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The Relationship Between Creative Hobbies and Visual Spatial Ability

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THE RELATIONSHIP BETWEEN CREATIVE HOBBIES AND VISUAL SPATIAL ABILITY

by

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ABSTRACT

Recent developments in educational practices have identified the teaching of STEM (science, technology, engineering, and mathematics) areas as important, but this emphasis on STEM fields has sacrificed educational focus on the arts (Cohen, 2016). This is a significant loss, not only in terms of the loss of humanities education in itself, but through the potential loss of foundational skills through practice in artistic areas. The current paper explores this idea by investigating the correlational relationship between visual spatial abilities and participation in a variety of creative activities. Spatial ability is known to be a cognitive skill that underlies success in STEM related disciplines. Though numerous studies have explored spatial ability, not much is known about how individual differences in spatial ability arise. One possible area of inquiry is personal hobbies. It seems likely that participating frequently in creative hobbies involving spatial-cognitive mechanisms would increase general spatial ability. Knowledge gained concerning the relationship between spatial ability and creative pursuits may not only support education within artistic fields, but also within science, academia, and industry. If there is a relationship between frequent engagement in creative activities and increased spatial abilities, we will have a stronger case for maintaining or increasing funding for arts education and can potentially provide a new approach to STEM pedagogy.

The intent of the proposed study is to investigate the connection between the frequency of engaging in eight extracurricular activities (e.g. literature, music, arts-and-crafts, creative cooking, science and engineering, sports, visual arts, and performing arts) and whether or not engagement in these activities corresponds with increases in spatial ability.

DEDICATIONS

To my father and mother for supporting me through this whole process. Thank you for always being here for me and for encouraging me to never give up. You have inspired me with your exemplary demonstrations of faith, hope, and love.

To my brothers for calming me down whenever I am stressed. Thank you for all the laughs, food, and jam sessions. You both are major influences on my research.

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To my close friends for your patience and understanding. Thank you for reminding me that I'm never alone.

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INTRODUCTION

Imagine you are an artist standing in front of your easel with a lovely family seated before you. Instinctually, you begin examining each intricate the detail of the individuals and their surroundings. You observe depths and perspectives, consider increasing and decreasing the scale. As your mind observes the angles, decides on colors, and finally manipulates brushes on canvas to recreate the display, your painting comes to life. In this example, you are mentally translating the three-dimensional objects of focus into a two-dimensional work of art and unknowingly using a cognitive capacity called spatial ability to achieve this.

The first time one attempts a creative project like the example above, the process may be taxing; however, with practice the process becomes easier each time the artist puts brush to canvas. Spatial visualization is a crucial cognitive skill needed to perform such a task, and it may be one of the skills that are strengthened with each practice session. The skills needed to articulate the imagery through a painting resemble those required in spatial ability psychometrics commonly correlated to STEM (science, technology, engineering, and mathematics) success. Is it possible that frequent participation in some creative hobbies implicitly train spatial ability? If so, can this be transferred into spatial abilities needed to succeed in STEM? The current study will explore these questions. The implications may suggest that integrating the study of the arts will further drive the goal of the National Science & Technology Council goals of creating world leaders who are not only well versed in their prospective STEM subject matter but those who are also able to communicate clearly and think innovatively (Executive Office of the President, 2018).

Spatial Ability

Dating back to the late 1800s when Sir Francis Galton observed variations in the ability to visualize a breakfast table across 100 participants (Galton, 1883), the capacities of mental imagery and spatial ability have been subjects of interest for psychologists. Spatial ability can be defined as the cognitive ability to interact with mental images, including the ability to produce, manipulate, and interpret these images (Jeunet et al., 2016). Spatial ability is complex and multifaceted allowing us to complete seemingly mundane tasks (e.g., navigating our way to turn on the light in the dark) to more astounding accomplishments (e.g., designing the Leaning Tower of Pisa). Due to the immense diversity within its execution, researchers believe spatial ability involves three primary factors (Thurstone, 1950): 1. the ability to recognize the identity of an object in various positions and angles, 2. the ability to imagine the movement and transformations of an object, and 3. the ability to understand elements of an object relative to one's own orientation. The first and third factors are commonly referred to as spatial orientation, whereas the second as spatial visualization (McGee, 1979).

