Explanations for creativity

Shashank Sahu(sahus@iitk.ac.in)

Prof. Amitabha Mukherjee(amit@cse.iitk.ac.in)

Cognitive Science Project Report

April 18, 2013

Abstract:

This project supports the stochastic component of blind variation approach required in creative thinking, while giving evidence to prove that there must be the same mechanism or mechanisms in our brain for random behavior and creative thinking. For objective measurement of random behavior and creative thinking, The Mittenecker Pointing Test and The Torrance Test of Creative Thinking have been conducted respectively. Finally it has been shown that there is positive correlation between random behavior and creative thinking. The role of memory updation and cognitive inhibition in the process creative thinking and random sequence generation, is also discussed.

Introduction:

Creativity is defined as "the process of producing novel ideas which has some utility and they are non-obvious [1]." Campbell (1960) has given the theoretical model for the creative process, known as Blind variation and selective retention (also Darwinian model of creative thinking) [1]. This model has two stages, one is blind variation, and other is selective retention. The former stage can be done by either systematically or stochastically or with both [1]. In this experiment, I would study (on a rough scale) the correlation between random behavior and creative ability of an individual. Assuming that there is an insignificant roll of systematic blind variation in the creative thinking process. Intuitively, I suspect that there must be a positive correlation of random behavior and creativity, since our performance in both tasks decreases as we tend to converge to few comforting strategies (or categories) instead of frequently switching and creating new strategies (or categories).

What work has been done?

Underlying mechanism behind creative thinking is not yet discovered. Scientists have given various theories, but they do not have rigorous empirical evidence to support it or their theory is unsuccessful in explaining the various questions (main questions: role of intelligence, domain expertise) related to creativity [2]. The study conducted by William Bains concludes that random sequence generation is a "basic" function of the human mind, even if this sequence may not be mathematically "random" [3]. He supports his argument by analyzing the effect of intoxication and language in random number generation task. He also argues that mechanism behind random sequence generation and creation of novel idea are correlated. This argument is supported by two observation. One is, random sequence generation appears to be sensitive to neuropsychological conditions that are assumed to influence executive processes [4], in a same way creativity is also

associated with mental disorders [5]. Other argument is, creativity and random behavior is not affected by mild intoxication [3, 6]. Based on my present knowledge, I am not familiar with any such experiment of finding the correlation between objective measurements of creativity and random behavior.

Objectives:

Objective of this experiment is to find the correlation between a person random motor behavior and his creativity. Random motor behavior can be tested using The Mittenecker Pointing Test [7]; and to measure person's creativity subset of The Torrance Test of Creative Thinking [8] is used.

Methodology:

The Mittenecker Pointing Test (MPT)

Objective measurement of random behavior of a person can be done by asking him/her to dictate a random sequence (of letters or numbers) or using his/her random motor behavior. In the present project I would be using the Mittenecker Pointing Test (MPT) because it has advantages over dictation of random sequence [7]. If participants were asked to dictate a random sequence of number or letters then because of their pre-existing individual preferences, or their aversions to certain numbers or letters, or by the frequency of occurrence of letters or number in their daily language (e.g. 'e' is more common than 'j' or 'z') [9] will affect the randomness of generated sequence. But random motor generation is not biased in this way, since in contrast to numbers or letters, the relative frequencies of selected (unlabeled) keys are virtually equal for healthy individuals [10]. MPT has another advantage over dictation of random sequence. The advantage is that MPT is capable of reducing memory load and attentional demand. Since subjects do not have to recall range or previously dictated number which decreases the spontaneity of subject to generate random sequence [7]. Because of lack of spontaneity subject may keep using comforting newly developed selection strategies repeatedly.

In MPT, participants are instructed to press the one of nine unlabeled keyboard keys with their both hands (or with their one hand but this test would be completely different) in a sequence as random as possible. This data was then analyzed by the MPT software program, which gives various parameters related to randomization behavior. In present experiment, I have only used those parameters which measures mandatory cognitive ability of a healthy individual. These parameters are following.

Symbol redundancy (SR): This parameter refers to the inequality of the relative frequencies of chosen keys. Mathematically, SR can be defined as the complement of relative entropy [7]. If redundancy is minimal then series approximates randomness or maximal disorder. Latent variable analysis suggests that it is related to the memory-updating component of random sequence generation [11].

