Journal of Literature and Art Studies, August 2017, Vol. 7, No. 8, 1039-1053
doi: 10.17265/2159-5836/2017.08.013

# A Variation Account of Divergent Thinking

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A variation account was applied to divergent thinking accommodated as a kind of creative thinking. To provide control (contrast) condition the variation account was applied to psychometric intelligence. Guilford's (1956, 1967, 1988) theory of divergent—convergent thinking served the background of our study. The main premise was that creative variation represents "thought trials" with diverse ways to find a solution to the problem. Task demands and the respective creative problem solving reveal advantageous sources that suggest the variation. Probably, uncertainty, information search, and finding alternatives extracted from memory precede, entail and provide variety of seeking, as well. A principal hypothesis to be tested was that divergent thinking enables its variation rather than intelligence does that to its variation. As predicted, the divergent thinking and its variation were related. Compared to uncreative, creative persons were characterized by larger variation. Apart from the mathematical intelligence, other kinds of intelligence and their variation did not correlate. Mainly, the data obtained, thus, lend support to the claimed hypothesis.

*Keywords:* variation, creativity, divergent thinking, intelligence, scattering

## Introduction

The notion of creativity is pervasive. It is applied everywhere and brings various connotations. In a socio cultural context, for instance, narratives, poetry, dance, music, myths, and metaphor are among the creative endeavors (e.g., Iezzi, 2013; Mack, 2012; Pinker, 2003; Spalva, 2013). In this study, creativity is developed in another context. It is bearing in mind creativity with its own values based on the individual and cognitive ground.

In this view, of great importance is whether there is only one creative process or are there many. Basically, a main assumption is that the human mind is not a unitary. Rather it involves multidimensional aspects and this claim concerns the creativity. With this perspective, a closer look at the variation of creative thoughts and the relationships between divergent thinking and its variation are in order.

Surprisingly, there has been a few of parsimonious theories that explain the origin and manifestation of the relationship between divergent thinking and its variation. The cause of this neglect may be referred in part to the historical background of the constructs or, more particularly, to problems with their comprehending. Therefore there is some empirical uncertainty to what extent divergent thinking and its (creative) variation can be associated and if so, in what direction they ought to be, that is increased or, vice versa, decreased.

A reasonable framework hinting at possible basis of this issue traces back to Joy Paul Guilford (1950, 1956, 1967) when he specified creativity as an underlying area of psychological research, proposed to capture creativity as divergent thinking, and distinguished between divergent and convergent types of creative problem

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solving. Every person can be different from the other by the way he thinks, feels, or act. Divergent thinking is a thought process or method which demonstrates generating creative ideas by various ways. Typically, it occurs in a spontaneous, free-flowing manner, such that many ideas are generated in a random, unorganized fashion. As a result, many solutions are possible. Guilford thus associated divergent thinking with creativity. Convergent thinking is in contrast with divergent thinking. The former is the ability to apply rules; it follows a particular set of logical steps to arrive at one solution, which in some cases is a "correct" solution. Thus, the convergent thinking is systematic; it is oriented towards deriving the single best (or correct) answer to a clearly defined question at hand. Guilford's approach, then, indicates that creative thinking as measured by divergent thinking tests is not the same as intelligence when it is considered and measured as convergent thinking. A crucial question in creativity research has been to what extent divergent thinking may be delineated from convergent thinking. Besides, experts agree that within the psychometric study of creativity divergent thinking is the most promising candidate for taking into account creative ability (e.g., Plucker & Renzulli, 1999; Runco, 2007; Silvia et al., 2008).

Adopting the concept of divergent thinking as it is articulated by Guilford (1967) seems appropriate to study relations between creative thinking and its variation. Diverse ideas lead to divergent thinking, yet diverse ideas and their relationships are the ground of creative variation. This is a special kind of thoughts. They pertain to creative variation due to divergent thinking and relationships of diverse ideas operate in a shared way. Actually, they supplement one another but not merge. Surprisingly, we did not find direct quantitative studies whether divergent thinking and thought variation are related.

The current study is intended to investigate whether divergent thinking links to its variation. To provide a contrast, the variation basis of psychometric intelligence was also investigated. Still, the variation basis of creativity would seem promising and fruitful due to it opens the door for complemented knowledge of how creative thinking operates as such.

## Background

Despite some theoretical thrusts took place, there actually have been very few studies that attempted to construct a theory of relations between creativity and its variation. Nevertheless, several theories of creative variation appear to be noteworthy. Their efforts have been encouraged to some extent to highlight latent routs of creativity and its variation. We briefly refer to theories proposed by Campbell (1960, 1974), Simonton (2013), Martindale (1995, 1999), Eysenck (1995), and Csikszentmihalyi (1997).

### Campbell—Simonton Model

Of special relevance here is Campbell's (1960, 1974) account. He proposed the theory that creativity requires blind variation and selective retention (BVSR). Simonton (2013) engaged in developing own elaborations and extensions of the BVSR model. Eysenck (1993, 1995) termed them the "Campbell—Simonton model." As Simonton (2013) put it, Campbell (1960) focused on "thought trials." The variations are blind to the extent that the creator cannot completely anticipate and estimate what idea will appear; work and what will not, what idea will succeed and what will fail. Purely by chance, some random idea could suggest a creative solution to the problem. In this case, the thought will be retained or remembered. The selective retention results in that fit ideas would be extracted, held and remembered. The BVSR model suggests that the variation procedure would operate according to the several processes rather than consists in one process. Simonton (2013)

argues that a variant set of the ideas are first described via three parameters: (a) the idea's initial probability of generation; (b) its final utility; and (c) any prior knowledge of its utility value.

