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Imagery Vividness, Creativity and the Visual Arts

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One hundred and twenty undergraduate psychology students completed the Vividness of Visual Imagery Questionnaire-2 (VVIQ-2) and a creative behavior inventory (CBI). Of these students, 54 were selected based on their CBI scores to participate in a second testing session that included the Surface Development Test and a directed and creative mental synthesis task. Significant relationships were found between the visual art subscore of the CBI and VVIQ-2 scores and all three objective tests of mental imagery. A significant correlation was also observed between VVIQ-2 scores and divergent production on the creative mental synthesis task. A proposed explanation for past ambiguous results involving visual artists and mental imagery evaluation is offered as well as a discussion of theories of image vividness, spatial abilities, divergent thinking, and creativity.

The history of science and art abound with accounts of discoveries which credit visual images as being important sources of insight. Kekule claims to have seen a snake biting its tail in a dream — an image that suggested the structure of Benzene (Shepard, 1978). Likewise, Einstein credits visual images used with a combinational play strategy as being critical to his creative process (Ghiselin, 1952). Many visual artists have described the important role which imagery plays in their creative processes (Ghiselin, 1952; Lindauer, 1983; Rosenberg, 1987-88). Many visual artists and dance choreographers talk about their creative processes in terms of a dialogue between their mental images and the work in progress (Rosenberg & Trusheim, 1989). The impressionist painter, Paul Cezzane, summed up much of what is said about mental imagery by visual artists when he expressed a concern about creating a pictorial setting

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which did not differ much from the one he visualized in his mind (Rosenberg & Trusheim, 1989). Although introspective accounts of the creative process are frequently rejected as inaccurate (e.g., Weisberg, 1993), Hishitani (1990), in his study of expert abacus operators, found that introspective accounts of imagery utilization were highly correlated with actual imaging abilities as demonstrated in objective imaging tasks. Nonetheless, it is clear that more objective studies involving the use of mental imagery in the creative process are necessary.

To date, several approaches have been utilized to understand how mental imagery may be important in the creative process. One line of inquiry has involved correlational designs that seek to examine the relationship between various tests of mental imagery or spatial abilities and actual creative behavior. Getzels and Csikszentmihalyi (1964, 1976) found that spatial visualization ability, as measured using the Guilford-Zimmerman Aptitude Surveys subtest of spatial visualization, Part VI, Form B (Guilford & Zimmerman, 1956), was positively correlated with creative performance as measured by college art grades for all students, except a sample of "highly creative male art students." However, Getzels and Csikszentmihalyi did not discuss how the artist's performance on this test of spatial ability related to scores for non-artists.

In a second study, Winner, Casey, DaSilva, and Hayes (1991) studied the visual spatial abilities of undergraduate art students and compared them to math/science and verbal undergraduate students. Art students performed significantly better on the Surface Development Test (Ekstrom, French, Harman, & Dermen, 1976) than verbal students but slightly worse than math/science students. When scores were corrected for SAT scores, the art students performed significantly better than both math/science and verbal students. Winner and Casey (1992) also found that when SAT scores were taken into account, art students performed better at a task involving image generation than math/science students who performed slightly better than verbal students.

Finally, Kay (1996) studied professional visual artists' visual spatial abilities using both the surface development task and the Guilford-Zimmerman task. Professional visual artists who regularly exhibited their work at galleries and museums in the New York City area were compared to control participants who were graduate students at New York University and had not had an art class since high school. Using these tests, Kay found no significant differences between the visual spatial abilities of the artists and those of the control group. Thus, no definitive pattern has been observed between spatial visualization test scores and art involvement.

It is possible that one difficulty with these studies is their failure to recognize differences between art participation versus art achievement when classifying their participant samples. The use of a creative behavior inventory may provide a solution to this problem. Such checklists as those developed by Holland (1961; Holland & Astin, 1962) and Hocevar (1976, 1979) have been shown to exhibit high levels of reliability and validity in measuring creativity (Bull & Davis, 1980; Davis, 1975; Hocevar, 1981; Hocevar & Bachelor, 1989; Milgram & Milgram, 1976; Wallach, 1976). With such checklists, participants are presented with a long list of activities traditionally associated with creativity. These items cover a variety of domains (e.g., craft, visual art, music, etc.) and also place limitations on when the activity was performed (i.e., scholastic or post-scholastic) and cover both participation (i.e., simply doing an activity) and achievement (i.e., receiving some form of outside validation such as an award or an exhibition or publication). Respondents are simply asked to use a scale to indicate how many times they have performed a particular activity or received a validation (e.g. award, etc.). Thus, using creative behavior inventories as a quantitative measure of past creative behavior in a variety of domains may be collected. This measure, instead of purely occupational or scholastic groupings, may be used to characterize a population for parameters such as visual art involvement. This more accurate measure would then provide a more reliable standard for future studies of mental imagery abilities.

