NATIONAL RESEARCH UNIVERSITY
HIGHER SCHOOL OF ECONOMICS

Sergey Yagolkovskiy

COGNITIVE STIMULATION OF INDIVIDUAL CREATIVITY IN A GROUP CONTEXT: MEDIATED AND FACE-TO-FACE IDEA SHARING

BASIC RESEARCH PROGRAM

WORKING PAPERS

SERIES: PSYCHOLOGY
WP BRP 11/PSY/2013

Sergey R. Yagolkovskiy[1]

COGNITIVE STIMULATION OF INDIVIDUAL CREATIVITY IN A GROUP CONTEXT: MEDIATED AND FACE-TO-FACE IDEA SHARING[2]

We examine how idea exposure produces cognitive stimulation. Study participants were given stimulus ideas with a low or high level of originality, or with absurd content. Stimuli were exposed in conditions of face-to-face communication and with computer and paper mediation, respectively. Three parameters of creativity were analyzed: Fluency, flexibility, and originality. Results revealed a positive effect on fluency scores for face-to-face communication. This effect is the most evident for the exposure of absurd stimulus ideas. We also found a positive effect on originality scores for highly original stimulus ideas.

JEL Classification: Z.
Keywords: creativity, brainstorming, idea sharing, cognitive stimulation, group creativity, electronic brainstorming

[1] National Research University Higher School of Economics. Department of general and experimental psychology, Associate professor, E-mail: syagolkovsky@hse.ru.
[2] This work was supported by the Basic Research Program of the National Research University Higher School of Economics.

Creativity is often regarded as an activity that is closely related to making new products in various forms. It is a multidimensional concept that is important at various levels: Physiological, cognitive, emotional, motivational, social, economic, etc. (e.g. Armbruster, 1989; Amabile, 2000; Csikszentmihalyi, 1999; Martindale, 1999; Perry – Smith, Shalley, 2003; Plucker, Renzulli, 1999; Simonton, 2001; Sternberg, Lubart, 1999; Ward, Smith, Finke, 1999; Williams, Yang, 1999).

A crucial point in creativity research is the examination of its parameters. One of the most important quantitative characteristics of creativity is fluency: The more ideas a person generates, the more unique ideas can be found among these (Osborn, 1957). One more quantitative parameter is flexibility, or the number of semantic categories that generated ideas belong to. Originality, which is the degree of novelty and innovative potential of new ideas, and feasibility, being the relevance of ideas to the topic or potential to be implemented in a practical way, are the most important qualitative characteristics of creativity (Rietzschel, Nijstad, Stroebe, 2007).

An important factor of individual creativity is an encouraging environment that may enhance creative abilities. A concept of the "creative knowledge environment" focuses on cognitive aspects of this process. It is regarded as a context or surroundings that affect a person's creative abilities in a positive way (Hemlin, Allwood, Martin, 2008). This sort of environment can be produced and supported in a group context.

Group creativity

One of the most popular modes of group creative activity is brainstorming. Osborn (1957), the founder of this concept, regarded it as a method of group problem solving and idea generation, which could considerably increase both the quality and quantity of generated ideas. If one sees creativity as the ability to think in a divergent way, a group seems to be a source that provides individuals with a unique opportunity to bring together their experience, knowledge, and opinions. In these conditions a group can produce unique conceptual combinations (Paulus, Coskun, 2011).

But numerous experimental studies have revealed shortcomings of the method. Among them are evaluation apprehension, free riding, production blocking, and matching (Diehl, Stroebe, 1991). One more disadvantage of brainstorming that is inherent to almost all kinds of group creative activity is that group members concentrate their discussion mostly on ordinary ideas and perspectives. In this case, unique ideas could be underestimated (Paulus, Coskun, 2011). So brainstorming seems to be not as effective as it has appeared earlier (Brown, Paulus,

2002; Craig, Kelly, 1999; DeRosa, Smith, Hantula, 2007; Diehl, Stroebe, 1991; Litchfield, 2009; Nijstad, Stroebe, Lodewijkx, 2002). Despite the effects of inspiration and mutual emotional stimulation, creative performance in nominal groups, where participants work alone, could be higher than in face-to-face brainstorming groups (Diehl, Stroebe, 1987; Lamm, Trommsdorf, 1973; Mullen, Johnson, Salas, 1991).

The crucial factor that influences the productivity of a brainstorming session is the size of the group. It has been shown that there is no improvement in performance if a group's size increases from 5 to 9 persons. The best size of a small group to perform verbal brainstorming is 6 individuals or less (Aiken, Vanjani, Paolillo, 1996). Inhibiting effects, which often take place in a brainstorming session, are small in dyads, but increase rapidly with group size (Nijstad, Stroebe, Lodewijkx, 1999; Coskun et al., 2000).