Spatial Orientation

Spatial orientation is a function within spatial cognition that allows individuals to create mental maps, understand the space between various objects, and the movement of an object relative to one's own orientation (whether that be imaginary or physical). Hegarty and Waller (2004) described spatial orientation as one's "ability to make egocentric spatial transformations" as one's reference changes in relation to the environment, though the "object-based and environmental frames" remain constant (p.184). Researchers may take various approaches in measuring spatial orientation. For example, participants may be asked to navigate their way through a virtual scene (Gagnon et al., 2018) or to imagine themselves as an object interacting with other objects (Borella et al., 2014).

Spatial Visualization

The second factor of spatial ability, spatial visualization, involves processes in which one is able to mentally understand transformations and manipulate visual objects and spatial patterns (Michael et al, 1957; Ekstrom et al., 1976). There are a plethora of ways to test spatial visualization ability. Most spatial visualization tests require individuals to use their imagination to manipulate an object. Examples of these types of psychometrics include mental rotation tasks and paper-folding tasks. Mental rotation tasks typically ask participants to indicate which objects, if rotated, would be exactly the same. The items may be presented in pairs where the participant is asked to identify if the two objects are intrinsically the same or intrinsically different (e.g., Shepard & Metzler, 1988), or the objects may be shown among distractors such as mirror images or different shapes where participants are asked to identify the objects that are the same (e.g., Vandenberg & Kuse, 1978). In paper folding tasks, a participant may be shown a folded piece of paper with a single hole punched into it. Participants are asked what the unfolded paper would look like; i.e. to identify where the holes in the paper would be (Ekstrom et al., 1976).

Spatial Ability and STEM

Within STEM, researchers have found significant correlations among academic learning, success in industry, and spatial ability (Gilligan et al., 2018; Humphreys et al., 1993; Lubinski, 2010; Shea et al., 2001; Wai et al., 2009; etc.). Spatial ability tasks have even been used as predictive measures within engineering, physics, and even the military (Gohm et al., 1998) because individuals who succeed within STEM have been found to have notably strong spatial abilities (Wai et al., 2009). Unlike many cognitive functions, spatial ability is malleable (Uttal et al, 2013), thus it is believed that it can be strengthened with proper training (Burte et al., 2017; Hawes & Ansari, 2020). Furthermore, it is predicted that if students are able to strengthen spatial abilities, they may have higher achievements in STEM (Uttal et al., 2013). Burte et al., (2017), suggests that developing spatial abilities during elementary school, along with other foundational cognitive abilities, may yield more promising and sustained improvements within STEM than those currently found among high school and college students. Numerous studies have supported this idea by finding significant improvements in STEM subjects among younger students (Burte et al., 2017; Mix et al., 2020). Research concerning spatial ability training and STEM improvement has a promising future (Stieff & Uttal, 2015).

Creativity

Like most cognitive capacities, creativity is complex in nature and can be expressed in many different ways. Though the definition of creativity has taken a variety of forms throughout history, most scholars agree that in order for something to be described as creative, it must be both novel and of value (Kaufman, 2009; Smith et al., 1995; Stein, 1953). This novel production, according to Smith et al., (1995), can be found at three levels: 1. novel to humanity, 2. novel to a specific culture/society, 3. novel to an individual. Despite which level a creation may fall into, someone is experiencing something new. The novelty experienced can propel our society into further advancement through creative innovations, unique approaches to problem solving (Suh & Cho, 2020).

