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Araştırma Makalesi

GENDER DIFFERENCES IN VISUAL IMAGERY: OBJECT AND SPATIAL IMAGERY

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Abstract

Research findings on gender differences in visual imagery are mixed. One reason suggested to account for the inconsistent results has been the treatment of imagery as a unified construct despite the recent arguments of its multifaceted quality. In order to explore how visual imagery is related to gender, the present study differentiates between two different visual imagery construct; object and spatial imagery. In addition, it explores two other factors in characterizing gender differences: the type of the visual imagery measure (i.e., performance type vs. self-report measures) and academic training. One hundred and twenty undergraduates completed the Vividness of Visual Imagery (VVIQ), Mental Rotation Test (MRT) and Object-Spatial Imagery and Verbal Questionnaire (OSIVQ). Gender differences were observed in: (1) favoring females in the vividness measure as well as the object imagery questionnaire; (2) favoring males in the mental rotation performance and spatial imagery questionnaire. Academic training did not contribute as a factor. These results suggest that object and spatial imagery are differentially related to gender, and the type of the visual imagery measure does not seem to contribute to the story.

Keywords: *Visual Imagery, Object Imagery, Spatial Imagery, Gender Differences, Academic Training.*

GÖRSEL İMGELEMDE KADIN-ERKEK FARKLILIKLARI: NESNESEL VE UZAMSAL İMGELEM

Öz

Görsel imgelemede cinsiyet farklılıkları konusunda bulgular tutarlılık göstermemektedir. Alan yazında buna neden olarak, ampirik çalışmalarda görsel imgelemin tekil ve birleşik bir kavram olarak düşünülüyor olması gösterilmektedir. Buradaki

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araştırmada, görsel imgelem ve cinsiyet ilişkisi, görsel imgelemin iki çeşidi ele alınarak, yani, nesnel imgelem ve uzamsal imgelem ayrıştırılarak incelenmektedir. Aynı zamanda akademik eğitim (örn., Sosyal Bilimler ya da Mühendislik Bilimleri eğitimi almış olmak) ve görsel imgelemi ölçmek için kullanılan aracın çeşidi (performans tipi ya da öz bildirim ölçekleri) de bu ilişki kapsamında değerlendirilmiştir. Bu bağlamda, yüz yirmi (120) üniversite öğrencisi katılımcı, Nesnel-Uzamsal İmgeleme ve Sözel Ölçeğini (NUS Ölçeği), Görsel İmgelemin Canlılığı Ölçeğini (VVIQ) ve Mental Rotasyon Testi (MRT) tamamlamıştır. Bulgular, kadın katılımcıların görsel imgelemede imgelemin canlılığında ve nesnel imgelemede erkek katılımcılara göre daha yüksek skorlar aldıklarını; erkek katılımcıların ise mental rotasyonda ve uzamsal imgelemede kadın katılımcılara göre daha yüksek skorlar aldıklarını gözlenmiştir. Ölçüm aracı tipinin ya da akademik eğitimin etkisi gözlenmemiştir. Buna göre, görsel imgeleme çeşitlerinin toplumsal cinsiyet ile ilişkisinde farklı örüntüler izlediği alan yazındaki bulgular ile karşılaştırmalı olarak değerlendirilmiştir.

Anahtar Kelimeler: Görsel İmgelem, Nesne İmgelemi, Uzamsal İmgelem, Kadın-Erkek Farkları.

INTRODUCTION

A notable feature of the human mind is its capacity to visualize objects in the absence of corresponding external stimuli or visual input; a capacity known as *visual imagery* (Kosslyn, 1994; Finke, 1989). Sometimes referred to as the ‘eye’s mind’ (Zeman et al., 2015), visual imagery has direct implications for central cognitive processes; such as, memory (Paivio, 1971; Brewer, 1986; Conway & Pleydell-Pearce, 2000), reasoning about possible life scenarios (Addis, Wong, & Schacter, 2007), and perceptual processes (Kanwisher and Wojciulik, 2000).

