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Ph.D. THESIS

- summary-

EFFECT OF EXPERTISE IN VISUAL ARTS ON MENTAL REPRESENTATION OF GEOMETRICAL FORMS

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CHAPTER I.

Theoretical Substantiation of Studies

Visual Perception

According to the computational approach to visual perception, starting from the theory of Marr (1982), visual perception can be divided into three levels, a low level, an intermediate level, and a higher processing level (Raftopoulos, 2001). During low-level processing, the visual sight is processed at the local level, the perceived object is recognized at the intermediate level, while at the highest levels, categorical representation takes place; at this level, previous experiences and stored schemas appear. In the early stages of visual perception, the processes do not appear consciously, in the bottom-up direction the lower-order processes work, if the visual sight has caught our attention, the higher-order processes, which are knowledge-driven, are already activated to process this information (Minissale, 2013).

During visual perception, control of the visual analyzer by visual stimuli is observed. In the case of art, the figures and human faces appearing in the works can also play such a role, i.e., the form appearing in space directs attention through perception. Pihko et al. (2011) examined how the level of abstraction of objects as well as art expertise influence the perception of art. The findings demonstrate that the level of abstraction influences the perceptual experience and that artistic expertise influenced aesthetic judgment. Non-artist participants preferred works that were figurative and less abstract, while the least popular works were works of an abstract nature (Koide, Kubo, Nishida, Shibata & Ikeda, 2015; Pihko et al., 2011).

Perception, therefore, is a complex process in which both the physical environment and the beliefs of the individual play an important role, and we, therefore, distinguish between bottom-up and top-down theories in terms of theoretical approaches to perception. According to bottom-up theories, information from the world around us is determined by permanence, immutability, they are directly accessible and contain all the information about the environment. As a result, perception is very fast, it is automatic, so there is no need for analytical processing. In the case of art, however, this theoretical approach is not entirely valid, as in many cases the works of art are displayed on a 2D surface but provide a 3D sight. With the help of the Piagetian approach, we can get a more complete answer to the nature of perception and that of artistic perception. In this sense, the result of perception involves a cognitive maturation process, while prior knowledge is also emphasized in processing. We use our representations of the world to interpret current visual information (Parker & Deregowski, 1990).

Object recognition

Object recognition is a complex process in which the neocortex is responsible for visual processing (DiCarlo, Zoccolan & Rust, 2012). Although the complexity of the process cannot be questioned, we are able to recognize objects easily and extremely quickly (Thorpe, Fize & Marlot, 1996). During the process of object recognition, spatial attention is activated, and then after activating the hand muscles, we can grasp the recognized object. According to another approach, object recognition appears as a labeling ability, in which different properties of an object are named: position, size, background (DiCarlo, Zoccolan & Rust, 2012). Our knowledge of objects is stored concerning different properties (color, shape, size) (Herwig, Schneider, 2014), these properties are mostly constant to be able to recognize objects even if one of their properties has seemingly changed. This is called object constancy (Jolicoeur, 1990). Knowledge of the properties of an object influences recognition, this may relate to color, form (Marr, 1982), or position (Olkkonen et al. 2008).

Context effect

In everyday life, objects do not appear randomly, without context. The appearance of the object in a certain environment helps to recognize the object. Changing the environment to a very small extent can already cause a mistake in recognizing the object. In cases when the object is placed in a different background or environment, the semantic, i.e., interpretive processes of the given object are manipulated. In the process of object recognition, the environment also provides information. We distinguish between local and global information. Local recognition involves the simultaneous appearance of an object and its associated environment, while global recognition involves the properties of an environment, i.e., a particular environment presupposes the presence of a particular object (Lauer et. Al., 2018).

Context can facilitate object recognition (Hiatt, Lawson, Harrison & Trafton, 2016). Context can also act as a kind of categorization process. Discrimination between two subjects is more difficult to be established if the two subjects are members of one and the same category (Cheal & Rutherford, 2013). Research findings support that this type of categorical perception is present in addition to visual perception in vocal stimuli as well (Laukka, 2005). The context can, therefore, appear concerning several features. Such may be stimulus position, semantic context, and scene context (Hiatt, Lawson, Harrison & Trafton, 2016). To answer the question of whether there is a difference in perception between the relationships of visual stimulus features, Biederman et al. (1972) performed a series of experiments. The results demonstrate that semantic information is activated at an early stage in the appearance of a stimulus, and this appears even when new, unknown stimuli are presented (Biederman, Mezzanotte, & Rabinowitz, 1972).

Works of art are represented in a particular setting, and this is most commonly a museum setting. The question arises as to how much the museum context determines whether to attach artistic value to a work. This is important because aesthetic studies often do not consider the fact that context can facilitate the degree of aesthetic experience (Cupchik, 1995). Findings of studies published in the literature are often inconsistent. While some studies of aesthetic preference in a museum setting show that a greater degree of preference is observed for works, the visual stimuli presented there have also received a higher aesthetic evaluation (Specker, Tinio & van Elk, 2017; Grüner, Specker & Leder, 2019); others suggest that context has no significant effect on the qualitative evaluation of a work of art (Brieber, Leder & Nadal, 2015).

Visual attention, visual search

Attention is a limited-capacity process aimed at selecting relevant information for a later stage of information processing (Kahneman, 1973). Attentional processes can be automatic and directed (Stelmach & Herman, 1991). In cases where attention is directed, attention is defined as visual search processes (Wolfe, 2018). The findings of previous research demonstrate that visual search is essential for accurate visual processes (Rensink, 2000). An essential feature of attention is that it successfully selects the currently relevant information as well as excludes irrelevant information. The selection of the relevant stimulus and the exclusion of irrelevant stimuli occur simultaneously, however, the exact functioning of these processes is unclear, especially under conditions where the target stimulus and the interfering stimulus share certain physical features (Lee, Leonard, Luck & Geng, 2018).

Visual search is influenced by both bottom-up and top-down processes (Cave & Wolfe, 1990). This means that repeated presentation of a stimulus has an impact on visual search processes (Folk & Remington, 2008). Other stimulus features that also affect effective visual search may be the physical properties of the stimulus known from the bottom-up processes, i.e., color, shape, i.e., meaning that they have striking details (Shurygina, Tudge, Kristjánsson & Chetverikov, 2019; Watson, Pearson, Chow, Theeuwes, Wiers, Most & Le Pelley, 2019).

Semantic and conceptual priming

Procedures and tests that examine the relationship between visual attention and memory are explicit in most cases. Most studies, where shared attention is the object of research, find that results are not uniform due to explicit recall, therefore it is difficult to distinguish which cognitive processes played a role in correct object identification (Sbicigo, Janczura & de Salles, 2017). Priming studies can be used to obtain more detailed images of implicit memory processes. In the study of the implicit system, the processes of recognition and recall are not consciously created (Vakil, Wasseman & Tibon, 2018), for which non-declarative memory is responsible, as declarative memory is responsible for conscious recall (Levy, Stark & Squire, 2004).

The process examines automatic, unconscious recall, where the process of storing information activates an unconscious mechanism (Vakil et al., 2018). In studies of priming, the priming effect is indicated by an increase in reaction time, which suggests that the priming stimulus inhibits the induction of a response from memory (Kristjánsson, 2016). Research results demonstrate that semantic priming processing occurs as early as the first 60ms (Heyman et al., 2018). This means that the processing of semantic stimuli, i.e., the meaning-making processes, are not always conscious processes, however, despite of their automatic nature, semantic information about stimuli is also processed.

Effect of art expertise

The most fundamental difference between artists and non-artists lies in drawing skills (Ostrofsky, Kozbelt & Seidel, 2011). During drawing, several cognitive processes occur that appear to be more advanced in the case of artists. Some hypothesized that artists' advanced realistic drawing ability stems from their perception of the environment in a different way (Kozbelt & Seeley, 2007). Research findings suggest that experience gained during drawing results in some level of change in visual working memory function, as evidenced by various working-memory tests, in which artists perform better than beginners (McManus et al., 2010). However, the findings of Perdreau and Cavanagh (2015) suggest that in addition to working memory, other cognitive processes also appear in addition to better drawing performance in the case of artists and non-artists. Such processes include a more accurate mental representation of the object to be drawn. This is made possible, among other things, by the more efficient use of attentional processes, in which experts focus on the relevant details of the visual stimulus that are important in the reproduction of that stimulus. Previous research findings also demonstrate that the ability to draw also allows for the reduction of the effect of perceptual constants (Ostrofsky, Kozbelt & Seidel, 2012).

Art expertise is also achieved by perceptual organizations, where local-global processes work similarly to bottom-up and top-down processes. The organization of perception is essential in healthy perception (Chamberlain, Van der Hallen, Huygelier, Van de Cruys, Wagemans & 2017). The interaction of these two processes is necessary for the perception and global interpretation of visual space in unity (Van der Hallen, Evers, Brewaeys, Van den Noortgate & Wagemans, 2015). Although research findings do not provide clear evidence of local and global differences between artists and non-artists (Chamberlain, McManus, Ruley, Rankin & Brunswick, 2013; Chamberlain & Wagemans, 2015), the results nevertheless suggest that in the case of artists global processing is more advanced, and the alternation between local and global processing is much more efficient and fluent, implying a top-down nature of attentional processes (Chamberlain & Wagemans, 2015).