**Martindale's Theory**

Martindale (1995, 1999) wondered if Campbell's theory explains why chance favors creative ideas. A purely random searching leads to many casual ideas. It is less probable to discover a creative idea among them. Although Campbell's (1960) theory attempted to explain how creative ideas arise, it does not shed much light on the psychological processes involved. Martindale (1995, 1999) proposed to put forward Campbell's theory into neural-network terms. A neural network model suggests that each node receives "informational" input from other nodes and nonspecific input from the arousal system (Martindale, 1995). Behavior and cognition vary when arousal decreases and more nodes to be activated. The connection strength between them would be also increased. On the contrary, when arousal increases minor nodes arise in an activated state. Then behavior and cognition turn to be more stereotyped. Martindale (1995) argues that creative people are in general more variable in their level of arousal.

Based on arousal, Martindale (1995) has been developed the assumption of creative variation in several but intersecting areas. First, he drew attention to Kris's (1952) claim that creative variation emerges along the secondary process—primary process continuum. Primary process thinking is analogical, autistic, and free associative. Secondary process thinking is abstract, logical, goal oriented, and reality oriented. According to Kris, creative inspiration is possible when a movement toward a primary process state of mind arises. It makes the discovery of new combinations (creative ideas appear) more likely because primary process thinking is associative. Creative elaboration or verification involves a movement toward secondary process thinking because it is abstract and logical. Martindale (1995) points out that the primary process—secondary process continuum may be thought of as the main dimension along which consciousness varies. Creative people are more variable to alternate between primary process and secondary process cognition than are uncreative people.

Second, attention has been emphasized an area of creative variation. This idea is derivative from the contention that more nodes can be simultaneously activated in creative people than in uncreative people. Then the total number of elements in consciousness of creative people ought to be greater as compared to less creative people. The total number of elements in consciousness produces a ground of variation between them. But creative variation relies on a task demand, as well. A state of defocused attention would enable to explore more concepts to select fit creative ideas. In contrast, when they are relatively unambiguous, a state of focused attention would enable for further inspection, discarding unrelated concepts (Martindale, 1989, 1995).

Recent experiments demonstrate that in creative people attention fluctuates rather than stands as a stable trait. Creative people are better at adjusting their attention as a function of task demands. For instance, the greater a person's creative potential the faster reaction times was on a simple task not involving interference (the concept verification task). But the slower reaction times was on a task requiring interfering information (the negative priming task) (Dorfman et al., 2008; Vartanian, 2009; Vartanian, Martindale, & Kwiatkowski, 2007).

Third, Martindale (1999) has hypothesized that creativity is a cognitive disinhibition syndrome. Descriptively, it shares many similarities with primary process cognition (Kris, 1952; Suler, 1980). Within an associationist or connectionist framework, cognitive disinhibition concerns with a cognitive network within which activation can either spread along several nodes, or remain restrained to a single region (Martindale,

1995). Cognitive disinhibition is either analogous to the spreading of activation along a wide associative horizon. Vartanian, Martindale, and Kingery (2002) revealed cognitive disinhibition conceptually along two lines. First, it is free-floating, and thoughts are allowed to go where they may. A creative person is able to some extent to move from one idea to another as well as to immerse in a single thought. Basically, the cognitive disinhibition provides a variation of thoughts. They are possible within a state of defocused attention, low cortical arousal, and a flat associative gradient. Second, cognitive disinhibition is associated with a continuous rather than a categorical distinction between primary and secondary process modes of thinking. Variation takes place between them as well. Then, cognitive disinhibition leads to a variation of thoughts which facilitate creative thinking.

**Eysenck's Approach**

Eysenck (1995) has used the associationistic approach to creativity, according to which a creative idea results from the novel combination of two or more ideas that previously have been isolated (Spearman, 1931). Eysenck (1995) stated, in part, the theory of creativity to be developed as follows: (1) All cognitive endeavors require new associations to be made, or old ones to be reviewed; (2) Speed in the formation of associations is the foundation of individual differences in intelligence; (3) Individuals differ in the range of associations considered creative in problem-solving; (4) Wideness of range reveals individual differences in creativity; (5) Wideness of range and speed of forming associations are, in principle, irrespective, suggesting that creativity and intelligence are essentially independent; (6) Genuine creativity requires: (a) a large pool of elements to form associations, (b) speed in producing associations, and (c) a comparator to eliminate false solutions. Our suggestion is that Eysenck (1995) has actually shown essential distinctions between creativity and intelligence because the former deals with most a variation of associations whereas the latter with speed of forming associations.

**Csikszentmihalyi's Account**

Csikszentmihalyi (1997) attempted to provide a personality basis for creative variation. His claim was that creativity is the property of a complex system, and none of its components alone can explain it. Instead of being an "individual," creative personality is a "multitude." He or she tends to bring together the entire range of human possibilities within him- or herself. Thought and action of creative personality display contradictory extremes that in most people are segregated. A complex personality does not imply some position at the midpoint between two poles. Rather one can observe the ability of the complex personality to shift from one pole to the other without inner conflict but with respect to the circumstance requires.

Csikszentmihalyi (1997) illustrates this claim presenting a list often pairs of apparently antithetical traits: (1) Creative person has a great deal of physical energy, but he or she is also often quiet and at rest; (2) Creative person tends to be smart, yet also naïve; (3) The combination of playfulness and discipline, or responsibility and irresponsibility takes place; (4) Creative person alternate between imagination and fantasy at one end, and a rooted sense of reality at the other; (5) Creative person displays features of extroversion and introversion; (6) Creative person is remarkably humble and proud at the same time; (7) In all cultures, creative men are brought up to be "masculine" and to disregard and repress those aspects that the culture regards as "feminine," whereas women are expected to do the opposite; (8) Creative person is thought to be rebellious and independent; (9) Creative person appreciates his or her work, yet he (she) is objective about it; (10) Finally, the openness and sensitivity of creative person often demonstrates him (her) to suffering and pain yet also a great deal of enjoyment.