Some negative effects of face-to-face communication in a brainstorming session could disappear when participants exchange their ideas with each other in a salient written way. This modification of the brainstorming method, which is known as brainwriting, has the following advantages: Participants can work simultaneously, because they do not need to wait to articulate their ideas as in traditional brainstorming; brainwriting provides individuals with more anonymity; there is no risk that one or a few participants will dominate (Aiken, Vanjani, Paolillo, 1996); and this procedure minimizes the risk of conflicts and neutralizes status differentials (Heslin, 2009).

There is one more method of group creative activity, namely electronic brainstorming (EBS). Interest in EBS has been increasing over the last decade. This method is free from the many drawbacks of traditional brainstorming. But numerous studies concerned with comparing the efficiency of traditional and electronic brainstorming have obtained controversial results. On the one hand, EBS looks more effective because it gives participants opportunities to communicate in parallel ways, fix ideas just upon their appearance, work in anonymous conditions, get additional information to produce more qualitative ideas, be free from apprehension effects, etc. (Benedek, Fink, Neubauer, 2006; Kerr, Murthy, 2009). On the other hand, face-to-face brainstorming provides group members with emotional contacts and nonverbal communication. There is also no necessity for them to type new ideas, and so on.

Taking into account the fact that each of the mentioned methods of group creativity has both advantages and disadvantages, and that studies comparing them provide us with controversial results, they need to be examined in more detail and compared with each other in more specific conditions.

Cognitive aspects of idea sharing

Research on group creativity and idea sharing concentrates on analyzing the characteristics of a group, including structure, diversity, size, cohesiveness, cooperation, autonomy, etc. (Cooper, Jayatilaka, 2006). It also analyzes characteristics of a task, referring to structure, time pressure, complexity, and conditions, as well as analyzes the personal characteristics of individuals participating in the process, meaning creativity, intelligence, and cognitive style. Various combinations of these factors determine to a considerable degree the effectiveness and productivity of a creative group activity.

Under the conditions of this kind of activity, cognitive stimulation takes place when the ideas of others serve to activate a subject's own relevant knowledge. The process of idea generation requires individuals to use their memory. It is clear that the retrieval of necessary relevant information from memory is one of the most important points of the process: An individual cannot generate any feasible ideas without any knowledge of the topic (Brown, Paulus, 2002). There are a number of models of activation of one's memory and knowledge network during idea sharing (e.g.Tennyson, Breuer, 2002). At the earlier stages of the idea generation process, a partner's ideas could be regarded by an individual as being not as valuable and useful as at later stages. The more ideas an individual has been producing, the more difficulties he/she may face during the process of generating each new idea. At this stage, the ideas of other's can activate related categories and potential ideas in his or her memory and knowledge network (Kohn, Paulus, Choi, 2011). At the same time, an individual can regard as his or her own ideas those that have been produced by his or her group mates beforehand**.** This phenomenon is known as "unconscious plagiarism" (Kohn, Smith, 2011).

The process of retrieving relevant information was taken into account in a theory of idea generation proposed by Nijstad, Stroebe, and Lodewijkx (2002) and entitled SIAM (Search for Ideas in Associative Memory). According to this theory, the process of idea generation comprises two stages. At the first stage, knowledge activation takes place. At the second stage, an individual produce his or her own idea.

A number of papers have studied the role of attention in creative group processes. In a group context, attention could be focused on individual's own ideas, on the ideas of other group members, and on interpersonal communication processes (Dugosh et al, 2000). Results from numerous studies showed that attention and concentration on the task both affect a group's creative performance in a positive way. On the other hand, focusing on a task can influence the productivity of a creative group activity in a negative way in some specific conditions. For example, task-focus when pressed for time can prevent group members from modification and developing generated ideas (Kelly, Karau, 1993). There are some other models of attention as a

factor of a creative group activity. For example, it might be seen as the probability that an individual takes into account another person's idea when he or she is generating his or her own ones (Brown, Paulus, 2002).

An essential factor of creative group performance is the characteristics of ideas exchanged. This factor affects the particular parameters of creativity of those individuals who are involved in creative group activities. One of the characteristics that are important in this context is a variety of considered categories. It was discovered by Baruah and Paulus (2011) that groups that had been given a small amount of stimulus categories produced more ideas, used more semantic categories, and performed better in clustering similar ideas than did groups where participants focused on one unique category. Concentration on a limited number of categories could lead to deeper exploration within each of them and, consequently, to generating more novel ideas (Rietzschel, Nijstad, Stroebe, 2007).