Eye movement during visual perception

There are fundamental differences in visual perception, which are the result of factors such as prior knowledge about the stimulus (Folk, Remington, 2008), expectations (Shurygina, Kristjánsson, Tudge, Chetverikov, 2019), or domain-specific knowledge (Grüner, Specker, Leder, 2019).

The local and global processing of visual stimuli is part of the organization of perception. Organization is a phase of multi-stage processing that may be influenced by factors such as experience in visual arts, culture, or genetics (Chamberlain, Van der Hallen, Huygelier & de Cruys, 2017, Fayena-Tawil, Kozbelt & Sitaras, 2011). At the same time, research findings also prove that these two mechanisms are not uniform parts of a process, but the results of different cognitive processes (Nayar, Franchak, Adolph & Kiorpes, 2015).

Gegenfurtner et al. (2011) examined the eye movement behavior of experts in several fields. The results prove that eye movement is greatly influenced by the instructions of the given task. Different time periods and patterns can be detected when observing a given visual stimulus, requiring tasks such as simple observation (free viewing), decision, or problem-solving. There are several contradictions between the results of previous studies. Harland et. al's (2014) findings show that artists spend more time processing the visual stimuli, while other research has shown that the duration of eye fixation for artists is shorter than for non-artists. Artists focus on visual stimuli that have a clear meaning (Koide, Kubo, Nishida, Shibata & Ikeda, 2015; Kołodziej, Majkowski, Rak, Francuz & Augustynowicz, 2018) for a shorter period of time. However, contrary to expectations, there is not always a difference between artists and non-artists in terms of observational strategies during drawing (Tchalenko, 2007).

CHAPTER II.

OBJECTIVE OF THESIS

Significant differences can be noticed between aesthetic evaluation of artists and non-artists (Hagtdvet et al., 2008; Weichselbaum et al., 2018). However, in terms of performance in visual perception tasks, no difference can be detected between artists and non-artists (Kozbelt, 2001; Cohen & Jones, 2008). Tasks examining the characteristics of visual perception examine visual illusions, visual constants (Cohen & Jones, 2008; Chamberlain & Wagemans, 2015), as well as bottom-up and top-down processes (Chamberlain et al., 2019; Pelowski et al., 2017). In many cases, research has been conducted using eye movement studies (Pelowski et al., 2019).

The general objective of the research included in the thesis is to investigate the peculiarities of altered perceptual processes derived from domain specific knowledge, thereby gaining a more detailed picture of how the functions of different cognitive processes can be modified with the help of artistic expertise. The common goal of the research is to examine the extent to which the specific processes acquired during the fine arts training can be used outside the field.

Theoretical Objectives

This thesis aims at examining the differences between artists and non-artists in the reaction time of cognitive processes that have changed as a result of art expertise. One of the aims of the present thesis is to provide a comprehensive study that presents a detailed picture of the findings of studies in the literature, and between the processing of visual information by artists and non-artists.

Methodological Objectives

The first methodological objective of the present thesis is to investigate the reaction time of object meaning making processes among artists and non-artists. Objects are presented in a distorted form in different contexts.

As a second methodological objective, the present study aims at examining the processes of form perception by artists and non-artists under the influence of conceptual priming.

The third methodological objective of the present thesis is to examine visual grouping processes as well as visual search processes as a result of artistic training.

Practical Objectives

The practical objective of the thesis is to elaborate an artistic training program, that facilitates visual searching mechanisms and also to elaborate several computer programs that will assess reaction time of object recognition, of conceptual priming influence, and of visual grouping.

Key words

visual art expertise, art history expertise, domain specific knowledge, eye- movement, object recognition, meaning making, top- down information, bottom- up information, context, conceptual priming, geometrical forms, visual grouping illusion, visual search, triple conjunction

CHAPTER III.

VISUAL ART, AS DOMAIN SPECIFIC KNOWLEDGE IN VISUAL STIMULI COMPREHENSION: A META-ANALYTICAL REVIEW OF ART AND NON-ART EXPERTS' EYE FIXATION DURATION

Objectives

Due to the different results in the literature regarding the differences between artists and non-artists, this meta-analysis seeks to examine the domain-specific effects of reaction time differences. To this end, the purpose of this meta-analysis is to examine the effect of artistic expertise on eye fixation duration. It is assumed that expertise in art results in an increased fixation period. Another purpose of the meta-analysis is to examine the factors that influence eye-fixation differences between artists and non-artists. It is assumed that eye fixation is affected by the type of task, the person's qualifications, and the person's sex. At the same time, it is assumed that both task time, sampling rate, and stimulus presentation type contribute to the increase in fixation duration.

Characteristics of included studies

In the majority of the included studies (n = 7) the type of stimulus that was employed most for differentiating between artists and non-artists was painting. The most employed experimental task was aesthetic evaluation (n = 5), followed by drawing (n = 4) and free viewing (n = 3). In the majority of the included studies (n = 7) the specific art domain from which experts were recruited was the fine arts. In only five studies the specific criterion which was used in selecting between artists and non-artists was formal education in art

Methods

We computed the individual ES's with the Comprehensive Meta-Analysis software (CMA, version 3.3.070). For the average fixation duration, we calculated the standardized mean difference (SMD) at post-test, by subtracting the mean score of the comparison group (non-artists) from the mean score of the artists' group and dividing the result by the pooled standard deviation of the groups. We employed Hedges'g, as the indicator of ES because of its robustness to small sample sizes (Hedges & Olkin, 1985) and used a random-effects model. A positive ES indicates a longer eye fixation duration for the artist groups, as compared to the non-artist groups. To calculate differences between independent groups in average eye fixation duration, we mainly used the means and standard deviations (SD) that were provided in the individual studies. Where these were not available, for determining the SMD, we employed t-values or F-scores for differences between groups.

We also conducted sensitivity analyses by excluding outliers. Outliers were defined as those studies that had a 95% CI that did not overlap with the 95% CI of the pooled ES (on both sides).

Heterogeneity was assessed with the I2 statistics. We also calculated the 95% CI around I2 to gain a better evaluation of heterogeneity. For categorical moderators we conducted subgroup analyses, using the mixed effect model, which uses a random-effects model within subgroups and fixed/effects one across subgroups. For continuous moderators, we employed a univariate meta-regression model, using the unrestricted maximum likelihood method (Borenstein et al., 2009).

Multiple methods were employed in evaluating publication bias. Firstly, we visually inspected the funnel plots. Additionally, we employed statistical tests for funnel plot asymmetry, namely the Egger's test (Egger et al., 1997) and Duval & Tweedie's trim and fill method (Duval & Tweedie, 2000).

Results

Results from fourteen eye fixation duration studies were pooled concerning the art experts versus novices contrast, yielding a statistically significant ES of g = 0.63, 95% CI 0.24 to 1.03, with substantial heterogeneity (I2 = 75%, 95% CI: 59 to 85) and favoriting artists (i.e., eye fixation durations were significantly longer in the case of artists, as opposed to non-artists) (Figure 2). The exclusion of one outlier led to a moderate increase of the ES, g = 0.75, 95% CI 0.41 to 1.09, and a decrease in heterogeneity (I2 = 66, 95% CI: 39 to 81).

No statistically significant moderator effects were identified for task type (i.e., drawing, free viewing, aesthetic evaluation), the type of presented stimulus (i.e., images/figures/geometric shapes, paintings), and the status of participants (i.e., beginners - yes/no).

Univariate meta-regression indicated no significant relationship between any of the continuous variables (sampling rate, percent of females, and task time limit) and ES, even after excluding outliers.

Egger's regression intercept test revealed no evidence for publication bias (intercept = 1.74, 95% CI: -1.31 to 4.80, p = 0.237). The Duval & Tweedie's trim and fill method revealed 3 potentially missing studies, which, if included would lead to a moderate decrease of the effect size, to g = 0.41, 95% CI: 0.01 to 0.80.

These findings suggest that artistic expertise has a significant effect on eye fixation duration. Although the differences are clear between artists and non-artists, other factors that may have influence on the duration of eye fixation remain unclear.

COMPARATIVE STUDY OF THE SPECIFICITIES IN PERCEPTION AND MEANING MAKING OF DISTORTED OBJECTS BY ART AND NON-ART STUDENTS

Study II

Theoretical background

Object recognition is influenced by a number of factors, such as the context of visual organization (Hiatt et al., 2016) (Specker et al., 2017; Fenske et al., 2006) as well as the bottom-up and top-down nature of the stimulus (Taniguchi et al., 2018). As a result, object recognition is affected not only by the visual aspects of the stimulus, such as colour, shape, position of the stimulus but also by our prior knowledge and experience of the given object and stimulus.

Preliminary research findings suggest that experience gained during visual arts training has an impact on visual perceptual processes (Feltovich et al., 2006; Ostrofsky et al., 2012). Visual processing mechanism alterations by art training are also reflected in the performance given on spatial-visual tasks. Results show that artists perform better in these tasks than non-artists (Chamberlain et al., 2019). Although clear differences can be detected between the two groups for some task types, other studies report conflicting results (Winston & Chupchik, 1992; Chamberlain et al., 2019).

Objectives and hypotheses

The aim of the present study is to examine the effect of domain specific knowledge on the reaction-time pattern of recognizing distorted ordinary objects. Another aim of the present study is to examine the effect of bottom-up and top-down instructions on object recognition. Another practical objective is to investigate the effect of the presentation context of the stimulus on object recognition. At the same time, the aim of our research is to examine object meaning making processes of distorted images of ordinary objects using a computer program created by us.