## The Present Study

The objective of the present study is to investigate whether creative thinking correlates with its variation. The former is framed in reference to the divergent thinking as it was propounded by Guilford (1956, 1967, 1988). In turn, the variation is taken into the intra-individual account rather than inter-individual one. This within-person variation takes a form of systematic fluctuation. Either, it is situation-induced and/or intraindividual-derivative rather than time-dependent (e.g., Brown, Wood, & Chater, 2012; Eid & Diener, 1999; Woolley & Doupe, 2008; Wu et al., 2014).

We place great importance on three crucial questions. First, the clarification and therefore articulation of creative variation is necessary. Second, the divergent thinking will be considered with their possible new theoretical meaning. Third, the relative paucity of empirical evidence sharpens the problem of how to bring together divergent thinking and its eventual variation. Identifying feasible answers to these questions is an important step towards clearing the ground on which further study of the relationship between divergent thinking and its variation can be raised.

### Creative Variation

How to understand a variation within the creativity framework? Commonly, variation (variability) is ubiquitous and from a theoretical view point can be seen in several facets. The occurrence of mind or behavior demonstrates more than one distinct form. It is either shown that some features are capable of being changed, although typically within certain limits. Any characteristic of human beings involves the range of possible values and polar extremes of phenomena or traits lead to an emergent field within which a person migrates among them. In statistical terms, one can say that variation is data points that diverge from the average, as well as the extent to which they differ from each other. Despite of simplified, all these meanings of variation are worth if we intend to find further measures that can readily pertain to creative variation (e.g., Dorfman & Baleva, 2014).

The *creative* variation cannot be reduced to any variation. For instance, from the perspective of personality development, variation has meaning of change or stability of a person over time (e.g., Brown, Wood, & Chater, 2012). This kind of variation does not refer to the proper creative variation. The latter would be treated a kind of variation and, then, there is a reason to allocate it in a separate category. We underlay the creative variation on the premise that reflects the mind's ability to explore different configurations of thoughts looking for a solution facilitating task demands. They represent "thought trials", as Campbell (1960) and Simonton (2013) emphasize, and would entail a variation as ways intended trying to find a solution to the problem. Task demands and the respective creative problem solving reveal advantageous sources that suggest a variation (e.g., Vartanian, 2009). To our knowledge and experience, uncertainty, information search, and finding alternatives extracted from memory precede, entail and provide variety of seeking. Actually, previous findings indicate high-variability when exploration requires learning a novel task (e.g., Woolley & Doupe, 2008; Wu et al., 2014).

### Divergent Thinking

One can find another elaboration of variation in Guilford's (1956) classic theory of divergent—convergent thinking. As compared to convergent thinking, divergent thinking is characterized by various directions of thoughts and no a unique judgment can be exhaustive.

From this standpoint, an old controversy of how creative thinking and intelligence relate comes to mind. Conceptually, this problem can be viewed in terms of divergent and convergent thinking as Guilford (1956, 1967) put it. One can raise the question whether the variation of divergent thinking and the variation of intelligence

differ. Conversely, if the divergent thinking and the intelligence are closely interwoven as Sternberg (1999) indicates, then, variation of both divergent thinking and intelligence are to be shared.

Adopting the concept of divergent thinking as it is articulated by Guilford (1967) seems appropriate to study relations between creativity and its variation. Certainly, divergent thinking is neither synonymous with nor sufficient for creativity. Divergent thinking is a kind of creative thinking, but the latter extends the former (e.g., Runco, 2008). Divergent thinking is the ability to generate many diverse ideas in various paths (e.g., Runco, 2008). Then, it would, at least theoretically, correspond to variation.

We assume that divergent thinking and variation differ yet can be separated into two distinct categories. Diverse ideas and paths where they go yield the ground of divergent thinking as such. The ground of variation is extended. Both diverse ideas and their relationship sought to be taken into account. They pertain to creative variation due to divergent thinking and relationships of diverse ideas operate in a shared way. Actually, they supplement one another but not merge (e.g., Dorfman, 2016). Surprisingly, there is no direct quantitative evidence whether divergent thinking and thought variation are related.

**Relationship Between Divergent Thinking and Variation**

Imagine that ideas possess a shared mental space but distinct places (e.g., Gärdenfors, 2000; Lefebvre, 1991; Malpas, 2012). Each idea aspires looking for own place. Even if several ideas collide in the same place, the latter can evidence of its importance to hold an idea in a separate place. But most often ideas disperse and jointly can be seen as shared space. Distances between diverse ideas would appear demonstrating the extent to which their discrepancy arises. Apart from that, diverse ideas and distances between them taken together can indicate a volume of their shared space.

Notice, one can study the divergent thinking ignoring variation, but it is hardly possible to examine the variation of thoughts by passing their divergence. The former supplements the latter without their blending so that the variation of thoughts is based on their number. Theoretically, divergent thinking would bring its variation but not in reverse. Besides, the metric of divergent thinking and variation differ, one is based on quantity, another on range and standard deviation.

A special point is whether divergent thinking and variation of thoughts can be related. As compared to uncreative people, we propose that creative people reveal the greater diverse ideas and the larger their variation. Divergent thinking and variation are not identical. Actually, they ought to differ but link one another.

**Tasks and Research Hypotheses**

The main premise was that creative variation represents “thought trials” with diverse ways to find a solution to the problem. The task of this study was to investigate a variation account of divergent thinking. To provide a control (contrast), another task was to examine a variation of intelligence. The third task was to compare the variation of divergent thinking and the variation of intelligence.

