problem solving, followed by a focused attention in later stages, may better describe creative processes. In fact several researchers share the view that creativity requires variations in the field of attention (Gabora 2007) and some experimental results show that distractions improve creativity (Baird et al. 2012; Gallate et al. 2012).

Based on these considerations one could expect that forced changes in attention focus, e.g. interruptions, may actually improve creativity. Consequently one should find that interrupting participants completing a creativity tests would actually improve their creativity scores. However, previous research also tells us of another related factor that may intervene with a possible opposite effect. Some researchers (Karau and Kelly 1992; Smith, Michael, and Hocevar 1990) have found that stress or arousal, generated for example by time pressure or evaluation apprehension, may reduce breadth of attention and therefore hinder creativity. Since, as mentioned earlier, interruptions may have some of these effects (stress in particular), the question then is, will interruptions and multi-tasking support creativity by inducing a wider attention, or will they hinder creativity by generating stress and therefore narrowing attention focus?

Effects of Task Switching on Creativity Tests

Method

19 participants were submitted to three versions of a creative production test under three different conditions. In one condition participants were asked to complete the creativity test uninterrupted (C_{noInt}); in the other two conditions participants were interrupted while completing the test by requests to solve simple mathematical calculations (C_{math}) or by requests to solve simple word association problems (C_{word}).

Although several different tests have been proposed to measure creative production - some of which aimed at

evaluating aspects of creativity not necessarily related to divergent thinking, e.g. (Urban 2004) - we have chosen to apply a classic ideational fluency test (Snyder et al. 2004) in which we asked participants to list all possible uses that they could think of for a familiar object.

The three versions of the creativity test differed only by the objects that participants were asked to describe uses of: a piece of white paper, a coffee mug, a plastic bag.

Figure 1: Screen for Creativity Test.

The experiment was administered on a computer. The creativity test appeared in the main window (fig. 1) and in conditions other than C_{noInt} , interruptions appeared in an overlapping window (fig. 2) that forced participants to attend the interrupting task. The interruption window would disappear, and the participant was able to return to the creativity test, only after the correct answer was provided to the calculation or word problem.

Figure 2: Overlapping window with interruptions.

The three versions of the creativity test were randomly associated with interruption conditions C_{noInt} , C_{math} , C_{word} and the order of the conditions was randomly selected for each run of the experiment. In this manner we obtained tests in the form: $\{C_{noInt,paper}, C_{math,mug}, C_{word,bag}\}$, $\{C_{math,paper}, C_{noInt,bag}, C_{word,mug}\}$, etc. where $C_{i,q}$ represents the condition with interruption type i and test version containing question q . Because each participant took the creativity test under each one of the interruption conditions we were able to control for individual differences. The randomization of the association between the versions of the creativity test (q) and the interruption conditions (i), as well as the randomization of the order of the conditions allowed minimizing learning effects.

While we needed to prevent participants from being able to predict interruptions, we also wanted to minimize effects of interruption timing on the results, for this reason the time of interruptions were not constant but they were

the same for all participants and across C_{math} and C_{word} , i.e. participants were asked to solve mathematical problems or word association problems at times (+90", +60", +30", +15", +60") during their creativity tests. This means that the first interruption would appear 90" after the beginning of the creativity test, the second interruption appeared 60" after the end of the first interruption, the third one 30" after the end of the second interruption, etc. The program was designed so that it would not interrupt the subjects if less than 30" remained before the end of the test. Each creativity test was designed to last 5 minutes including the time for the five interruptions. The three versions of the creativity test, associated with a random interruption condition, would simply follow one another.

The problems proposed to participants in the C_{math} and C_{word} conditions were simple and accompanied by multiple choice answers (fig. 2). The objective was to provide enough distraction to avoid fixation and widen attention focus without excessive cognitive load. The following are examples of C_{math} interruptions: $(17-8)*2$, $3+5+6+8+8-18$, $7*8-9$, $60/5+11$, $78+45$ and of C_{word} interruptions: HAND is to Glove as HEAD is to ?, WATER is to Glass as LETTER is to ? The four possible answers (only one of which was correct) were proposed in random order.

Measures and Creativity Quotient evaluation

Information about the participants' performance on the test was measured through a set of indicators including: (1) Each answer to the creativity test with a time stamp corresponding to the time elapsed between the question appearing on the screen and the answer being typed; (2) the time at which each interruption occurred and the length of time used by the participant to answer (correctly) the interruption question. Some basic information about participants (age, gender, etc.) was also collected. From the indicators we derived: (1) the number of answers to the creativity tests under the three conditions C_{noInt} , C_{math} , C_{word} ; (2) the number of answers to the creativity test immediately before each one of the math and word association problems; and (3) the level of creativity.