Context redundancy (CR): This parameter reflects the extent to which responses are continuously influenced by previously chosen alternative. If we consider doublet, triplet, quartet, quintet, sextet, septet etc. as a one entity then complement of their relative frequency is defined as CR [7]. CR can be of various types, depending on the how many symbols we are including in one entity. In this experiment I would be using complement of relative frequency of duplet as context redundancy. This formula is similar to Tulving (1962) formula [12], which was adapted by Evans (1978), who defined it as the *random number generation score* [13]. This parameter is indicator of the efficiency of

inhibitory processes [14]. It has also been confirmed that higher context redundancy score is related to restricted cognitive flexibility [7].

Median of repetition gap distribution (MdG): If we define gap length associated with 'x' key as the number of pressed keys between pressing the 'x' key twice, then median of the frequency distribution of repetition distance is called MdG [7]. This parameter is low in those individual who have strong tendency to repeat their responses in short intervals. This parameter is also attributed as the memory-updating component of random sequence generation [11].

Lateral preference : Keyboard has "3", "5", "D" and "V" keys on the left side, and "9", "P", "J" and "." keys on right side. So lateral preference is defined as the division of difference by sum of frequency of pressing keys on the left side and the frequency of right side [7]. $\mathrm{LQ} = \frac{f_L - f_R}{f_L + f_R}$. This score tells us about the hemispherical attention of an individual.

The Torrance Test of Creative Thinking (TTCT)

In the present experiment, I would be using most widely used The Torrance test of Creativity (TTCT) for objective scoring of creative thinking [8]. This test is based on Guilford's model [8]. Although this test measure only one component, that is divergent thinking. But they claim to predict creative performance generally [15]. The Torrance tests have two forms, TTCT-Verbal and TTCT-Figural. Former is a verbal task, which includes activities like ask-and-guess, product improvement, unusual uses, unusual questions and just suppose. Latter is a drawing kind of task, and it consists of activities like picture construction, picture completion and repeated figures of lines or circles [8]. Time duration for this task is 90 minutes. To reduce this time period, I had only considered five activities which was supposed to be done in fifteen minutes, (considering three minutes for each activity. Designed TTCT-Verbal and TTCT-Figural form is given in the appendix of this report.

Measurement process [16]

Suppose N responses were given for a particular question. Now an expert would categorize these responses based on identification of common features. Let's say $u_1, u_2, u_3 \ldots u_c$ respectively the number of responces offered for category 1, 2, 3, 4 and c. Then creativity quotient (CQ can be defined as

$$CQ = \log_2(1 + u_1)(1 + u_2)(1 + u_3) \ldots (1 + u_c)$$

I gave final creative thinking score as sum of CQs corresponding to all activities included in the test.

Experiment:

This Experiment was conducted on ten healthy children of class five students which includes five boys and five girls. Their average age were ten years with standard deviation of 5 months. Everyone in my experiment was right handed. I instructed every participants individually about the questions, since I wanted to make sure that everyone understands the question properly. I was unsuccessful in equally motivating everyone.

Experiments begins with allowing them to write on TTCT form. It takes around 15 minutes to complete this test. For their ease and constant attention, I gave them few sample answers (which I am not supposed to do at all [8]). I also told them that if you include sample answer as your answer then it will not be evaluated. So I think giving sample answer was the price which I paid to get their interest and attention.

Then I asked participants to give their random behavior test. In this test participants were instructed to press one hundred twenty eight unlabeled keys from the keyboard. I also had suggested to choose a comforting pace (1 key per second) to press keys. I asked them to use their both hands to press the keys, because it may tell us about most active hemisphere of the brain. Each participant had generated two random sequence of one hundred twenty eight symbols. At the end of experiment, I gave some goodies to them, thanking for their efforts and attention.

Results

	Symbol Redundancy	**Context Redundancy**	MdG	**Lateral Preference**	Final CQ
Average for all	0.00806	2.61	8.08	-0.0669	21.7
Standard deviation	0.00415	0.063	0.54	0.0614	3.32
Average for girls	0.0087	0.235	8.08	-0.0725	**22.2**
Average for boys	0.0083	0.269	8.17	-0.0724	**20.4**

To find the correlation of Creativity Quotient and Random behavior of a person, have plotted CQ against various parameter of randomness. I have also fitted a linear model.