One more promising aspect in group creativity and idea sharing is examining the semantic aspects of idea exchange (Coskun et al, 2000)**.**

The experiment reported here was designed to further examine the impact of various characteristics of the idea sharing process on individual creativity. We hypothesize that the parameters of individual creativity are influenced by the semantic characteristics of the ideas of others and also by the mode of idea sharing. We expected that ideas with a high level of originality influence individual creativity in a positive way, while common ideas influence creativity mainly in a negative way. In accordance with one more of our assumptions, absurd ideas could stimulate individual creative performance.

Method

Participants and design

Three hundred and thirty-one undergraduates participated in the experiment – 178 females and 153 males, with ages ranging from 14 to 25 years (M=17.92, SD=2.90). Participants were not informed about the purpose of the study.

We assessed the influence of idea sharing on particular parameters of individual creativity in an idea-exposure paradigm, which is often used to provide respondents with the products of other people's creative activity (Kohn, Paulus, Choi, 2011).

The design of the study involved a manipulation of semantic characteristics of stimulus ideas. Stimuli with low levels of originality, with high levels of originality, and with absurd content had been presented to participants. We also varied the mode of idea exposure using

computer and paper mediation, and the condition of face-to-face communication, as well. Stimulus ideas were presented to participants as other people's ideas.

For each mode of idea exposure, participants were randomly assigned to groups where stimuli with various semantic characteristics were presented. The size of each group of participants can be seen in Table 1.

Table 1
Sizes of experimental groups

Condition	Low-originality ideas	High-originality ideas	Absurd ideas	**Total**
Computer mediation	50	46	36	**132**
Paper mediation	40	39	42	**121**
Face-to-face communication	17	24	16	**57**
Total	**107**	**109**	**94**	**310**

The control group consisted of 21 participants.

Materials

We assessed participant creativity by using a psychometric paradigm. We used the Russian version of J.Guilford's "Unusual uses" verbal test of creative thinking (Averina, Shcheblanova, 1996)**.** This test comprises two parallel and interchangeable forms. The first form requires a respondent to think up the maximum number of unusual applications for the first object – standard newspaper. In the second form a respondent should carry out the same task for another object – a wooden ruler.

In the course of individual creativity diagnostics, we analyzed the following parameters by means of quantitative measures as suggested by J.Guilford:

- ✓ fluency - the total number of ideas proposed by a participant;
- ✓ flexibility - the quantity of semantic categories that the proposed ideas relate to;
- ✓ originality - singularity and statistical rarity of the proposed ideas.

Originality was scored by using a five-point scale on tables assumed in the Russian version of the test.

Stimulus ideas relevant to the task were subdivided into 3 semantic categories with the following procedure. Stimulus ideas with either a low- or high-level of originality were selected in accordance with psychometric principles as proposed by J.Guilford himself. Stimuli belonging to these semantic categories were taken from the list of ideas that had been included by Averina and Shcheblanova into tables for processing obtained data (Averina, Shcheblanova, 1996). We regarded as stimuli with a low level of originality those ideas with a score of 1 from the tables (e.g. "To make a cross"), and as stimuli with a high level of originality those ideas with a score of 5 (e.g. "To make a sole for an old shoe"), respectively. Dugosh and Paulus (2005) in their experiment used common and unique stimulus ideas, as well. Unlike us, they did not manipulate the mode of idea exposure (participants got stimuli on computer screens only and typed generated ideas on keyboards).

Stimulus ideas belonging to the third type of semantic characteristics were taken from our prior studies on this topic. We selected 40 ideas from participants that seemed to be the most absurd and unfeasible from previous experiments. Afterwards, 14 untrained persons in a group discussion selected the 11 most absurd ideas concerning unusual application of a wooden ruler from the list (e.g. "To imagine that it is a person and speak with it").

Procedure

The experiment had two stages. At the first stage, all participants performed the first task for assigned 6 minutes: To generate the maximum number of unusual applications of a standard newspaper. At the second stage, for the same amount of time they thought up various unusual applications for a wooden ruler while being exposed to stimulus ideas. In accordance with the instruction, while performing their own tasks, participants could use the information obtained from the stimulus material to their own discretion**.**

Computer-mediated idea exposure. Participants who were exposed to stimuli under computer-mediated conditions read stimulus ideas that appeared on computer screens. The stimuli were exposed to them sequentially. Participants had been previously informed that other persons were generating ideas within the same electronic brainstorming session. The procedure of idea exposure was as follows. Each participant started to generate new ideas and typed them on the keyboard of a computer. After he or she typed the next generated idea, a new stimulus idea of appropriate content appeared on the computer screen immediately. If a participant had not typed the next idea within 20 sec, the next stimulus idea appeared on the screen. If it had

taken less than 6 min for a participant to produce 11 ideas while reading stimulus ideas one by one, then he or she continued the process without any stimulation up to the moment when the assigned time ran out.