Creativity and STEAM

Long ago Einstein said, “The greatest scientists are always artists as well” (as cited in Rolling, 2016, p.5). Creativity is an indispensable tool in STEM when formulating hypotheses, designing projects, and solving problems (Daker et al., 2020). Unfortunately, instead of using the arts to promote creativity within students in STEM, arts programs are dwindling out of educational institutions (Perry & Collier, 2018). Consequently, students often find it difficult to be creative within their respective fields (Chien et al., 2020). The arts may serve to be a bridge between creativity and STEM (Conradty et al., 2020). For example, aspects of the arts have been used to break creative barriers (e.g. cognitive traps like functional fixedness), and consequently promote innovative thinking (Katz-Buonincontro, 2008). Creative education is needed in schools, but instead of reinventing the wheel, it may be beneficial to use the tools we know to naturally induce creativity: the arts.

A newer term, STEAM (science, technology, engineering, arts, and mathematics), was created to reflect the importance of the arts and humanities in STEM learning. Incorporating the arts into education allows students to develop soft skills such as communication and real-world application that are also fundamental to their success (Innella & Rodgers, 2021). It also creates an environment conducive for growth in critical thinking skills (Deogracias, 2019). Often, STEAM initiatives have been used as a way of inhibiting boredom in classrooms (Lynch, 2017), however, when the arts are integrated into the curriculum in engaging, meaningful ways it can become an integral part of student success within STEM fields (Monkeviciene et al., 2020).

Spatial Ability, Creativity, and Domain Specificity

There is discussion regarding whether or not strengthening spatial ability in one domain will be transferable to other domains requiring that ability. For instance, routinely attending dance classes likely uses spatial visualization skills that presumably improve with each class attended. However, if this hypothetical dancer were to have to navigate through the streets of a new town, would those abilities transfer to this new domain of navigation; or would those skills be available only in the context of dancing. Some studies suggest that spatial ability as a general cognitive capacity that can be strengthened with the right training (Wright et al., 2008), and that these skills can be transferred into other areas such as education (Temple et al., 2020). The idea is that training and practice will change the way individuals process spatial stimuli which could be translated into “novel stimuli and new tasks” (Wright et al., 2008, p. 763). In contrast, other researchers believe spatial ability psychometrics measure specific, isolated skill sets that do not represent spatial thinking in its entirety (Atit et al., 2020). In general, the type of training or area of expertise individuals receive may strengthen their spatial skills needed in that domain (i.e., Brandt & Wright, 2005; Ishikawa, 2013), however, the innate ability to transfer such skills remains under investigation. For example, many musicians are required to hold mental images of their instrument as they move their fingers along the space to translate written manipulations of space and time into melodies (also known as sight-reading). Similar processes of spatial translation and manipulation are required in STEM subject learning, yet not every musical student naturally recognizes this association. This is important because if spatial ability is not a transferable skill across domains, then there isn’t a connection between the arts and STEM. However, the hypothesis for the present study is that spatial ability is transferable; therefore, the spatial skills acquired during the learning and practice of the certain arts will be highly associated with spatial visualization.

A similar debate has been ongoing among researchers of creativity: is creativity a generalizable cognitive ability or it is a capacity that is restricted to a professional domain. This question has been further complicated by the diverse ways of measuring creativity as a cognitive capacity. Due to the complexity and nature of creativity, it has been difficult for researchers to produce consistent empirical findings concerning its cognitive processes and mechanisms (Simonton, 2012). Since most creativity psychometrics used in these studies often focus on one aspect of creativity, some scholars suggest that the inconsistencies found within literature are the result of domain specificity (Baer, 1993; Funke, 2009). One aspect of creativity that requires further exploration is its relationship with spatial cognition. The present paper does not investigate creativity as a cognitive capacity rather, it investigates whether or not activities thought to be creative are associated with a particular cognitive capacity: spatial ability.

However, the mechanisms underlying spatial cognition's malleability and the extent in which it can be transferred, assuming transference is possible, requires further investigation. It remains unknown if these skills can be transferred across domains as some may suggest (ie. Uttal et al., 2013), or if training is domain specific as others may believe (ie. Palmiero et al., 2010).