A second approach that has been used to study a possible mental imagery-creativity connection, are correlational designs involving imagery self-report questionnaires and traditional psychometric measures of creativity. One characteristic of visual imagery that has been extensively studied using self-report questionnaires is image vividness. Vividness relates to the *realness* of a mental image; however, images, like other manifestations of memory, are not actual mental copies of previously perceived scenes and thus vivid imagers are sometimes misled by their mental images (Reisberg, Culver, Heuer, & Fischman, 1986). In spite of the possibility of deception, vivid images may help to motivate individuals in activities requiring deliberate imagery (Shepard, 1978; Roskos-Ewoldsen, Intons-Peterson, & Anderson, 1993). One possible route for this motivation may be through the moderating process of absorption.

The Absorption Scale (Tellegen & Atkinson, 1974) was developed to measure an individual's "disposition for having episodes of total attention that fully engage one's representation, i.e., perceptual, enactive, imaginative and ideational resources" (p. 268). Richardson's (1994) meta-analysis of imagery measures found a mean correlation of .42 between AS and imagery vividness (based on three studies all with significant results). Similar results were also reported by McKelvie (1995). Imagery vividness is most commonly measured by use of the Vividness of Visual Imagery Questionnaire or VVIQ (Marks, 1973).

The VVIQ asks participants to rate details of a variety of different scenes using a scale which ranges from an image which is "perfectly clear and as vivid as normal vision" to "no image at all, you only 'know' that you are thinking of the object." Thus, it is possible that people with greater imagery vividness may be more likely to become absorbed in tasks where their mental imagery is activated and thereby focus more attention on the task at hand.

In an initial study exploring the potential link between imagery vividness as measured by the VVIQ (also referred to as the VVIQ-A) and creativity as measured by psychometric tests, Shaw and Belmore (1982-83) found that scores on the VVIQ correlated significantly with performance scores on the figure-based Circles Test and the abstraction-based Just Suppose Test from the Torrance test of creative thinking (TCTT; Torrance, 1974). Performance scores for these tasks were calculated as the sum of fluency, flexibility, originality and elaboration ratings of the individual responses. Unfortunately, Shaw and Belmore do not report correlations for the individual sub-scores and the VVIQ. In this study the Just Suppose Test requires language-based responses and the Circles Test, although figural in nature, does not specifically require individuals to use mental imagery to perform the task.

In a subsequent study, Shaw and Demers (1986) found that fifth and six graders' VVIQ scores correlated strongly with their scores on originality, flexibility and fluency sub-scales of the TCTT for a group of children with IQ's over 115. In another task involving the figural sections of the TCTT, Parrott and Strongman (1985) found that VVIQ score was significantly correlated with figural fluency and inversely related to figural elaboration. Thus, there appears to be a relationship with performance on creativity tests and image vividness. However, it is difficult to conclude whether this performance advantage for vivid imagers actually results from improved imaging performance or some other moderating mechanism because an exclusive task of mental synthesis was not utilized.

A third line of research that has attempted to explore the relationship between mental imagery and creativity has sought to develop tasks in which mental imagery is used to generate a creative product. One such task, developed by Finke, Pinker, and Farah (1989), involves directed mental synthesis. In this task participants are guided in generating and transforming a series of symbols until the mental image forms a recognizable object or symbol. The subject is asked to identify the mental image and then to draw the image. Thus, this task involves several imaging abilities which seem to be important for discovering emergent patterns in mental images, an ability which many believe is central to the imagery-creativity link.

