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Creativity, visualization abilities, and visual cognitive style

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Background. Despite the recent evidence for a multi-component nature of both visual imagery and creativity, there have been no systematic studies on how the different dimensions of creativity and imagery might interrelate.

Aims. The main goal of this study was to investigate the relationship between different dimensions of creativity (artistic and scientific) and dimensions of visualization abilities and styles (object and spatial). In addition, we compared the contributions of object and spatial visualization abilities versus corresponding styles to scientific and artistic dimensions of creativity.

Samples. Twenty-four undergraduate students (12 females) were recruited for the first study, and 75 additional participants (36 females) were recruited for an additional experiment.

Method. Participants were administered a number of object and spatial visualization abilities and style assessments as well as a number of artistic and scientific creativity tests.

Results. The results show that object visualization relates to artistic creativity and spatial visualization relates to scientific creativity, while both are distinct from verbal creativity. Furthermore, our findings demonstrate that style predicts corresponding dimension of creativity even after removing shared variance between style and visualization ability. The results suggest that styles might be a more ecologically valid construct in predicting real-life creative behaviour, such as performance in different professional domains.

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Mental visualization or visual imagery refers to an experience of 'seeing in the mind's eye', that is, perceiving some object, event, or scene in the absence of corresponding visual input (Kosslyn, 1994). There is much historical evidence that imagery plays a crucial role in creative scientific discoveries and insights such as Galileo's thought experiments on inertia, Einstein's Special and General Theory of Relativity, Kekule's structure of benzene ring, or Feynman diagrams in quantum field theory (Miller, 2000; Shepard, 1978). Likewise, the history of visual art is rich in evidence from prominent visual artists such as Kandinsky, Moore, O'Keeffe, and Dali reporting the crucial role of imagery in creation of their masterpieces (Kassels, 1991; Miller, 2000). Furthermore, recent research based on reports of professional artists and scientists has provided further evidence that imagery plays a crucial creative role for visual artists and designers, as well as scientists, engineers, and other technology professionals (Blazhenkova & Kozhevnikov, 2009, 2010; Ferguson, 1977; Kozhevnikov, Motes, & Hegarty, 2007; Rosenberg, 1987).

Despite the above evidence, current psychological research has failed to find a consistent relationship between creativity and imagery (Forisha, 1978; LeBoutillier & Marks, 2003; Parrott & Strongman, 1985). One approach (Allen, 2010; Kay, 1996; Winner, Casey, DaSilva, & Hayes, 1991) involved unsuccessful attempts to find a relationship between spatial visualization ability (i.e., performance on tests that measure the ability to transform and manipulate spatial images, such as mental rotation) and creative achievements (typically using professional membership or student's grades in a creative field, usually art). A second prevailing approach involved attempts to find correlations between self-report imagery assessments of vividness and brightness of generated images (e.g., Vividness of Visual Imagery Questionnaire [VVIQ], Marks, 1973) and psychometric measures of creativity (usually Torrance Test of Creative Thinking [TTCT], Torrance, 1972). Although this line of research established more consistent positive correlations between TTCT creativity scores and visual imagery rating (Shaw & Belmore, 1982), a number of studies showed that subjective visual imagery ratings on VVIQ are not predictive for science and technology and that most scientists' VVIQ scores are actually below average in comparison with the general population (e.g., Blazhenkova & Kozhevnikov, 2010; Kozhevnikov, Blazhenkova, & Becker, 2010). A third approach attempted to establish the relationship between imagery and creativity by developing tasks that require imagery to generate a creative product (Finke, Pinker, & Farah, 1989; Finke & Slayton, 1988). Finke and Slayton (1988) found that participants are able to produce recognizable inventions if they are given enough time to generate visual images and that these discoveries are indeed the result of using mental imagery. One of the limitations of such an approach, however, is that it confounds imagery and creativity in one task such that the relationship between the two cannot be explored quantitatively. Finally, a recent meta-analytic study (LeBoutillier & Marks, 2003) reported only weak association between imagery and creativity: the individuals' imagery capacity was able to account for only 3% variance in their creativity performance, implying that imagery might not be so important in the creative process.