Current Study

As of now, the majority of research concerning the correlations between STEM and spatial ability uses psychometrics designed to test spatial visualization (Hawes & Ansari, 2020). In effort to test spatial skills more comparable to those frequently utilized in STEM fields, new psychometrics were developed. One of these new tests is the Santa Barbara Solids Test (SBST) designed by Cohen and Hegarty (2008). The researchers understood that cross-sectional skills are particularly useful in many areas of STEM (e.g. geology, engineering, and anatomy). In response, they designed this spatial cutting task to directly test these skills with future aspirations to see if training in such a task can improve academic success in STEM. Because the aim of this proposal is to understand the relationship between creativity and spatial ability with implications in STEM learning, the Santa Barbara Solids Test will be used to measure spatial visualization ability.

While there is research concerning the relations between specific cognitive mechanisms of creativity and spatial ability, at present there is no study that has examined the effect of active participation in creative activities on spatial ability. For this reason, a questionnaire regarding the frequency and level expertise in creative hobbies called the Inventory of Creative Activities and

Achievements (ICAA) will be used and correlated with the SBST to examine how each activity relates to spatial visualization ability. This inventory asks about the activities and achievements across 8 domains: literature, creative cooking, visual arts, arts and crafts, science, sports, performing arts, and music. There is little evidence relating many of these activities to types of spatial ability, so the hypotheses about how activities utilize different kinds of spatial abilities is intuitive.

Music has been one of the most studied creative activities in relations to spatial ability. Rauscher, Shaw, and Ky (1993) found an improvement in spatial tasks after students listened to a Mozart sonata (commonly referred to as "the Mozart effect"). Since then, researchers have attempted to replicate this effect, and further explore the relationship between music and spatial cognition. In 2012, Pietsch and Jansen found musicians to score higher on mental rotation tasks compared to academic students. As mentioned earlier, a possible explanation for this can be due to the frequent rehearsal of complex spatial tasks while sight-reading. Their training requires an understanding of unique spatial positions which plausibly leads to high spatial performance (Pietsch & Jansen, 2012).

Visual arts, including arts and crafts are likely to be related to spatial visualization because it requires individuals to analyze and interpret transformations (i.e, size or position) of an object of interest (Orde, 1997) through mental visualizations before producing their art piece. Literature concerning the relationship between visual arts and spatial ability has been mixed. A team of researchers (Salthouse et al., 1990) asked both active and retired architects, as well as nonarchitects to complete a spatial visualization test. They found that the architects completed the task with greater accuracy than their counterparts. However, when artists were compared to individuals involved in other spatially demanding fields such as mathematics and science, this effect was no longer found (Casey et al., 1990; Hermelin & O'Connor, 1986).

Performing arts and sports are likely to be related to spatial orientation. Currently, it is unknown how that will reflect on the spatial visualization measure. It is likely that there is a positive relationship; i.e. that spatial orientation skills are positively related to spatial visualization skills. Finally, cooking and literature are unlikely to be correlated with spatial visualization because they don't intuitively involve spatial skills, and there is no evidence in the literature to support this connection.

It is clear that STEM is important to further our society, and spatial abilities are important to success in STEM. Therefore, in showing that the arts facilitate spatial ability, and this ability can be captured on a test of general spatial ability, we have more support for maintaining the arts education within academic institutions. Based on previous literature the following three hypotheses were formulated:

Hypothesis 1: Frequency of engagement in hobbies that rely on spatial visualization (specifically, arts and crafts, visual arts, music, and science) will be positively correlated with a spatial visualization test. This would support the theory that these skills are transferable across domains.

Hypothesis 2: Frequency of engagement in hobbies that rely on spatial orientation (namely, performing arts and sports) will be positively correlated with a spatial visualization test. This would support the theory that there is a degree of generalizability across types of spatial skills.