In order to evaluate the level of creativity, we followed Howard-Jones and Murray observation that "A creative idea is generally considered to possess two main qualities: appropriateness and originality" (Howard-Jones and Murray 2003, 153) and we assigned to each creativity test result a level of creativity score that took into considerations, not only the number of answers provided but also their appropriateness and originality. The originality score is based on a system similar to that proposed by Snyder and his colleagues (Snyder et al.

2004) who evaluate Creativity Quotient based on the number of response items that fall in different categories. We examined the answers provided by the participants and defined a set of responses categories for the three question types (paper, mug and bag). As for appropriateness, we discarded those answers that definitely did not describe a potential use of the object. We also followed a procedure based on participants' lines of thoughts. If a participant gave a few answers along one line (e.g. 'drink whiskey', 'drink tea', 'drink milk' for a coffee mug) followed by something along the same line, e.g. 'eat soup' or 'eat cereal', then we did not categorize the latter responses under 'food' (and thus creating a new category and increasing the CQ by a larger amount). Instead we categorized them under 'drinks' just like the previous responses. Similarly, if a participant said 'store pens and crayons' in a coffee mug, while later saying something similar but with an obviously different context, we marked it as a new category.

Procedure

Small groups of participants (2 or 3) took the test in a computer laboratory. As we were interested in evaluating the effects of interruptions in realistic environments, we did not take any particular measure to maintain the environment quite, although during all the tests there were no particular noises or other distracting events.

Participants were informed that there were absolutely no restrictions on the responses they could give to the open questions (corresponding to the creativity test) and that they could answer with a sentence or just a word. They were also informed that their responses were recorded automatically and if they had filled all the text boxes they could press the button on the bottom to get more space.

The test started with a pre-test questionnaire collecting basic information about the participants: gender, age, study major, and computer experience. Once completed the pre-questionnaire the program would take the participants immediately to the first screen of the test.

Results

Of the 19 participants in the experiment, we could only retain the data for 17 of them because two participants did not complete all three parts of the test.

We started by comparing the average number of answers produced by participants in any of the three interruption conditions and we noted two types of effects. On average more answers were produced for the *white paper* test (41% of the answers) followed by the *coffee mug* test and finally the *plastic bag* test. A repeated

measures ANOVA¹ analysis shows a significant difference in the number of answers for the three different questions ($F(2, 32) = 5.797, p = 0.007$) and a set of three paired samples t-tests² suggest that, irrespective of interruption conditions, the *white paper* question produces significantly more answers than the *plastic bag* question ($t(16)=2.955, p<0.01$); however, no significant difference in number of answers exists between the *white paper* question and then the *coffee mug* question, nor between *coffee mug* question and the *plastic bag* question.

We then considered the number of answers produced by participants under the three different interruption conditions irrespective of the creativity question. On average more answers were produced for the C_{noInt} condition (40% of the answers) followed by the C_{word} condition (31%) and the C_{math} condition (29%). A repeated measures ANOVA shows a significant difference in the number of answers under the three types of interruption conditions ($F(2, 32) = 3.983, p = 0.02$) and a set of three paired samples t-tests suggest that there is a significant difference in number of answers to the creativity tests between the C_{noInt} condition and the C_{math} condition ($t(16)=2.608, p<0.01$), and a marginally significant difference between the C_{noInt} condition and the C_{word} condition ($t(16)=2.286, p=0.0181$); no significant difference exists between the C_{word} and the C_{math} condition.

We then proceeded to the coding of answers in order to obtain the Creativity Quotient (CQ) as described above. CQ ranged from 2.7 to 19.7 (while number of answers ranged from 4 to 35). In general, values of creativity scores remained close to the number of answers when the number of answers was small while, for large number of answers, the creativity score was smaller than the answer

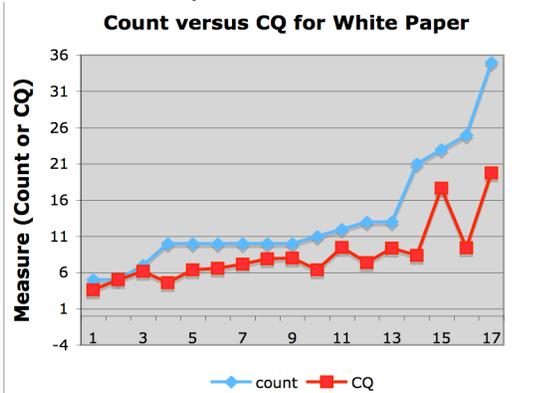


Figure 3: The ratio between number of answers and the associated creativity quotient tends to increase as the number of answers increases.