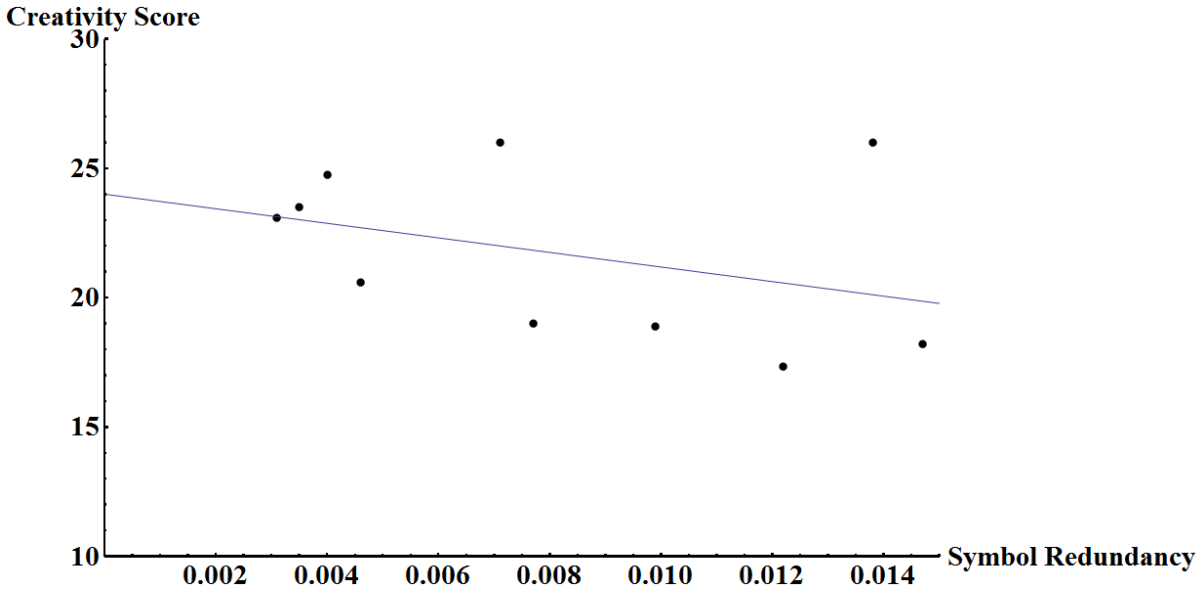


Figure 1. Plot for Symbol Redundancy (a parameter for measuring randomness) vs. Creativity Score with a linear model fit $24.0 - 281.6x$