Given the centrality of visual imagery in cognitive functioning and abstract reasoning, it is important to examine individual and group variation in its processing. The present study addresses group differences; particularly gender differences, in visual imagery by examining different imagery constructs among university students. To date, only a handful of studies have systematically looked into the contribution of gender in different forms of visual imagery (e.g., Campos, 2014) despite the fact that there is abundant research on various other aspects of visual processing (e.g., spatial processing) and gender differences. Furthermore, in those studies the findings in relation to gender are inconsistent. Here, we argue that what partly explains these mixed findings in the literature may be the treatment of visual imagery as a unitary/unified construct – as has been suggested by others (e.g., Vanucci et al., 2016). Given the converging evidence on a minimum of two separate subsystems of visual imagery; namely, object and spatial imagery (Kosslyn, Thompson & Gannis, 2006; Logie, 2003; Farah, Hammon, Levine, & Calvanio, 1988), we argue that systematically investigating how these particular sub-processes relate to gender may provide a more nuanced story. In the following sections, these ideas will be reviewed briefly. First, the complex nature of visual imagery is

discussed. Then, gender differences reported in the field of visual imagery are summarized. Finally, possible relations between gender and different visual imagery types, namely, object imagery and spatial imagery, are considered.

HOW IS VISUAL IMAGERY CONCEPTUALIZED?

Briefly defined, visual imagery is the ability to visualize objects in the absence of corresponding external stimuli (Winlove et al., 2018; Finke, 1989). There has been a recent upsurge of interest, especially with the advance of cognitive neuroscience, on whether or not it is a unitary, undifferentiated construct or a multi-sided construct that can be divided into several distinct cognitive processes (Kosslyn, Thompson, & Ganis, 2006; Farah, Hammond, Levine & Calvanio, 1988).

This rising interest is partly due to the gradual accumulation of the findings, such as the lack of or infrequent correlations between the subjective measures of individual differences of visual imagery, such as questionnaires of vividness, and other imagery tasks, such as spatial ability performance tasks (e.g., Poltrock & Brown, 1984; Burton & Fogarty, 2003; Dean & Morris, 2003; Campos, 2012.). For instance, a widely-used individual differences task, Vividness of Visual Imagery (VVIQ; Marks, 1973)- which consists of subjective ratings of the vividness of the visual experience rarely correlated with another frequently used measure of visual imagery; Mental Rotation Test (MRT; Vanderberg & Kuse, 1978)- which measures rotating or reorienting of mentally generated visual images (e.g., Lorenz & Neisser, 1985). According to Borst & Kosslyn (2010), the reason for this lack of correlation may simply lie in that visual imagery is a collection of a myriad of abilities, and these abilities include vividly imagining objects (and subjectively reporting them) and manipulating mental images of those objects - which may very well be processes independent from each other.

The idea of two specialized systems is a frequently visited topic in the visual perception literature either. In fact, as Kosslyn (1994) stated, imagery is connected to the experiential and psychological processes within an individual; therefore, it is not surprising that visual imagery processes reflect the workings of the perceptual processes. It has been some time since neuroscientific research demonstrated that the areas of the brain that process visual input are separated into distinct pathways; one of them is responsible for spatial (dorsal pathway: *where*), and one of them is responsible for the perception of object characteristics (ventral pathway: *what*) (Courtney, Ungerleider, Keil, & Haxby, 1996; Ungerleider & Mishkin, 1982). The reported functional dissociations between the *where* and *what* pathways also apply to visual imagery (Bartolomeo, 2002; Farah, Hammond, Levine, & Calvanio, 1988; Pearson, Naselaris, Holmes, & Kosslyn, 2015; Ungerleider & Mishkin, 1982; for reviews; but see Bartolomeo, 2008; Lambert, Sampaio, Mauss, & Scheiber, 2004). Recent evidence supports this functional dissociation, and also that the processes are

also dissociated at the the individual differences level (Vannucci & Mazzoni, 2009; Kozhevnikov et al., 2010).

Given this backdrop, a consensus stating that that representing visual information is not the same for everyone, and that individuals seem to vary to a large extent in the quality and types of their mental images seems to be emerging (Pearson & Kosslyn, 2015). A distinction between object imagery and spatial imagery (Kozhevnikov et al., 2005) has been recently proposed. Based on this idea, individuals vary in encoding and processing visual input. Object imagery involves mental representations of items' appearance or physical characteristics; e.g., their color, brightness, size, and shape. Conversely, spatial imagery is involved with spatial transformations and movement as well as the spatial relations between the items, and location of the objects, (see also, Blazhenkova et al., 2006). Recently, the Object-Spatial Imagery and Verbal Questionnaire (OSIVQ) was developed to capture the differences between Object-Spatial-Verbal skills (Blazhenkova & Kozhevnikov, 2009). In addition to the object and spatial mental imagery subscales which characterize those respective abilities, a verbal subscale was also added in order to assess variation in the verbal style (Blazhenkova et al., 2006).