¹ All the ANOVA tests reported respect this test's assumptions, and in particular homogeneity of variance.

² For all the pairwise tests reported, significance level is adjusted with the Bonferroni correction

count. Fig. 3 exemplifies this for the number of answers provided to, and the CQ calculated for, the white paper question. This appears to be a reasonable result of the coding procedure since participants who provided more answers were also more likely to have several answers falling within the same category.

We proceeded to the analysis of the CQ as we had done for the answer count, we considered: (1) the CQ per question type, irrespective of the interruption type and (2) the CQ per interruption type irrespective of question type. Again we found two significant effects. First, the average CQ for *white paper* (8.08) was larger than that for *coffee mug* (7.03) and for *plastic bag* (5.57) – see fig. 4.

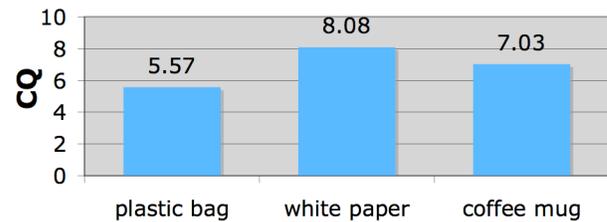


Figure 4: On average, the CQ for the *plastic bag* question is significantly lower than the CQ for both the other two questions.

A repeated measures ANOVA analysis shows a significant difference in the CQ for the three questions ($F(2, 32) = 5.858, p = 0.007$), however a set of three paired samples t-tests suggest that, irrespective of the interruption condition, the relevant result corresponds to the fact that the CQ of the *plastic bag* question is significantly lower of both that for the *white paper* question ($t(16)=2.813, p<0.01$) and that for the *coffee mug* question ($t(16)=2.479, p<0.013$); while no significant difference in CQ exists between the *coffee mug* question and the *white paper* question. Second (fig. 5), the average CQ for the C_{noInt} condition (8.913) was significantly higher than the CQ for both the C_{word} and C_{math} conditions.

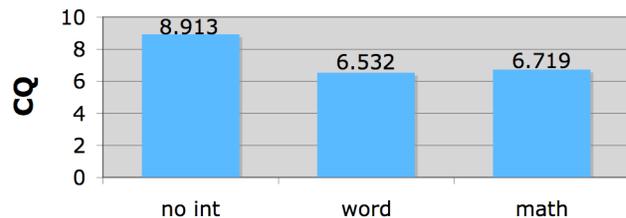


Figure 5: On average, the CQ for the *no interruption* condition is significantly higher than the CQ for both the two interruption conditions.

A repeated measures ANOVA analysis shows a significant difference in the creativity quotient under the three types of interruption conditions ($F(2, 32) = 5.675, p = 0.008$), and a set of three paired samples t-tests suggest that, irrespective of question type, the CQ in the C_{noInt} condition is significantly higher of the CQ in the C_{word} condition ($t(16)=3.894, p<0.01$) and in the C_{math} condition

($t(16)=2.479$, $p<0.013$); however, no significant difference exists between the C_{word} condition and the C_{math} condition.

These results indicate that the *white paper* question might have been more easily answered by participants and that participants were more creative in the C_{noInt} condition. In order to gain a better understanding of these two effects and their interaction, we examined the behavior of each condition $C_{i,q}$ comparing: (1) the CQ for different types of interruptions (i) for each question (q), and (2) the CQ for different questions (q) for each type of interruption (i). As show in fig. 6, and confirmed by a set of 3x3 independent samples t-tests, there is no significant difference in the CQ for different types of interruptions across the three creativity tests. In the case of the *white paper* question, the C_{noInt} condition produces only marginally significantly higher CQ scores than the C_{word} condition ($t(9)=1.649$, $p < 0.067$) and of the C_{math} condition ($t(6)=1.928$, $p < 0.052$).

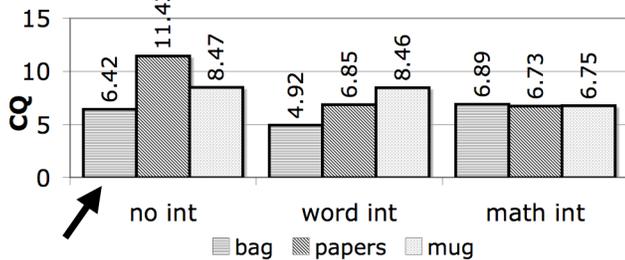


Figure 7: In the no-interruption condition, the CQ for the *plastic bag* question is significantly lower than the CO for the two other questions.