Paper-mediated idea exposure. Participants who were exposed to stimuli under paper-mediated conditions received instruction to produce their own ideas concerning uncommon applications of the wooden ruler after reading stimulus material printed on a sheet of paper for 1 minute. They were told that another participant of the experiment had produced these exposed ideas earlier. Each subject had access to the list with these ideas and was able to see them until the end of the experiment.

Idea exposure under conditions of face-to-face communication. Participants who were exposed to stimulus ideas under conditions of face-to-face communication participated in a dyadic creative activity. One member of each dyad was the specially trained experimenter assistant who imitated creative activity by "producing" stimulus ideas and articulating them to a naive participant. In fact, these ideas had been memorized by the experimenter assistant beforehand. All discussions in the face-to-face idea generation sessions were audio recorded.

Control group. In the control group participants did not get any stimulus ideas at all. But for 6 minutes under the creativity diagnostics procedure they thought up unusual applications of both a newspaper and a wooden ruler, respectively.

Results

The means and standard deviations of participant fluency, flexibility, and originality scores for each group are reported in Table 2.

Differences between groups

A one-way analysis of variance (ANOVA) with all groups showed that there were no differences between groups for fluency scores at the first stage of the experiment (before the experimental influence) ($p>0.05$). But we did find differences for flexibility ($F(9, 321)=3.18$; $p<0.005$) and originality scores ($F(9, 321)=10.8$; $p<0.001$). For flexibility scores, we excluded the group with paper-mediated exposure of highly creative ideas from the analysis. After that we found differences between groups with marginal significance ($p=0.048$).

For originality scores, Duncan's post-hoc test revealed two homogenous types of groups: 1) Three groups with computer mediation; and, 2) All other groups. One of the reasons why we performed separate analyses of variance on originality scores for groups with computer-mediated exposure of stimulus ideas was the revealed differences between groups with computer mediation and other groups.

Originality

A three-factor (stage of the experiment × mode of idea exposure × semantic characteristics of stimuli) repeated measures analysis of variance (ANOVA) on originality scores yielded main effects for the semantic characteristics of the stimuli ($F(2, 321) = 10.24$; $p<0.001$), for mode of exposure of the stimulus material ($F(2, 321) = 85.17$; $p<0.001$), and for the stage of the experiment ($F(1, 321) = 62.56$; $p<0.001$). A significant interaction effect for the stage of the experiment and semantic characteristics of stimuli was found: $F(2, 321) = 5.65$; $p<0.005$. In accordance with the goals of our study, we regarded this interaction effect as the most important one.

Table 2
Means and standard deviations of scores of creativity parameters across conditions

	Condition	Low originality		High originality		Absurd		Total	
		Stage 1	**Stage 2**	**Stage 1**	**Stage 2**	**Stage 1**	**Stage 2**	**Stage 1**	**Stage 2**
Fluency	Computer mediation	10.32 (5.01	8.44 (4.01)	10.48 (5.01)	9.48 (5.11)	8.83 (4.46)	7.78 (3.42)	9.97 (4.88)	8.62 (4.31)
	Paper mediation	11.70 (4.57)	10.20 (4.00)	10.49 (4.37)	8.95 (3.62)	11.79 (5.48)	10.98 (4.43)	11.34 (4.84)	10.07 (4.09)
	Face-to-face communication	12.12 (5.12)	13.06 (6.88)	11.46 (3.89)	12.62 (3.99)	13.25 (5.29)	18.44 (7.20)	12.16 (4.67)	14.39 (6.37)
	Total	11.12 (4.88)	9.83 (4.81)	10.69 (4.53)	9.98 (4.57)	10.90 (5.31)	11.02 (5.91)		
	Control group							10.19 (3.69)	9.62 (5.08)
Flexibility	Computer mediation	6.96 (3.14	7.28 (4.65)	6.91 (2.87)	7.48 (3.53)	5.78 (2.84)	6.33 (2.43)	6.62 (2.99)	7.09 (3.76)
	Paper mediation	6.32 (1.99)	5.60 (1.71)	4.95 (1.67)	5.05 (1.90)	5.48 (2.06)	6.02 (2.04)	5.59 (1.99)	5.57 (1.92)
	Face-to-face communication	6.00 (1.41)	5.94 (2.30)	6.33 (1.58)	6.25 (1.73)	7.06 (1.81)	7.94 (2.46)	6.44 (1.63)	6.63 (2.25)
	Total	6.57 (2.54)	6.44 (3.53)	6.08 (2.39)	6.34 (2.87)	5.86 (2.40)	6.47 (2.34)		
	Control group							5.76 (1.95)	5.71 (1.82)
Ori	Computer mediation	1.96 (0.51	2.26 (0.68)	1.96 (0.60)	2.58 (0.58)	1.88 (0.55)	2.01 (0.67)	1.94 (0.55)	2.30 (0.68)