Basically, we focus on Guilford’s (1956, 1967) theory. A starting point was to extend the notions of divergent thinking and convergent thinking with respect to a variation criterion. We contend that the key feature of divergent thinking refers to its variation. On the contrary, the variation of convergent thinking (intelligence) would be seen of some other kind as compared to the variation of divergent thinking.

Applying assumptions mentioned above, three guiding hypotheses to be tested were developed. The first hypothesis stated that divergent thinking enables variation. As compared to uncreative, creative persons would be characterized by larger variation. The second hypothesis stated that no shared variation appears across

intelligence categories. The third hypothesis stated that the variation of divergent thinking and the variation of intelligence do not correlate.

Specifically, it was suggested that scores of divergent thinking and variation correlate positively. The greater scores of divergent thinking occur, the larger distances between thoughts arise. Creative people (with greater divergent thinking scores) would be more flexible than noncreative people (with less divergent thinking scores) in their variation.

## Method

### Participants

Raw data were gathered from a Russian sample consisting of 211 volunteer participants recruited from Perm city high schools. Because of missing data and lack of participation in different aspects of the study, 17 participants (8.06%) were removed from subsequent analyses. The current results are based on raw data from 194 participants (75 boys and 119 girls). Their age ranged from 15 to 17, M = 15.36, SD = 54. The participants received no reward or compensation for taking part in the experiment.

### Materials and Procedure

The participants completed tests of divergent thinking and psychometric intelligence in a number of group sessions.

### Paper-and-Pencil Tasks

The paper-and-pencil tasks included psychometric measures of divergent thinking and intelligence.

### Divergent Thinking

To assess divergent thinking, the participants completed the Alternate Uses Test (Wallach & Kogan, 1965). This test was adapted in Russian by Averina and Scheblanova (1996). The Alternate Uses Test involves generating as many uses as possible for three regular objects (brick, newspaper, pencil). The participants were allowed 3 min per object. The final data consisted of three scores. Fluency is simply the total number of uses generated across the three objects. It is the most common way of scoring the Alternate Uses Test (Plucker & Renzulli, 1999). Flexibility is the total number of categories from which the uses were drawn. The categories were defined according to a comprehensive list of categories suggested by Averina and Scheblanova (1996). Originality was scored according to the scheme offered by Dorfman et al. (2008). The rarest response receives the highest rank, and the most frequent the lowest rank. The final originality score was the total of the originality scores for each use provided by a participant. We standardized scores on each of the three measures of fluency, flexibility, and originality and then averaged across the three standardized scores to create a composite measure of divergent thinking for each participant.

### Intelligence

Intelligence was measured using the German IST-70 Test Battery (the Intelligence Structure Test) developed by Amthauer (1973) (see also van der Yen, 1992). The IST-70 was adapted in Russian by Senin, Sorokina, and Chirkov (1993). The IST-70 measures verbal, numerical and spatial (visuo-spatial) abilities. Verbal abilities included five subtests, namely, general knowledge, word grouping, word analogies, word-pairing, and memory. Numerical abilities consisted of two subtests, namely, arithmetic reasoning and numerical series. Spatial abilities were composed of figure matching and cubes subtests. The word-pairing subtest consisted of 16

tasks. Each of the remaining subtests consisted of 20 tasks. For each correctly performed task, the participant was given 1 point. Scores on these subtests as well as total IQ were computed for each participant.

**Creative Variation**

Creative variation can be put in a between-individual or within-individual context of measurement. They contrast with much work on human personality and individual differences (e.g., Brown, Wood, & Chater, 2012). For some reason, we preferred the within-individual measurement of variation. Sources of variation locate within the person, not between persons. Then, this sheds light on the individual ground of creative variation whereas its between-individual context is taken out of consideration.

Variation was conceptualized in a narrowed sense—as scattering of responses on task demands. Scattering was broadly defined as the numerous redirections of discrete thoughts. They are dispersing and separating, whereas the original direction of propagation did not matter.

Statistically, variation in the sense of scattering of responses was represented as dispersion. The standard deviation was chosen as a measure of scattering of responses. It usually represents a measure of spread for a distribution. We attached another meaning to standard deviation—a marker and measure of variation. A variation was assessed using within-person standard deviation scores (e.g., Eid & Diener, 1999; Epstein et al., 2011; Reckess et al., 2014). First, the standard deviation of fluency, flexibility, and originality variables across brick, newspaper, and pencil stimuli were estimated at each participant separately from the other participants. Then a new variable composed of the individual values of standard deviations was established for the whole sample and entitled "Variation." The greater score on standard deviation evidences the larger variation. And, vice versa, the low score on standard deviation shows the narrower range of variation.

Four scores of variation were established. First is the variation of fluency score. Second is the variation of flexibility score. Third is the variation of originality score and fourth, finally, the variation score across fluency, flexibility, and originality. In the same manner, the variation variables of intelligence were assessed. They referred to the verbal subtest scores, the numerical subtest scores, the spatial subtest scores, and the total IQ variation across all subtests scores.

The rational that will be shown further, a mean score of fluency, flexibility, and originality variables across brick, newspaper, and pencil stimuli were estimated at each participant separately from the other participants. Then a new variable composed of the individual values of above mentioned mean scores was established for the whole sample. To avoid confusion with routine means, the new variable was titled "Central tendencies". Similar to variation, central tendency variables were computed for fluency, flexibility and originality categories separately, as well as for divergent thinking overall. Correspondingly, central tendency variables were computed for the verbal subtests, numerical subtests, spatial subtests, and total IQ.