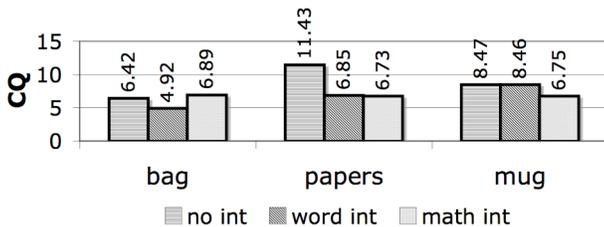


Figure 6: Within each of the three creativity tests, the CQ is similar across the three interruption types.

The comparison of each question for different types of interruption reveals only one significant effect, indicated by an arrow in fig. 7: in the no-interruption condition the CQ for the *plastic bag* question is significantly lower than the CQ for *white paper* ($t(6)= -2.064$, $p<0.05$) and the *coffee mug* ($t(9)= -2.022$, $p<0.04$) questions.

Because these results do not clarify to which extent the significantly better CQ on the *white paper* question might have affected the better CQ in the C_{noInt} condition we decided to eliminate results related to the *white paper* question and compare the effects of different interruption types considering only the other two questions (*plastic bag* and *coffee mug*). By eliminating the *white paper* question results we effectively create 3 groups of

participants: (1) those who had the *white paper* question in the C_{math} condition, for whom we can compare the CQ obtained in the C_{noInt} and C_{word} conditions, (2) those who had the *white paper* question under the C_{word} condition, for which we can compare the CQ obtained in the C_{noInt} and C_{math} conditions. And (3) those who had the *white paper* question under the C_{noInt} condition, for whom we can compare the CQ obtained in the C_{word} and C_{math} conditions. Figure 8 shows the average CQ obtained in the interruption conditions pairs described above irrespective of the question (either *plastic bag* or *coffee mug*). A set of three paired samples t-tests suggest that, irrespective of the questions type, the CQ for the C_{noInt} condition is higher than the CQ obtained under the C_{word} condition but this result is only marginally significant ($t(5)=3.535$, $p<0.027$). No significant difference exists between the C_{noInt} condition and the C_{math} condition, nor between the C_{word} condition and the C_{math} condition.

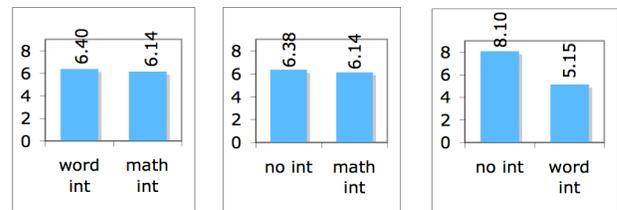


Figure 8: Effects of the interruption type when the *white paper* question is eliminated.

Discussion

Our research question asked whether interruptions and multi-tasking support creativity by inducing a broader focus of attention, or instead hinder creativity by generating stress and therefore narrowing attention focus. Although the results discussed above do not provide any ground for a definitive answer to our research question, they point in one clear direction. All our participants produced more answers, and obtained higher CQ scores in the condition with no interruptions. This result is statistically significant across all creativity tests (i.e. independently of the specific creativity question asked). However, the analysis also shows a “question type” effect that could have interfered with the result just mentioned. Indeed, an analysis of the CQ obtained for individual questions under each of the interruption conditions, shows that the highest CQs were obtained for the *white paper* question in the no-interruption condition. However, the fact that this result was not statistically significant suggests that better CQ scores are due to having no interruptions rather than being related to a specific question. With the objective to confirm or disconfirm this observation we analyzed the CQ removing the *white paper* question and compared CQ obtained under the two remaining conditions for each participant. We found that higher CQ in the no interruption condition as compared to

the word interruption condition were only marginally significant, and that the math interruption condition did not produce significantly worse results than the no interruption condition. These results hint that the specific creative activity interacts with the specific interruption type and that certain creative activities are hindered more significantly by interruptions of a specific type. In any case, the analysis performed so far provides no indication that interruptions could improve the results of the creativity test (neither in terms of number of answers nor in terms of CQ).