Hypotheses

1. There is a significant difference between the reaction time of art and non-art students. Students majoring in art seem to have a longer reaction time.

2. Object recognition RT is influenced by experience in art, task instruction, and stimulus presentation condition.

3. Visual art experience results in more unified RT over stimuli conditions and instruction types.

Method and Procedure

Design

The design of the present research is quasi-experimental design, ex post facto. The quasi- independent variables are art expertise, context of stimulus presentation (stimulus in isolated, facilitating, and inhibitory environments), and task instruction (bottom-up and top-down). The dependent variable is the reaction time of response to the distorted object and the correct naming of the object.

A statistical power analysis, G*Power (Faul, Erdfelder, Lang, Buchner, 2007; Faul, Buchner, Lang, 2009), has been used to compute sample size. To detect an effect of η 2 p = .04

with 80% power in the three-way analysis of variance ANOVA (twelve groups, alpha = .05), G*Power suggests we would need 34 participants in each group (N = 416).

Participants

The experiment involved 483 art and non-art high school and university students, including 10th, 11th, and 12th graders of Romulus LADEA Art High School in Cluj-Napoca, of Palló Imre Art High School in Odorheiu Secuiesc, of Tamási Áron High School and Salamon Ernő High School in Gyergyószentmiklós as well as 1st, 2nd and 3rd-year students of psychology and special education at the Faculty of Psychology and Educational Sciences of Cluj-Napoca, Babes-Bolyai University, as well as 1st, 2nd and 3rd-year students of painting, graphics, and sculpture at the University of Art and Design of Cluj-Napoca. All participants had normal or corrected- to- normal vision.

Procedure

We used a computer program designed by us. The program included 20 distorted images of 16 ordinary objects. In order to make the distortions uniform, we used the Adobe Photoshop Ocean ripple filter, which changed the distortion levels uniformly for each image presented. The level of distortion of the images varied by 10%, the variation between distortion levels was uniform along the three stimulus conditions as well as the instructions. The position of the objects shows the shapes from eye level, rotated at a 50-degree angle.

The images used in the program were downloaded from an internet database. CU3D is a high quality object recognition database. The database contains images of 100 categories of 3-dimensional objects. Pictures can downloaded from:

(https://grey.colorado.edu/CompCogNeuro/index.php/CU3D)

The images used in the program were selected based on a preliminary survey. During the survey, undergraduate students had to select subjects from a list of 100 words that they found commonplace. The images that all students marked as ordinary were used. A total of 16 items were selected which were knife, key, ladder, scissors, airplane, frying pan, chair, plate, bed, car, bicycle, cup, umbrella, watch, sink, and hat.

The program measured the global time spent per image and in the task, the level of distortion of the named object, and the exact naming by the person. There was no time limit for displaying images. The order in which the distorted objects were presented went from the most distorted (100%) to the less distorted.

Bottom-up and top-down instructions were separated along instructions. For bottom-up instructions, participants had to determine what they saw in the images ("Name the distorted stimulus you see in the image"). Individuals who received this instruction were not informed of the content or nature of the stimulus presented. Individuals who were given top-down instruction were informed that the stimuli they should name represent objects ("Name the distorted object you see in the picture"). Each participant received only one instruction and was confronted with one type of stimulus presentation.

Results

A Factorial ANOVA was conducted to compare the main effects of domain-specific knowledge, task instruction, the condition of the stimuli presentation, and the interaction effect between the domain-specific knowledge, task instruction, condition of the stimuli presentation on the reaction time (RT) of distorted object recognition.

The significance level of Levenes's Test of Equality of Error Variance was higher than .05, so we can conclude that we have not violated the homogeneity of variances assumption.

A three-way analysis of variance was conducted on the influence of three independent variables (domain-specific knowledge, task instruction, condition of the stimuli presentation) on the reaction time of distorted object recognition. All effects were statistically significant on the .05 significance level except for the task instruction factor (Table 1).

Table 1

Means, Standard Deviations, and Three- way ANOVA for Groups as a function of Stimuli presentation and Task instruction

Variable		Art		Non- art		ANOVA			
		M	*SD*	*M*	*SD*	Effect	*F* ratio	*df*	η^2
Instruction	Set					G	19.04**	1	0.039
Bottom-up	A	5.37	0.31	5.31	0.51	S	4.772**	2	0.02
	B	5.03	0.37	5.2	0.44	I	2.2	1	0.05
	C	5.35	0.48	5.52	0.4	G x S	0.88	2	0.004
Top-down	A	5.06	0.38	5.34	0.38	G x I	4.250*	1	0.009
	B	5.18	0.41	5.35	0.42	S x I	6.88**	2	0.029
	C	5.09	0.45	5.4	0.34	G x S x I	1.5	2	0.006

Note. N = 483. ANOVA = analysis of variance; Art = art university/ school students; Non- art = non-art university/ school students; G = group, art/ non- art specialty; S = stimulus presentation condition (A-, B-, C- sets); I = bottom- up or top- down instruction.

*$p < .05$

**$p < .001$

The main effect for domain-specific knowledge yielded an F ratio of F (1,464) = 19.04, p < .001, indicating a significant difference between art students (M = 5.197, SD = .424) and non-art students (M = 5.351, SD = .436). The main effect for the stimulus presentation condition yielded an F ratio F (2, 464) = 4.77, p < .001, indicating that the effect for stimulus presentation condition was significant, A(M = 5.31 , SD = .44), B(M = 5.21, SD = .43), C(M = 5.37, SD = .44). The main effect for task instruction yielded an F ratio F (1, 464) = 2.2, p > .05, indicating that the effect for instruction was not significant, Bottom-up (M = 5.31, SD = .45), Top-down (M = 5.26, SD = .41).

The interaction effect between domain-specific knowledge and stimulus presentation condition was not significant, F (2, 464) = .88, p > 0.5 (Figure 1.). The interaction effect between domain-specific knowledge and task instruction was significant F (1, 464) = 4.25, p < .05. The interaction effect between domain-specific knowledge, stimulus presentation condition and instruction was not significant, F (2, 464) = 1.5, p > 0.5.

To fully understand group differences, we conducted Bonferroni pairwise comparison tests of the differences between the art and non-art student groups (Table 2).

Table 2

Analyses for the Interaction of Set, Instruction on reaction time of Art- and Non- art students

Set	Instruction	Art	Non- art	*F* ratio	*p*	η^2
A		5.37	5.31	.37	.54	.00
B	Bottom- up	5.03	5.2	2.72	.09	.01
C		5.35	5.52	3.1	.07	.01
A		5.06	5.34	8.53	.004	.03
B	Top- down	5.18	5.35	3.08	.08	.01
C		5.09	5.4	3.78	.003	.01

Note. Means with different subscripts differ at the p = .05 level by Bonferroni pairwise comparison test.

An independent samples t-test was conducted to compare the correct object recognition scores for art and non- art groups. There were no significant differences in scores for art students (M = 1.63, SD = .41) and non- art students (M = 1.54, SD = .4; t (480) = -2.35, p = .19).

The relationship between RT and correct answer was investigated using Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity. There was a small, negative correlation between the two variables, r = -.111, n = 482, p = 0.15, with a high level of correct answers associated with shorter reaction time.

Discussion

The present study aims at examining the responses to distorted object recognition of artists and non-artists. We used a computer program created by us, in which the distorted versions of 16 ordinary objects were presented. In addition to the distortions of the objects, the distorted stimuli were presented in three conditions, along two instructions.

The results of the present study suggest that artists focus on relevant properties of visual stimuli, as evidenced by the reduced reaction time and the ratio of accurately recognized objects. Also, there is a significant difference between artists and non-artists in terms of recognition time, as well as in the accuracy of detecting distorted objects. The reaction time of artists is shorter, while their object recognition is more accurate. The results of the present study are consistent with Zangemaister et al.'s (1995) findings who found that artists focus on the formal properties of visual stimuli, making object recognition more accurate. These formal properties can be color, shape, composition, etc., which is why artists focus on the stimulus they want to recognize and are less distracted by irrelevant information in the process of object recognition.

Although the visual stimuli presented in the present study were not works of art, the results obtained can also be interpreted as the occurrence of interpretations of abstract forms acquired during art training in the process of recognizing distorted objects.

What is more, the results of the present study are consistent with the results of Antes and Kristijanson’s (1991) research, i.e., artists are more inclined to focus on units with meaning in their meaning-making processes, which results in effective meaning-making. These results may also suggest that during their education in arts, they acquire knowledge about abstract arts at art history education, and at the same time, learn abstraction processes while being trained in drawing. They reproduce simplified visual stimuli, images that are distorted beyond recognition. Therefore, the results of the present study can also be interpreted as applying the techniques acquired during art education to object recognition.

The results of previous research support that in the tasks that contain figurative reasoning elements (Goldhammer, Entink, 2011) a correlation can be observed between reaction time and accuracy of responses (Heitz, 2014). There is a moderate negative correlation between reaction time and accuracy of the response, as demonstrated in the present research. Thus, we may conclude that if the reaction time decreases, an increase in the accuracy of the response can be observed.

