Object-spatial imagery in Fine Art, Psychology, and Engineering

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1. Introduction

The term cognitive style refers to the ways individuals process information. It is related to a series of skills that can be enhanced using appropriate teaching and learning strategies. Knowing the way university students process information is of the uttermost importance for the design of effective educational programs, which could allow the development of better working strategies and ways to improve students' performance (Cho, 2017; Höffler, Koć‑Januchta, & Leutner, 2017).

Despite substantial research on cognitive style, there is a lack of clarity in terms of differentiating image cognitive styles (see Höffler et al., 2017). This study explores cognitive styles and spatial ability in different academic disciplines and, taking into account the variable of gender, compares the different cognitive styles of students of Fine Arts, Psychology and Engineering.

1.1. Verbalizer–visualizer dimension of cognitive style

The debate about information processing posits two possible types of coding of mental information: visual or verbal. A classic approach (e.g. Paivio, 1979, 1983, Richardson, 1977) identifies two processing styles according to the user's preference for one code over the other. Individuals who prefer a visual processing style are called visualizers. Visualizers first use mental images in information processing while thinking, remembering, solving problems, etc. Individuals who use a verbal processing style are called verbalizers. They use verbal strategies based on linguistic signs while processing information. Although the concepts of visualizers and verbalizers are still in use (e.g. Höffler et al., 2017), this approach implies a unitary vision of mental images that is contrary to recent findings from the fields of neuroscience and cognition. These findings revealed the existence of ventral (object) and dorsal (space) visual processing streams (Goodale & Milner, 1992) and showed that the two image sub-systems codify and process visual images differently. They also supported the existence two types of visualizers who may prioritize one type of visual processing over the other (e.g. Kosslyn, Ganis, & Thompson, 2001; Kosslyn, Thompson, Sukel, & Alpert, 2005). Object visualizers focus on the literal appearance of objects and are skilled at envisioning visual details such as colour, form, brightness, etc. Spatial visualizers, on the other hand, focus on spatial relations among objects, their parts, location, movements and spatial transformations (see, Blajenkova, Kozhevnikov & Motes, 2006; Lacey, Tal, Amedi, & Sathian, 2009).

1.2. Object-spatial-verbal cognitive style in different disciplines

On the basis of the distinction between object and spatial imagery, several studies were carried out to examine the image cognitive style in different professional categories (Blazhenkova & Kozhevnikov, 2009, 2010; Kozhevnikov & Blazhenkova, 2013). Those studies assumed that certain occupations required skills related to a specific cognitive style and conferred a preeminent status to experience in the development of such skills. Broadly, previous studies showed that the object visual ability is closely related to specialization in visual arts and such processing favours the creative process of visual artists (Blazhenkova & Kozhevnikov 2010; Kozhevnikov & Blazhenkova, 2013; Kassels, 1991; Miller, 1996; Rosenberg, 1987; Winner, 1997). In contrast, the spatial visual ability was linked to specialization in Science. Scientists define their images as abstract and schematic and show preference for spatial images (Blajenkova et al., 2006; Blazhenkova & Kozhevnikov, 2009, 2010; Lindauer, 1983).

The visual abilities preferred by professional bodies are reflected in the academic world. Each single degree has certain competences that require improvement in a particular set of skills that are tied to a certain cognitive style. Accordingly, many studies investigated the cognitive style and the visual imagery skills needed in different academic disciplines (Blazhenkova & Kozhevnikov, 2009; Kozhevnikov, Kozhevnikov, Yu, & Blazhenkova, 2013; Pérez-Fabello, Campos, & Campos-Juanatey, 2016). Comparably to the observed with different professionals, Fine Arts students preferred object image processing (Kozhevnikov et al., 2013; Pérez-Fabello et al., 2016), while spatial visual abilities were associated with scientific creativity (Cho, 2017; Kozhevnikov et al., 2013). High school students from Science and Humanities reveal differences in their object cognitive style two years ahead of University entry; similar divergent preference was observed in the verbal cognitive style of Art and Science students (Campos & Castro, 2016).