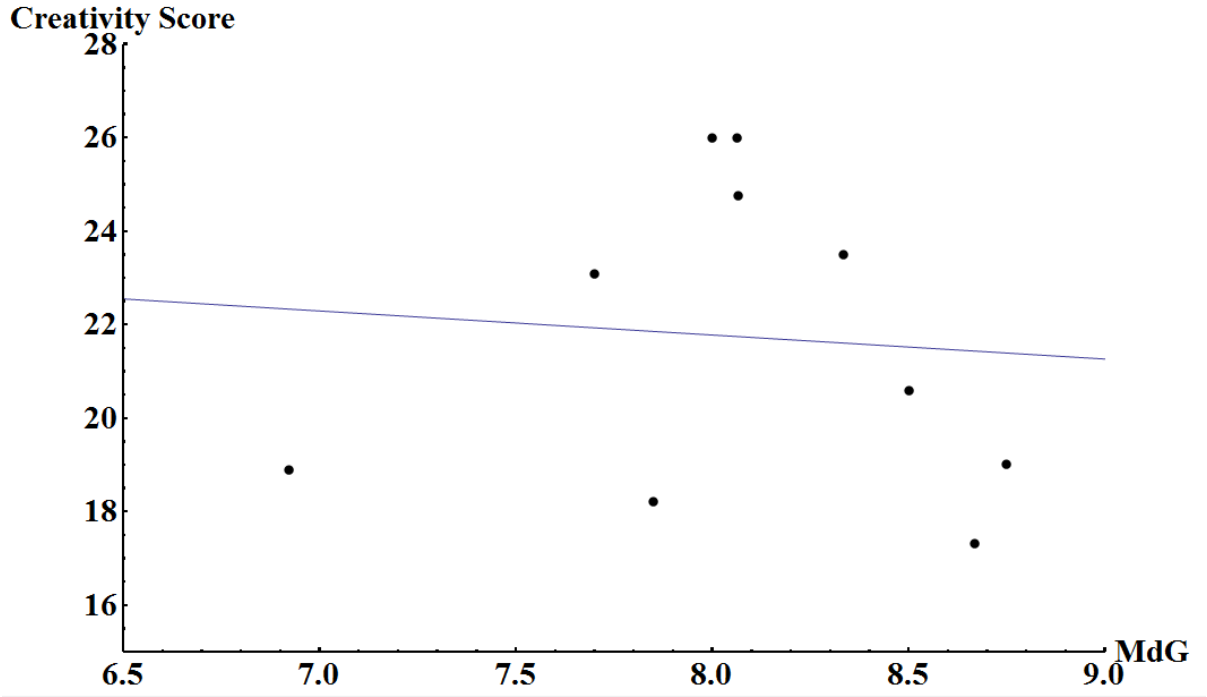


Figure 2. Plot for Median of repetition gap distribution ((MdG)a parameter for measuring randomness) vs. Creativity Score with a linear model fit $25.9 - 0.51x$

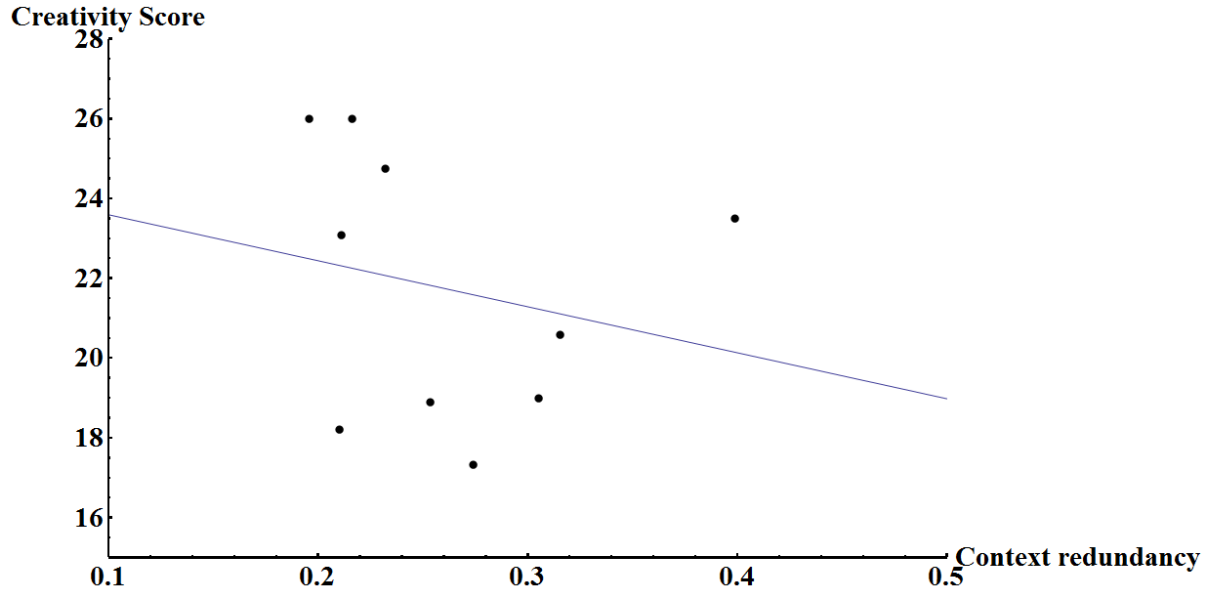


Figure 3. Plot for Context redundancy ((CR)a parameter for measuring randomness) vs. Creativity Score with a linear model fit $24.7 - 11.5x$

Discussion

Results are not as good as expected, but they definitely show the decrease in creativity quotient as redundancy parameters increases (it means decrease in randomness). The reasons for poor quality of these data may be that my assumption, that systematic blind variation is insignificant, is not completely true. Or, it may possible that participants were lucky to correlate it with their recently learned things. Since I had conducted this test on children, so it might possible that they may not fully understand these questions because of shyness or ego to be self-sufficient. I also had problem in measuring random behavior because it was not possible for me to restrict participants to press keys at instructed pace (one key per second). As it is well known that increased response rate decreases the random generation performance, so it might have significantly affected my data [17]. Choosing only the subset of TTCT to conduct it in minimum time, might have given me something else other than CQ. Since it is also controversial that how the set of questions of divergent thinking can give the measure of creativity [8].