The effect of context, domain specific knowledge, and instructions can be observed on the speed of object recognition. Object recognition for art students is faster and more accurate with both bottom-up and top-down instructions. This result is valid in cases where the distorted object is presented in an environment that hinders recognition. From this result, we can conclude that when lacking experience in visual arts, or history of art knowledge, the role of context influences the time of object recognition to a greater extent than task instruction. The context that hinders recognition has less impact on recognition speed with domain specific knowledge present. From this, we can conclude that in the object recognition process of non-art students, confusing context results in distraction. It can also be concluded that in the case of non-artists, the distorted object is recognized and influenced by information obtained from the environment, while in the case of art students, the information acquired and stored during studying fine arts overcomes the context which hinders the stimulus.

Based on the results obtained, we can say that task instruction, as well as the interaction of the major of the students, have a significant effect on the object recognition reaction time. The difference is observed especially in the case of top-down instruction. This result is consistent with previous research findings, where a significant difference was found between the two groups when they were given top-down tasks (Kozbelt & Seeley, 2007; Chamberlain, Wagemans, Drake, Kozbelt, Hickman, 2018). At the same time, the results of the present research also demonstrate that domain specific knowledge leads to a kind of cognitive flexibility. In the cases where the stimulus was presented in isolation, without context, or in a recognition-stimulating environment, there was no significant difference in response time between the two groups. The presentation of the stimulus in a facilitative or isolated form requires a kind of global processing, i.e. the whole context of the stimulus presentation either facilitates or it has no effect on object recognition. In the context where stimuli contrary to object recognition appear, a kind of local processing occurs, i.e., faster stimulus processing takes place that excludes information coming from the environment. The results of several previous studies support this assumption, as do also the results of the NAVON test (Chamberlain & Wagemans, 2015). Although no significant difference with regard to local-global thinking style can be detected between artists and non-artists, the mechanism of stimulus processing by artists is more flexible (Chamberlain et al., 2013).

The speed of object recognition in art students in condition "C" can be explained by the drawing skills acquired during their training in fine arts. During the training, they acquire representation of perspective, which appears not only in context but also in the presentation of individual objects. In the case of objects appearing in condition "C", the image of the distorted object was displayed taken out of perspective, which did not affect the speed of object recognition in art students. In terms of form constancy, the recognition of an object is not affected by the change in the point of view of the object (Niall and Macnamara, 1989), still, previous information, as well as ambient perspective cues, are factors that influence form constancy (Thouless, 1972). In the case of the stimuli we presented in condition "C", the ambient perspective signal stimuli did not provide sufficient information in the object recognition process. The results we obtained are, to some extent, similar to the results of previous research, where individuals trained in perspective representation showed a better constancy effect than those who did not have experience in visual arts (Hammad, Kennedy, Juricevic, Rajani, 2008; Kapkın, 2020). Thus, we can assume that the preliminary drawing experience facilitated the recognition speed of a distorted object in a recognition hindering context.

The increase in reaction time of art students in a bottom-up condition may be explained by the nature of the stimulus. The stimuli we chose were object representations drawn with computer graphics. The results of preliminary studies suggest that in the cases where a visual stimulus is interpreted as a work of art, an increase in reaction time is observed (Pelowski, Gerger, Chetouani, Markey & Leder, 2017). As a result, the time for object recognition may have increased if the stimuli were interpreted as works of art. This means that art students implicitly interpreted the stimuli we presented as works of art. The results of further research suggest the same. In cases where the visual stimuli presented were also associated with aesthetic preference, the reaction time of task completion increased. The stimuli presented could either be ordinary objects (Brieber, Nadal, Leder, & Rosenberg, 2014) or simple shapes (Isham & Geng, 2013). Taking into account the conclusions of preliminary research, findings can also suggest that the increased reaction time of non-art students is due to the implicit labeling of stimuli. This means that, due to the nature of the images, non-art students interpreted the stimuli presented in condition “C” as works of art, which may also have resulted in increased reaction time.

Limitation

One of the limitations of the present study is the design of the bottom-up and top-down processes. In the study, the two processes were examined with one question each, so this factor should also be considered when discussing the results. Another limitation is that the level of expertise of art students varied, as both high school and college students participated in the study.

As a further limitation, we highlight the images used in condition “C”, where the context elaboration of the distorted objects may deviate the results.

THE EFFECT OF CONCEPTUAL PRIMING ON RECOGNITION OF ANIMATED-INANIMATED FORM OF ART AND NON-ART STUDENTS
Study III

Theoretical background

The priming paradigm is a way of measuring implicit memory. The process examines automatic, unconscious recall, where the process of storing information activates an unconscious mechanism (Vakil et al., 2018). In studies of priming, the priming effect is indicated by an increase in reaction time, which suggests that the priming stimulus inhibits the induction of a response from memory (Kristjánsson, 2016). Research results demonstrate that semantic priming processing occurs as early as the first 60ms (Heyman et al., 2018). This means that the processing of semantic stimuli, i.e., the meaning-making processes, are not always conscious processes, however, despite of their automatic nature, semantic information about stimuli is also processed.

Results that demonstrate a better performance given by artists on the various visual tasks suggest that the better performance stems from the information stored in memory. As a result, representations acquired and stored during fine art education may also be interpreted as better performance on tasks (Perdreau & Cavanagh, 2011; Ostrovsky et al, 2011).

Previous research findings have shown that the nature of the presented stimulus influences the processing processes, thus the processing mechanisms of living and inanimate objects also differ (Connolly et al., 2012; Proklova et al. 2016).

Objectives and hypotheses

The present study aims at examining the implicit memory functions between art and non-art students with the use of the priming paradigm, as well as at examining how the semantic priming effect appears in the reaction time pattern of the two groups. Another aim of the present research is to investigate the effect of timing priming, i.e., the effect of stimulus presentation time on reaction time. a further objective of the present research is to examine by using a computer program created by us, the response time patterns of target stimuli displayed for different time periods both in art and non-art students.

Hypotheses

1. We predict that art students' RT is shorter compared to non-art students' RT.

2. We predict that visual art experience results in more unified RT over priming condition.

Method and Procedure

Design

The design is quasi-experimental, , ex post facto. The quasi- independent variables are art expertise and two conditions for the display of the semantic priming stimulus (50 ms and 100 ms), while the response time is a dependent variable.

A statistical power analysis, G*Power (Faul, Erdfelder, Lang, Buchner, 2007; Faul, Buchner, Lang, 2009), has been used to compute sample size. To detect an effect of η 2 p = .04 with 80% power in mixed between- within subjects analysis of variance ANOVA (two groups, alpha = .05), G*Power suggests we would need 64 participants in each group (N = 128).

Participants

In the experiment 156 art and non-art university students have been gathered, students in their 1st, 2nd, or 3rd year of study at the Babes-Bolyai University of Cluj Napoca, Faculty of Psychology and Educational Sciences, majoring in Psychology and Special Education, as well as students of UAD Cluj-Napoca, studying painting, graphics, and sculpture. The vision of all participants was normal or adjusted to normal.

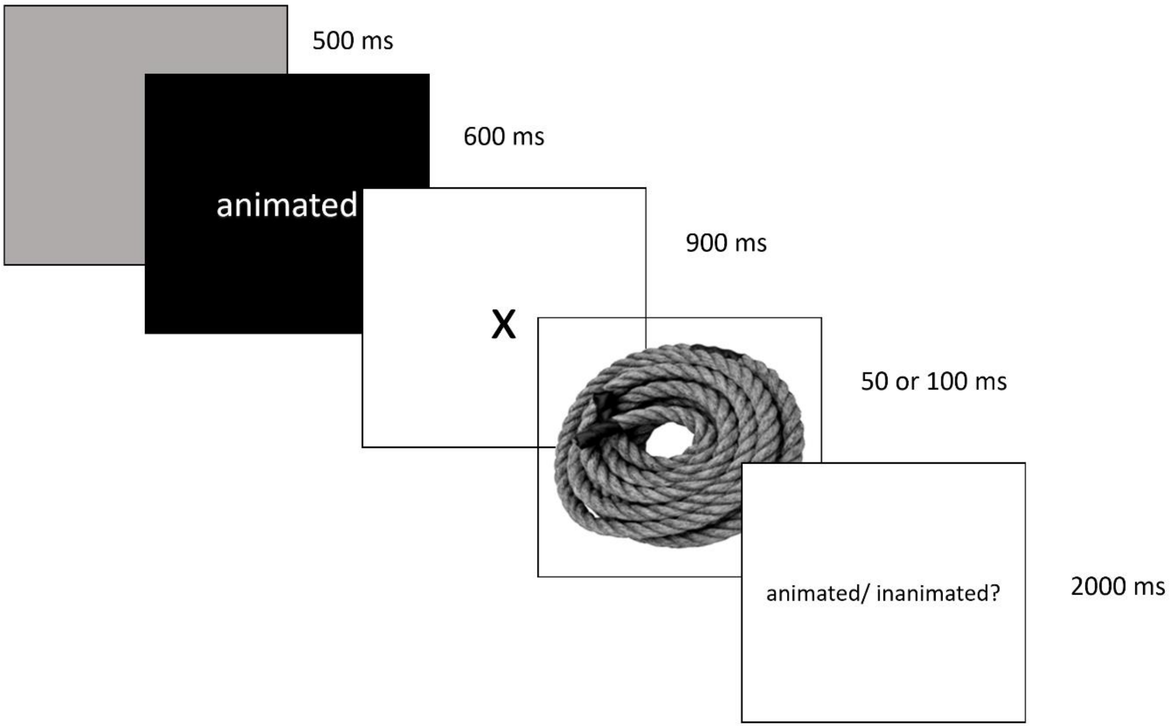
Procedure

Using a computer program developed by us, we examined the effect of semantic priming on the recognition of animate-inanimate shapes. The program contained 24 pairs of images where the shapes of the image pairs were the same, however, one component represented a living being while the other represented an inanimate object. The program contained 48 trials in total, each trial displaying one pair of images. Each image was presented once, and their order was randomized for each person. The test recording was counterbalanced. The structure of the program is shown in Figure 1. The reaction time was measured in the last phase, during the period between the display of the response option and the indication of the presumed response. Participants were instructed to provide their answers as quickly and as accurately as possible.