1.3. Object-spatial-verbal cognitive style and gender

Many differences in mental imagery skills have been reported between men and women (see, Campos, 2014). The findings differ depending on the kind of mental image or the kind of measure involved. In self-evaluation tests on image vividness, the results showed significant differences in gender, with the best scores obtained by women (Campos & Pérez, 1988a; Campos, Pérez-Fabello, & Gómez-Juncal, 2004; Campos & Sueiro, 1993; Harshman & Paivio, 1987; McKelvie, 1986), while others found no significant differences between men and women (Ashton & White, 1980; Campos, 2014; Campos, González, & Amor, 2002; Campos & Pérez, 1988b; Campos & Pérez-Fabello, 2005; McConkey & Nogrady, 1986). On the other hand, performance in skills related to spatial images favour men (Blazhenkova, & Kozhevnikov, 2010; Campos, 2012; Campos, 2014; Campos et al., 2004; Campos-Juanatey, Pérez-Fabello, & Campos, 2017; Pazzaglia & Moé, 2013; Voyer, 2011). Interestingly, the Measure of the Ability to Form Spatial Mental Imagery (MASMI) showed no meaningful differences between men and women (Campos, 2009, 2013).

Research on cognitive style revealed that men show a significantly better performance in the spatial image scale than women (Blajenkova et al., 2006; Blazhenkova & Kozhevnikov, 2009, 2010; Blazhenkova, Becker, & Kozhevnikov, 2011; Campos, 2014; Cho, 2017; Pazzaglia & Moè, 2013), whereas women have better scores than men in object image (Blazhenkova et al., 2006; Blazhenkova & Kozhevnikov, 2009, 2010; Blazhenkova et al., 2011; Campos, 2014; Cho, 2017; Pazzaglia & Moè, 2013). No significant differences were found in the verbal scale (Blazhenkova & Kozhevnikov, 2009; Blazhenkova et al., 2011; Campos, 2014; Pazzaglia &Moè, 2013).

1.4. Aims

Continuing and expanding previous studies, this work aimed at a deeper understanding of the cognitive styles in three university degrees, namely Humanities, Science and Technology, which had never been compared before. Furthermore, the spatial image ability was measured with a test that has been scarcely used in previous research. In particular, we were interested in evaluating the cognitive styles of students of Fine Arts, Psychology, and Engineering as well as eventual gender differences. Equally, the cognitive style of spatial image was also measured to investigate differences in image rotation and spatial image as well as gender differences.

2. Method

2.1. Participants

A total of 281 second year undergraduates participated in this study (142 women and 139 men) with a mean age of 21.79 years, (SD = 4.91, age range = 18-42). They came from three different degrees: 99 from Fine Arts (45 men and 54 women), 92 from Psychology (40 men and 52 women) and 90 from Engineering (54 men and 36 women).

2.2. Materials

The following questionnaires were used: (i) the Spanish version (Campos & Pérez-Fabello, 2011) of the Object-Spatial Imagery and Verbal Questionnaire (OSIVQ; Blazhenkova & Kozhevnikov, 2009), (ii) the Mental Rotation Test (MRT; Vandenberg & Kuse, 1978), and (iii) the Measure of the Ability to Form Spatial Mental Imagery (MASMI; Campos, 2009, 2013).

The Spanish version of the OSIVQ has three Likert-like scales: the object imagery scale, the spatial scale, and the verbal scale. The questionnaire consists of 45 items: 15 corresponding to the visual–object cognitive style (e.g., 'My mental pictures are very detailed, precise representations of real things'), 15 items corresponding to the visual–spatial cognitive style (e.g., 'I can easily imagine and mentally rotate 3-dimensional geometric figures') and 15 items corresponding to the verbal cognitive style (e.g., 'I would rather have a verbal description of an object or person than a picture'). Each item is assessed in a scale of 5 points, 1 meaning "you fully disagree with the statement" and 5 being "you absolutely agree with the statement." There is no time limit to finish the test. Cronbach's alphas obtained in this research in the three subscales were: verbal ($\alpha = .78$), object ($\alpha = .83$) and spatial ($\alpha = .82$).