In a second mental synthesis task (Finke & Slayton, 1988), participants were presented with a series of 15 different simple geometric and alphanumeric forms. For each trial the participant was verbally instructed to retrieve three of these parts and to use his or her mental imagery to generate a recognizable object or symbol. Unknown to the participants, their "inventions" were then rated for creativity and recognizability by several independent judges using the Consensual Assessment Technique (CAT; Amabile, 1996). In the CAT, judges are instructed to use their own subjective understanding of creativity to rate products. Thus, unlike the psychometric studies described previously (e.g., TTCT), results from a task which utilizes the CAT were not limited by a researcher's definition of creativity, but rather by use of a consensus of views to judge creativity. Using this task, Finke and Slayton studied undergraduate psychology students and found that if participants are given two minutes from image generation to report, they are able to produce recognizable inventions 38.1% of the time with 6.1% of trials resulting in highly creative product. Finke and Slayton also showed that these discoveries could not result from guessing (either by novice students or by trained experts) and required the use of mental imagery. Thus, this task allows for the assessment of creative products directly generated during a mental imagery exercise.

To date one limitation of the creative mental synthesis task has been the failure to truly measure divergent thinking. Past studies have equated divergent thinking with how many ideas participants generated over a series of trials. Although participants have been encouraged (to varying degrees) to consider more than one image for a given trial, they were not asked to record their different images so that these could be evaluated either qualitatively or quantitatively. Thus, divergent production of images has never been truly measured given that divergent thinking represents the ability to generate multiple solutions for a given problem. In order to understand how divergent thinking and image vividness may relate and how either may contribute to discovering creative images, the creative mental synthesis task must be modified to provide a true measurement of divergent thinking.

In this study we explored the relationships between image vividness, spatial ability and several tasks involving mental synthesis, all with respect to an individual's past visual art involvement. Specifically, undergraduate psychology students were prescreened for imagery vividness using the VVIQ-2 (Marks, 1995), an expanded version of the VVIQ, and past visual art involvement using Hocevar's Creative Behavior Inventory (CBI-VA). A sample of students representing a distribution of CBI-VA scores then participated in a second testing session which included the surface development test and both directed and creative mental synthesis tasks.

We predicted that significant relationships would be found between CBI scores, VVIQ-2 scores, and objective test scores of mental imagery. We also predicted a significant relationship between VVIQ-2 scores and divergent production on the creative mental synthesis task.

Method

Prescreening. Participants were prescreened using a two-part questionnaire compiled for this study. Part 1 included administration of VVIQ-2, which consists of 32 items that ask the participant to create a mental image of a scene, inspect it and then to rate its vividness using a 5-point scale. The version of the VVIQ-2 used in this study was reverse scaled from Marks' version so that increasing VVIQ-2 scores correspond to an increase in reported image vividness. The first 16 items of the VVIQ have been used extensively for rating imagery vividness (McKelvie, 1995; Richardson, 1994).

In the second part of the prescreening, participants completed the Creative Behavior Inventory (Hocevar, 1976), which was developed to assess an individual's level of involvement in a variety of activities usually associated with creativity. Of particular interest was the individual's visual art sub-score (CBI-VA; Plucker, 1999).

All tests used in this study have been found to be reliable and valid with respect to the various tasks being assessed. Reliability and validity information can be found in the various references cited for each test.

Participants. Students enrolled in a child psychology class at Cleveland State University served as participants. Individuals received extra credit for participation in the study. Participants representing the full range of CBI-VA scores obtained from the prescreening were selected (see Results section for details) for participation in a second, one-and-one-half hour session. During this session participants completed, in random order, the Surface Development Test, the directed mental synthesis task and the creative mental synthesis task. Participants were tested in groups of one to three. The experimenter conducting the testing session was blind to the participants' scores on both the VVIQ-2 and the CBI.

Task 1: Surface Development Test

The Surface Development Test from the Kit of Factor-Referenced Cognitive Tests, published by Educational Testing Service (Ekstrom, French, Harman, & Dermen, 1976), was used to evaluate participants in nonrigid image transformation. In this test, participants were presented with a series of "flattened," three-dimensional shapes which they were instructed to mentally assemble in order to match lettered edges with numbered edges on an assembled shape.

Materials and Methods. The Surface Development Test was licensed from the Educational Testing Service for $0.10 per use. Participants were given as much time as necessary to study an instruction sheet explaining the test and to complete an example. Participants were then given six minutes to complete as many of the six figures as possible. Their corrected score was determined by subtracting one-fourth of their incorrect answers from their number of correct responses.