	Paper mediation	2.58 (0.71)	2.99 (0.57)	2.57 (0.44)	3.33 (0.53)	2.53 (0.63)	2.89 (0.55)	2.56 (0.60)	3.07 (0.58)
	Face-to-face communication	2.66 (0.69)	2.79 (0.58)	2.61 (0.59)	3.08 (0.50)	2.30 (0.40)	2.71 (0.48)	2.54 (0.59)	2.89 (0.54)
	Total	2.30 (0.69)	2.62 (0.71)	2.32 (0.62)	2.96 (0.64)	2.24 (0.63)	2.53 (0.72)		
	Control group							2.63 (0.53)	3.06 (0.77)

Note. Standard deviations are in parentheses

Planned comparisons for semantic characteristics of stimuli and the stage of the experiment showed that participants who had been exposed to highly original ideas generated significantly more original ideas than respondents who had been exposed to stimuli with a low level of originality ($F(1,214) = 9.72$; $p<0.005$), and those who had been exposed to absurd ideas ($F(1,201) = 11.37$; $p<0.001$), as well.

We performed two additional separate two-factor (stage of the experiment × semantic characteristics of stimuli; and, stage of the experiment × mode of idea exposure) analyses of variance (ANOVA) on originality scores (see Table 3). The results revealed significant simple effects for semantic characteristics of stimuli under conditions of exposure to face-to-face and computer-mediated ideas, as well as for the mode of ideas exposure under conditions of presenting all kinds of stimuli (see Table 3). We found a significant interaction effect for the semantic characteristics of stimuli and the stage of the experiment under conditions of exposure only to computer-mediated ideas. Planned comparisons showed that there were significant differences in the dynamics of originality scores under the mentioned condition between groups where highly original ideas and other kinds of stimuli had been exposed: $F(1, 80) = 7.42$; $p<0.01$ for comparison between conditions of exposure to highly creative and absurd ideas; and, $F(1, 94)=4.04$; $p<0.05$ for comparison between conditions of presenting stimuli with a high- and low-level of originality, respectively.

Fluency

Taking into account that Levene's test for equality of variances for fluency scores revealed a lack of homogeneity, we conducted two separate repeated measures of variance analyses (ANOVA) for each condition (stage of the experiment × semantic characteristics of stimuli; and, stage of the experiment × mode of idea exposure). The F-values for significant effects and their associated p-values for each source of variance are presented in Table 3.

Results yielded significant simple effects on fluency scores for the semantic characteristics of stimuli under conditions of face-to-face communication and for the mode of stimuli exposure under conditions of presenting ideas with a high level of originality. We found significant interaction effects on fluency for the mode of idea exposure and stage of the experiment under all conditions ($p < 0.10$ for each of them).

Planned comparisons revealed significant differences in the dynamics of fluency scores between face-to-face and mediated conditions of idea exposure. We did not find a significant difference between conditions of computer and paper mediation ($p>0.5$), but there were significant differences between conditions of face-to-face communication and computer mediation ($F (1, 187) = 26.96$; $p < 0.001$), as well as between face-to-face communication and paper mediation ($F (1, 176) = 28.05$; $p < 0.001$).

Table 3

F-values for significant effects and their associated p-values

Source of variance	Condition	*Fluency*	*Flexibility*	*Originality*
Semantic characteristics of stimulus ideas	Paper mediation			
	Face-to-face communication	5.27**	4.17**	2.45*
	Computer mediation		2.36*	18.53***
Semantic characteristics of stimulus ideas × stage of the experiment	Paper mediation		4.70*	
	Face-to-face communication	4.59**		
	Computer mediation			2.74*
Mode of idea exposure	Ideas with low originality			24.28***
	Ideas with high originality	2.72*		34.92***
	Ideas with absurd content		4.81*	28.94***
Mode of idea exposure × stage of the experiment	Ideas with low originality	3.99*		
	Ideas with high originality	4.27*		
	Ideas with absurd content	15.55***		

*p < 0.10
** p < 0.01
*** p < 0.001

Under conditions of face-to-face communication, there was a significant difference in fluency scores between groups where absurd and highly original stimuli had been exposed: $F (1, 38) = 5.44$; $p<0.05$. We also found a significant difference in the fluency scores between groups where absurd and non-original ideas had been presented: $F (1, 31) = 4.69$; $p<0.05$.

Planned comparisons showed that for the exposure of highly creative ideas there were significant differences between face-to-face communication and each mediated condition: F (1,

61) = 7.39; $p < 0.01$ for the paper mediation, and $F(1,68) = 4.81$; $p < 0.05$ for the computer mediation, respectively.