The 24 image pairs presented in the trials included images prepared by Proklova et al. (2016). The stimulus set contained images of two categories: living beings and inanimate objects. An image of an inanimate object was paired with the image of each living being. The pairing was based on the details of the shape. To make the pairing of images as accurate as possible, Proklova et al. (2016) used both computational and behavioral models of visual perception. Each of the image pairs was grayscaled, brightness and contrast were adjusted with the use of the SHINE toolbox. The image pairs depicted the following associations: snake - rope, snail - cinnamon roll, ladybug - safety helmet, turtle - computer mouse, wild goose - airplane, bat – paraglider (Figure 1).

Figure 1

Structure of program design



Note. In each trial, there was a 500ms waiting time before semantic priming was displayed. Semantic priming was visible for 600ms, followed by a 900ms attention-focusing phase. Then, the image of the living being or the object appeared for 50ms or 100ms, followed by the response, for which the time limit was 2000ms. The reaction time was measured in the last phase, during the selection of response options displayed up to 2000ms.

After completing the demographic information, participants were given the instructions for the task. The specific testing phase was preceded by a practice phase where participants were introduced to the task. The images used in the practice phase did not appear in the testing phase, the resulting reaction time results were not processed either.

Results

Levene's Test of Equality of Error Variance showed that the results did not violate the assumption of homogeneity of variance. The value for each variable is greater than .05 (.58, .53); therefore we can proceed.

Box's Test of Equality of Covariance Matrices shows that the Sig. value is greater than .001, the value is .278; therefore, we have not violated this assumption.

Table 3

Means, Standard Deviations, and mixed between- within subjects ANOVA for Groups as a function of Stimuli presentation and Task instruction

Variable	Art		Non- art		ANOVA			
	M	*SD*	*M*	*SD*	Effect	*F* ratio	*df*	η^2
Stimulus presentation duration					G	6.51*	1	.041
50 millisecond	437.15	170.91	350.68	148.19	P	51.04**	1	.24
100 millisecond	482.95	175.17	438.49	178.29	P x G	5.05*	1	.032

Note. N = 156. ANOVA = analysis of variance; Art = art university/ school students; Non- art = non-art university/ school students; G = group, art/ non- art specialty; P = stimulus presentation duration
*$p < .05$

**$p < .001$

A mixed between- within subjects analysis of variance was conducted to assess the impact of the two levels of visual art expertise (art students, non-art students) on semantic priming effect across two priming conditions (target stimuli presentation for 50ms and 100ms) (Table 3).

There was a significant interaction between the level of visual arts expertise and priming condition, Wilks' Lambda = .96, F (1, 154) = 5.04, p = 0.02, partial eta squared = .032.

There was a substantial main effect for priming condition, Wilks' Lambda = .751, $F(1, 154) = 51.04$, $p < .000$, partial eta squared = .24.

An independent samples t-test was conducted to compare the correct answer scores for art and non- art groups. There were no significant differences in scores for art students ($M = 6.99$, $SD = 8.03$) and non- art students ($M = 8.04$, $SD = 7.82$; $t(154) = .812$, $p = .418$).

Discussion

In this study, with the use of semantic priming, we examined the reaction time of art and non-art undergraduate students by presenting verbal stimuli accompanied by figures of animate and inanimate visual stimuli. The aim of the present research was to examine the interaction of art expertise and priming effect on reaction time.

In order to get a more detailed picture of the interaction between art expertise and priming effect, semantic effort was presented along two conditions. As semantic priming appears at less than 60ms already (Heyman et al., 2018), in the present research it was implemented by using a shorter 50ms and a longer 100ms stimulus presentation.

Our findings show that art expertise has a significant effect on reaction time. The reaction time of art students was longer than that of non-art students. Since the extended reaction time indicates the priming effect (Kristjánsson, 2016), the result suggests that the semantic priming effect is more obvious in art students. This can also mean that knowledge acquired during art training inhibits the automatic processing and meaning-making processes.

One possible explanation for the semantic priming effect is to be found in the nature of the priming itself. Results of previous research demonstrate that semantic priming is also influenced by such top-down processes as controlled attention mechanisms (Kiefer, Adams, Zovko, 2012). Domain specific knowledge mainly results in top-down activation, which appears in cases where the task itself is related to the field (Harel, Gilaie-Dotan, Malach, Bentin, 2010), but in cases where the task is not related to the field of knowledge, there is no significant difference between the performance of experts and that of beginners (Bukach, Phillips, & Gauthier, 2010). The increased reaction time of art students may also be due to the nature of the animate and inanimate objects presented. Although the stimuli presented were visual, it is possible that the position or category of the stimuli was not familiar. As a result, task performance was not area-specific, demonstrated by the fact that there was no significant difference in the response of art students and non-art students. This assumption is supported by the results of Bukach et al. (2010) as well. In cases where decision making did not include domain specific information, beginners took external factors into consideration, while in the decision-making process of experts internal factors also appeared. Considering the findings, in the case of this study, we can conclude that processing mechanisms resulting from art expertise caused increased reaction time, which is due to the multiple internal response processes. However, the presence of internal factors cannot be detected in the correct responses of the two groups.

We found no significant difference between the two groups based on the incorrect answers. This result suggests that priming effect is observed at the time of stimulus processing, but not in the accuracy of the response. One possible explanation may be that domain specific knowledge is activated during non-domain specific task completion. However, this does not result in better performance in the case of semantic priming, on the contrary, it slows down the reporting processes with the appearance of the interference effect.

One possible explanation for the results obtained is to be found in holistic processing. In holistic processing, we are able to process specific visual stimuli as a whole, which allows us to differentiate between different categories (Richler, Wong, & Gauthier, 2011). The results of previous research prove that holistic stimulus processing is a sign of expertise, however, this form of processing is not generalized outside the specialized field. (Bukach, Phillips, Gauthier, 2010). Based on the results of the present study, we can conclude that the performance of art students outside the field of expertise is similar to that of non-art students.

The effect of domain specific knowledge on reaction time can be observed based on the duration of stimulus presentation. In the present research semantic priming was presented in two conditions, the presentation of concepts was displayed for a shorter (50 sec) and a longer time (100 sec). It can be observed that the reaction time of art students is much more uniform in the two conditions of stimulus presentations. Mandel and Johnson (2002) found similar results in their research, where experts' stimulus observation time was much more uniform than the observation time of less skilled groups, regardless of stimulus, in the case of tasks where decisions had to be made according to different criteria. Thus, it can be concluded that during fine art training, artists acquire a typical processing method. This means that domain specific knowledge has a direct effect on reaction time, which increases reaction time. However, as a result of their expertise, students majoring in fine arts are less affected by the duration of stimulus display.

The priming paradigm results in implicit memory activation. Recalling information from implicit memory is an automatic process in which attention-related processes are also activated (Lin, Meng, Lin, 2021). Although there is no significant difference in the response of art and non-art students according to the findings of the present study, a significant difference can be observed in terms of their reaction time. Lin et al. (2021) found that the inhibition processes formed during priming will be neutralized with timing of 600ms. In the case of our study, recall occurred immediately after the presentation of the stimuli, thus the results can be interpreted as a consequence of the inhibition processes activated by the domain specific knowledge.

Considering these results, we did not find a significant difference between the response accuracy of the two groups, however, the reaction time of art students is longer but much more uniform, regardless of priming duration. Thus, we can conclude that the priming effect is stronger as a result of art expertise. The more uniform reaction time of art students may suggest some level of domain specific knowledge activation triggered by the visual nature of the stimuli.

The increased reaction time of art students can also be interpreted as a rudimentary domain specific processing activity. Initially, the processing of new, non-domain specific stimuli resulted in more holistic processing during the trials, which is also reflected by the unity of the reaction time. Because experts use multiple internal response options in stimulus processing regardless of the stimuli presented, we suppose that the increased or more uniform response time is due to this internal response process.

Limitation

Ecological validity can be highlighted as a fundamental limitation of the present study. The stimuli presented as well as the nature of the task are artificial. Another limitation of the study is the measurement of visual working memory, as we can deduce the operation of the system from the obtained results; however, in the case of the present study, the VWM processes were not explicitly measured in this sense. The system was measured implicitly in the present study, making the interpretation of the results difficult for VWM. Another limitation of the research is the difficulty of exploration of serial and parallel mechanisms related to visual processing.

MEASURING PERCEPTUAL GROUPING ABILITIES OF ART AND NON-ART STUDENTS
Study IV

Theoretical background

By using the principles of visual organization, we perceive the individual units as a whole. Visual stimuli are grouped according to their physical traits, which can relate to the color, shape, or direction of the stimuli (Yu et al., 2019). Although these principles of perceptual organization are universal in nature and function, the results are inconsistent in terms of the dimensions of properties that influence organizing principles. The inconsistency in the results is mainly related to the fact that grouping is made according to one or multiple characteristics of the visual stimulus (Levinthak & Franconeri, 2011; Han et al., 2001).