Task 2: Directed Mental Synthesis Task

Task 2 involved a directed mental synthesis task originally developed for experiments by Finke, Pinker, and Farah (1989). In this task, participants were verbally guided in generating and transforming a series of symbols until the mental image formed a recognizable object or symbol. The participants were then asked to name the resulting mental image and then to draw their image. If they were unable to name the figure from their mental image, they were allowed to attempt to name their drawing (see Appendix A for a list of trials).

Materials and methods. A series of nine scripts asking participants to image and manipulate a series of simple figures was developed after the methods of Finke, Pinker, and Farah (1989). In order to avoid bias resulting from experimenter expectations (Intons-Peterson, 1983), scripts were recorded on cassette tape by a naive experimenter. The directed mental synthesis task was conducted using a cassette recorder to present the prerecorded scripts. A three-ring binder containing instruction sheets and the response sheets was used to record participants' answers. The task began with prerecorded instructions followed by an example trial. When the participants indicated that they understood the instructions, the testing began with Trial 1. No additional instructions were given during the trials. Each trial began with a recorded voice reading the first imaging instruction. This was followed by a 3 s pause. Subsequent instructions were then read, each followed by a pause, until the entire script had been heard. No instructions were repeated. A final announcement instructed the participants to write down the name of their mental image on the supplied response sheet. The participants were then told to draw the image and if they were previously unable to name the mental image, to name it from their drawing. The number of correct drawings was recorded as the participants' imaging accuracy score (DMS-IA) and the percentage of correctly named images which where also correctly drawn was recorded as the participants' image naming score (DMS-IN).

Task 3: Creative Mental Synthesis Task

Task 3 involved a modification of the creative mental synthesis task (CMS) originally developed for experiments conducted by Finke and Slayton (1988). In this task participants were presented with a set of 15 different simple geometric and alphanumeric forms. For each trial the participant was verbally instructed to retrieve three of these forms and use his or her visual imagery to generate one or more recognizable objects or symbols. Independent judges for both creativity and recognizability rated these images.

Materials and methods. A figure that displayed the 15 geometric or alphanumeric forms used by Finke and Slayton (1988) was prepared. Eight sets of these forms (see Appendix B) were selected based on an example provided by Finke (1990). As with the DMS task, the CMS task was conducted using a prerecorded tape with instructions read by an experimenter blind to the intent and hypotheses of the study. Instructions and response sheets were presented in a three-ring binder.

For each trial, participants were given 2 min to use three named parts to form a recognizable figure. At the conclusion of the imaging period they were instructed to record the name and draw the picture of their "best" image. In this modification of the CMS task, participants were also asked to record any other images which they thought of during the imaging period. They were reminded to only record images that they thought of during the imaging period and not to record ideas that they might think of while drawing their images. This modification of the task allowed for a true measurement of individual differences in divergent production (CMS-DV). It also allowed for analysis of differences in judged creativity and recognizability between figures which participants judged (based on their mental image) to be "best" (CMS-BC) and figures which judges believed to be most creative (CMS-MXC). Participants performed in a total of 8 trials.

Figures were coded and randomized before judging. Four judges were selected to participate in the study. Two judges were undergraduate psychology students and two judges were professional visual artists. Judges were asked to independently rate each image for creativity and recognizability as compared to other images for that trial using the Consensual Assessment Technique (Amabile, 1996). Thus, judges used their own understanding of creativity and not definitions or components that were predetermined by the investigator. Judges were asked to use a 5-point scale that ranged from not creative (1) to highly creative (5). Secondly, judges were to rate the image for recognizability, where a score of 1 indicated poor recognizability and 5 indicated a very easily recognizable image. Judges rated the images for each trial in a random order.

Results

Creative Behavior Inventory. One hundred and twenty-one students completed the prescreening questionnaire. Of these, the 31 participants who scored highest on the visual art sub-score of the Creative Behavior Inventory (CBI-VA) were contacted concerning participation in the second part of the study. Twenty-three students from this group agreed to participate. In order to complete the range of CBI-VA scores, a random sample of students from the remaining 90 prescreening participants was contacted. From this group 31 participated in the second study. The resulting distribution of CBI-VA scores ($N = 54$) was highly skewed to the low end. Thus, the natural log of the CBI-VA (CBI-lnVA) was used in all statistical procedures. The distribution of these transformed scores approached normality with a skewedness rating of -.23. The CBI-VA showed adequate internal reliability with an alpha of .73 (Cronbach, 1951).