**Data Analysis**

To make an operational sense of variation, its three kinds of evidence criteria were examined this way: External evidence, structure evidence, and discrimination/cohesion evidence.

1. External evidence criterion. The mean score of divergent thinking category, as well as the mean score across divergent thinking categories was used as an external evidence criterion for the creative variation. If the scores of variation within divergent thinking categories or across them significantly correlated with respective mean scores, it was concluded that the variation refers to divergent thinking. If above mentioned correlations were not significant, it was concluded that no support brings the evidence in favor of the proper creative variation.

Instead, a random variation arises. It would be seen as irrelevant to the creative variation.

Specifically, correlations of variation and central tendency scores within the same category were carried out to detect the external evidence of variation. These computations were yielded for fluency, flexibility, and originality categories separately, as well as across divergent thinking overall.

Respectively, a mean score of intelligence subtest, as well as a mean score across intelligence subtests was used as an external evidence criterion for the intelligence. If the scores of variation within intelligence subtests or across them significantly correlated with respective mean scores, it was concluded that the variation refers to intelligence. If above mentioned correlations were not significant, it was concluded that no support brings the evidence in favor of the proper variation of intelligence. Instead, a random variation arises. It would be seen as irrelevant to the intelligence.

2. Structure evidence criterion. Inter-correlations between scores of divergent thinking variation across categories reveal the structure evidence criterion. It supports the view that a shared field of variation covers divergent thinking. To the contrary, if scores of divergent thinking variation categories do not inter-correlate or inter-correlate partially, then the structure evidence criterion fails to acknowledge the view that a shared field of variation arises across divergent thinking.

Respectively, if variation of intelligence subtests inter-correlate, then the structure evidence criterion provides the view that a shared field of variation covers intelligence. Yet, if it is not the case, then the structure evidence criterion fails to acknowledge the view that a shared field of variation arises across intelligence.

3. Discrimination/cohesion evidence criterion. It deals with extending divergent thinking variation outside. The issue to be assessed is whether the variation of divergent thinking and the variation of intelligence differ or, vice versa, link one another.

Basically, foregoing significant correlations provide the standpoint of coherence between the variation of divergent thinking and intelligence. Conversely, non-significant respective correlation sought to reveal discrimination across the variation of divergent thinking and intelligence.

Exploratory factor analysis was either used to indicate cohesion/discrimination of the variation scores of divergent thinking (fluency, flexibility, and originality) and the variation scores of intelligence (verbal, numerical, and spatial). Principal factor analysis was conducted, with iterations, using an orthogonal varimax solution with Kaiser normalization to identify simple structure. Total scores of divergent thinking and intelligence variations were removed from factor analysis to avoid additive effects. If extracted factors discriminate loadings of divergent thinking variation and the intelligence variation, then the variation of divergent thinking ought to be treated detaching from the variation of intelligence. Contrary to that, if factor loadings of the divergent thinking variation and the intelligence variation fall into the same factor, then a common space shares them.

All computations were conducted after values of all variables were converted into z-scores.

## Results

### Descriptive Statistics

The average scores on the three measures of divergent thinking and the four measures of intelligence are shown in Table 1. Women scored significantly higher than men on all three measures of divergent thinking and on two of the three intelligence test scales but not on total-scale IQ. The scores of total-scale IQ, as well as verbal, spatial, and numerical abilities were modest. Although scores on the divergent subscales and several of the intelligence subtests differed for women and men, the correlations for men and women were very similar in all

cases, so only the correlations for the entire sample are shown below.

Descriptive data differed on Fluency, $p < .001$ and originality, $p < .05 \div .01$ (total sample, men and women). Descriptive data differed on numerical (total sample, $p < .001$ and women, $p < .001$), and verbal (total sample, $p < .001$, men, $p < .001$, and women, $p < .05$) subtests, and on full-scale IQ (total IQ, $p < .001$ and women, $p < .001$).

Table 1

*Means and Standard Deviations of Divergent Thinking, Intelligence and T-tests Between the Scores of the Participants, Girls and Boys*

| Variable | Total sample | | Boys | | Girls | | *t*-test |
|---|---|---|---|---|---|---|---|
| | *M* | SD | *M* | SD | *M* | SD | |
| *Divergent Thinking* | | | | | | | |
| Fluency | 15.71 | 4.24 | 14.53 | 4.23 | 16.46 | 4.10 | 3.16** |
| Flexibility | 13.92 | 3.52 | 13.21 | 3.87 | 14.36 | 3.22 | 2.23* |
| Originality | 52.30 | 17.53 | 45.91 | 16.84 | 56.33 | 16.80 | 4.21*** |
| *Intelligence* | | | | | | | |
| Num | 24.29 | 11.02 | 20.61 | 11.10 | 26.61 | 10.37 | 3.81*** |
| Spatial | 19.53 | 4.08 | 19.56 | 4.37 | 19.51 | 13.91 | .08 |
| Verbal | 50.72 | 9.77 | 48.48 | 9.63 | 52.14 | 9.64 | 2.58* |
| Total IQ | 99.94 | 8.16 | 99.11 | 7.57 | 101.46 | 8.51 | 1.13 |

*Note*. Num = numerical ability, M = mean, SD = standard deviation, * $p < .05$, ** $p < .01$, and *** $p < .001$.

**Variation of Divergent Thinking and Intelligence**

The external evidence scores of *divergent thinking* variation are seen in Table 2. Within each category (namely, fluency, flexibility, and originality, as well as across divergent thinking), variation and central tendency scores significantly and positively correlated or, at least, revealed such a trend ($p < .07 \div .001$). This means that the variation is increased while the divergent thinking or its categories are greater. And, vice versa, low variation was yielded while the divergent thinking and its categories were decreased. Thus, the variation of responds on task demands is not chance. Rather, it pertains to divergent thinking regularly.