In previous research, where Gestalt sorting principles have been applied to artists and non-artists, the results show that artists perceive the stimuli presented in the Gestalt test as a whole in more cases than non-artists (Gainas, 1975). One possible explanation for this is the results of the NAVON tests. The results of these studies have shown that artists show increased global processing, and their shift from local to global perception is much more flexible than that of non-artists. Perceptual flexibility is accounted for as a result of drawing skills and frequent drawing activities (Chamberlain & Wagemans, 2015).

Objectives and hypotheses

The primary goal of the present research is to examine the interaction between visual grouping illusions and art expertise. Another research goal is to examine the effect of top-down information on the reaction time of visual grouping processes. What is more, the aim of the present research is also to examine the effect of spatial and feature grouping stimuli on task performance.

Hypotheses

1. We predict that domain specific knowledge activation results in prolonged RT in visual grouping illusion task.

2. We predict that art students are less influenced of spatial-grouping illusions.

3. We predict that the interaction between domain-specific knowledge and visual-grouping illusion affects RT.

Method and Procedure

Design

The design is quasi-experimental, , ex post facto. The quasi- independent variables are art expertise, 7 forms of visual grouping illusion, i.e.: common region, proximity, direction, similarity, color, shape, and color-shape, while the dependent variable is reaction time.

A statistical power analysis, G*Power (Faul, Erdfelder, Lang, Buchner, 2007; Faul, Buchner, Lang, 2009), has been used to compute sample size. To detect an effect of η 2 p = .04 with 80% power in two-way between- groups analysis of variance ANOVA (two groups, alpha = .05), G*Power suggests we would need 37 participants in each group (N = 74).

Participants

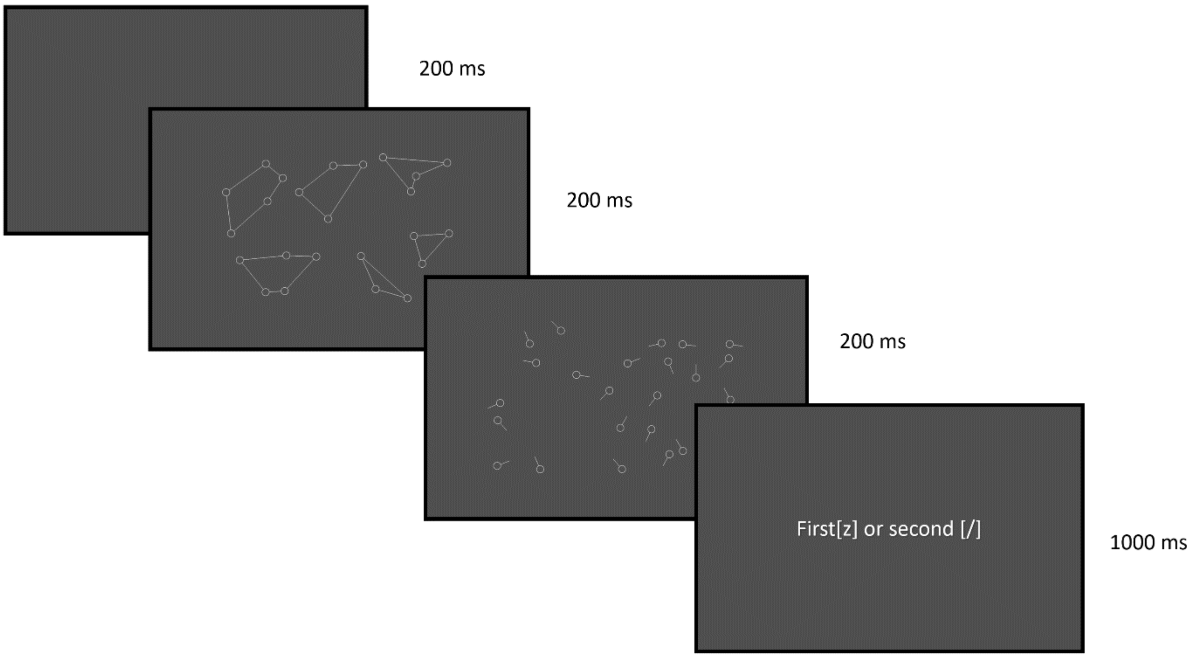
47 art and non-art university students have been gathered in the experiment. 1st 2nd and 3rd year students of Psychology and Special Education from the Babes-Bolyai University, Faculty of Psychology and Educational Sciences in Cluj-Napoca, and students of painting, graphics, and sculpture at the University of Art and Design Cluj-Napoca have been recruited. The vision of all participants was normal or adjusted to normal.

Procedure

In the present study, we used a computer program elaborated by us. The program included a package of pictures. The images were grouped according to 7 grouping illusions, which are: common region, proximity, direction, similarity, color, shape, and color-shape. The grouping illusions listed were divided into two groups: spatial and feature-based groupings. The image material was prepared by Yu et al. (2019). An equal number of items appeared on each component of the image pairs (24 items), the items of one component of the image pair were grouped according to a certain feature, while the items of the other image appeared in a separate, ungrouped form. During each trial, the grouped form of the displayed items was presented first, followed by the ungrouped image. Participants had to indicate by pressing a button whether they saw more items in the first or the second pair of images. The answers were given with the use of 2 keys; if the first picture was considered to be the correct answer, key “z” had to be pressed, while for indicating the second picture, “/” was the correct key. The program measured the responses given by participants. Reaction time was measured in the last phase, the time between the display of the response option and the indication of the presumably correct response (Figure 1).

Figure 1

Design structure



Note. In each trial, there was a 200ms waiting time before the display of the grouped stimulus. Both components of the image pairs (grouped, ungrouped) were visible for 200ms. This was followed by a response with a time limit of 1000ms. The response time was measured in the last phase, during the selection of response options displayed for 2000ms.

After the start of the trial, a grey screen appeared for 200ms. Then, in the next step, a grouped image was displayed also for 200ms, after which the ungrouped stimulus was visible for another 200ms. In the response phase, participants had 1000ms to give an answer. There was no right or wrong answer in terms of answering. Participants were instructed to provide their answers as quickly and as accurately as possible.

Results

A two-way between-group analysis of variance was conducted to explore the impact of visual art experience and visual grouping illusion type on RTs. Participants were divided into two groups according to their specialty in university (Table 4, Table 5).

The significance level of Levenes' Test of Equality of Error Variance was greater than .05; we can conclude that we have not violated the homogeneity of variances assumption.

Table 4

Means, Standard Deviations, and Two- way between- group ANOVA for Groups as a function of Visual Grouping Illusions

Variable	Art		Non- art		ANOVA			
	M	*SD*	*M*	*SD*	Effect	*F* ratio	*df*	η^2
Visual Grouping Illusions								
Common Region	1039.65	436.917	938.55	439.59	G	7.96*	1	.008
Proximity	1026.81	407.17	911.75	443.45	V	.53	6	.003
Direction	981.67	431.91	1028.91	439.88	G x V	.623	6	.004
Similarity	1024.16	416.01	889.02	425.459				
Color	933.82	415.9	869.25	505.87				
Shape	1041.67	460.34	937.1	471.23				
Color- shape	1023.3	459.36	869.55	443.14				

Note. N = 47. ANOVA = analysis of variance; Art = art university/ school students; Non- art = non- art university/ school students; G = group, art/ non- art specialty; V = Visual grouping illusion
$^*p < .05$

The interaction effect between specialty and visual grouping illusion type was not statistically significant, F (6, 1034) = .53, p = .786. There was a statistically main effect for specialty, F (1, 1034) = 7.96, p = .005, the effect size was small.

Table 5

Analyses for the Interaction of Set, Instruction on reaction time of Art- and Non- art students

Visual grouping illusion	Art	Non- art	*F* ratio	*p*	η^2
Common Region	1039.65	938.55	3.72	.054	.02
Proximity	1026.81	911.75	2.41	.12	.01
Direction	981.67	1028.91	.27	.6	.00
Similarity	1024.16	889.02	4.44	.35	.02
Color	933.82	869.25	.25	.615	.00
Shape	1041.67	937.1	1.33	.24	.00
Color- shape	1023.3	869.55	5.75	0.17	.03

Note. Means with different subscripts differ at the p = .05 level by Pairwise comparison test. The main effect for visual grouping illusion, F (6, 1034) = .53, p = .786, did not reach statistical significance.

An independent-samples t-test was conducted to compare the answer type (the ungrouped stimulus as an answer) scores for art and non- art groups. There were no significant differences in scores for art students (M 13.78, SD = 4.01) and non- art students (M = 12.13, SD = 4.04; t (45) = .1.41, p = .165).

Discussion

In the present study, we examined the effect of visual grouping illusion, and art expertise on reaction time. The stimulus material of our computer program contained 7 grouping illusions, which were part of 2 large categories, spatial-grouping cues and feature-similarity-grouping cues. The stimulus materials presented in the program contained an equal number of items, and it was the task of the participants to mark which image had more items. The reaction time of art students increased for both grouping illusions.