The MRT consists of 10 items to measure the ability to mentally rotate objects. Every item contains a model with four answers, two are right and two are wrong. All participants must mentally rotate each figure in order to decide whether it is identical to the model or not. They must solve this test within three minutes. Vandenberg and Kuse (1978) recommend the test be assessed by awarding two points when the two answers of each item are correct, no reward when one answer is correct but the other is wrong or if both are wrong and one point when only one design was chosen and it is correct. The maximum score is 20. Our findings show Cronbach's alpha of .92.

The MASMI consists of an unfolded cube which must be mentally reassembled by all participants prior to answering 23 questions related to it. Each question has four responses: two correct and two incorrect ones. The final score is obtained by adding the right answers and deducing the wrong ones, thus, the total score ranges from 46 to – 46. All participants must finish the questionnaire within 10 minutes. The internal consistency of the MASMI as measured by Cronbach's alpha was .73.

2.3. Procedure

The test was administered to groups of approximately 20 undergraduates in their usual classrooms. All participants were alike in age and educational status. All of the undergraduates freely volunteered to participate in the study and assured their data would remain confidential and anonymous. The study was conducted in accordance with ethical rules contained in the Declaration of Helsinki of 1964. Written informed consent was obtained from each participant.

2.4. Data analysis

Statistical analysis was performed using the SPSS 22.0 software programme. The Cronbach's alphas were computed for the reliability of the MRT, the MASMI, and the verbal, object imagery, and spatial imagery scales of the OSIVQ. Our findings show MRT Cronbach's alpha of .92.Vandenberg and Kuse, (1978) obtained a test-retest reliability of .83. The internal consistency of the MASMI as measured by Cronbach's alpha was .73. Campos (2009, 2013) obtained .93. Cronbach's alphas obtained in this research in the three subscales of the OSIVQ were: verbal ($\alpha = .78$), object ($\alpha = .83$) and spatial ($\alpha = .82$). Campos and Pérez-Fabello (2011) found similar Cronbach's alphas: .72, .77 and .81 for the verbal, object imagery and spatial imagery scales respectively, just the same as Höffler et al., (2017), who obtained the following scale results: verbal ($\alpha = .79$), object ($\alpha = .93$) and spatial ($\alpha = .86$).

To find out about the cognitive processing style of the students of Fine Arts, Psychology and Engineering we carried out three repeated measures analyses of variance (ANOVA). Multivariate analyses of variance (MANOVA) or analyses of variance (ANOVA) were used to examine the relationship between processing styles (object image, and verbal style), the three academic degrees (Fine Arts, Psychology and Engineering), and gender. The independent variables were gender and the type of degree, while the scores for spatial, object, and verbal styles or the accuracy for the test in the spatial imagery and mental rotation task were the dependent variables.

3. Results

3.1. Cognitive style analysis in Fine Arts, Psychology and Engineering

Firstly, we evaluated the cognitive processing style (object, spatial or verbal) dominant in students from each different degree (see Table 1). The repeated measures ANOVA showed that in the Fine Arts group there were significant differences among the three styles: $F(1, 98) = 4.31$, $p = .04$, $\eta_p{}^2 = .04$, power = .54. Subsequent analyses with the Least Significant Difference (LSD) test proved significant differences ($p < .001$). The Fine Arts students had higher scores in object image ($M = 54.46$, $SD = 8.69$) than in spatial image ($M = 40.59$, $SD = 7.43$). There were also significant differences ($p<.001$) between scores in the object image and verbal ($M = 38.34$, $SD = 7.68$) scales. Finally, differences were also meaningful ($p <.05$) between scores in the spatial and the verbal scales.