In addition to the dissociation between these two components at the behavioral and neurological levels, findings have also been reported for the individual differences level; paralleling the visual processing findings (Kozhevnikov, Kosslyn, & Shephard, 2005). For example, it has been shown that people who received higher scores on the object imagery scales were better at generating vivid mental images of the objects, and they subjectively evaluated themselves as skilled in tasks of memory for objects and visual object attributes as opposed to low "object-imagers" (Vanucci & Mazzoni, 2009), but their spatial imagery scores, such as MRT, mental rotation scores, were average or below average (Blazhenkova, Kozhevnikov, & Motes, 2006). It would be interesting to see how gender is related to what came to be known as the "trade-off" pattern (Blazhenkova et al., 2006). Since individual differences in visual representation abilities are shown to impact task representations (Reeder, 2017), it is timely to investigate whether the trade-off would interact with gender differences.

Gender Differences In Visual Imagery

Research evidence on gender and visual imagery relationship broadly mimics the visual imagery literature in the sense that visual imagery is treated as a unitary construct, tasks that tap onto spatial and object imagery are not specified. Given the backdrop on visual imagery, it would be timely to explore whether the distinct forms of imagery have different patterns of relationships with gender. In the following review, existing findings are summarized by evaluating studies using object imagery and spatial imagery together.

The largest and most consistently reported pattern of findings regarding the gender-imagery relationship is the difference between males and females on spatial imagery -as indexed by dynamic mental transformations of stimuli and spatial location tasks (Lawton, 2010; Verde et al., 2013). The list of these tasks are comprehensive but a few of the most commonly used ones include: Measure of the Ability to Rotate Mental Images (MARMI: Campos, 2012), the Paper Folding Test (PFT; Ekstrom et al., 1976; as cited in Campos, 2014), Mental Rotation Test (MRT; Vandenberg & Kuse, 1978). In these tasks, the general trend is that males perform better than females regardless of the task; and this pattern seems to be stable across life periods (Geiser et al., 2008; De Frias et al., 2006). For instance, when Mental Rotation Test (MRT; Vandenberg & Kuse, 1978) has been administered to undergraduate students, the scores of male students were significantly higher than that of the female students across studies (Blazhenkova et al., 2006; Vandenberg & Kuse, 1978; Parsons et al., 2004; Campos, 2014). As discussed above, the MRT task involves mentally rotating stimuli to match the original presentation which presumably recruits schematic representations to perform complex spatial transformations; therefore, leads to a possible interpretation that males on average are better spatial imagers than females.

One point to note here is that in all these studies, the measure is a performance/ability test rather than a subjective rating of spatial processing. Very limited number of studies of spatial imagery rely on self-reported experiences. One exception is the OSIVQ scale which also with also reported higher scores for men when subjective ratings of spatial imagery preference and skill in question (Blazhenkova et al., 2006). The authors critically noted, however, although they observed gender differences, almost 30% of the female participants demonstrated above the average preferences for spatial imagery.

With regards to object imagery, however, the story is not that straightforward. Since object imagery is defined as representing the objects holistically and high in detail, the spectrum of the required skills is quite wide. Among the skills categorized under object imagery is and being able to vividly think about them is also included in that category. Based on an extensive review by McKelvie (1995), there are no considerable gender differences on the Vividness of Visual Imagery Questionnaire (VVIQ). However, Richardson (1995) reported in his review that women scored slightly higher than men on VVIQ. Recently, based on individuals' scores on the Object and Spatial Imagery Questionnaire, Blazhenkova et al. (2009) reported that men obtained lower object imagery scores than women; and this finding was corroborated in newer studies (e.g., Blazhenkova & Kozhevnikov, 2010).

Even though gender differences are reported and described in tasks that tap visuo-spatial processing as well as visual imagery, it has been unclear how to account for these differences. Some researchers suggested that the reason is different