Hypothesis 3: Frequency of engagement in hobbies unrelated to spatial ability (specifically, cooking and literature) will be uncorrelated with spatial visualization ability. This would provide further support for the concept of transference across domains by establishing a baseline.

METHODS

Participants

Eighty undergraduate students from the University of Central Florida were recruited to participate in this study through the UCF undergraduate SONA subject pool. The average age of participants was 20.94 with a standard deviation of 3.99, and 66.25% were female. Furthermore, 51.25% identified as Caucasian, 17.5% Hispanic/Latino, 15.0% Black/African American, 5.0% Asian, 1.25% American Indian/Native American, and 1.0% undefined. There were 48 students identified as either a freshman or sophomore, and 29 as a junior or senior. The remaining 3 classified themselves as “other”.

Participants were given an online explanation of research in lieu of a consent form in alignment with IRB protocol. One SONA experiment participation credit was granted at the end of the study as compensation. No monetary compensation was given for participation. The entire study was administered online using SONA (http://ucf.sona-systems.com/) and Qualtrics, an online survey platform. Since this study was fully online, participants needed to have access to a desktop or laptop with stable internet connection during the time of the study.

Materials

Santa Barbara Solids Test (SBST). The SBST (Cohen & Hegarty, 2007; Cohen & Hegarty, 2012) is a 30-item spatial cutting task in which participants are asked to imagine what the cross-sections of a three-dimensional image would look like as a two-dimensional image. There are three types of geometric structures: simple, joined, and embedded. Each of these structures will have one of the two cutting planes: orthogonal or oblique. The levels and planes are equally distributed throughout the task. An example of a simple figure with an orthogonal cutting plane can be found in Appendix A. The internal reliability was reported to be Cronbach's α =.86 (Cohen & Hegarty, 2007).

Inventory of Creative Activities Assessment (ICAA). The ICAA (Diedrich et al, 2018) is a questionnaire that assesses personal and public real-life creativity across eight domains: literature, music, arts-and-crafts, creative cooking, sports, visual arts (graphics, painting, sculpting, architecture), performing arts (theatre, dance, film), science and engineering. Within these eight domains, six activities and eleven levels of achievement are assessed. Participants are asked to answer each question based on their experience within the last ten years. There is an example presented in Appendix B. The Cronbach's alpha including all creative activity subdomains was α = .926 (Dumas et al., 2020) . Alpha levels of individual subdomains are ranged as follows from lowest to highest: literature (α = .800), visual arts (α = .826), cooking (α = .874), performing arts (α = .876) arts and crafts (α = .90), and music (α = .909) (Dumas et al., 2020).

Demographics Questionnaire. Finally, a background questionnaire was administered to gather data concerning the basic demographics of participants including educational level, age, major, ethnicity, and sex.

<u>Procedure</u>

This study was available online through SONA and Qualtrics, and was completed in a single session. Before beginning the study, participants had the opportunity to read an online version of the explanation of research which gave an overview of the experiment. Next, the participants were asked to complete the following three tasks in the given order: 1. Santa Barbara

Solids Test, 2. Inventory of Creative Activities Assessment, and 3. Demographics questionnaire. Participants were given a sample problem of the SBST before beginning the test. Each task was divided into blocks. Participants were given the opportunity to take a brief break at the end of each block, and were required to press “continue” via mouse click or screen press.

RESULTS

Pearson bivariate correlations were conducted on the 8 subscales of the ICAA with the SBST. The correlation matrix is reported in Table 1. Due to a lower than expected number of participants, results were calculated for the creative activity subscale of the ICAA only (not the creative achievement subscale). A one-tailed test with an alpha level of .05 determined statistical significance.