There were significant differences in cognitive style in Psychology students, $F(1, 91) = 17.45$, $p < .001$, $\eta_p{}^2 = .16$, power = .99. The significant difference between the object image scale ($M = 53.98$, $SD = 7.29$) and the spatial scale ($M = 37.91$, $SD =$

9.88) was confirmed by LDS analyses ($p < .001$). The same was true for the difference between the object image scale and the verbal image scale ($M = 42.66$, $SD = 6.74$) ($p < .001$). Significant differences ($p < .001$) were also found between the verbal and the spatial scales. Psychology students tended to use mental images of objects instead of verbal processing and spatial images, but they preferred language to spatial images (Table 1).

Engineering students also showed significant differences in cognitive style, $F(1, 89) = 48.45$, $p < .001$, $\eta_p^2 = .35$, power = 1. The scores in the spatial scale ($M = 50.01$, $SD = 8.04$) were significantly higher than in the object scale ($M = 46.00$, $SD = 8.43$) ($p < .001$). A significant difference was also found ($p < .001$) between the spatial scale and the verbal scale ($M = 40.51$, $SD = 8.46$) as well as between scores in the object scale and the verbal scale ($p < .001$). The Engineering students had a preference for a spatial processing over verbal or object processing, but object processing was more common than verbal processing (Table 1).

3.2. Distinctive features in cognitive style: gender and degree

We investigated if there were significant differences in processing styles (object, spatial or verbal style) between women and men and among participants from the three academic degrees. To do so, we carried out a MANOVA of 2 (gender) x 3 (type of degree) as independent variables and processing style (object, spatial or verbal style) as dependent variables. The means and standard deviation among groups are in Table 1. There were meaningful gender differences in processing styles, Wilks'Lambda = .90, $F(3, 273) = 10.23$, $p <.001$, $\eta_p^2 = .10$, power = 1. Univariate analyses showed that there was a significant difference between men and women in the spatial scale $F(1, 275) = 26.76$, $p < .001$, $\eta_p^2 = .09$, power = 1. The result of the LSD test showed significant differences ($p < .001$) between the men's scores ($M = 45.97$, $SD = 9.89$) and the women's scores ($M = 39.55$, $SD = 8.84$). However, no significant differences were found between men and women in the object scale $F(1, 275) = 2.79$, $p = .10$, $\eta_p{}^2 = .01$, power = .38 and the same was true for the verbal scale $F(1, 275) = .79$, $p = .38$, $\eta_p{}^2 = .003$, power = .14.

The type of degree was another variable that influenced the processing style, Wilks'Lambda = .61, $F(6, 546) = 25.44$, $p < .001$, $\eta_p{}^2 = .22$, power = 1. A univariate analysis revealed that the object scale differed significantly among the three degrees, $F(2, 275) = 28.51$, $p < .001$, $\eta_p{}^2 = .17$, power = 1. LSD analyses proved significant difference ($p < .001$) between the students of Fine Arts ($M = 54.46$, $SD = 8.69$) and the students of Engineering ($M = 46.00$, $SD = 8.43$). The students of Fine Arts obtained better scores in the object image than the students of Engineering. Moreover, the Psychology students obtained better scores in object image ($M = 53.98$, $SD = 7.29$) than the Engineering students ($p < .001$), but there were no significant differences between Fine Arts and Psychology students ($p = .54$).

Univariate analyses also revealed degree differences in the spatial scale $F(2, 275) = 46.37$, $p < .001$, $\eta_p{}^2 = .25$, power = 1. The result of the LSD test showed significant differences in spatial scores between Engineering ($M = 50.01$, $SD = 8.04$) and Fine Arts ($M = 40.59$, $SD = 7.43$) as well as Psychology students ($M = 37.91$, $SD = 9.88$) ($p < .001$). The Fine Arts students obtained a significantly higher spatial score than the Psychology students ($p <.05$).