Conclusions and Future Work

The analysis performed in this experiment indicates that interruptions are more likely to hinder, rather than improve, creativity; and that different types of interruptions may have varying degree of impact on different creative activities. While these results appear to contradict some previous reports of positive effects of distraction on creativity, we believe that several variables, including the activity and interruption types, and the timing of interruptions, play a role in the interaction between distraction and creativity. We plan to analyze the time-related data collected in our experiment in order to gain a better understanding of the effects of timing. We expect that one of the challenges in designing future experiments will be, as it is often the case, the simultaneous control of both learning and individual differences effects.

Given the frequency of interruptions and multi-tasking, in nowadays activities, a better understanding of their effects on creativity could provide important insights for the support of creative activities in, for example, working and learning environments.

References

Bailey, Brian P., and Konstan, Joseph A. 2006. On the need for attention-aware systems: Measuring effects of interruption on task performance. *Computers in Human Behavior* 22 (4):685-708.

Baird, B., Smallwood, J., Mrazek, M.D., Kam, J.W.Y., Frankline, M.S., and Schooler, J.W. 2012. Inspired by Distraction: Mind Wandering Facilitates Creative Incubation. *Psychological Science* 23(10): 1117-1122.

Morrison, J. Bradley, and Rudolph, Jenny W. 2011. Learning from Accident and Error: Avoiding the Hazards of Workload, Stress, and Routine Interruptions in the Emergency Department. *Academic Emergency Medicine* 18 (12):1246-1254.

Dietrich, Arne. 2004. The cognitive neuroscience of creativity. *Psychonomic Bulletin and Review* 11:1011-1026.

Franke, Jerry L., Jody J. Daniels, and Daniel C. McFarlane. 2002. Recovering context after interruption. Paper read at 24th Annual Meeting of the Cognitive Science Society (CogSci 2002).

Friedman, Ronald S., Fishbach, Ayelet, Förster, Jens, and Lioba Werth. 2003. Attentional Priming Effects on Creativity. *Creativity Research Journal* 15 (2/3):277.

Gabora, Liane. 2007. Revenge of the "Neurds": Characterizing Creative Thought in Terms of the Structure and Dynamics of Memory. *Creativity Research Journal* 22 (1):1-13.

Gallate, J., Wong, C., Ellwood, S., Roring, R.W., and Snyder, A. 2012. Creative People Use Nonconscious Processes to Their Advantage. *Creativity Research Journal* 24, (2-3):146-151.

Gillie, T., and Broadbent, Donald E. 1989. What makes interruptions disruptive? A study of length, similarity and complexity. *Psychological Research Policy* 50:243-250.

Howard-Jones, P. A., and Murray, S. 2003. Ideational Productivity, Focus of Attention, and Context. *Creativity Research Journal* 15 (2/3):153.

Karau, Steven J., and Kelly, Janice R. 1992. The effects of time scarcity and time abundance on group performance quality and interaction process. *Journal of Experimental Social Psychology* 28 (6):542-571.

Kasof, Joseph. 1997. Creativity and Breadth of Attention. *Creativity Research Journal* 10 (4).

McFarlane, Daniel C., and Latorella, Kara A. 2002. The Scope and Importance of Human Interruption in Human-Computer Interaction Design. *Human-Computer Interaction* 17 (1):1-62.

Roda, Claudia, ed. 2011. *Human Attention in Digital Environments*. Cambridge, UK: Cambridge University Press.

Runco, Mark A. 2004. Creativity. *Annual Review of Psychology* 55 (1):657-687.

Smith, KLR, Michael, W.B., and Hocevar, D. 1990. Performance on creativity measures with examination-taking instructions intended to induce high or low levels of test anxiety. *Creativity Research Journal* 3:265-80.

Snyder, Allan, Mitchell, John, Bossomaier, Terry, and Pallier, Gerry. 2004. The Creativity Quotient: An Objective Scoring of Ideational Fluency. *Creativity Research Journal* 16 (4):415-420.

Speier, Cheri, Vessey, Iris, and Valacich, Joseph S. 2003. The effects of interruptions, task complexity, and information presentation on computer-supported decision-making performance. *Decision Sciences* 34 (4):771-797.

Urban, Klaus K. 2004. Assessing Creativity: The Test for Creative Thinking - Drawing Production (TCT-DP) *Psychology Science* 46 (3):387 - 397.

Vartanian, Oshin. 2009. Variable attention facilitates creative problem solving. *Psychology of Aesthetics, Creativity, and the Arts* 3 (1):57-59.

Wickens, Christopher D., and Jason S. McCarley. 2008. *Applied Attention Theory*. CRC press, Taylor & Francis group.