Based on the results obtained in the two-way analysis of variance, art expertise had a significant effect on reaction time. The reaction time of art students was longer than that of non-art students. We found no significant differences between the accuracy of the answers of art and non-art students. The response was examined in terms of which of the presented image pairs were marked as a multi-element image by the participants. Both the artist and non-artist groups marked non-grouped images as images with multiple elements. We found a significant difference in reaction time between the two groups in terms of similarity and color-shape illusions.

Considering the results, we can conclude that the increased reaction time in the case of art students means the visual illusion effect, which is also proved by the results of previous research. During drawing processes, the presence of illusion results in increased reaction time, but this sensitivity can be observed for both artists and non-artists, so illusions affect both artists and non-artists (Cohen, Jones, 2008), i.e. the effect of illusions is universal. In the present study, visual illusion was not examined by a drawing process, but by information recall, where recall occurred after the direct presentation of two stimuli, which can be interpreted as a kind of visual working memory activity, too.

Visual working memory is a system with limited capacity, which is of 3-4 units in length, and this capacity is also influenced by the number of items, or the properties of the items (Awh, Barton, Vogel, 2007). This capacity is also affected by the visual stimulus complexity. Complexity influences interest and preference according to the results of Berlyne (1971) (Caraball, Fernandez-Lozano, Rodriguez-Fernandez, Santos, Romero, 2020). In terms of complexity, color-shape stimuli are characterized along two dimensions, while in terms of similarity grouping, they can only be characterized in terms of the position of the elements. However, in terms of the number of items, each stimulus contained the same number of items, however, we distinguished between grouped and non-grouped stimuli. The grouped stimuli presented in the study contained six groups and 24 items, with no groups formed for the non-grouped, but the number of items was the same as the number of items in the grouped.

Similarity illusion follows spatial grouping principles, while color means property grouping. The results of previous research suggest that artists perform better in spatial-visual tasks (Chamberlain et al., 2019), which is also a system of visual working memory, while professionals in different fields (chess, music, sports) have better visual memory, and their performance in tasks is also better (Sala, Gobet, 2017). The results of the present study do not confirm the results reported in the literature, as we did not find a significant difference in response results between the two groups. However, the result obtained also suggests that the effects of visual grouping illusions are of a general nature, which are not determined by domain specific knowledge.

Since visual working memory is also influenced by the number of items and complexity (Eng, Cheng, Jiang, 2005), a significant increase in the reaction time of artists' color-shape illusion may suggest that visual illusion has a greater impact on complexity. The increased reaction time in the illusion of similarity can also be interpreted as meaning that in the case of perceptual illusions, the complexity of the properties affects performance. A similar result was obtained by Chen, Li, Liu (2017) in their research, where the degree of complexity influenced visual working memory functioning.

The increased reaction time of art students may also indicate the activation of meaning-making processes. In the case of visual perception, we not only perceive the mere physical nature of the stimuli but meaning-making is also associated with the process (Pinna & Reeves, 2009). This difference in reaction time can also be interpreted as an activation of the experience gained during art expertise. During fine art education, students often encounter works of fine art, which are also analyzed according to various criteria (Leder, Belke, Oeberst, Augustin, 2004). The longer reaction time can therefore be interpreted as a result of the inhibitory effect of domain specific knowledge, i.e. the processes that are activated during the analysis of works of fine art have been activated, which are also meaning-making processes. During art training, students are often confronted with figurative or abstract works where the message of the work does not appear explicitly. The increased reaction time of art students can thus be interpreted as the activation of domain specific knowledge on the geometric stimuli of the present task, which in turn, delayed the recall and response reaction time.

Another possible explanation for the increased reaction time of art students is to be found in the nature of the task. Since the response options did not include an option that represents an equal number of items of the presented stimuli, the increased reaction time may indicate that art students in the recall phase tried to resist the grouping illusion. The tendency to resist illusion can also be attributed to frequent drawing. During art training, artists acquire the ability to depict a 3-dimensional effect in a 2-dimensional plane using illusions. Drawing accuracy is affected by the misperception of the object to be drawn, which stems from visual illusions (Cohen and Bennett, 1997). The results of Perdreau and Cavanagh (2013) suggest that artistic experience does not help us either to have access to an early, illusion-free view of the object to be drawn, so better drawing performance cannot be explained by access to a raw, early view of the stimulus. As a result, better drawing processes do not result from visual perception properties, but from the results of top-down processes gained during art expertise. This can be interpreted in terms of the results we obtained that the observational techniques learned during drawing were activated during the process of comparing stimuli so that art students were more resistant to visual illusion and tried to overcome it.

In conclusion, the experience gained during art education influences the processing of visual stimuli, as visual perception includes both stimulus-driven and knowledge-driven processing. Since stimulus-driven processes are predominantly biological in nature, automatic, and universal, visual articulation illusions affect art students as well. Visual illusion grouping is a universal process unaffected by art expertise. This statement is supported by the results of the present research that there is no significant difference in the response of art and non-art students. The effect of domain specific knowledge can be observed in the increased reaction time, where the reaction time of art students is longer, suggesting that meaning-making processes also appeared in the task performance, which inhibited the development of stimuli.

Limitation

One of the limitations of the present study is the number of individuals involved in the research. As another limitation, it is important to highlight the measurement of VWM system performance. The system was measured implicitly in the present study, making the interpretation of the results difficult for VWM. A third limitation is the lack of ecological validity, as the artificial nature of the tasks used in the research makes it difficult to generalize the findings.

TRAINING IN HISTORY OF ARTS RESULTS PROLONGED, BUT CONSTANT RT IN VISUAL SEARCH TASK PERFORMANCE
Study V

Theoretical background

Fine art expertise changes the bottom-up and top-down process of perception, and stimulus processing differs between artists and non-artists (Feltovich et al., 2006; Ostrofsky et al., 2012). The results of previous research provide clear evidence that visual search processes are driven by both the bottom-up and top-down properties of the stimulus (Cave & Wolfe, 1990; Shurygina et al. 2019). However, according to Treisnam’s (1980) Feature Integration Theory (FIT), in search processes, the color of the target stimulus has a greater effect on processing than shape (Lee et al., 2018) or spatial position (Spence & Frings, 2020).

In guided search processes, a combination of both bottom-up and top-down activations appears (Serences & Yantis, 2006). This means that the search process will be influenced not only by the striking nature of the stimulus, but also by prior information about the stimulus. The findings of previous research do not provide clear evidence for the relationship between art expertise and visual search strategies (Chamberlain & Wagemans, 2015; Chamberlain et al., 2019), more specifically, what the bottom-up and top-down factors that influence controlled search processes are.

Objectives and hypotheses

The present study aims at examining guided search processes along the physical properties of visual stimuli, which are triple conjunction features. However, we aim at investigating the effect of visual stimulus timing on reaction time. A further objective of the present study is to examine the effect of art history training on the reaction time of guided search processes.

In order to get a more accurate picture of the impact of art history knowledge in search processes, the present study aims at compiling an art history training where the search techniques used and mastered in the training can also be used in conducting visual search tests.

1. Training in art history reduces the difference between exposure time RTs in the experimental group

2. We predict that training in art history results in shorter RT in visual search task.

3. We predict that training in art history results in a unified RT over stimuli exposure.

Method and Procedure
Design

The design is quasi-experimental, non- equivalent group design. The quasi- independent variables are the history of arts training and stimulus presentation time, and the dependent variable is the reaction time.

A statistical power analysis, G*Power (Faul, Erdfelder, Lang, Buchner, 2007; Faul, Buchner, Lang, 2009), has been used to compute sample size. To detect an effect of η 2 p = .04 with 80% power in mixed between- within subjects analysis of variance ANOVA (three groups, alpha = .05), G*Power suggests we would need 37 participants in each group (N = 113).

Participants

In the experiment, the participants were 75 art and non-art majors, students in their 1st, 2nd, and 3rd year of study from the Babes-Bolyai University, Faculty of Psychology and Educational Sciences in Cluj-Napoca majoring in Psychology and Special Education, and students of painting, graphics, and sculpture from the UAD Cluj-Napoca. The vision of all participants was normal or adjusted to normal.

Procedure

We used a computer program that we developed to examine the impact of art history expertise on visual search processes. The computer program contained a 27-element stimulus material with 3x3x3 properties. In 114 random trials, a combination of the 27 items appeared. Stimuli are based on stimuli used in Nordfang & Wolfe's (2014) research, where the properties of the items appeared along color (red, green, blue), shape (oval, rectangle, zigzag), and direction (horizontal, vertical, diagonal); these are the so-called triple conjunction features.

The 114 trials were presented twice, along 2 conditions, one with no time limit, and one with the time limit of 3 seconds. In the case of the time limit, the appearing visual stimulus disappeared after 3 seconds, while in the condition without a time limit, the stimulus did not disappear until the participant reacted. Measurements were counterbalanced.

After providing demographic data, each participant solved a series of tests containing 114 trials. Before each series of tests, participants completed a practice phase of 10 trials, the results of which were not processed. For each trial, the task for the participants was to click on the red horizontal rectangle as accurately and as quickly as they could. The program measured the time elapsed between displaying the trial and reacting.

The pre-and post-tests were surveyed each time with the computer program we created. In order to reduce the testing effect, the trials were presented randomly in each case. The results were recorded twice all in all. During the pre-test, along the condition of the presentation of the trials (with or without a time limit), for each person, we decided by randomization which condition the participant should perform first. During the post-test, the order was opposite to the order obtained in the pre-test.