As it is mentioned earlier that SR and MdG is related to the memory updation and CR is related to efficiency of inhibitory process [7, 11 and 14]. Based on data obtained, it can be said that cognitive inhibition helps person to generate creative ideas. Cognitive inhibition assists creative thinking because it helps an individual to switch to new strategy or category by inhibiting the dominant and comforting strategy or category. There is no doubt that memory updation will not assist creative thinking because an individual must remember the train of his/her previously generated ideas to give a new improved idea.

I have also measured the Lateral Preference parameter of participants, which is the measure of hemispherical attention. This parameter was negative for nine out of ten individuals, which means that most of the time, they were using there right hand to press the keys. Since all the participants were right handed and they were instructed to use there both hands to press the keys. So it cannot be firmly said which brain was more attentive during the given task. Another experiment can be performed to test which hand is better in producing a good random sequence. This would confirm association of random behavior with particular side of brain. According to right-brain dominance theory, the right side of the brain is good at creative thinking. [18] So, if right hemisphere is also good at random behavior, then it will support the hypothesis that there is common mechanism for creative thinking and random behavior.

In this experiment, equal number of boys and girls have participated. According to the obtained that there is no significant role of gender difference in random behavior or creativity.

The objective of the present project is to look the correlation between random behavior and creative thinking and to support the stochastic component of blind variation approach during creative thinking. Finally, I have found the positive correlation, irrespective of quality of data. I am not able to say anything about which hemisphere of the brain was more active during these activities.

Conclusion

Obtained data clearly shows a decline in creative performance as his/her randomness decreases. This evidence can support the hypothesis that random behavior and creative thinking are governed by same intrinsic mechanism or mechanisms. So hypothesis behind stochastic component blind variation process of Darwinian model of creativity cannot be completely wrong. The same data also

implies that memory updation and cognitive inhibition assist creative thinking. I also found that there is no gender biasing for the random behavior or creative thinking on an individual.

Acknowledgements

I am very thankful to prof. Amitabh Mukherjee for personally assisting me to pursue a project of my interest. I also apologies for my mistakes, ignorance of his advices and not performing as per his expectations. I am thankful for principal of campus school Mrs. Achla Josan to help me collect data required to conduct this experiment. I am thankful to every participants of my experiment for their interest and attention. I thank my all friends for listening to my ideas and giving me relevant suggestions to improve it.

References

[1] Simonton, Dean Keith. "Creativity and discovery as blind variation: Campbell's (1960) BVSR model after the half-century mark." Review of General Psychology 15.2 (2011): 158-174.

[2] Kaufman, James C., and Robert J. Sternberg, eds. The Cambridge handbook of creativity. Cambridge University Press, 2010.

[3] Bains, William. "Random number generation and creativity." Medical hypotheses 70.1 (2008): 186-190.

[4] Spatt, J., & Goldenberg, G. (1993). Components of random generation by normal subjects and patients with dysexecutive syndrome. Brain and Cognition, 23, 231± 242.

[5] Preti, Antonio, and Paola Miotto. "Creativity, Evolution and Mental Illnesses." Journal of Memetics-Evolutionary Models of Information Transmission 1 (1997).

[6] Berglas, S., and E. E. Jones. "Control of attributions about the self through self-handicapping strategies: The appeal of alcohol and the role of underachievement." Personality and Social Psychology Bulletin 4.2 (1978): 200-206.

[7] Schulter, Günter, Erich Mittenecker, and Ilona Papousek. "A computer program for testing and analyzing random generation behavior in normal and clinical samples: The Mittenecker Pointing Test." Behavior research methods 42.1 (2010): 333-341.

[8] Kim, Kyung Hee. "Can we trust creativity tests? A review of the Torrance Tests of Creative Thinking (TTCT)." Creativity research journal 18.1 (2006): 3-14.

[9] Kuhl, J., and W. Schönpflug. "Ordnungsverhalten, Lärmbelastung und Persönlichkeit." Psychological Research 37.2 (1974): 143-176.

[10] Mittenecker, Erich. "Die Analyse" zufÃ¤ lliger" Reaktionsfolgen." Zeitschrift fÃ¼r Experimentelle und Angewandte Psychologie (1958).

[11] Miyake, Akira, et al. "The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis." Cognitive psychology 41.1 (2000): 49-100.

[12] Tulving, Endel. "Subjective organization in free recall of" unrelated" words." Psychological review 69.4 (1962): 344.