Table 1. Correlations of Creative Tasks with Spatial Abilities

	Literature	Music	Arts and Crafts	Cooking	Sports	Visual Arts	Performing Arts	Science
Pearson Correlation	.201*	.498**	.299**	.217*	.081	.0168	.2222*	.016
p value	.037	.001	.004	.027	.237	.069	.024	.445

Note. n = 80

Because multiple correlations were calculated, a Bonferroni adjusted alpha of .00625 was used. At this conservative alpha level, the following 2 subscales of the ICAA were determined to be significantly correlated with the SBST, presented in order of statistical significance: music, $r(80) = .489$, $p < .001$, and arts and crafts, $r(80) = .299$, $p = .004$. Also of note were 3 correlations that approached significance, including performing arts $r(80) = .222$, $p = .024$, cooking $r(80) = .217$, $p = .027$, and literature $r(80) = .201$, $p = .037$. All other subscales were not found to be significantly correlated with SBST. Figure 1 presents a bar graph representing the correlation coefficient of each subscale of the ICAA with the SBST, grouped by type of spatial ability.

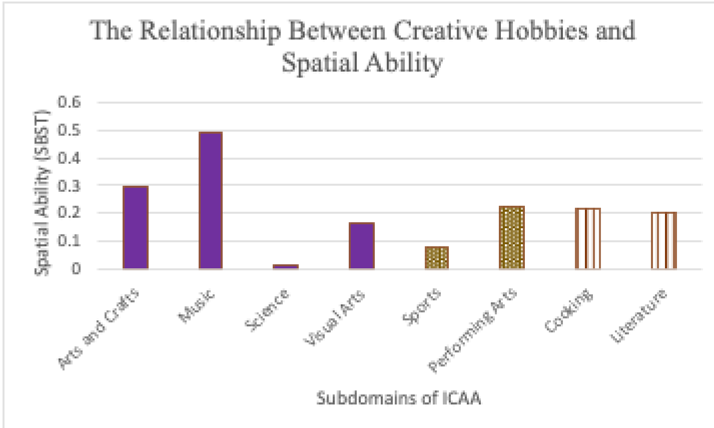


Figure 1. The correlation coefficients for each subscale of the ICAA with scores on the SBST. Solid color identifies correlations with domains which rely on spatial visualization, dotted patterned bars identify domains relying on spatial orientation and striped pattern identify subdomains with no known relationship with spatial ability.

DISCUSSION

The purpose of the present study was to identify and examine possible relationships between engagement in creative activities and spatial ability. It was hypothesized that participating in activities that more evidently involve spatial visualization skills (such as the visual arts) would result in better performance on the SBST compared to the other creative domains. Additionally, it was also hypothesized that activities relying on high degrees of spatial orientation (such as performing arts) would be positively correlated with spatial ability. Finally, it was hypothesised that activities that don't seem to involve spatial abilities, such as cooking and literature, would not have a statistically significant impact on spatial visualization skills.

There was mixed support for Hypothesis 1 with only 2 out of 4 correlations showing a significant predicted effect. Unexpectedly, engagement in the visual arts had no statistical relationship with spatial visualization though it was climbing in the predicted direction. It is possible that visual arts did not reach statistical significance due to the small sample size of participants engaged in this domain. Previous literature is itself mixed. There has been literature suggesting that experience and expertise within certain subdomains of visual arts (i.e., architecture) may aid in spatial task performance (Salthouse et al., 1990). However, more correlations with the visual arts in general have found results similar to the current study. While other aspects of spatial cognition appear to be strengthened through artistic practices (i.e., spatial reasoning, Hermelin & O'Connor, 1986), it does not seem to be advantageous in spatial visualization tasks (Casey et al., 1990). The other subdomains have little to no research regarding its effect on spatial ability thus leaving a gap in this line of literature. This pattern has been found among all the creativity activity domains, and serves to be a limitation to the study. It would be beneficial for future studies to correlate specific activities within the subdomains to see if there is a specific aspect of the creative activity that leads to higher spatial skills.