problem-solving strategies across genders (Blough & Slavin, 1987), while others focused on social factors and socialization (Lawton, 2010), and yet others emphasized the role of sexual hormones (Pompili et al., 2012; Collaer & Hines, 1995). Even though proposing an exact mechanism is difficult, it would be helpful to systematically disentangle the contribution of the non-unitary view of visual imagery and the nature of the imagery measures. For instance, when differences are reported for spatial imagery, they are based mostly on performance type of tests, whereas object imagery differences are based almost solely on self-report measures where individuals reflect on their preferences and abilities. It is possible, in fact, the findings are conflated because either males and females have different preferences for reporting or better at reflecting on their abilities compared to the other gender. This is not the ideal testing ground to compare individuals' preferences/abilities. The only other study that we know of which focuses on both of the visual imagery constructs with respect to gender is by Campos (2014). Their participants received three performance tests of visual imagery and three imagery questionnaires. The male participants scored higher on all the performance tests (namely; the Mental Rotation Test (MRT: Vanderber & Kuse, 1978), the Rotate Mental Images (MARMI; Campos, 2012) and the Spatial Scale of Primary Mental Abilities (Thurstone & Thurstone, 2002). The questionnaires, on the other hand, yielded mixed results. While female participants scored higher than male participants on the Object OSIVQ, male participants attained higher scores on the spatial OSIVQ. Verbal part of the questionnaire yielded no gender differences. Similarly, no gender differences were detected on the Vividness of Visual Imagery Questionnaire (VVIQ). The differences between genders in the spatial imagery performance, and mostly image rotation, was attributed mostly to socialization factors, and a call was noted for further studies investigating how education and training would factor in.

Given this backdrop, in the current study we also explored whether academic background of the participants would, in part, explain the gender differences in visual imagery. When developing their model and the questionnaire (OSIQV), Kozhenikov and colleagues argue that specialization in a subject area matter in individuals' preferences and abilities for visual processing (Kozhevnikov et al., 2005). Blazhenkova et al. (2006) reported that engineers and scientists (mostly natural sciences) tend to have higher scores on the spatial imagery measures, whereas object imagery scores are higher in visual artists, and they have shown this both with measures loading on object and spatial imagery dimensions on separate tests and also on the OSIQV questionnaire. Interestingly, students and experts from humanities professions had higher scores on the verbal questionnaire compared to individuals from other disciplines.

These trends were corroborated recently by Nuhoğlu et al. (2016) in a comprehensive study involving 448 university students. They found that based on the scores on the OSIVQ; spatial skills and preferences were higher among science

students, whereas verbal tendencies were stronger among the students who were studying linguistics and language sciences. Unexpectedly, object imagery scores were not higher in the visual arts undergraduates. Therefore, it seems likely that academic training or expertise areas are systematically related to visual imagery components; that is, experience may modulate gender differences. This idea that experience or familiarity to be an explanation of gender differences in the scores of the spatial imagery tests; such as measures of relative positioning of the objects, has been favored by several other researchers as well (Fields & Shelton, 2006; Coluccia & Louse, 2004).

In sum, in the present study, the overarching aim is to evaluate in as systematic way different visual imagery processes by considering their relations to gender and academic training. For these purposes, we gave the participants both performance tests and self-report questionnaires to probe object imagery and spatial imagery. In addition to the standard tests, such as MRT and VVIQ, we gave the participants, the Object Spatial Imagery and Verbal Questionnaire (OSIVQ) which is a self-report measure to explore individual variation in preferences and experience for object and spatial imagery processes (Blazhenkova et al., 2006). The questionnaire also yields a verbal score. Previous findings on gender differences in episodic memory showed that females are generally more skilled in remembering past experience and providing detailed autobiographical narratives (Wang, 2013). Therefore, we also examined gender differences in the OSIVQ verbal test. Moreover, the present study also explores whether there is an interaction between gender and academic training as factor in explaining the reported gender differences. Finally, subjective ratings of the vividness of a past experience and the visual perspective of the past experience are also examined in order to see whether reporting visual imagery experiences would yield gender differences following the findings gained by using standard tests.

METHOD

Participants

A total of one hundred-twenty (120) undergraduate students volunteered to participate in the study. The age range was 19 to 26 (55% females; $M_{Age} = 21.4$ years; $SD = 1.58$). All of the participants were native speakers of Turkish, and the study was administered in Turkish. A consent form stamped by the Sabancı University Institutional Research Ethics Board (Approval Date and Number: March 2018, FASS-2018-17), therefore complying with research ethics regulations, was provided to the participants. Students from three different faculties; Faculty of Engineering (40%), Faculty of Social Sciences (35%), and Faculty of Management (25%) make up the study sample. Description of the sample based on gender and academic faculty is presented in Table 1 below.

Table 1: Sample Characteristics

Faculty	Female	Male	%
Management Sciences	17	13	25
Natural Sciences and Engineering	18	30	40
Social Sciences and Arts	31	11	35
Total	66	54	100 (120)

Materials and Procedure

The participants were invited to a study on “shape and object perception.” Each participant was provided with a booklet that contained questionnaires on visual imagery. The presentation order of the following measures was counter-balanced for each participant.