VVIQ. Since the VVIQ-A (items 1-16) makes up the first half of the VVIQ-2, it is not surprising that these two measures of imagery vividness were significantly correlated (.90; see Table 1). In addition, each scale showed high internal reliability (alpha = .84 and .92, respectively; Cronbach, 1951). CBI-lnVA and VVIQ-2 scores were also significantly correlated (.29, $p < .05$), confirming the hypothesis that individuals with higher visual art involvement report more vivid imagery than those with lesser visual art involvement.

Task 1: Surface Development Task. There was a significant correlation (.38, $p < .01$) between CBI-lnVA and performance on the Surface Development Task (SDT; see Table 1), indicating that people with higher visual art involvement perform better on this task of spatial abilities than those with lower visual art involvement.

Task 2: Directed Mental Synthesis. There was a significant correlation between both image accuracy score (.36, $p < .01$) and image naming score (.29, $p < .05$) and CBI-lnVA (see Table 1). Imaging accuracy and image naming were also significantly correlated with SDT scores (.45, $p < .05$ and .36, $p < .01$, respectively) and with each other (.55, $p < .005$).

Table 1
Correlation Matrix

	CBI-InVA	*VVIQ*	*VVIQ-2*	*SDT*	*DMS-IA*	*DMS-IN*	*CMS-DV*	*CMS-BC*	*CMS-MXR*
VVIQ	0.28*								
VVIQ-2	0.29*	0.90***							
SDT	0.38**	0.06	0.09						
DMS-IA	0.36**	0.23	0.16	0.45***					
DMS-IN	0.29*	0.19	0.21	0.36**	0.55***				
CMS-DV	0.51***	0.37**	0.40**	0.21	0.22	0.46***			
CMS-BC	0.33**	- 0.07	- 0.01	0.34**	0.42*	0.21	0.07		
CMS-MXR	0.31*	- 0.08	- 0.06	0.31*	0.36**	0.15	- 0.07	0.90***	
CMS-MXC	0.44***	0.10	0.29*	0.33*	0.36**	0.30*	0.30*	0.86***	0.90***

Note: CBI-InVA = Visual Art subscore of the Creative Behavior Inventory; *VVIQ* = original 16 items of the Visual Vividness of Imagery Questionnaire; *VVIQ-2* = 32 item Visual Vividness of Imagery Questionnaire,;*SDT* = Surface Development Task; *DMS-IA* = Directed Mental Synthesis imaging accuracy; *DMS-IN* = Directed Mental Synthesis image naming; *CMS-DV* = Creative Mental Synthesis divergent production; *CMS-BC* = Creative Mental Synthesis rated creativity image reported to be best; *CMS-MXR* = Creative Mental Synthesis mean rated creativity of all reported images; *CMS-MXC* = Creative Mental Synthesis rated creativity of most creative image.

$p < .05^{*}$, $p < .01^{**}$, $p < .005^{***}$

These data provide a second confirmation that people with higher visual art involvement perform better on tasks involving visual imagery than those with lower visual art involvement. In addition, the significant correlations between scores on the DMS task and SDT task provide additional support for the SDT involving visual imagery.

Task 3: Creative Mental Synthesis. As previously described, creativity and recognizability ratings were recorded for each mental image. Measures for each participant were calculated as follows: (1) CMS-DV indicated the total number of images that the individual generated in all 8 trials (i.e., the total divergent output); (2) CMS-BC indicated the mean of judged creativity ratings for the images, which the participant labeled his or her "best" image for each trial; (3) CMS-BR was the judged recognizability rating for the corresponding "best" images; (4) CMS-MC indicated the mean rated creativity of all reported images; (5) CMS-MR indicated the mean rated recognizability of all reported images; (6) CMS-MXC was the mean judged creativity rating for the most creative image for each trial; and (7) CMS-MXR was the mean of the corresponding recognizability ratings. When no image was listed for a given trial (i.e., $\text{CMS-DV}_i = 0$), it was not included in calculating the mean performance scores (i.e., CMS-BC, CMS-BR, CMS-MXC, and CMS-MXR) in order not to contaminate these scores with divergent thinking.