Flexibility

We performed two separate two-factor repeated measures analyses of variance (ANOVA) on flexibility scores. We did this for the same reason and in accordance with the same process that had been used in the examination of the dynamics of fluency scores.

Results yielded significant simple effects on flexibility scores for semantic characteristics of stimuli under two conditions: Face-to-face communication and computer mediation (see Table 3). The mode of idea exposure significantly affected flexibility scores under conditions of exposure to stimuli with absurd content. We found a significant interaction effect for the semantic characteristics of stimuli and stage of the experiment under paper-mediation conditions.

Planned comparisons showed that there was a significant difference in flexibility scores between groups where absurd stimulus ideas and stimuli with a low level of originality had been exposed ($F(1, 118) = 9.50$; $p < 0.05$).

Discussion

The results of the study confirmed our prediction about the influence of semantic characteristics of stimulus ideas on the parameters of individual creativity. We revealed the most evident effect for this factor on originality scores.

The obtained results confirmed our expectation of the positive influence of highly original ideas on the originality of individual creative performance. We explain this influence by a cognitive-social stimulation effect: The cognitive stimulation manifested in a form of the activation of an individual's knowledge network and his or her memory. It has been shown earlier that the ideas of one member of a brainstorming group could activate related ideas in the mind of other group members (Coskun et al, 2000). The social stimulation took place when an individual regarded another's novel ideas as a high external standard. In this condition, an upward social comparison effect could take place: Motives to perform better were activated, and individuals tried to attain a higher level of creative activity to follow the high standard (Diehl, Stroebe, 1987; Paulus et al., 2002). We assume that some peculiarities in the influence of the upward social comparison on originality scores under conditions of face-to-face idea exposure existed. One of them was related to an additional comparison mode when an individual compared not only his or her own ideas with those generated by other person, but him or herself

with the "author" of these novel ideas. In this condition a blocking of one's creative activity could take place for some participants because the results of the comparison might be rather disappointing for them.

Obtained results showed that, under the condition of computer-mediated idea exposure, semantic characteristics of stimuli affected originality in a more evident way in comparison with other modes of idea presentation (see Table 3). This finding could be explained by a lack of emotional contacts and dominance of verbal communication in conditions of computer mediation. But these peculiarities were inherent to the paper-mediated mode of idea exposure, too. The difference between paper and computer mediation in this context was closely related to sequential organisation of the process of stimulus exposure. Under the condition of computer mediation it was sequential, but under paper-mediated conditions it was simultaneous. Coskun et al. (2000) showed that the sequential exposure of stimuli leads to a higher rate of idea generation than simultaneous exposure does. It might be a promising point for future research on the topic to examine this effect in more detail for stimuli with different content.

We revealed a significant simple effect on fluency under conditions of face-to-face communication for the semantic characteristics of stimulus ideas, as well as an interaction effect for the semantic characteristics of stimuli and the stage of the experiment (see Table 3). These effects could be caused by specificity of dyadic face-to-face communication: In conditions of dyadic creative activity, individuals were free from the influence of some inhibiting factors, which take place in brainstorming groups of a bigger size. One of these inhibiting effects is social loafing. It appears when individuals in a big brainstorming group become less responsible for their performance because they could be hardly identified or accounted for (Harkins, Latané, Williams, 1980; Paulus et al., 2002).

Fluency scores for those participants who had been given stimuli in both mediated ways tended to decrease. A possible reason for these results seems to be related with time losses that took place for those participants who were writing or typing generated ideas with low speed. That was not the case for participants who had been given stimuli under conditions of face-to-face communication. They did not need to spend time for writing or typing. But we see one more possible explanation of decreases in fluency scores for individuals who had been given stimuli in both mediated modes: They might get tired after doing the required task during the experiment's first stage and, when starting to generate ideas at the second stage, they did not get any social-emotional stimulation from partners, as they performed the second task in conditions of dyadic creative activity.

Revealed differences in the dynamics of fluency sores for mediated and face-to-face conditions seems also to be in line with the compensatory adaptation theory (CAT), which

maintained that human brains are more effective in face-to-face communication (Kock, 2007). This kind of communication provides people with opportunities to exchange information in both verbal and nonverbal modes. So, in this context, participants who communicated with each other directly obtained advantages in comparison with those who communicated in mediated ways.