The main focus of this study is to investigate the relationship between imagery and creativity. We suggest that the inconsistent results and weak correlations reported in the previous creativity research are due to the fact that both imagery and creativity were treated as single homogeneous constructs. Imagery has long been considered by psychologists to be of a unitary nature, but recent developments in cognitive science and neuroscience give evidence for two distinct visual pathways in the brain, namely object (ventral) and spatial (dorsal) pathways (Kosslyn, Ganis, & Thompson, 2001; Mazard, Tzourio-Mazoyer, Crivello, Mazoyer, & Mellet, 2004; Ungerleider & Mishkin, 1982).

The object pathway processes information related to visual appearances of individual objects or scenes in terms of their shape, colour, and texture. In contrast, the spatial pathway processes information about spatial relations, locations of objects in space, and spatial transformations.

The object–spatial dissociation has been reported in connection with visualization abilities and visual cognitive styles (Kozhevnikov, Kosslyn, & Shephard, 2005). In this context, object and spatial visualization abilities refer to an individual's cognitive capacity to process information in terms of object and spatial images, respectively, and object versus spatial visualization style refers to an individual's preferences or habits of processing information in terms of object and spatial images. It has been shown that, in contrast to visual–spatial ability, which is associated with more efficient use of spatial resources in the dorsal pathway (Lamm, Bauer, Vitouch, & Gstattner, 1999), visual–object ability is associated with more efficient use of visual–object resources in the ventral pathway (Motes, Malach, & Kozhevnikov, 2008). Furthermore, Kozhevnikov *et al.* (2005) identified individuals of two very different visual styles, *object visualizers* who consistently prefer to construct pictorial, colourful, high-resolution images of individual objects and scenes, and *spatial visualizers*, who consistently prefer to use imagery to schematically represent spatial relations among objects. Further research (Blazhenkova & Kozhevnikov, 2009) reported that visual artists are primarily object visualizers and generally exhibit high object visualization ability, while scientists and engineers are spatial visualizers and possess high spatial visualization ability.

Similar to imagery research, creativity research has long considered creativity as a unitary construct, defining it as a general ability to produce work that is both novel and appropriate (Mumford, 2003; Plucker, Beghetto, & Dow, 2004; Runco, 2007). The most common approach to creativity has conceptualized it as a *divergent thinking ability*, defined as the ability to generate multiple possible solutions to a problem in terms of fluency, flexibility, originality, and elaboration (Guilford, 1956). In this approach, *general* creativity is measured by performance on divergent thinking tests such as TTCT (Torrance, 1972). This view 'was supplanted by a focus on ideational fluency as a general associative process, a sort of "g" factor underlying virtually all types of creativity' (Brown, 1989, p. 21). Creativity has also been viewed as an *insight experience*, commonly known as an 'ah hah!' moment, when an individual suddenly realizes a solution to a creative problem. In this approach, creativity is measured by performance on insight problem-solving tasks, which involve non-routine problems that require overcoming a familiar way of thinking and inventing a novel approach (Dow & Mayer, 2004). The insight problem-solving approach also does not differentiate between different types of creativity, assuming creativity is either all or none. However, beginning in the 1990s, growing evidence has supported the existence of domain-specific creativity (Baer, 1998; Kaufman & Baer, 2004; Plucker & Zabelina, 2009). In particular, research has revealed three major types of creativity based on self-ratings (Kaufman & Baer, 2004; Oral, Kaufman & Agars, 2007): Artistic/Bodily ('hands-on' creativity in art, craft, and bodily/physical creativity), Math/Science (creativity in math and science), and Writing/Communication (creativity in interpersonal relationships, communication, and writing). Similarly, Carson, Peterson, and Higgins (2005) identified separate arts and science factors, using the self-report Creative Achievement Questionnaire. Ward, Smith, and Finke (1999) concluded that achievement in one area of creative endeavour (such as painting or scientific discovery) does not necessarily imply creative excellence in all areas.

In summary, despite the recent evidence for a multi-component nature of both visual imagery and creativity, there have been no systematic studies on how the different dimensions of creativity and imagery might interrelate. Thus, the main goal of this study was to investigate this multi-dimensional relationship. We hypothesized that object visualization ability and style relate to artistic creativity, whereas spatial visualization ability and style relate to scientific creativity, and they are both unrelated to verbal creativity. Moreover, we expect that traditional measures of creativity such as TTCT and the insight problem-solving task assess different aspects of creativity (artistic and scientific, respectively), rather than general creativity. Support for our hypothesis comes from previous research that found a positive relation between vividness (VVIQ) and creative behaviour in art (e.g., Morrison & Wallace, 2001), as well as recent studies of different professions, where scientists reported that their creative processes involved spatial but not object visualization, and vice versa for visual artists (Blazhenkova & Kozhevnikov, 2010).