Vividness of Visual Imagery Questionnaire (VVIQ, Marks, 1973): There are 15 items in the questionnaire, asking of the participants to visualize several settings, and afterwards, to evaluate the vividness of the generated image on a 5-point Likert scale. It was devised to capture the individual differences in the vividness of the mental visual images.

Object-Spatial Imagery and Verbal Questionnaire (OSIVQ, Blazhenkova et al., 2006): This is a self-report questionnaire that differentiates between types of visual imagery abilities: Object imagery (being able to vividly think of objects’ physical attributes and qualities), spatial imagery (imagining the location of the objects, their movement, spatial relationships, and spatial transformations) as well as verbal imagery. The questionnaire consisted of thirty items in which the participants rated on 5-point Likert scales how they used their imagery skills in daily experiences. Adaptation of the OSIQ scale to Turkish was carefully conducted by Nuhuoğlu Kibar & Akkoyunlu (2012). Based on the Kolmogorov Smirnov test conducted by Nuhuoğlu Kibar & Akkoyunlu (2012), all three scales were normally distributed. Reliability for the whole scale was reported to be $\alpha = .825$. Reliability scores for each of the subscales were as follows; object imagery $\alpha = .82$, spatial imagery $\alpha = .84$, and verbal was $\alpha = .76$. The paper-pencil version of the questionnaire was used in the current study.

Mental Rotation Test (MRT; Peters et al., 1995, originally by Vandenberg & Kuse, 1978): The task comprised of items where the participants compare 3D blocks in order to locate the rotated version of the original item. Total score consists of the total correct matches.

Each participant received a counterbalanced order of these questionnaires. Demographics questions, such as gender and age were asked at the end of the experimental procedure.

As the present data is part of a larger project on how memory is represented in relation to visual imagery, the participants also completed autobiographical memory tasks after the visual imagery tasks were administered. Autobiographical memory tasks were described elsewhere (Aydin, 2018). The two measures from that portion of the study that was used for the present purposes was the visual/imagery perspective question and the subjective experience of vividness for the past experiences. Participants were asked to report the visual perspective they adopted while remembering the past events by choosing from one of the three categories: An “observer” perspective would be when the representation is from a third person view, and they “saw” themselves in it; a “field” perspective would be when they saw the event from their own, an insider’s point of view, or they felt that neither perspective was appropriate (*N*) (see Nigro & Neisser, 1983).

The current data was collected in two waves in 2017 (*N* =71), and 2018 (*N* = 49), the procedure was the same, therefore two datasets were combined for the present analyses. Part of the data (visual imagery scales) from the first wave was presented elsewhere (Aydin, 2018) however gender differences were not reported there.

RESULTS

Characteristics of the visual imagery scales

Following up with the previous conventions, we first calculated the Pearson correlations between visual imagery measures. Please note that none of the correlational analyses were corrected for multiple comparisons. OSIVQ scores were calculated based on the steps outlined in Blazhenkova et al. (2006). The mean object imagery score was 3.69 (*SD* = 0.61), the mean spatial imagery score was 2.96 (*SD* = 0.72), and the mean verbal imagery score was 3.12 (*SD* = 0.65). These values are in parallel with the earlier studies (Sheldon et al., 2016; Aydin, 2018). Table 2 below displays the means and standard deviations as well as the correlations between the measures.

Similar to the findings in Aydin (2018), the scores in VVIQ are correlated with the object and spatial imagery scores. VVIQ’s correlation with the visual imagery scales can be interpreted to indicate that as a measure, it does not make a distinction between different imagery constructs; but is related to them because they are all self-report measures rather than ability measures. MRT is not correlated with any of the other scales. With the same logic, the fact that MRT is not correlated with any of the other measures underlines the fact that it is tapping into some other aspect of visual imagery; probably a performance component; rather reflective processes.