Among groups that were presented with stimuli in conditions of face-to-face communication, we found the most profound positive changes in fluency scores for those participants who had been exposed to stimulus ideas with absurd content. These results seem to partially support the idea of Nijstad, Stroebe, and Lodewijkx, who stated that "…topics with a relatively large solution space, with many categories of solutions and many possible ideas per category…, are more likely to show stimulation effects than topics with a small solution space" (2002, p. 543). The meanings of absurd ideas are mostly ill defined, and they could be understood and interpreted in various ways. In fact, these ideas embrace a wide solution space, being at the same time hardly feasible and applicable. Moreover, absurd ideas could be regarded as examples of overcoming boundaries of stereotypical thinking. Following these examples, some participants might break the experiment's instructions, which required them to generate only feasible ideas. In this case, the fluency of an individual's creative performance could increase to a great extent. It would be interesting for future research to examine the dynamics of fluency scores when a participant breaks the rules of the experiment's instructions concerning the generation only of feasible ideas.

In general, results of the study outlined a number of possible ways for the cognitive stimulation of individual creativity. The appropriate combinations of semantic characteristics for stimulation with a particulate mode of stimulus exposure could be used in the development of methods for enhancing creativity.

Acknowledgements

Special thanks go to Julia Babaeva for moral support and encouraging influence. Thanks are also due to Olga Mitina and the Moscow Department of Education for help in organizing the computer-mediated idea exposure, and to Maxim Ushakov and Anna Borisenko for assistance in coding the experimental data from computer-mediated conditions.

This work was supported by the Program of Basic Research at the National Research University Higher School of Economics.

References

Aiken, M., Vanjani, M., Paolillo, J. (1996). A comparison of two electronic idea generation techniques/ Information & Management, 30, 91-99.

Amabile, T. M. (2000). Stimulate creativity by fueling passion// In E. Locke (Ed.), The Blackwell handbook of principles of organizational behavior. Oxford: Blackwell Publishers, 331-341.

Armbruster, B.B. (1989). Metacognition in creativity// In J.A. Glover, R.R.Ronning, & C.R.Reynolds (Eds), Handbook of creativity. NY: Plenum Press, 177-182.

Averina, I.S., Shcheblanova (1996). Verbalnij test tvorcheskogo myshlenija "neobychnoe ispolzovanie" [Verbal test of creative thinking "unusual uses"]. Moscow: Sobor.

Baruah, J., Paulus, P.B. (2011). Category assignment and relatedness in the group ideation process/ Journal of Experimental Social Psychology, 47, 1070–1077.

Benedek, M., Fink, A., Neubauer, A.C. (2006). Enhancement of Ideational Fluency by Means of Computer-Based Training/ Creativity Research Journal, Vol. 18, No. 3, 317–328.

Brown V.R., Paulus P.B. (2002). Making group brainstorming more effective: recommendations from an associative memory perspective// Current directions in psychological science, Blackwell Publishing Inc., 11, 208-212.

Cooper R.B., Jayatilaka, B. (2006). Group Creativity: The Effects of Extrinsic, Intrinsic, and Obligation Motivations / Creativity Research Journal, Vol. 18, No. 2, 153–172.

Coskun, H., Paulus, P., Brown, V., Sherwood, J. (2000). Cognitive stimulation and problem presentation in idea generation groups // Group Dynamics: Theory, Research, and Practice, 4, 307-329.

Craig T.Y., Kelly J.R. (1999).Group cohesiveness and creative performance// Group Dynamics: Theory, Research, and Practice, 3, pp.243- 256.

Csikszentmihalyi, M. (1999). Implications of a systems perspective for the study of creativity/ In R.J. Sternberg (Ed), Handbook of creativity. Cambridge: Cambridge University Press, 313-335.

DeRosa. D.M., Smith, C.L., Hantula, D.A. (2007). The medium matters: Mining the long-promised merit of group interaction in creative idea generation tasks in a meta-analysis of the electronic group brainstorming literature / Computers in Human Behavior, 23, 1549–1581.

Diehl, M., Stroebe, W. (1987).Productivity loss in brainstorming groups: toward the solution of a riddle/ Journal of Personality and Social Psychology, 53, 497-509.

Diehl, M., Stroebe, W. (1991).Productivity loss in idea-generating groups: tracking down the blocking effect/ Journal of Personality and Social Psychology, 61, 392-403.

Dugosh, K.L., Paulus, P.B. (2005). Cognitive and social comparison processes in brainstorming/ Journal of Experimental Social Psychology 41, 313–320.

Dugosh, K. L., Paulus, P. B., Roland, E. J., Yang, H. (2000).Cognitive stimulation in brainstorming/ Journal of Personality and Social Psychology, 79, 722–735.

Harkins, S.G., Latané, B.,Williams, K. (1980). Social loafing: Allocating effort or taking it easy? /Journal of Experimental Social Psychology, V.16, Issue 5, 457-465.

Hemlin, S., Allwood, C.M., Martin, B.R. (2008). Creative Knowledge Environments / Creativity research journal, 20(2), 196–210.