Our second goal was to compare the contributions of visualization abilities versus visual cognitive styles (object and spatial) to corresponding creativity dimensions (artistic and scientific). Cognitive style can be viewed as a heuristic that individuals use to process information about their environment (Kozhevnikov, 2007). While styles are generally stable, they develop slowly within individuals as a result of experience, affected by the interplay between basic individual characteristics (general intelligence, abilities, personality) and long-term external factors (e.g., education, professional requirements, cultural, and social norms). Although studies have consistently demonstrated that visualization abilities are highly correlated with their corresponding visual styles (Blazhenkova & Kozhevnikov, 2010; Kozhevnikov *et al.*, 2010), they are still distinct psychological constructs. Specifically, cognitive styles are more adaptive constructs than cognitive abilities and are more related to life and educational experiences (Moskvina & Kozhevnikov, 2011). Thus, we hypothesized that the degree of object versus spatial cognitive style might be a better predictor of artistic versus scientific creativity than the corresponding abilities.

Method

Participants and procedure

First, 24 undergraduate students (12 females) were recruited for the study through advertisement. They were administered the following paper-and-pencil assessments: Paper Folding Test (PFT, Ekstrom, French, & Harman, 1976) assessing spatial visualization ability; VVIQ (Marks, 1973) assessing object visualization ability; Object-Spatial Imagery and Verbal Questionnaire (OSIVQ, Blazhenkova & Kozhevnikov, 2009) assessing object, spatial, or verbal cognitive styles; as well as creativity assessments: TTCT (Torrance, 1972), insight problem-solving tasks (spatial subset) (IPS-spatial, Dow & Mayer, 2004), and Creative Behavior Inventory (art, science and literature scales; CBI, Hocevar, 1979).

Second, 75 additional participants, undergraduate and graduate students (36 females), were recruited for an additional experiment. The participants completed the same paper-and-pencil tests as above, and in addition, they completed computerized tests of spatial visualization ability (Mental Rotation Test [MRT], Shepard & Metzler, 1971) and object visualization ability (Degraded Picture Test [DPT], Kozhevnikov *et al.*, 2005).

To ensure different visualization profiles and specializations, about half of the students ($N = 49$) were recruited from schools of engineering and computing. The other half of the students ($N = 50$) were specialized in business, arts, or social sciences. All participants were tested in groups of up to eight. The order of the paper-and-pencil tests was randomized, and the order of the computerized tests was counterbalanced among different groups to eliminate the order effect.

Materials

Visualization ability assessments

The spatial visualization assessments included the PFT, MRT, and the spatial scale of the OSIVQ. The object visualization assessments included VVIQ, DPT, and the object scale of the OSIVQ.

Paper Folding Test. According to Ekstrom *et al.* (1976), the PFT measures spatial visualization ability, which reflects the ability to apprehend, encode, and mentally manipulate abstract spatial forms. The test consists of 10 items, which represent successive drawings of two- or three-folds made to a square sheet of paper and a final drawing showing the folded paper with a hole punched through it. The participants were to select one correct drawing among five drawings, which depicts how the paper would look when fully opened (see Appendix). They had 3 min to complete the test. The score was calculated as the number of correct answers minus the quotient of the number of incorrect answers divided by four (total score = correct − incorrect/4). The internal reliability of the test is .84.

Mental Rotation Test. The MRT measures spatial visualization ability (Shepard & Metzler, 1971). This computerized test consists of eight practice trials and 36 test trials, in which participants were shown pairs of 2D pictures of 3D geometric shapes composed of cubes and rotated from 0 to 180 degrees relative to each other (see Appendix). Participants were asked to judge whether the figures in a pair were same or different. Both accuracy and response time were recorded. The internal reliability of the computerized test for accuracy is .88.