All measures of creativity and recognizability showed significant correlations with CBI-InVA (see Table 1). The greatest of these was divergent thinking and maximum creatively (.51, $p < .005$; see Table 1). Only CMS-MXC of the creativity performance scores was significantly correlated with CMS-DV (.30, $p < .05$). Although VVIQ scores were significantly correlated with CMS-DV, they were not significantly correlated with any of the other measures of creativity or recognizability. SDT and DMS-IA spatial ability scores were significantly correlated to all measures of rated creativity and recognizability. Also of interest was a significant correlation between image naming and divergent thinking and image naming and CMS-MXC. A stepwise regression of VVIQ-2 and all spatial ability scores showed only image naming and VVIQ-2 score to be significant predictors of divergent thinking performance on the CMS task (adjusted $R^2 = .27$, $F(5, 48) = 4.94$, $p < .001$).

Predictors of Visual Art Involvement. In an effort to discover the relative importance of the various measures of imaging ability in predicting visual art involvement, CBI-InVA was regressed on several of the scores including VVIQ-2, SDT, DMS-IA, DMS-IN, CMS-DV and CMS-MXC. The resulting model accounts for 41% of the variance observed in CBI-InVA, $F(6,47) = 5.38$, $p < .001$, adjusted $R^2 = .33$. Inspection of the model showed that only CMS-DV produced a significant beta weight (.37, $p < .05$); however, the beta weight for CMS-MXC approached significance (.24, $p = .06$). Eliminating the nonsignificant variables resulted in a model which accounted for 34% of the observed variance in CBI-InVA, $F(2,51) = 13.30$, $p < .001$, adjusted $R^2 = .32$ with both CMS-DV (.40, $p < .01$) and CMS-MXC (.32, $p < .01$) yielding significant beta weights.

Discussion

It is surprising, given the general acceptance that mental imagery may be an important cognitive ability for creative people, that so little has been done to explore the mental imagery abilities of visual artists. The studies which have been conducted, whether they have used interview (e.g., Lindauer, 1983; Rosenberg, 1987-88) or have instead focused on objective measures of spatial abilities (e.g., Getzels & Csikszentmihalyi, 1964, 1976; Kay, 1996; Winner, Casey, DaSilva, & Hayes, 1991), have yielded ambiguous results. It is easy to dismiss ambiguity in the interview studies given their inadequate sample numbers and subjective techniques. However, the three objective studies deserve some explanation, particularly given the significance of the relationships between visual art involvement and the mental imagery abilities as determined in the present study. Why has this relationship not been this evident in the past?

One reason might well be considered methodological. Both Winner et al. (1991) and Kay (1996) divided participants into groups and then tested the relationship between artistic status and spatial ability using analysis of variance. Neither of these studies used designs that could capture the considerable variability in the level of actual art participation and art achievement in these groups. Consistent with this argument is Getzel and Csikszentmihalyi's (1964, 1976) findings that although there was a significant relationship between art grades and spatial ability in most art students, the relationship did not hold for very high achieving students who would most likely not have been included in the present study. In fact, when CBI-VA scores are divided into their participation (e.g., keeping a sketchbook, making sculpture, taking and developing photographs, etc.) and achievement (e.g., winning an award, being published, having an art show, etc.) components, correlations between mental imagery abilities are usually stronger with participation than achievement. It is not surprising that participation, rather than achievement, is a better predictor of mental imagery ability.

Achievement depends on many factors other than ability, including socio-economic status, education level, and the subjectivity of judging criteria used to determine the importance and value of art. In contrast, participation is a much better estimator of the actual amount of time that an artist has spent using mental imagery. Thus, the clear and significant relationship between visual art involvement and mental imagery abilities reported here most likely resulted from careful measurement of visual art achievement and participation. It is possible that if a sample of visual artists who were higher in achievement were tested instead of this sample of college students, that only their actual art participation scores and not their achievement scores would significantly correlate with their mental imagery abilities.