[13] Evans, Frederick J. "Monitoring attention deployment by random number generation: An index to measure subjective randomness." Bulletin of the Psychonomic Society (1978).

[14] Herzog, G. R. "Die Zufallskonzepttheorie: Experimente zur Vorstellung vom Aufbau von Zufallsreihen." Zeitschrift für experimentelle und angewandte Psychologie 36.2 (1989): 199-220.

[15] Plucker, J. A., & Runco, M. A. (1998). The death of creativity measurement has been greatly exaggerated. Roeper Review, 21(1), 36–39.

[16] Snyder, Allan, et al. "The creativity quotient: an objective scoring of ideational fluency. Creativity Research Journal 16.4 (2004): 415-419.

[17] Hamdan, Amer C., Juberty A. de Souza, and Orlando FA Bueno. "Performance of university students on random number generation at different rates to evaluate executive functions." Arquivos de neuro-psiquiatria 62.1 (2004): 58-60.

[18] http://psychology.about.com/od/cognitivepsychology/a/left-brain-right-brain.htm

Appendix 1.

Torrance Tests of Creative Thinking—Figural and Verbal

Directions: Do not begin until you are told to do so.

- Try to think of things that no one else will think of.
- Try to think of as many ideas as possible.
- Add details to your ideas to make them complete.
- If you finish before time is up, you may continue to add details or sit quietly.
- Please do not go to the next activity until told to do so.

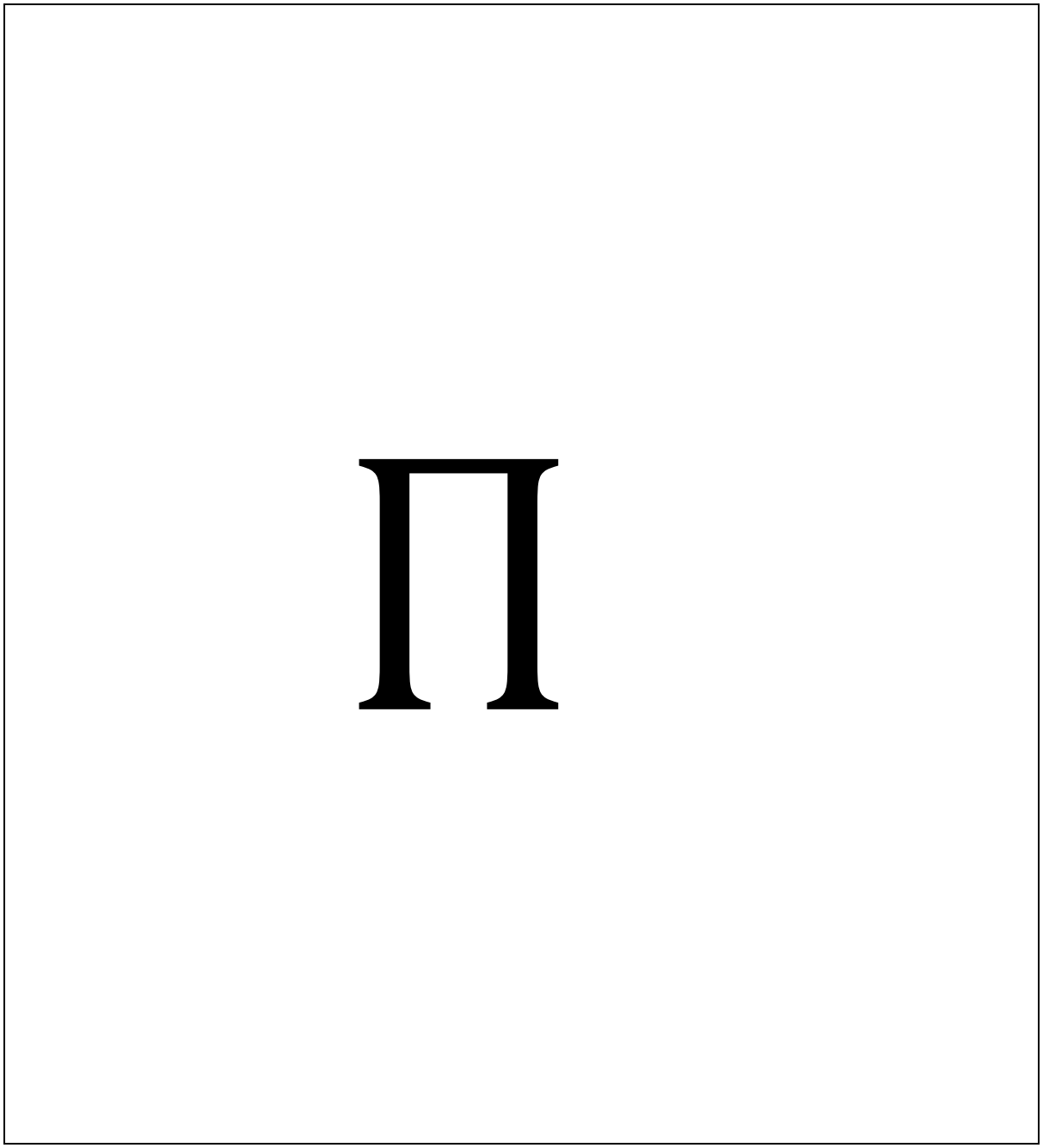
ACTIVITY 1: Try to improve this stuffed toy rabbit so that it will be more fun to play with. You have 3 minutes.