Vividness of Visual Imagery Questionnaire. The VVIQ is the most common self-report instrument assessing vividness and brightness of individuals' imagery (Marks, 1973). The VVIQ consists of 16 items, in which participants read verbal descriptions of scenes (e.g., 'The sun is rising above the horizon into a hazy sky. A strong wind blows on the trees and on the lake, causing waves') and then rate the subjective vividness of the evoked visual images on a scale from 1 to 5 (from 'no image at all' to 'perfectly clear image', respectively). The internal reliability of the questionnaire is .88.

Degraded Picture Test. According to Kozhevnikov *et al.* (2005), DPT involves top-down holistic processing to fill in the obscured portions of the degraded object, which rely on object visualization (Kosslyn, 1994). It consists of 10 items, each showing a degraded line-drawing of a common object embedded in visual noise (see Appendix). Participants were asked to identify the objects as quickly as possible without sacrificing accuracy. Both accuracy and response times were recorded. The internal reliability of the test is .74.

Object-Spatial Imagery and Verbal Questionnaire. The OSIVQ is a self-report measure assessing individuals' visual (object and spatial) as well as verbal cognitive style dimensions (Blazhenkova & Kozhevnikov, 2009). The OSIVQ consists of 45 items with 15 items assessing visual–object cognitive style (e.g., 'My mental pictures are very detailed precise representations of the real things'), 15 items assessing visual–spatial cognitive style (e.g., 'My images are more like schematic representations of things and events'), and 15 items assessing verbal cognitive style (e.g., 'I would rather have a verbal description of an object or person than a picture'). Participants were asked to read each statement and rate on a 5-point scale with '5' indicating absolute agreement with the statement and '1' indicating total disagreement. Scores for object, spatial, and verbal styles were calculated by averaging the 15 ratings, respectively. The internal reliabilities of the object, spatial, and verbal scales are .83, .79, and .74, respectively.

Creativity assessments

Torrance Test of Creative Thinking-picture completion task. The TTCT is the most frequently used creative test, assessing divergent thinking ability (Torrance, 1972). For this research, only the picture completion task was used. In this task, participants were asked to finish 10 incomplete drawings and make up an interesting title for each. Participants had 10 min to complete the task and were instructed to be as creative as possible. Examples of participants' responses and sample items of the test are shown in Appendix. The creative drawings were scored according to 'Torrance Test of Creativity Thinking Streamlined Scoring Guild for Figural Forms A & B' (Torrance, Ball, & Safter, 1998). The total TTCT creativity score was calculated for each participant by averaging the following TTCT subscales: fluency, originality, elaboration, abstractness of titles, and resistance to premature closure subscales.

Insight Problem Solving Task (spatial subscale). The spatial insight problems require overcoming the constraints of routine ways of thinking (Dow & Mayer, 2004). For the current study, ten insight problem-solving tasks were selected from the spatial subset of IPS. For example, in the 9-dot problem (see Appendix), the spatial configuration of dots encourages the problem solver to complete the square shape and to draw lines within this shape. However, the right approach requires extending the lines beyond this given shape. Participants had 10 min to solve the problems and were instructed to be creative. They were asked to circle the item if they had solved it before. The creativity score was calculated as a sum of the correct items. Half a point was given if the participant was correct on an item he/she had solved before. The internal reliability of IPS-spatial is .60.

Creative Behavior Inventory. Creative Behavior Inventory is a self-report instrument assessing individuals' creative behaviours and achievements in art, science, and literature domains (Hocevar, 1979). Participants were asked to report the frequency of their creative behaviour and achievements in visual art, science, and literature (not counting school requirements) on a 6-point scale with '1' denoting never and '6' denoting more than six times. Typical items were as follows: 'Drew a picture for aesthetic reasons', 'Wrote an original computer program', and 'Wrote poetry'. Scores for domain-specific creative behaviours were calculated by averaging the ratings of respective items separately for each scale. The internal reliability of CBI in art, science, and literature domains are .78, .75 and .78, respectively.

Results

Relationship between different dimensions of visualization and creativity measures

Factor analysis

To examine the structure of relationships between the different dimensions of creativity and visualization, we conducted a principal component analysis using a varimax rotation on all the paper-and-pencil visualization and creativity assessments, with the full (99 participants) data set. Only three-first factors (out of 10) with eigenvalues >1 (2.48, 1.93, and 1.29) were retained. None of the other seven factors met recommendations regarding component saturation (e.g., Zwick & Velicer, 1986; at least two variables having high loading on the factors). For example, none of the seven factors had loadings above 0.60. Thus, these factors were not considered further.