Table 2: Means And Standard Deviations, and Correlations Between The Measures

Measures	M	SD	MRT	VVIQ	Object	Spatial
MRT	6.9	4.4				
VVIQ	63.7	7.6	0.02			
OSIVQ_Object	3,7	0.6	0.85	0.47**		
OSIVQ_Spatial	2.8	0.6	0.17	0.22**	0.19*	
OSIVQ_Verbal	3.1	0.6	0.03	-0.06	0.09	-0.4**

Note. MRT, Mental Rotation Test; VVIQ, Vividness of Visual Imagery Questionnaire; OSIQ, Object, Spatial and Verbal Imagery Questionnaire

* $p < .05$; ** $p < .01$

Gender differences

In order to investigate the role of gender on the performance of the visual imagery scales, a series of univariate analyses of variance (ANOVA) are conducted with gender as the independent variable. Not all participants responded to all scales which is the reason for the slightly varying degrees of freedom for each analysis. Means and standard deviations are reported in Table 3.

Regarding VVIQ, analyses did not reveal significant differences between the groups. $F(1, 116) = .59$, $p = ns$, $\eta^2 = .00$. For MRT, univariate analyses showed significant group differences - male students scoring higher than female students ($F(1, 118) = 7.96$, $p < .01$, $\eta^2 = .06$).

As for the three scales of OSIVQ, gender differences were observed for all of them; with varying trends. Female participants obtained higher scores than male participants on the Object Imagery and Verbal Imagery scales ($F(1, 115) = 4.00$, $p < .05$, $\eta^2 = .03$; $F(1, 115) = 6.01$, $p < .05$, $\eta^2 = .05$; respectively.). Male students acquired higher scores on the Spatial scale of OSIQ compared to that of the female participants, $F(1, 115) = 13.83$, $p < .001$, $\eta^2 = 1.0$.

Academic training differences

In order to test whether academic training had an effect on visual imagery separate ANOVAs were carried out for each of the imagery test types. For VVIQ, a univariate ANOVA did not reveal significant differences between the groups ($F(2, 118) = .64$, $p = ns$, $\eta^2 = .01$). Similarly, no academic training differences were observed in the MRT scores following a univariate ANOVA ($F(2, 118) = .64$, $p = ns$, $\eta^2 = .01$). Academic training seem to make a difference for the Spatial Imagery scores, with higher scores of the Faculty of Natural Sciences and Engineering students and Management Students than the Faculty of Social Sciences and the Arts ($F(2, 114) = 9.55$, $p < .01$, $\eta^2 = .11$) even though no differences were observed for

the OSIVQ Object Scale ($F(2, 114) = 2.49, p = ns, \eta^2 = .04$). On the verbal scale of OSIVQ, Faculty of Social Sciences and Arts students had higher scores than the other two faculties ($F(2, 114) = 6.21, p < .01, \eta^2 = .09$). Please see Table 3 for means and standard deviations.

Table 3: Means And Standard Deviations As A Function of Gender and Academic Program

Faculty	N		VVIQ	MRT	OSIQ-Object	OSIQ-Spatial	OSIQ-Verbal	
Social Sciences and Arts	31	Female	Mean	64,7	5,6	3,9	2,4	3,4
			SD	1,4	0,8	0,1	0,1	0,1
	10	Male	Mean	64,5	9,4	3,6	2,9	3,4
			SD	2,4	1,4	0,2	0,2	0,2
Natural Sciences and Engineering	18	Female	Mean	60,5	6,4	3,6	2,9	3,3
			SD	1,8	1,0	0,1	0,1	0,1
	24	Male	Mean	64,2	8,3	3,5	3,2	2,8
			SD	1,4	0,8	0,1	0,1	0,1
Management Sciences	17	Female	Mean	63,4	6,2	3,9	2,8	3,0
			SD	1,9	1,1	0,2	0,1	0,2
	13	Male	Mean	64,3	6,9	3,7	2,9	2,9
			SD	2,1	1,2	0,2	0,2	0,2

In order to explore whether academic training and gender jointly influence imagery variables, separate multivariate analyses of variance were conducted for each of the and no interaction effects were observed in any one of the visual imagery scores.

Finally, in order to test the idea that female participants generally report higher vividness compared to the reports of male participants, we conducted univariate analyses of variance for two dependent variables; vividness rating of a past experiences and vantage point of past experiences. Neither of these variables yielded significant results; showing no differences between female participants ($M = 3.77; SD = 1.07$) and male participants ($M = 3.80; SD = 1.07$) ($F(2, 115) = 0.28, p = ns, \eta^2 = .00$).

DISCUSSION

In the present study, gender differences in visual imagery, particularly, object and spatial imagery among university undergraduates were examined. Academic training as a factor possibly interacting with the gender differences were also explored. The tasks were selected to encompass not only different constructs of imagery, namely, object and spatial imagery but also to employ both performance abilities and reflective processes; i.e., self-report. These tasks used have been reliably utilized in earlier studies (Blazhenkova et al., 2006; Campos, 2014; Nuhoglu Kibar & Akkoyunlu, 2016) but not examined together to systematically investigate in relation to gender and academic training.