Heslin, P.A. (2009). Better than brainstorming? Potential contextual boundary conditions to brainwriting for idea generation in organizations/ Journal of Occupational and Organizational Psychology, 82, 129–145.

Kelly J.R., Karau S.J. Entrainment of creativity in small groups/ Small Group Research, 1993, 24, pp. 179-198.

Kerr, D.S., Murthy, U.S. (2009). Beyond brainstorming: The effectiveness of computer-mediated communication for convergence and negotiation tasks/ International Journal of Accounting Information Systems, 10, 245–262.

Kock, N. (2007) Media naturalness and compensatory encoding: the burden of electronic media obstacles is on senders/ Decision Support Systems 44, 175–187.

Kohn, N.W., Paulus, P.B., Choi, Y.H. (2011). Building on the ideas of others: An examination of the idea combination process/ Journal of Experimental Social Psychology, 47, 554–561.

Kohn, N.W., Smith, S.M. (2011) Collaborative Fixation: Effects of Others' Ideas on Brainstorming / Applied Cognitive Psychology, 25, 359–371

Lamm, H., Trommsdorff, G. (1973). Group versus individual performance on task requiring ideational proficiency (brainstorming)/ European journal of social psychology, 3, 361-387.

Litchfield, R.C. (2009). Brainstorming rules as assigned goals: Does brainstorming really improve idea quantity? / Motivation and Emotion, 33/1, 25–31. DOI: 10.1007/s11031-008-9109-x

Martindale, C. (1999). Biological bases of creativity. In R.J. Sternberg (Ed.), Handbook of creativity. Cambridge: Cambridge University Press, 137-152.

Mullen, B., Johnson, C., Salas, E. (1991). Productivity loss in brainstorming groups: A metaanalytic integration/ Basic and applied social psychology, 12, 3-23.

Nijstad B.A., Stroebe W., Lodewijkx, H.F.M. (2002). Cognitive stimulation and interference in groups: exposure effects in an idea generation task/ Journal of Experimental Social Psychology, 38, 535-544.

Nijstad, B.A., Stroebe, W., Lodewijkx, H. F. M. (1999). Persistence of brainstorming groups: how do people know when to stop/ Journal of Experimental Social Psychology, 35, 165-185.

Osborn, F.A. (1957). Applied imagination. New York: Shribner.

Paulus, P.B., Coskun H. (2011). Group creativity / In Encyclopedia of Creativity, Elsevier, 575-580. DOI: 10.1016/B978-0-12-375038-9.00111-4

Paulus P.B., Dugosh K.L., Dzindolet M.T., Coskun H., Putman V.I. (2002). Social and cognitive influences in group brainstorming: predicting production gains and losses/ European review of social psychology, 12, pp. 299-325.

Perry – Smith, J.E., Shalley, C.E. (2003). The social side of creativity: a static and dynamic social network perspective/ Academy of Management Review, 28, 89-106.

Plucker, J.A., Renzulli, J.S. (1999). Psychometric approaches to the study of human creativity// In R.J. Sternberg (Ed), Handbook of creativity. Cambridge: Cambridge University Press, 35-62.

Rietzschel, E.F., Nijstad, B.A., Stroebe, W. (2007) Relative accessibility of domain knowledge and creativity: The effects of knowledge activation on the quantity and originality of generated ideas/ Journal of Experimental Social Psychology 43 , 933–946.

Simonton, D.K. (2001). Creativity in personality, developmental, and social psychology: any links with cognitive psychology? //In T. Ward, S. Smith, & J. Vaid (Eds), Creative thought: an investigation of conceptual structures and processes. Washington, DC: American Psychological Association, 309-324.

Sternberg, J.R., Lubart, T.I. (1999). The concept of creativity: prospects and paradigms// In R.J. Sternberg (Ed.), Handbook of creativity, Cambridge: Cambridge University Press, 3-16.

Tennyson, R.D., Breuer, K. (2002) Improving problem solving and creativity through use of complex-dynamic simulations/ Computers in Human Behavior, 18, 650–668.

Ward T.B., Smith S.M., Finke R.A. (1999). Creative cognition// In R.J. Sternberg (Ed.), Handbook of creativity, Cambridge: Cambridge University Press, 189-211.

Williams, W.M., Yang, L.T. (1999). Organizational creativity// In R.J. Sternberg (Ed.), Handbook of creativity. Cambridge: Cambridge University Press, 373-391.

Sergey R. Yagolkovskiy
National Research University Higher School of Economics (Moscow, Russia)
Department of General and Experimental Psychology: Associate Professor;
Cognitive Research Laboratory: Senior Research Fellow;
E-mail: syagolkovsky@hse.ru; Tel. +7 (495) 709-65-67