Also of interest was the interrelationship between imagery vividness, mental imagery abilities, and creativity. There was a significant correlation between imagery vividness as measured by the VVIQ-2 and divergent production in the creative mental synthesis task (CMS-DV). However, there was no significant correlation between VVIQ-2 score and any of the measures of creativity. This relationship between divergent production and imagery vividness is similar to the result reported by Shaw and DeMers (1986), that individuals with greater image vividness scored higher in fluency on the Torrance Test of Creative Thinking (TTCT). The TTCT is a psychometric test which defines creativity as the composite of fluency (i.e., divergent production), originality, and flexibility. Thus, unlike tasks that use the consensual assessment technique to directly judge creativity, the TTCT simply measures these three components which are operationally defined as creativity.

Shaw and DeMers (1986) also found significant correlations between the originality and flexibility sub-scores of the TTCT and VVIQ scores. Although this study did not directly evaluate the originality or flexibility of the products from the mental synthesis task, our results did not show a significant correlation between VVIQ score and judged creativity. One possible explanation for this difference is that while mental imagery may be very useful for generating ideas, it may not be as useful during the evaluation of ideas. A second piece of evidence, which appears to support this argument, is that only maximal judged creativity (CMS-MXC) was significantly correlated with divergent thinking. Thus, those who came up with more images were more likely to discover creative images. However, they were not good at choosing which image was most creative. It is possible that they used some criterion other than creativity for selecting their "best" image, although past studies involving instructions given in creativity tasks have suggested that whether an individual is instructed to be creative does not affect performance.

Finke, Smith, and Ward's (1992) Genaplore model provides a second approach to these data. In this model, the creative discovery process is divided into two phases, both of which are moderated by product constraints. In phase one, focus is on the generation of pre-inventive forms while in phase two, these forms are further explored and interpreted. Using this model to understand the creative mental synthesis task, the parts dictated at the beginning of each trial and the requirement that the resultant image be recognizable, may be understood as product constraints. Pre-inventive forms are generated using these parts and then are named and perhaps further refined through additional image transformation. While the first phase of the Genaplore model may be characterized by a rather chaotic combination of possible parts, the second phase relies more heavily on the analogical examination of these parts within the problem's broader semantic context. Placing image vividness within this model, pre-inventive forms (images) which are more vivid may be more likely to be "seen" and secondly, people experiencing vivid images may be more likely to remain engaged in the task, thereby seeing more images and perhaps further refining them. Thus, it is possible that vivid imagers may be better at discovering pre-inventive forms but are not necessarily better at exploring or interpreting these forms. Thus, while vivid imagers may be better at "seeing" possible images, they are not necessarily better at naming these images with concepts considered by the judges to be creative, and they may not be better at modifying the pre-inventive forms to create images which are considered to be creative. In fact, the relationship between VVIQ-2 score and either image naming (DMS-IN, $r = .21$) or spatial abilities (SDT, $r = .09$, or DMS-IA, $r = .16$) is much smaller than that between VVIQ-2 score and divergent production (CMS-DV, $r = .40$, $p < .005$). Secondly, while spatial abilities are only mildly related to divergent production ($r = .21$), they are significantly related to the ability to produce creative images ($r = .36$, $p < .01$). Thus, image transformation seems to be less important in discovering pre-inventive forms and more important in exploring how they may be modified to be creative.

Adding complexity to this interpretation is the observation that image naming, as measured in the directed mental synthesis task, while only mildly correlated with image vividness, seems to be related to divergent thinking ($r = .46$, $p < .005$). Thus, it appears that there may be another role for image vividness to contribute to divergent thinking than just through either improved image naming or image transformation. Tellegen and Atkinson (1974) have developed the Absorption Scale (AS) which seeks to measure the individual "disposition for having episodes of total attention that fully engage one's representation, i.e., perceptual, enactive, imaginative and ideational resources" (p. 268). Richardson's (1994) meta analysis of imagery measures found a mean correlation of .42 between the VVIQ and AS (based on three studies all with significant results). Thus, it is possible that individuals with high imagery vividness are more likely to become absorbed in tasks that involve their imagery. Thus, they may be more likely to generate more ideas from that process. In this role, vivid imagery may be seen as enhancing motivation for the task (through absorption) and thus facilitating the generation of more ideas. The notion that image vividness can be affected by context is also consistent with Ahsen's (1988, 1990) work involving the AA-Vividness of Visual Imagery Questionnaire.