Spatial ability (PFT), spatial style (OSIVQ-spatial), and scientific creativity (CBI-science and IPS-spatial) measures were loaded on the first factor; object ability (VVIQ), object styles (OSIVQ-object), and artistic creativity (CBI-art and TTCT) measures were loaded on the second factor; and verbal style (OSIVQ-verbal) and verbal creativity (CBI-literature) measures were loaded on the third factor (Table 1). Thus, we identified the first factor as spatial, second as object, and the third one as verbal. The factor structure supports our hypothesis that object visualization closely relates to artistic creativity, while spatial visualization relates to scientific creativity, and both are distinct from verbal dimension.

Visualization as predictor of creativity. To examine how object and spatial visualizations relate to scientific and artistic components of creativity, *Grand-Scientific Creativity* and *Grand-Artistic Creativity* scores were created for each participant by averaging his/her standardized *Z*-scores of all scientific (CBI-science and IPS-spatial) and all artistic creativity measures (CBI-art and TTCT), respectively. Similarly, for each participant, we

Table 1. Principal component loadings for all the paper-and-pencil measures (after varimax rotation)

	Factor 1	Factor 2	Factor 3
OSIVQ-object	0.00	**0.81**	−0.02
VVIQ	0.15	**0.77**	0.00
Torrance	−0.34	**0.52**	−0.19
CBI-art	0.14	**0.56**	0.32
OSIVQ-spatial	**0.81**	−0.03	−0.03
Paper folding	**0.80**	0.18	−0.17
Insight-spatial	**0.72**	0.07	0.13
CBI-science	**0.52**	−0.18	0.38
OSIVQ-verbal	−0.48	0.12	**0.74**
CBI-literature	0.03	0.01	**0.72**

Note. CBI = Creative Behavior Inventory; OSIVQ = Object-Spatial Imagery and Verbal Questionnaire; VVID = Vividness of Visual Imagery Questionnaire.
Bold indicates the highest loadings within a factor.

computed *Composite Spatial Visualization* as well as *Composite Object Visualization* measures by averaging his/her standardized *Z*-scores of spatial assessments (PFT and OSIVQ-spatial scale) and object assessments (VVIQ and OSIVQ-spatial scale), respectively. A linear regression with *Composite Object Visualization* and *Composite Spatial Visualization* as predictors and *Grand-Artistic Creativity* as the criterion variable was significant, $R^2 = .11$, $p < 0.01$; while *Composite Object Visualization* significantly predicted *Grand-Artistic Creativity* ($t(95) = 2.89$, $p = .005$), the *Composite Spatial Visualization* score did not ($t(95) = -1.93$, $p = .06$). Furthermore, a linear regression with *Composite Object Visualization* and *Composite Spatial Visualization* as predictors and *Grand-Scientific Creativity* as the criterion variable was also significant, $R^2 = .11$, $p < .001$; while *Composite Spatial Visualization* significantly predicted *Grand-Scientific Creativity* ($t(95) = 3.05$, $p < .005$), *Composite Object Visualization* score did not ($t(95) = 0.79$, $p = .43$). The results demonstrated that object and spatial visualizations account for about 11% of variance in artistic as well as in scientific creativity, in contrast to only 3% of variance explained by imagery in previous studies that assumed domain generality of creativity (e.g., LeBoutillier & Marks, 2003).

Gender differences in visualization and creativity. Consistent with previous research (Blazhenkova & Kozhevnikov, 2009; Voyer, Voyer, & Bryden, 1995), the results of independent samples *t*-test (two-tailed) revealed that females scored significantly higher on object visualization than males, $t(97) = 2.09$, $p < .05$, whereas males scored marginally higher on spatial visualization than females $t(97) = 1.78$, $p = .07$.

With regard to gender differences in creativity, the literature has reported inconsistent results (Baer & Kaufman, 2008; Forisha, 1981). Our results demonstrated that females significantly outperformed males on artistic creativity, $t(97) = 1.90$, $p = .006$; and there was no difference between males and females on scientific creativity, $t(97) = 0.90$, $p = .40$.