Table 2

*Correlations Between Variation and Central Tendency Scores of Divergent Thinking*

| Variable | *Variation* | | | |
|---|---|---|---|---|
| | Fluency | Flexibility | Originality | Composite score DT |
| *Central tendency* | | | | |
| Fluency | .13* | | | |
| Flexibility | | .17** | | |
| Originality | | | .19** | |
| Composite score DT | | | | .21*** |

*Note*. DT = divergent thinking, * $p < .07$, ** $p < .01$, and *** $p < .001$.

The external evidence scores of *intelligence* variation are seen in Table 3. Only a few of significant correlations were obtained. Within the numerical subtests, variation and central tendency scores correlated positively ($p < .001$). This means that the variation is increased while the numerical ability is greater. And, vice versa, low variation was yielded while the numerical subtests were reduced. Within verbal and spatial subtests,

or total IQ, variation and central tendency scores did not correlate significantly. Thus, the variation pertains to the numerical ability only. But the variation of verbal and spatial subtests, as well as the total IQ, ought to be considered occasional.

**Structure Evidence**

Structure evidence of scores of *divergent thinking* variation appears in Table 3. Variation scores of fluency, flexibility, and originality closely and positively correlated ($p < .001$). Given this, the variation score of flexibility only positively correlated with the variation of divergent thinking composite ($p < .05$). These findings mostly resulted in the variations of divergent thinking categories are coherent.

Table 3

*Correlations of Variation Scores of Divergent Thinking Categories*

| | Fluency | Flexibility | Originality | Composite score DT |
|---|---|---|---|---|
| Fluency | | .64** | .73** | .11 |
| Flexibility | | | .55** | .15* |
| Originality | | | | .13 |
| Composite score DT | | | | |

*Note*. DT = divergent thinking, * $p < .05$ and ** $p < .001$.

Structure evidence of *intelligence* variation scores appears in Table 4. Variation scores of verbal and spatial subtests correlated in trend and negatively ($p < .08$). Variation scores of total IQ and its subtests did not correlate significantly. Either, variation scores of numerical subtests did not correlate significantly with variation scores of other subtests. Variation scores of remaining subtests were not inter-correlated significantly, as well. Obtained data show that the structure of intelligence variation is partial and low. Rather, it is quite dissociated than displays a shared space for intelligence variation.

Table 4

*Correlations of Variation Scores of Intelligence Subtests*

| | Num | Spatial | Verbal | Total IQ |
|---|---|---|---|---|
| Num | | .02 | -.01 | .01 |
| Spatial | | | -.12* | -.08 |
| Verbal | | | | -.03 |
| Total IQ | | | | |

*Note*. Num = Numerical ability, * $p < .05$.

**The Variation of Divergent Thinking and the Variation of Intelligence: Discrimination Versus Cohesion Evidence**

No significant correlations were established between the variation scores of divergent thinking and intelligence. Exploratory factor analysis with varimax rotation was performed on these data. Two orthogonal factors were extracted. They accounted for 56.91% of the total variance. The first extracted factor had eigenvalues of 2.29 and the second extracted factor of 1.13. These data are shown in Table 5.

Table 5

*Factor Loadings (Extraction: Principal Components, Orthogonal Varimax Normalized Solution) of Variation Scores of Divergent Thinking Categories and Intelligence Subtests*

| Variation variable | Factor 1 | Factor 2 |
|---|---|---|
| *Divergent thinking* | | |
| Fluency | **-.91** | .01 |
| Flexibility | **-.82** | .01 |
| Originality | **-.87** | .09 |
| *Intelligence* | | |
| Verbal | .11 | **.73** |
| Numerical | .08 | -.18 |
| Spatial | .03 | **-.75** |
| Eigenvalue | 2.29 | 1.13 |
| Variance explained, % | 38.11 | 18.80 |

*Note*. Significant factor loadings are in bold.

Extracted factors clearly discriminated the variation of divergent thinking loadings (of fluency, flexibility, and originality variation scores), and the variation of intelligence loadings (of verbal IQ and spatial IQ variation scores). Factor loadings provided evidence in favor of the fact that the variation of divergent thinking is distinguished from the variation of intelligence.

## Discussion

We examined a variation account of creative thinking as measured with the Alternate Uses Test. To provide a control (contrast) condition a variation account of intelligence as measured with the German IST-70 Test Battery was also employed. Guilford's (1956, 1967, 1988) theory of divergent—convergent thinking was the common ground for the both. Guilford has passed the issue of creative variation, yet it can be embedded in the construct of divergent thinking. The creative variation deals with both diverse ideas and their relationships. They supplement one another but not merge. We proposed that divergent thinking and its variation are related. On the contrary, the variation of convergent thinking (intelligence) would be seen of some other kind as compared to the variation of divergent thinking.

Data obtained were consisted with proposed hypotheses. Three main results were received. First, it was established that the variation is increased while the divergent thinking or its categories are greater (the external evidence). Thus, the variation of responds on task demands is not chance. Rather, it pertains to divergent thinking regularly. In contrast, a variation within intelligence was only supported with respect to the numerical ability, not to other abilities. The variation of verbal and spatial subtests, as well as total IQ, would be considered occasional (the poor external evidence).

Second, the variations of divergent thinking categories were closely related (the structure evidence). In contrast, the structure of intelligence variation was partial and low. Rather, it is quite dissociated than displaying a shared space for intelligence variation (the poor structure evidence).

Third, no significant correlations were established between the variation scores of divergent thinking and intelligence. According to exploratory factor analysis, two orthogonal factors were extracted. Factor loadings provided evidence in favor of the fact that the variation of divergent thinking is distinguished from the variation of intelligence (the discrimination versus cohesion evidence).