Finally, univariate analyses revealed differences among groups from the three degrees in the verbal scale, $F(2, 275) = 7.79$, $p < .001$, $\eta_p{}^2 = .05$, power = .95. The result of the LSD test showed that the mean scores in Psychology ($M = 42.66$, $SD = 6.74$) and Fine Arts ($M = 38.34$, $SD = 7.68$) were significantly different ($p < .001$).

Similarly, significant differences were found in the verbal scale scores between Psychology and Engineering students (*M* = 40.51, *SD* = 8.46) ($p < .05$). No significant difference was observed between Fine Arts and Engineering students ($p = .06$). The interaction between gender and type of degree was non-significant, Wilks'Lambda = .98, $F(6, 546) = .92$, $p = .48$, $\eta_p{}^2 = .01$, power = .37.

3.3. Differences in spatial image tests: gender and degree

To know whether there were reliable gender differences between degrees in the MRT, an ANOVA was carried out with gender and type of degree as independent variables and the MRT score as dependent variable. The means and standard deviation of the different groups are in Table 2. The findings revealed significant gender differences in MRT, $F(1, 275) = 39.28$, $p < .001$, $\eta_p{}^2 = .13$, power = 1. The result of the Least Significant Difference test showed significant differences ($p < .001$) between the men's scores (*M* = 11.36, *SD* = 4.64) and the women's scores (*M* = 7.96, *SD* = 4.03). The type of degree influenced the image ability in image rotation $F(2, 275) = 12.07$, $p < .001$, $\eta_p{}^2 = .08$, power = 1. LSD analyses showed that there were differences between Engineering (*M* = 11.50, *SD* = 4.75) and Fine Arts (*M* = 9.68, *SD* = 4.28) students ($p < .05$). Also, there was evidence of significant differences between Engineering and Psychology (*M* = 7.79, *SD* = 4.26) students ($p < .001$). Engineering students obtained higher scores in the mental image rotation test than Fine Arts and Psychology students. Differences were also significant between students of Fine Arts and Psychology ($p < .01$). The interaction between gender and degree in MRT was significant, $F(2, 275) = 2.98$, $p = .05$, $\eta_p{}^2 = .02$ power = .5. Female students of Engineering and Fine Arts had similar scores in the MRT (*M* = 8.75, *SD* = .53; *M* = 8.94, *SD* = .57, respectively), and both groups scored higher than the female students of Psychology (*M* = 6.40, *SD* = .69). (see Figure 1).

To investigate gender and degree differences in MASMI, an ANOVA had gender and degree as independent variables and the scores in the MASMI as dependent variable. The means and standard deviations of the different groups are in Table 2. No reliable gender differences were observed, $F(1, 275) = 1.37$, $p = 24$, $\eta_p^2 = .01$, power = .22. However, the results revealed the existence of significant differences between degrees, $F(2, 275) = 7.69$, $p < .001$, $\eta_p^2 = .05$, power = .95. The LSD analyses showed that the Engineering students had higher scores ($M = 34.24$, $SD = 12.86$) than the Fine Arts ($M = 28.82$, $SD = 13.30$) ($p < .01$) and Psychology ($M = 26.54$, $SD = 14.00$) students ($p < .001$). No significant differences were found between the Fine Arts and Psychology students ($p = .32$). The interaction between gender and degree was non-significant for the test (MASMI), $F(2, 275) = 2.83$, $p = .06$, $\eta_p^2 = .02$ power = .55.