In parallel with the previous investigations, the findings indicate that in the spatial ability tasks, in both performance measures and questionnaires, male participants preferred to use spatial imagery or scored higher than females. However, the reverse pattern was true for the object imagery questionnaires and the verbal questionnaire. VVIQ, an individual difference measure of vividness of the visual imagery, yielded no gender differences. Below we discuss these findings further.

With regards to spatial imagery, the present results add to the literature that consistently report gender differences favoring men over women (e.g., Campos, 2012; Blazhenkova & Kozhevnikov, 2010). They also reveal that, at least at the spatial imagery level, trends from the performance type and subjective report measures of visual imagery were in the same direction.

Before concluding that spatial imagery skills/preferences are higher in men than women however, we could qualify this pattern of by considering the recently raised discussions on what constitutes as spatial imagery, and the processes underlying it (e.g., Palermo et al., 2016). These discussions revolve around Kosslyn's influential mental imagery model (1994, 2005) which proposes four different processes of mental imagery; namely, generation, maintenance, inspection, transformation. Neuroscientific studies report that when selectively affected by brain damage, the first two and the last two processes are grouped together. Researchers later proceeded to label these "factors" as object and spatial imagery. That is; there may be dissociation between transformation and generation, but not between transformation and inspection (Farrah et al., 1998; Luzzati, 1998). These findings indicate that what is described as spatial imagery may not only involve mental rotation abilities but also skills that involve the relative relations within an image. The last of these two processes, inspection –the ability to notice the partitions and relations in the trace-, and transformation –the ability to manipulate the image- are described as two different processes. Moreover, as summarized in the Introduction part, other neuroscientific studies reported dissociations within transformation abilities, such that patients showed problems in mental rotation tasks, however they had intact abilities in assembling the mental images. Therefore, using solely MRT performance to describe spatial imagery differences would be problematic as this particular measure mostly deals with transformation abilities. Moreover, the spatial part of the OSIVQ questionnaire seems to highly correlate with MRT in other studies (Aydın, 2018; Sheldon et al., 2016), and our findings show that males' scores in OSIVQ-spatial are also higher than that of the female participants. When closely examined, the particular items of the questionnaire such as "*I can easily imagine and mentally rotate 3-dimensional geometric figures.*" closely draw on transformation abilities rather than the other visual imagery processes, such as inspection, that can be considered under spatial imagery. Therefore, the questionnaire does not provide much information how gender differences stand in the wide array of abilities in spatial imagery but rather explore transformation abilities in self report. One

direction future studies could take is to disentangle different visual imagery processes following the Kosslyn's model (2001), and explore whether gender differences persist in all areas of spatial imagery.

These results also contribute to the discussion on the relationship between subjective reporting of visual imagery and spatial experiences. Previous literature reports a puzzling lack of relation between the two (Dean & Morris, 2003) however in the present study the ability and the self-report measures point to the same direction. Systematical examinations of for the object imagery and verbal measures should follow in order to better capture the tasks-related effects. With regards to object imagery, on the other hand, female participants scored higher than male participants in the OSIQ scale. This is not only in line with previous studies conducted with Spanish and American samples (Campos, 2014; Blazhenkova et al., 2006) but also with the only other study that we know of conducted with undergraduates in Turkey (Nuhoğlu Kibar & Akoyunlu, 2016). Therefore, it is conceivable to say that object imagery skills as well as spatial imagery show the same pattern with regards to gender differences across different cultures. This is particularly interesting given that there is an active literature demonstrating the relations between culture and perceptual abilities, such as the cultural differences in the evaluation of relative and absolute sizing of objects as well as the remembering objects in the center vs information in the background in a scene (Park & Huang, 2010).