Contribution of visualization abilities versus styles to creativity. The second goal of this study was to explore whether object and spatial visual styles had unique contributions to creativity, independent from object and spatial visualization abilities, and vice versa. To create a more reliable measure of object and spatial visualization abilities, the two computerized ability tests (MRT and DPT) were added in the analysis (only the data from the 75 participants who completed the computerized assessments are used for the analysis below).

For MRT and DPT computerized tests, the *efficiency scores*, which take into account both accuracy and reaction time, were used to avoid speed–accuracy trade-off confounds often found in the literature (Lohman & Nichols, 1990). The efficiency score was computed by dividing the proportion of correct responses by average response time after a natural logarithmic transformation (Blazhenkova & Kozhevnikov, 2010).

Both simple bivariate correlation and semipartial correlations between visualization abilities, styles, and corresponding creativity dimensions are presented in Table 2. After partialling out the shared variance between object visualization ability and object visual style, the semipartial correlation between object visual style and artistic creativity was still significant ($p < .05$), while the semipartial correlation between object visualization ability and artistic creativity was not significant. Similarly, after partialling out the shared variance between spatial visualization ability and spatial visual style, the semipartial correlation

Table 2. Simple correlations and semipartial correlations between object ability/style and artistic creativity and between spatial ability/style and scientific creativity

	Artistic-Grand		Scientific-Grand
Object-Ability	.19†	Spatial-Ability	.27*
Object-Style	.33**	Spatial-Style	.25*
Residual: OA-OS	.13	Residual: SA-SS	.10
Residual: OS-OA	.24*	Residual: SS-SA	.19†

Note. Residual: OA-OS = Object-Ability minus the shared variance with Object-Style; Residual: OS-OA = Object-Style minus the shared variance with Object-Ability; Residual: SA-SS = Spatial-Ability minus the shared variance with Spatial-Style; Residual: SS-SA = Spatial-Style minus the shared variance with Spatial-Ability.
**$p < .01$ (two-tailed).
*$p < .05$ (two-tailed).
†$p < .10$ (two-tailed).

between spatial style and scientific creativity was marginally significant ($p = .09$), while the semipartial correlation between spatial visualization ability and scientific creativity was not significant. In summary, although visualization ability and corresponding style correlate significantly with each other ($r = .35$ for object and $r = .52$ for spatial dimensions) and with corresponding creativity dimension, style predicts corresponding creativity dimensions even after removing the shared variance between ability and style.

Discussion

The results from this study demonstrated that object visualization (ability and style) relates to artistic creativity, and spatial visualization (ability and style) relates to scientific creativity, and both are distinct from verbal creativity. The three factors revealed in the factor analysis (object/artistic, spatial/scientific, and verbal/literature) are consistent with the three main modes of information processing (visual–object, visual–spatial and verbal) described in the cognitive psychology literature (Blazhenkova & Kozhevnikov, 2009; Kozhevnikov *et al.*, 2005) and consistent with the three major professional domains tapping different creativity dimensions (art, science, and communication/verbal) reported in creativity research (Kaufman & Baer, 2004; Oral *et al.*, 2007).

Furthermore, the present study challenges the foundations of the current assessments of creativity as a general ability. As reported in the current study, TTCT-picture completion and IPS-spatial creativity assessments are loaded on different factors, suggesting that these measurements assess different domain-specific creativities (in art and in science, respectively). Our data showed that the TTCT-picture completion task, which was originally designed to measure general creativity (Torrance, 1998), is in reality only measures artistic creativity. Similarly, IPS-spatial Insight-Spatial Problem Solving Task (Dow & Mayer, 2004) is related only to the scientific dimension of creativity. Overall, our findings challenge the previous conceptualizations of creativity assessment and suggest directions for further development of creativity measures. For example, some aspects of object visualization that might be important to artistic creativity, such as the ability to visualize and discriminate colours or textures, are not currently assessed by any existing creativity measures.