Detailed and subtle methodological considerations are beyond the scope of our discussion. But we would draw attention to our results that give priority to the variation of divergent thinking than to the variation of intelligence. This implies that creative persons are capable not only to produce diverse ideas but also to change them and shift from one to another gradually. Conversely, persons with high IQ (with an exception of the mathematical intelligence) rather do not hold this ability. Possibly, they solve problems using other strategies.

As for the creative variation, we propose to some extent to deepen its meaning. In our study distances between diverse ideas convey their variation. As compared to uncreative, creative persons tap larger distances which are cohesive. Then we come to the claim that the creative variation yields a shared mental space. Unlike less creative, creative persons hold a greater mental space. It is therefore their variation is enlarged. Besides, in the greater mental space, movements and shifts are possible between remote ideas.

Within this framework, a new turn can be committed with reference to remote associations (Mednick, 1962) and defocused attention (Eysenck, 1995; Martindale, 1995, 1999) as features of creativity. Instead of considering remote associations as flat associative hierarchy (Mednick, 1962) and defocused attention referred to the total number of elements in consciousness (Martindale, 1995), the both can either mark a greater mental space of creative people.

Some current findings are not entirely clear and go beyond the general trend. For instance, the variation of divergent thinking composite correlated with the variation score of flexibility, not with the variation scores of fluency and originality. These data are not consistent with a suggested claim that the variation of divergent thinking composite would be viewed a shared indicator of variation of any divergent thinking category. Another example demonstrating extra results arises within the variation of intelligence subtests. The variation of numerical subtests would be seen regular. Yet, the variation of verbal and spatial subtests and total IQ are not regular, rather, they are casual. Their special meaning remains out of comprehending. Clearly further investigation is required in order to explore these extra data in more detail.

## Conclusions

The current study was intended to investigate whether thought variations relate to divergent thinking. To make a control (contrast), the variation of intelligence subtests was also applied. Guilford's (1956, 1967, 1988) theory of divergent—convergent thinking served the background of our study. The variation was taken into the intra-individual account rather than inter-individual one. This within-person variation takes a form of systematic fluctuation. Either, it is situation- and/or intra-individual-derivative rather than time-dependent.

A principal hypothesis to be tested was that divergent thinking enables variation. As compared to uncreative, creative persons would be characterized by larger variation. Mainly, the data obtained lend support to this hypothesis. Besides, it was also found that the variations of divergent thinking categories are closely related. In contrast, the structure of intelligence variation was quite dissociated than displaying a shared space of intelligence variation. Finally, the variation of divergent thinking was distinguished from the variation of intelligence.

We put forward that the creative variation refers to a shared mental space. Unlike less creative, creative persons ought to hold a greater mental space. It is therefore their variation is enlarged. Besides, in the greater mental space, movements and shifts are possible between remote ideas.

## Limitations

The findings of the present study are to some extent limited in generalizability. The study was conducted on a Russian sample, and it is open to question whether there are cross-cultural differences on our data or not. The sample was relatively homogeneous with respect to age, in that the tested participants were of traditional high school age.

A major concern of this research was done on the divergent thinking and its variation. However, additional work is needed to find out if other constructs of creative thinking and additional measures of variation are grounded. In our study the divergent thinking was used to tap creative thinking. Standard deviation as a measure of creative variation was employed. It is not unlikely that other constructs and measures will result in shift of the data to some degree.

We proposed an assumption that the creative variation refers to a mental space. So far, it would be seen speculative. In the near future, we intend to bring to this claim an empirical account. We expect this considerable line of work will appreciably contribute to further research.

## References

Amthauer, R. (1973). Intelligenz-Struktur-Test L S. T. 70. *Handanweisung fur dieDurchfahrung und Auswertung* (Intelligence-Structure-Test IST 70. Manual for Implementation and Evaluation). Gottingen: Verlag far Psychologie.

Averina, I. S., & Scheblanova, E. I. (1996). *The verbal test of creative thinking "the alternate uses"*. Moscow: Sobor (In Russian).

Brown, G. D. A., Wood, A. M., & Chater, N. (2012). Sources of variation within the individual. In P. Hammerstein and J. R. Stevens (Eds.), *Evolution and the mechanisms of decision making* (Vol. 11). Cambridge, MA: MIT Press.

Campbell, D. T. (1960). Blind variation and selective retention in creative thought as in other knowledge processes. *Psychological Review, 67*, 380-400.

Campbell, D. T. (1974). Unjustified variation and selective retention in scientific discovery. In F. Ayala and T. Dobszhansky (Eds.), *Studies in the philosophy of biology: Reduction and related problems* (pp. 139-161). London, UK: Macmillan.

Csikszentmihalyi, M. (1997). *Creativity: Flow and the psychology of discovery and invention.* New York: Harper Perennial.

Dorfman, L. Ya. (2016). Creative field, divergence, and variation. *Psychological Journal, 37*(1), 26-34. (In Russian).

Dorfman, L. Ya., & Baleva, M. V. (2014). Relationships between creativity and variation. *Psychological Journal, 35*(2), 57-78. (In Russian).

Dorfman, L., Martindale, C., Gassimova, V., & Vartanian, O. (2008). Creativity and speed of information processing: A double dissociation involving elementary versus inhibitory cognitive tasks. *Personality and Individual Differences, 44*, 1382-1390.

Eid, M., & Diener, E. (1999). Intraindividual variability in affect: Reliability, validity, and personality correlates. *Journal of Personality and Social Psychology, 76*(4), 662-676.