Image source: http://pics5.this-pic.com/image/cute%20dog%20toys

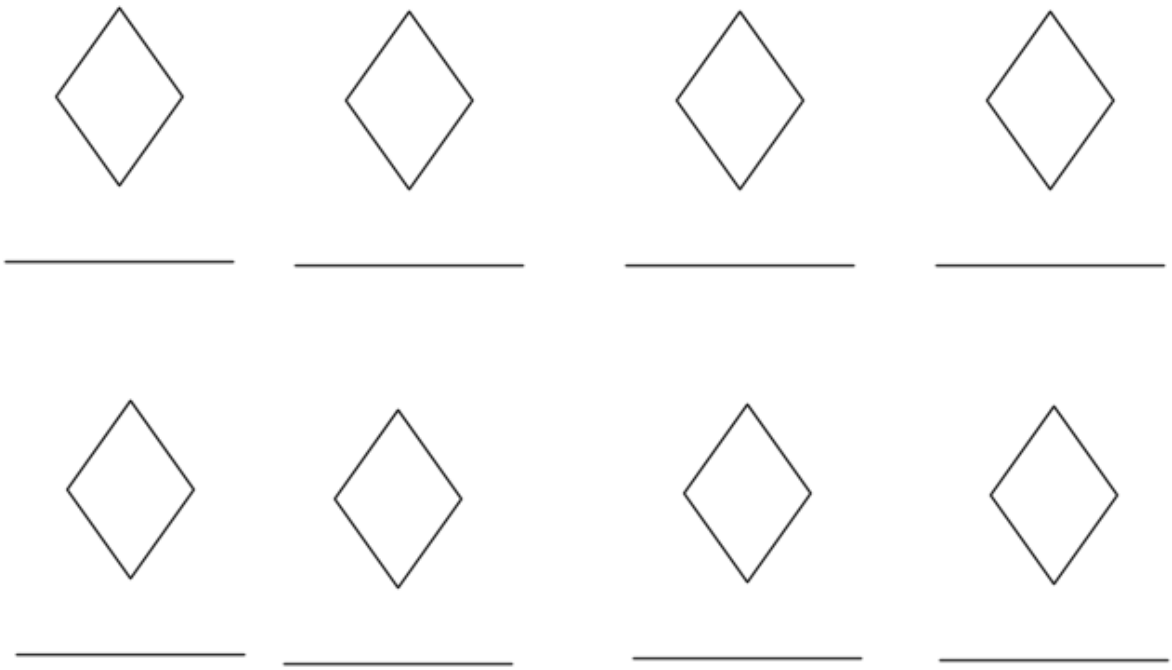
ACTIVITY 2: Just suppose that you are magician. What might be some things that would happen as a result? You have 3 minutes

ACTIVITY 3: What are the maximum number of unusual uses of your pencil? You have 3 minutes

ACTIVITY 4: Add lines to the incomplete figures below to make pictures out of them. Try to tell complete stories with your pictures. Give your pictures titles. You have 3 minutes.



ACTIVITY 5: Add details to the shapes below to make pictures out of them. Make the diamond a part of any picture you make. Try to think of pictures no one else will think of. Add details to tell complete stories with your pictures. Give your pictures titles. You have 3 minutes.



Name: _____

Class: _____

Gender: _____

Date of Birth: _____

Dominant hand: _____

You have done your Test,

Best of luck.