4. Discussion

4.1. Cognitive style in Fine Arts, Psychology and Engineering

The analysis of the cognitive style of Fine Arts, Engineering, and Psychology students confirms the existence of differences in the preferences for information processing (object, spatial, or verbal). As expected, the students of Fine Arts preferred the object image cognitive style as opposed to the spatial and the verbal styles. Similar results were found in previous studies (Blazhenkova & Kozhevnikov, 2009, 2010; Blazhenkova et al., 2006; Kozhevnikov et al., 2013; Pérez-Fabello et al., 2016). The Fine Arts students' preference for spatial images over verbal processing reported here is confirmed by the study of Pérez-Fabello and colleagues (2016) with respect to men but not to women, nor to the whole group.

Psychology students prefer mental object images over verbal and spatial images processing and verbal over spatial images processing. Campos and Campos-Juanatey (2014) found similar results in another sample of 203 students. The ability to process mental objects is essential to many psychological treatments that require visual imagery. Moreover, emotional knowledge and empathy help creating a peaceful environment, which requires individuals to visualize certain situations and recognize, for instance, facial expressions of emotion (Sheikh, 1983; 1984; 2002).

Engineering students are defined as spatial visualizers as opposed to processing by means of object or verbal images, even though object processing is more frequent among them than verbal processing. Though we have found no specific studies on cognitive style in those academic fields, previous researches expose the scientists' preference for spatial visual images (Blazhenkova et al., 2006; Blazhenkova & Kozhevnikov, 2009, 2010). Attention has also been drawn to the importance of spatial ability tests as guidelines to predict the students' achievements in Mathematics as well as in a wide range of technical areas (McGee, 1979; Clarkson & Presmeg, 2008) like Engineering, Mechanics and Physics (Kozhevnikov, Motes, & Hegarty, 2007; Kozhevnikov & Thornton, 2006).

4.2. Distinctive features in object-spatial imagery and verbal style: gender and degree

Men achieved significantly higher scores than women in the spatial image scale. This outcome confirms previous results (Blazhenkova et al., 2006, Blazhenkova & Kozhevnikov, 2009, 2010; Blazhenkova et al., 2011; Campos, 2014; Cho, 2017; Pazzaglia & Moè, 2013). No significant gender difference was observed in the object image scale, which is in contrast with studies showing women's preference for that kind of image (Blazhenkova et al., 2006; Blazhenkova & Kozhevnikov, 2009, 2010; Blazhenkova et al., 2011; Campos, 2014; Cho, 2017; Pazzaglia & Moè, 2013). As in previous studies, no gender differences were observed in the verbal scale (Blazhenkova & Kozhevnikov, 2009; Blazhenkova et al., 2011; Campos, 2014; Pazzaglia & Moè, 2013).

The type of degree had a significant impact on the students' image processing style. As expected, the Fine Arts students obtained better scores in the object image scale than the students of Engineering. However, surprisingly enough, Fine Arts and Psychology students performed equally well in the object image scale. Research comparing the cognitive styles in those academic degrees is non-existent, but a tendency towards the object image cognitive style has been reported in Humanities and in individuals involved in visual arts (Blazhenkova & Kozhevnikov, 2009, 2010; Chabris et al., 2006; Kozhevnikov, Blazhenkova, & Becker, 2010; Kozhevnikov et al., 2013; Pérez-Fabello et al., 2016; Yoon, Choi & Oh, 2015).

Engineering students achieved a higher score in spatial processing than Fine Arts and Psychology students. Once again, the preference for this type of image is confirmed in disciplines related to Science and Technology (Blazhenkova et al., 2006; Blazhenkova & Kozhevnikov, 2009, 2010). Similarly, Fine Arts students obtained significantly higher scores in the spatial scale than Psychology students. These results are of the utmost interest, as they expose the differences in cognitive styles between diverse fields of study.

Lastly, Psychology students obtained significantly higher scores in the verbal scale than Fine Arts and Engineering students, with no reliable differences between the last two. It is important to underline how the use of words is critical for psychologists, since highly developed language skills are essential to the level of communication and human interactions required in the field (Anderson & Hill, 2017; Hill, Spiegel, Hoffman, Kivlighan, & Gelso, 2017).