Ahsen (2000) further believes that the popular conclusion that imagery vividness correlates with task performance should be seen in light of opposite evidence that such vividness also negatively correlates with task performance for developmental and functional reasons. We can understand this to be a case of negative performance where vividness is acting as a suppressor of other sensory cues. If we keep statistics of all of these dynamic occurrences under separate categories rather than averaging them out (see Hilgard, 1987), this would help advance imagery in the needed areas of functional research.

Also, as we mentioned earlier, it is possible that one difficulty with many of the studies we cited is their failure to recognize differences between art participation versus art achievement when classifying their participant samples. Ahsen (2000) makes an interesting point regarding this in terms of imagery as an ongoing feedback-feedforward internal behavior (see also Ahsen & Lazarus, 1972; Ahsen, 1990, 1993). In the section titled "30 Parallels: Activity Is Its Own Reward" (pp. 25-47), Ahsen comments that "One may say that in the human mind, rewards in the form of feelings are being internally distributed all the time for encouraging activities which need to be encouraged. Reward is not what one offers to the organism from outside, but what one draws from inside the organism as activity. The hidden has only to be brought forth, and the resource laid bare" p. 25). These are important ideas in a discussion of imagery vividness and creativity.

In addition to what Ahsen has discussed, we believe that in order to generate creative ideas in the creative mental synthesis task, one must not only generate, transform and inspect mental images (combinational play) but also use analogical reasoning to determine the creative value of these images. One must also modify them using image transformation (for which spatial ability tests such as the SDT or DMA-IA are good estimators). Thus, image vividness (VVIQ) and image naming (DMS-IN) are important for divergent production (CMS-DV) while only visual art involvement, spatial abilities and divergent thinking (CMS-DV was only significant for CMS-MXC) are significant correlates of actual creativity scores. As a result, spatial abilities such as those measured by the SDT and DMA-IA may contribute not only to image transformation but also to the analogical processes.

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Appendix A

Directed Mental Synthesis Task Stimuli adapted from Finke, Pinker, & Farah (1989)

Trial	*Instructions*	*Correct Response*
1	• Imagine the number "7" • Make the diagonal line vertical • Move the horizontal line down to the middle of the vertical line • Now rotate the figure 90 degrees to the left.	The letter "T"
2	• Imagine the letter "B" • Rotate it 90 degrees to the left. • Put a triangle directly below it having the same width and pointing down. • Remove the horizontal line	a heart
3	• Imagine the capital letter "D" • Rotate it 90 degrees to the left. • Now connect a capital letter J at the bottom, in the center	an umbrella
4	• Imagine the capital letter "Y" • Put a small circle at the bottom of it. • Add a horizontal line halfway up the vertical line. • Now rotate the figure 180 degrees	a stick figure person

(Appendix A continued)

Trial	Instructions	Correct Response
5	• Imagine the capital letter "K" • Attach a square which is the same height on the left side. • Put a square with rounded edges inside of the first square. • Now rotate the figure 90 degrees to the left.	a television set
6	• Imagine the lowercase letter "k" • Surround the letter with a circle. • Now remove the lower half of the letter, below the point where the lines intersect.	A clock showing 2 o'clock
7	• Imagine a "plus" sign • Add a vertical line on the left side. • Rotate the figure 90 degrees to the right. • Now remove all lines to the left of the vertical line.	the letter "F"
8	• Imagine the a capital letter "H" • Rotate it 90 degrees to the right. • Now place a triangle at the top, with its base equal in width to that of the figure.	A Christmas (or pine) tree
9	• Imagine the capital letter "D" • Rotate it 90 degrees to the right. • Put the number 4 above it. Make sure to use the typewritten form of the number 4 in your image. • Now remove the horizontal segment of the 4 to the right of the vertical line	a sailboat

Appendix B

Creative Mental Synthesis Task modified from Finke and Slayton (1988).

Parts for each trial of the creative mental synthesis task.

Trial 1: Letter "L," Letter "P," Rectangle
Trial 2: Circle, Rectangle, Letter "L"
Trial 3: Letter "P," Rectangle, Letter "C"
Trial 4: Letter "L," Triangle, Letter "D"
Trial 5: Letter "V," Letter "D," Letter "L"
Trial 6: Triangle, Letter "T," Horizontal Line
Trial 7: Horizontal Line, Letter "V," Square
Trial 8: Square, Triangle, Number "8"