It was also unexpected that science would have no statistical significance when correlated with spatial ability. Many researchers have found high visual spatial ability and STEM success to be positively correlated (Gilligan et al., 2018; Gohm et al., 1998; Lubinski, 2010; Wai et al., 2009, etc.). The findings of the current study may be due to the aspects of scientific activities examined. The ICAA asked questions regarding the formulation of new material within science (ie., developing a computer program, utilizing an original technical track, writing a scientific paper, etc.). Within the literature, however, spatial ability is correlated with more technical aspects of science such as the interpretation of medical images (Hegarty et al., 2007).

The statistical significance found with music is supported by research (Pietsch & Jansen, 2012; Sluming et al., 2007; Tucker, 2019). Those who frequently engaged in musical hobbies had the highest positive correlation with the SBST. The cause of the correlational relationship remains unclear. Further research is required to test the reliability of both these findings as its implications may prove itself useful in incorporating music into academic curriculum.

Within the arts and crafts domain, it is purported that the tactical nature of the hobby may be a reason why its participants perform well on spatial ability tasks. While within the field of education, arts and crafts are used to build spatial awareness among preschool and elementary students, the particular aspects within this creative domain have not been thoroughly studied in relation to spatial ability. The results of this study indicate a positive relationship between the two, yet more research is needed to support this finding.

Hypothesis 2 was not supported at the adjusted alpha level, however, the correlation with the performing arts was in the predicted direction and approaching significance, lending some support that training in tasks requiring a high degree of spatial orientation may also facilitate spatial visualization, However, more research must be done with more participants. Also, Hypothesis 3 was confirmed at the adjusted alpha level, but these relationships were approaching significance. With more participants, it will be possible to determine if this relationship remains stable, or if cooking and literature are domains worth investigating in terms of their relationship to spatial ability.

Limitations

For future studies it would be beneficial to administer more traditional spatial tasks such as mental rotation so that results can be more easily compared to results found in literature. It is also suggested to incorporate more than one spatial task into the study to ensure the correlations are generalizable across spatial ability and not specific to a particular psychometric. Further research is also needed to explore how specific activities within creative domains and their respective subdomains may influence spatial ability. Furthermore, the sample size of the current study serves as a limitation since it restricted diversity within each domain and subdomain. Finally, it can be assumed that a larger sample size would better solidify the effects of creative activities on spatial ability.

Implications

When advocating for creative activities to be incorporated into education, the emphasis is generally placed on cultivating creativity for its own sake or improving social cognition within students. The intent of the present study was not to detract from the importance of those goals rather to add to the list of benefits derived from the participation in creative hobbies. Thus, we may begin bridging the gap between STEM and the arts by investigating a cognitive ability each domain has in common: spatial ability. Identifying a relationship between frequent engagement in creative activities, such as performing arts, provides a stronger case for maintaining or increasing the arts in education.

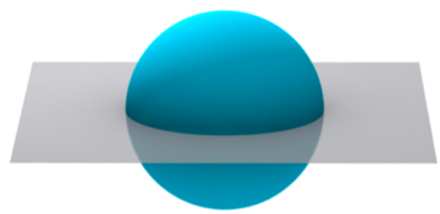
While there is still much to learn concerning spatial ability and its intricate nature, the results of this study indicate some level of transferability to occur across domains. The findings implicate that certain activities can be used to build cognitive skills necessary for success and retention in STEM fields. It is possible that new curriculum can be developed and incorporated into educational systems focusing on building spatial ability through fun and engaging activities. This methodology may attract more underrepresented students to STEM learning, and increase their retention in STEM fields. Nonetheless, the implications of this study provide a means in developing successful, innovative thinkers in our society.