4.3. Spatial image ability: gender and degree

The finding showing that men were more accurate than women in the mental rotation task (MRT) is in line with previous studies (Blazhenkova, & Kozhevnikov, 2010; Campos, 2012, 2014; Campos et al., 2004; Campos-Juanatey et al., 2017; Pazzaglia & Moé, 2013; Voyer, 2011). Moreover, Campos-Juanatey and colleagues (2017) used three types of score for mental rotation (correct answers, correct answers minus errors, and errors) with students from different degrees (Architecture, Psychology, Economics, and Fine Arts). The results showed that men got more answers and better scores (correct answers minus errors) than women, who made far more errors. Men also scored higher in other tasks related to spatial images such as orientation tests (Coluccia & Louse, 2004), virtual environment navigation (Castelli, Corazzini, & Geminiani, 2008; Cutmore, Hine, Maberly, Langford, & Hawgood, 2000; Martens & Antonenko, 2012), or in studies with virtual environments (Picucci, Caffò, & Bosco, Picucci , 2011;Yoon et al., 2015).

Something striking was revealed in some of those papers: from a behavioural perspective, women had a lower level of spatial confidence than men regardless of their level of accuracy (Picucci et al., 2011). In addition, women are less familiar than men with videogames / computer games and often show bigger spatial anxiety (Castelli et al., 2008). Cho (2017) gave a specific spatial ability test, the Architectural Spatial Ability Test (ASAT, Cho, 2012), to Architecture students and did not find any significant gender differences, despite men being significantly better than women in the general spatial ability test. This seems to support the hypothesis of socialization (Oosthuizen, 1991) to explain the consistent worse female performance in mental rotation tests. As Campos claims (2014), the fact that women had a different education in relation to image rotation can lead to worse results in such tests. When the MASMI was used to measure spatial capacity, no meaningful gender differences were observed, which is in line with some previous studies (Campos, 2009; 2013), but not with another (Campos, 2014), indicating the need for further studies.

In the image rotation test (MRT), the students of Engineering obtained better results than the students of Fine Arts and Psychology; and the students of Fine Arts also had better results than the students of Psychology. The ability to rotate images is critical for technical disciplines and Science just as several authors stated in previous studies (Blazhenkova et al., 2006; Blazhenkova & Kozhevnikov, 2009, 2010; Lindauer, 1983; Kozhevnikov et al., 2013).

Just the same as with image rotation, in the spatial image test (MASMI), the students of Engineering obtained better scores than the students of Fine Arts and Psychology. No significant differences were found between the students of Fine Arts and those of Psychology. The fact that the students of Fine Arts obtained significantly better results than the students of Psychology in image rotation with the MRT but not in spatial image with the MASMI poses new questions on what special features artists master and puts forward the need to outline a test to measure the artistic spatial image.

5. Conclusions

There is an open debate on the pertinence of differentiating visualizers from verbalizers based on experimental evidence (see, Höffler et al., 2017). We advocate the need for further studies on the relevance of identifying students' cognitive styles among different academic disciplines. Such knowledge is pivotal for a better understanding of the characteristics and needs for each discipline/profession. We are well aware that many questions remain unanswered. Even though two types of visualizers have been identified (object and spatial), the tests measuring skills related to the different cognitive styles are too broad and not sensitive enough to measure finer grained differences. As a matter of fact, the weakness of our study is related to the use of general tests which restrict the scope of the results. We believe that designing specific tests will help delineate new image cognitive styles such as an artistic spatial cognitive style related to the spatial location of objects, which is an essential starting point in artistic work (Meana, 2000). Visualizing the specific features of objects is vital and so is their position in space and their location dependent on the viewer. It seems reasonable to think that if artists are able to create a space, representing or generating an atmosphere, they must be using a certain spatial vision that is likely to be different from that of an architect or an engineer, which could be termed cognitive style of artistic spatial image.