Furthermore, our results indicate that visualization abilities and styles play an important role in the corresponding creativity dimension. Although both style and corresponding visualization ability appear to rely on common processing resources (Kozhevnikov *et al.*, 2010), and both reliably predict corresponding creativity dimension, our current findings demonstrate that object visual style was a reliable predictor of artistic creativity even after removing shared variance between object visual style and object visualization ability. Similarly, spatial visual style marginally predicted scientific creativity even after removing shared variance between spatial visual style and spatial visualization ability. These latter findings provide further evidence for the distinction between style and ability processes and demonstrate that style requires the use of some unique processing beyond ability, which is important for creativity.

Taking into account that style is a more adaptive construct than ability and changes more flexibly depending on the socio-cultural environment, we suggest that although both ability and style predict corresponding dimensions of creativity, in some cases, styles might be a more ecologically valid construct in predicting real-life creative behaviour, such as performance in different professional domains. This supports the value of cognitive style assessments in academic and professional settings.

The current study helps to resolve the existing controversy on the relationship between imagery and creativity. In particular, the results of the study help to understand specific imagery skills that underlie creative performance in different professional domains and establish their relationships with corresponding dimensions of creativity. The findings have implications in applied fields, such as visual art/science education, personnel selection, and career planning, and should lead to efficiently conceptualized teaching and training methods for improving creative performance in scientific and artistic domains.

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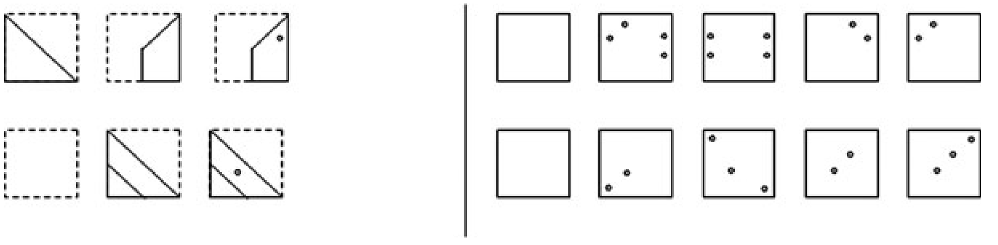
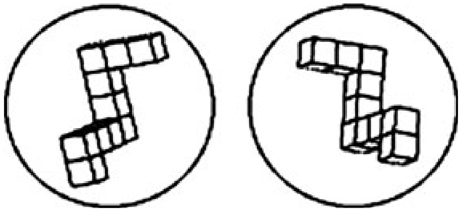
Appendix

Paper Folding Test example items

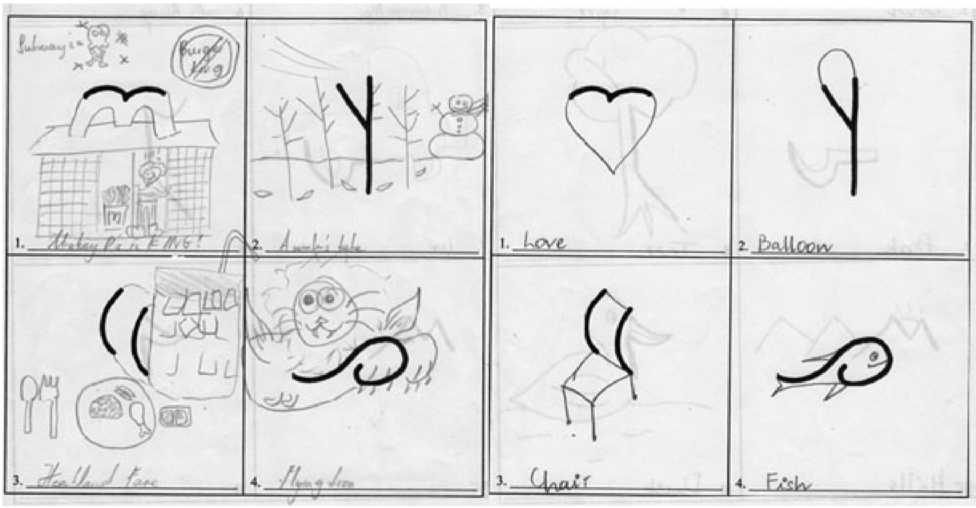


Mental Rotation Test Example item



Degraded Picture Test Example items

Torrance Test of Creative Thinking examples of two participants' responses



IPS example item

The task is to draw four continuous straight lines, connecting all the nine dots without lifting pencil from the paper.