Epstein, J. N., Langberg, J. M., Rosen, P. J., Graham, A., Narad, M. E., Antonini, T. N., ...Altaye, M. (2011). Evidence for higher reaction time variability for children with ADHD on arrange of cognitive tasks including reward and event rate manipulations. *Neuropsychology, 25*(4), 427-441.

Eysenck, H. J. (1995). Genius. *The natural history of creativity*. Cambridge: Cambridge University Press.

Gärdenfors, P. (2000). *Conceptual spaces: The geometry of thought.* Cambridge, MA: MIT Press.

Guilford, J. P. (1950). Creativity. *American Psychologist, 5*, 444-454.

Guilford, J. P. (1956). The structure of intellect. *Psychological Bulletin, 53*(4), 267-293.

Guilford, J. P. (1967). Creativity: Yesterday, today, and tomorrow. *Journal of Creative Behavior, 1*, 3-14.

Guilford, J. P. (1988). Some changes in the structure-of-intellect model. *Educational and Psychological Measurement, 48*, 1-4.

Iezzi, A. (2013). Contemporary Chinese calligraphy between tradition and innovation. *Journal of Literature and Art Studies, 3*(3), 158-179.

Kris, E. (1952). *Psychoanalytic explorations in art.* New York: International Universities Press.

Lefebvre, H. (1991). *The production of space*. Cambridge, England: Blackwell.

Mack, T. (2012). The transmigrating Evil Genius: From Boothby to Rohmer to Fleming. *Journal of Literature and Art Studies, 2*(8), 751-757.

Malpas, J. (2012). Putting space in place: philosophical topography and relational geography. *Environment and Planning D: Society and Space, 30*, 226-242.

Martindale, C. (1989). Personality, situation, and creativity. In J. A. Glover, R. R. Ronning, and C. R. Reynolds (Eds.), *Handbook of creativity* (pp. 211-232). New York: Plenum.

Martindale, C. (1995). Creativity and connectionism. In S. M. Smith, T. B. Ward, and R. A. Finke (Eds.), *The creative cognition approach* (pp. 249-268). Cambridge, MA: MIT Press.

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

Mednick, S. A. (1962). The associative basis of the creative process. *Psychological Review, 69*(3), 220-232.

Pinker, S. (2003). *The blank slate*. New York: Penguin.

Plucker, J. A., & Renzulli, J. S. (1999). Psychometric approaches to the study of human creativity. In R.J. Sternberg (Ed.), *Handbook of creativity* (pp. 35-61). New York: Cambridge University Press.

Reckess, G. Z., Varvaris, M., Gordon, B., & Schretlen, D. J. (2014). Within-person distributions of neuropsychological test scores as a function of dementia severity. *Neuropsychology, 28*(2), 254-260.

Runco, M. A. (2007). *Creativity*. Amsterdam: Elsevier.

Runco, M. A. (2008). Commentary: Divergent thinking is not synonymous with creativity. *Psychology of Aesthetics Creativity and the Arts, 2*(2), 93-96.

Senin, I. G., Sorokina, O. V., & Chirkov, V. I. (1993). *The test of intelllectual abilities*. Yaroslavl: Psychodiagnostica (In Russian).

Silvia, P. J., Winterstein, B. P., Willse, J. T., Barona, C. M., Cram, J. T., Hess, K. I., Martinez, J. L., & Richard, C. A. (2008). Assessing creativity with divergent thinking tasks: Exploring the reliability and validity of new subjective scoring methods. *Psychology of Aesthetics, Creativity, and the Arts, 2*(2), 68-85.

Simonton, D. K. (2013). Creative thought as blind variation and selective retention: Why creativity is inversely related to sightedness. *Journal of Theoretical and Philosophical Psychology, 33*(4), 253-266.

Spalva, R. (2013). Innovation in choreography of Leonid Yakobson. *Journal of Literature and Art Studies, 3*(10), 657-662.

Spearman, C. (1931), *Creative mind*. Oxford: Appleton-Century.

Sternberg, R. (1999). Intelligence. In M. A. Runco and S. R. Pritzker (Eds.), *Encyclopedia of creativity* (Vol. 2, pp. 81-88). San Diego et al.: Academic Press.

Suler, J. R. (1980). Primary process thinking and creativity. *Psychological Bulletin, 88*, 144-165.

van der Yen, A. H. G. S. (1992). Item homogeneity in verbal tests: A Rasch analysis of Amthauer's verbal tests. *Educational and Psychological Measurement, 52*, 623-641.

Vartanian, O. (2009). Variable attention facilitates creative problem solving. *Psychology of Aesthetics, Creativity, and the Arts, 3*(1), 57-59. doi:10.1037/a0014781

Vartanian, O., Martindale, C., & Kingery, L. (2002). Creativity and disinhibition. In Eu. Malianov, N. Zakharov, E. Berezina, L. Dorfman, V. Petrov, and C. Martindale (Eds.), *Personality, creativity, and art* (pp. 204-215). Perm: Perm State Institute of Art and Culture, Prikamsky Social Institute.

Vartanian, O., Martindale, C., & Kwiatkowski, J. (2007). Creative potential, attention, and speed of information processing. *Personality & Individual Differences, 34*, 1370-1380.

Wallach, M. A., & Kogan, N. (1965). *Modes of thinking in young children*. New York: Holt, Rinehart, and Winston.

Woolley, S. C., & Doupe, A. J. (2008). Social context-induced song variation affects female behavior and gene expression. *PLoS Biology, 6*, e62.

Wu, H. G., Miyamoto, Y. R., Gonzalez Castro, L. N., Ölveczky, B. P., & Smith, M. A. (2014). Temporal structure of motor variability is dynamically regulated and predicts motor learning ability. *Nature Neuroscience, 17*, 312-321.