Coincidentally, Cho (2017) and us see the need to generate specific measurement tests for skills and object ability given the importance of a holistic understanding of the students' skills during their academic education. Just like Höffler et al. (2017), we think that being aware of the differences leads to a better design of new learning materials, an idea that, not forming part of the main objective of this paper, could be of interest in future investigations.

One more debate is open on the difference in cognitive styles between men and women. The variable education and previous experience seems to be cornerstone in the explanation of gender differences in the ability to rotate images (Campos, 2014, Cho, 2017). However, new advances in the field are necessary to clarify the extent to which experience affects differences in female undergraduates.

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Figure 1. Mental rotation (MRT) scores in male and female students in Engineering, Fine Arts and Psychology.

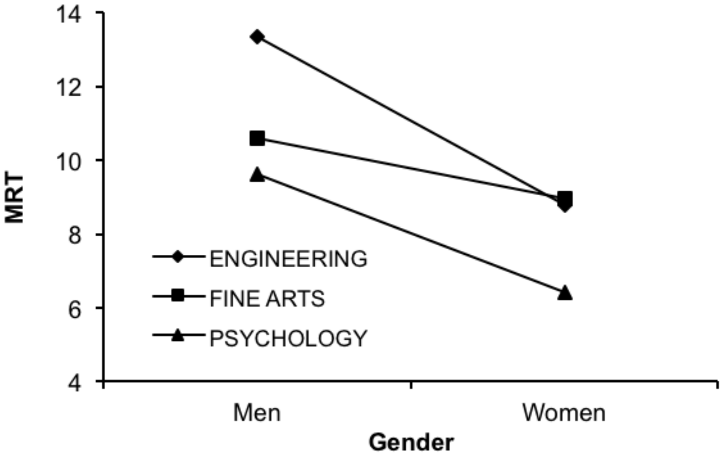
MRT
14
12
10
8
6
4
ENGINEERING
FINE ARTS
PSYCHOLOGY
Men
Women
Gender

Table 1

Means, Standard Deviations and ANOVA Results in the Object-Spatial Imagery and Verbal Questionnaire for Male and Female Students in Fine Arts, Psychology, and Engineering.

	Object		*Spatial*		*Verbal*			
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	η_p^2
Men	50.25	9.37	45.97	9.89	40.83	8.82		
Women	52.91	8.47	39.55	8.84	40.08	6.73		
$F(\eta_p^2)$	2.79	(.01)	26.76**	(.09)	.79	(.003)		
Fine Arts	54.46	8.69	40.59	7.43	38.34	7.68	4.31*	.04
Psychology	53.98	7.29	37.91	9.88	42.66	6.74	17.45**	.16
Engineering	46.00	8.43	50.01	8.04	40.51	8.46	48.45**	.35
$F(\eta_p^2)$	28.51**	(.17)	46.37**	(.25)	7.79**	(.05)		
Total	51.59	9.01	42.73	9.89	40.45	7.83		

* $p < .05$, ** $p < .001$.

Table 2

Means, Standard Deviations and ANOVA Results in the MRT and MASMI for Male and Female Students in Fine Arts, Psychology, and Engineering.

	MRT		*MASMI*	
	M	*SD*	*M*	*SD*
Men	11.36	4.64	31.24	13.97
Women	7.96	4.03	28.42	13.38
$F(\eta_p{}^2)$	39.28^{**}	(.13)	1.37	(.01)
Fine Arts	9.68	4.28	28.82	13.30
Psychology	7.79	4.26	26.54	14.00
Engineering	11.50	4.75	34.24	12.86
$F(\eta_p{}^2)$	12.07^{**}	(.08)	7.69^{**}	(.05)
Total	9.64	4.66	29.81	13.73

Note. MRT = Mental Rotation Test; MASMI = Measure of the Ability to Form Spatial Mental Imagery.

** $p < .001$.