Part of what is defined as object imagery involved the vividness and the resolution of the mental image (Blazhenkova et al., 2006), and therefore is captured by the self-report VVIQ measure. Accordingly, correlations between VVIQ and OSIQ Object were reported in several studies (Campos, 2014; Sheldon et al., 2016). Even though gender differences in VVIQ scores favoring women were expected based on these findings, no such differences were detected in the present findings. Since this is the first study that we know of where a Turkish sample is used with regards to VVIQ, caution should be taken when making arguments regarding culture and other factors, however, a similar cautionary note as to the different mental imagery processes in the Kosslyn model (2005) applies here. VVIQ as a measure may be capturing mostly generative processes because it deals with mentally generating new images and scenes, however OSIQ-verbal may involve a mixture of generation and maintenance as it inquires about individual differences in memory and retention of those images in mind (i.e., an example item: "*My mental images of different objects very much resemble the size, shape and color of actual objects that I have seen.*")

Even though a cultural socialization explanation does not follow directly from the present results, gender socialization, as suggested by other researchers, could be an explanation as to why we see differences in spatial imagery but not in object imagery. One speculative but plausible explanation would be the stereotype

threat explanation because gender stereotype activation effects have been reported in the related literature (Ortner & Sieverding, 2008). Stereotype threat is defined as a member of a social group being at risk of confirming the stereotypes about the group especially in the areas of performance such as IQ test scores (Steele & Aronson, 1995). For instance, if individuals are told that females underperform males in certain tasks, such as mental rotation or navigational skills, this idea alone will hinder the performance of women in the task and make them perform worse than both males and a control group that was never exposed to the idea. Recently, Moe (2009) showed that when confronted with stereotype threat (the conviction that one's own gender would perform lower in the task than the other gender), females were less affected by the task difficulty than male participants in a mental rotation task. Furthermore, when the instructions said that females typically perform better on the tasks than males, their performance level increased. These results signify that the gender differences in measures like mental rotation, social factors may play a major role. Object imagery, a skill encompassing being able to vividly imagine visual scenes is immune to these kinds of effects as it probably has not yet been identified as a performance variable in the general public. Further research involving several spatial imagery measures and their relationship to gender stereotype threat needs to be conducted (see, Moe & Pazzaglia, 2006).

Finally, gender differences favoring females in the verbal part of the OSIVQ has not been reported in the other studies using this measure (Campos 2014; Nuhoglu Kibar & Akkoyunlu, 2016) despite the fact that females scoring higher on other verbal tests is treated as a robust finding in earlier studies (e.g., Kimura & Harshman, 1984). Recently, however, an extensive meta-analysis covering years of studies from 1990 to 2007 with a sample size around a million revealed that there is very little to no differences across genders in verbal abilities (Lindberg, Hyde, & Peterson, 2010). All in all, the difference may be specific to our sample and further studies are needed to establish whether or not this is a real trend.

Finally, in order to help qualifying the gender differences in visual imagery, we explored academic training as a factor in explaining gender differences. Academic training differences were examined by comparing three different academic divisions; Faculty of Engineering, Faculty of Social Sciences, and Faculty of Management. While no differences among faculties were observed for MRT and VVIQ scores; OSIVQ spatial imagery scores were higher for Natural Sciences and Engineering students and Management students when compared with the Social Science students. The trend was reversed for verbal scores; and no differences were observed for OSIVQ object imagery scores. Critically, academic training did not interact with gender in any of the comparisons; therefore, the prediction that academic experience modulating gender differences was not supported. However, a better test of whether academic training has a contribution to the observed gender differences would be to contrast participants' performance before they started the

academic training and their later performance when they started the training. Nuhoğlu Kibar & Akkoyunlu (2016) observed that spatial imagery differences were larger in magnitude when third year students of engineering and English literature were compared as opposed to first year students of the respective fields. Thus, to reach a refined understanding of the gender and academic training interactions longitudinally designed studies would be helpful. Moreover, it is also likely that there could be selection bias when individuals picked their expertise areas (i.e., spatial imagers tend to select professions and academic training such as engineering and natural science), and therefore, instead of between-academic field comparisons; within-subjects comparisons across time would help fine-tuning our predictions regarding this relationship.

An obvious limitation of the current study is the unequal sample sizes for male and female participants in the social and natural sciences groups. Even though this is not ideal for the design, it actually reflects the fact that social sciences faculties are generally populated with female students whereas natural sciences faculties are dominated by male students. Future studies need to pay special attention to recruit equal sample sizes when corroborating the present findings.

All in all, the present study is an effort towards using a diverse assortment of measures, performance and questionnaires with the aim of understanding the relationship between visual imagery and gender. To be able to reach conclusions regarding gender differences in any psychological construct, idiosyncratic learning experiences, culture, education and gender stereotypes and any combination of these need to be taken into account. Neurological and behavioral studies would provide new insights in interpreting the frequently reported gender differences in the area of visual imagery.

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