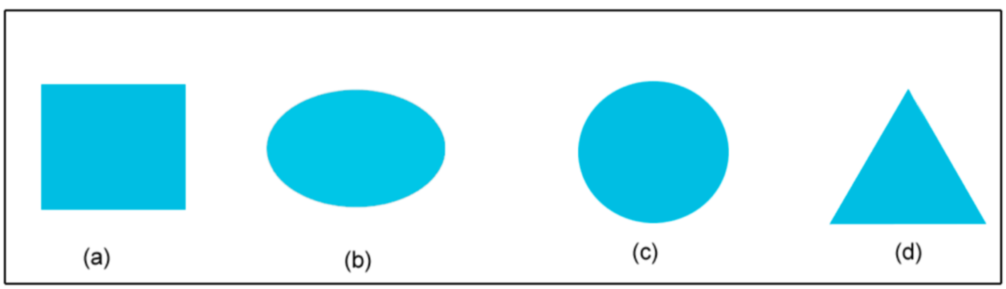
APPENDIX A: SANTA BARBARA SOLIDS TEST (EXAMPLE)

Santa Barbara Solids Test (*example*)

From Cohen & Hegarty 2007

Sample Problem





Instructions:

Circle the cross-section you would see when the grey cutting plane slices the object.
Imagine that you are facing the cutting plane head-on, as if you were looking in a mirror.
Make your choice based on the shapes of the possible answers, not their sizes.

This is an untimed test. Work at your own pace.
You can ask the experimenter a question at any time.

APPENDIX B: INVENTORY OF CREATIVE ACTIVITIES AND ACHIEVEMENT (EXAMPLE)

Inventory of Creative Activities and Achievement (*example*)

From Diedrich et al., 2018

Here is an example:

Question 1:
Specify how many times you have carried out a certain activity over the last 10 years.

Example: If you already invented your own magic trick four times, but never invented your own circus program, mark the boxes as follows:

	Never	1-2 times	3-5 times	6-10 times	More than 10 times
Made up a circus program	X				
Invented a magic trick			X		

Question 2:
In question 2, please specify the level of achievement you have attained in the particular field. You are given the same eleven choices in every domain. Please check all statements that describe your level of achievement in the whole field.

Example: If you already invented magic tricks, then you already tried this domain and produced your own original work. If you already showed them to friends but not yet to strangers, please mark the boxes as follows:

o 0. I have never been engaged in this domain
X 1. I have tried this domain once.
X 2. I have already created at least one original work in this domain.
X 3. I have shown my original work in this domain to some friends.
o 4. I have shown my original work in this domain to strangers.
…

Question 3:
Please state for how many years of your life you have already been engaged in this domain. Consider only voluntary activities of the particular domain, and ignore any activities that you were required to do, e.g. for school.

Example – Field Humor: If you have been inventing magic tricks for 3 years and have been making up funny short stories for 5 years, your answer to this question should be: 5 years.

APPENDIX C: DEMOGRAPHICS QUESTIONNAIRE (6 ITEMS)

Demographics Questionnaire (6 items)

1. What is your current age? ________
2. What sex were you assigned at birth? (What does your original birth certificate say?)
    a. Male
    b. Female
3. If you are comfortable, please describe your current gender identity. (i.e., cisgender-male, non-binary, transgender, etc.) _________
4. What is your college? (select all that apply)
    a. College of Arts and Humanities
    b. College of Business
    c. Burnett Honors College
    d. College of Community Innovation and Education
    e. College of Engineering and Computer Science
    f. College of Graduate Studies
    g. College of Health Professions and Sciences
    h. College of Medicine
    i. College of Nursing
    j. College of Optics and Photonics
    k. Rosen College of Hospitality Management
    l. College of Sciences
    m. College of Undergraduate Studies
    n. Pre-Professional Programs
5. What best describes your academic status?
    a. Freshman
    b. Sophomore
    c. Junior
    d. Senior
    e. Graduate
    f. Other
6. How would you describe yourself? (select all that apply)
    a. American Indian/Native America
    b. Asian
    c. Black/African American
    d. Hispanic/Latino(a)
    e. White/Caucasian
    f. Pacific Islander
    g. Other
    h. Prefer not to disclose

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