Participants were divided into 3 groups: art students and non-art students were further divided into two groups: training and no training groups. Non-art students were grouped using randomization. Participation in the training was credited as a seminar activity.

Training description

The art history training included a series of four 90-minute lectures, where in addition to frontal education, interactive activities also appeared. The structure of the training followed the curriculum that emerged during the formal training of fine arts, which, in addition to presenting the age of art history, also included the analysis of masterpieces of that age. The analysis of the works was done along composition, taking into account the peculiarities of the given age. The works presented at the training were paintings. The critical aspects of the analysis are based on Berger's (1972) book.

Results

Levene's Test of Equality of Error Variance showed that the results did not violate the assumption of homogeneity of variance. The value for each variable is greater than .05 (.43, .52); therefore we can proceed.

Box's Test of Equality of Covariance Matrices shows that the Sig. value is bigger than .001, the value is .21; therefore we have not violated this assumption.

A mixed between-within subjects analysis of variance was conducted to asses the impact of the history of arts training and stimuli exposure time on the score of the participants on visual search performance RT in two-timing in stimulus presentations, across two time periods. There was no significant interaction between the training and time period, Willks' Lambda = .998, F(1,138) = .32, p = .57 (Table 6).

Table 6

Means, Standard Deviations, and mixed between- within subjects ANOVA for Stimulus Presentaion Duration over time periods

Variable	Art		Training		Control		ANOVA			
	M	*SD*	*M*	*SD*	*M*	*SD*	Effect	*F* ratio	*df*	η^2
3 millisecond							G	3.17*	2	.044
Time 1	166825	25876.6	153693.54	26324.11	158191.12	25950.27	S	8.8**	1	.06
Time 2	159160	32654.11	150090	28246.14	158135.19	37523.42	M	5.23*	1	.037
No time limit							M x T	.32	1	. 002
Time 1	182315	30783.08	165548.38	28203.1	176707.75	21794.6	M x G	1.66	2	.024
Time 2	170050	39167.85	158183.87	31690.3	158135.19	38644.71	M x T x G	.142	2	.002

Note. N = 75. ANOVA = analysis of variance; Art = art university/ school students; Non- art = non- art university/ school students; G = group, art/ non- art specialty; S = Stimulus presentation time (3millisecond, no time limit); M = measure (pre-, post test measurement)
*** p < .01*

**p < .05*

There was a substantial main effect for the measurement, Willks' Lambda = .96, F(1, 104138) = 5.23, p = .024, partial eta squared = .037, with the art student group and training group showing a reduction in RT across the two time periods, suggesting differences in RTs of the two measures.

The main effect when comparing the two measures of RT over the stimuli presentation conditions, F (1,138) = 8.8, p = .004, suggests differences in RT. The main effect when comparing the RT of the 3 groups was significant, F (2, 138) = 3.17, p = .045, suggesting differences in RT between the two groups after training.

Pairwise comparison test indicates that the mean score for the no training group in no time limit condition (M = 177129.87, SE = 6226.82) showed significant differences from 3 ms time limit (M = 158163.15, SE = 5937.04) over time period. The mean score for training group in no time limit condition (M = 161866.12, SE = 5001.5) showed no significant differences from 3 ms time limit (M = 151891.93, SE = 5001.5) over time period. The mean score for the group of art students in no time limit condition (M = 176182.5, SE = 6226.82) showed no significant differences from 3ms time limit (M = 162992.5, SE = 6226.82) over time period.

Discussion

In the present study, we examined the effect of art history knowledge on visual attentional processes. Participants were divided into 3 groups, a group of art students, one of non-art students who participated in the training (experimental group), and one of non-art students who did not participate in the training. After the distribution of the groups, the experimental group participated in a series of four art history training compiled by us. The survey of the dependent variables was performed two times, during pre-and post-test. The visual search was presented concerning two conditions: search without a time limit and a 3-second time limit.

The interaction between training and pre-and post-measurements was not significant, and the interaction between training and timing of stimulus presentation was not significant either. According to the results we obtained, the pre-and-post measurements had a significant effect on the RT. The reaction time of art students and the group of students who participated in the training decreased during the measurements, the reaction time of the group who did not participate in the training did not decrease between the two measurements.

There was no significant difference in the timing of stimulus presentation between the group of trained students and that of art students, along the no time limit and the 3ms stimulus presentation, however, there was a significant difference in the reaction time of the non-trained group concerning no time limit and 3ms time limit.

The reaction time of students who participated in the art history training decreased between the pre-and post-test, i.e. the search processes were faster, while no difference could be observed along the condition of the stimulus presentation. This means that regardless of the time limit of the stimulus, those who participated in the training had a more uniform reaction time. This result can also be paralleled with the results of previous research. The research of Folstein, Monfared, and Maravel (2017) examined the formation of new category representations and visual attentional processes using a brain imaging procedure.

Their findings suggest that the formation of new categories does not change the functioning of attentional processes, but that the visual search is achieved by new representations. The results obtained in the present study can therefore be interpreted as meaning that the participants developed new representations through the art history training, which also included exercises related to image analysis. The new representations, that is, how we look at a work of art, viewing the given painting in a targeted and directed way, has created a representation of a new search technique. This technique applied to visual search tasks, and at the same time, resulted in a more uniform pattern of response time.

In the pre-test, we found a significant difference between students majoring in art and those participating in training but the results do not show a significant difference between the groups participating in training and those not participating in the training. According to the results of the post-test, there is no significant difference between the reaction time of the group of art students and the groups who participated in the training, however, no significant difference can be detected between the reaction time of the non-trained and trained groups. One possible explanation for the pattern of reaction times of the groups that did not participate and those that participated in the training can be found in the fact that the process of becoming an expert is a year-long process (Lehtinen, Gegenfurtner, Helle, Saljo, 2020), while in the present study, the training took place 4 times, which is not sufficient to become an expert.

The increased reaction time of art students in the pre-test can also be interpreted as an activation of domain specific knowledge, the increased reaction time is the same as in previous research (Harland et al., 2014). The stimulus material used in the measurements was characterized by color, shape, and direction. The increased reaction time can also be interpreted as a consequence of the complexity of the stimuli. Activation of top-down knowledge resulted in increased reaction time. However, findings of previous research suggest that top-down information may act as an inhibitory process. Top-down information represents the preliminary position of the stimulus; this inhibitory process will disappear after 400ms following the presentation of the stimulus (Wattson & Humphreys, 2000).

Findings of previous research also demonstrate that drawing processes affect the operation of visual working memory (VWM). VWM includes spatial-visual processing (Peterson & Berryhill, 2013) as well, therefore the increased reaction time of art students achieved in the pre-test can also be interpreted as a consequence of the continuous position change of the target stimuli appearing in the task. However, increased RT can also be interpreted as the disappearance of the influence of top-down information, i.e., the time of overwriting the effect of the pre-stimulus position.

The differences between the pre and post-test response times of the 3 groups can also be interpreted as the effect of knowledge in art history on visual search processes. Although the results of the participants in the training were not significant, the reaction time of the students who participated in the training and the students majoring in art decreased in the post-test. A possible explanation for the result obtained is to be found in the application of search techniques. This means that the representations used in visual search are activated faster, so the search process is also faster. According to the results, we can observe a decrease in the number of art students in RT, despite the fact that they did not participate in the art history training we held. We assume that this change is due to the formal training of art students, which they received in parallel during the training we held. However, no clear conclusions can be drawn in this regard.

To sum up, we can conclude that art history training has an impact on RT. By participating in the training, the RT becomes more uniform, regardless of the presentation of the stimulus, i.e. the search representations acquired during the training facilitate a faster search in the tasks. Since we can observe a difference between the pre-post reaction time (within subjects) of students majoring in art, and trained students, we can conclude that proficiency in art results in faster acquisition of techniques used in visual search processes and their more successful development, due to which search time is reduced.

This may suggest parallel processes in visual search, in which stimuli are processed in parallel along different dimensions (Wattson & Humphreys, 2000). As the visual search was influenced by both bottom-up and top-down processes (Shurygina et al. 2019), not only the properties of the task represented the top-down nature but directed search processes also emerged, which were derived from the techniques learned during image analysis.

Although we did not find a significant difference in reaction time between the training and no training groups, we can observe that the reaction time of the training group is shorter compared to the no training group. From this, we can conclude that the training we held allows the development of domain specific knowledge, however, we assume that more time would be needed to obtain significant differences between groups. Based on the findings, we can say that the art analysis techniques acquired during the art history training did not have a significant effect on the reaction time of the visual search processes but we assume that a more uniform time pattern means optimal use of the techniques by which the reaction times remained more stable regardless of the conditions. For clearer results, it would be useful to include drawing processes in future research, thereby examining the role of eye-hand coordination in visual search processes.

Limitation

One of the limitations of the present study is the nature of the stimuli used in the computer program we created, as the triples with no target stimulus were missing. Another constraint is the equal number of items of the stimuli shown. In each trial stimuli with the same number of items appeared. Another research limitation is the unequal number of participants in the groups.

CHAPTER IV.
FINAL CONCLUSIONS

The first study is a meta-analysis (1st Study) in which we compared the results of eye fixation durations resulting from the literature between artists and non-artists. According to our findings, the eye fixation period of artists was longer than that of the non-artists. This result suggests that art expertise has a significant effect on the duration of eye fixation. Although the difference between the two groups is clear, other factors that may influence this difference did not appear to be significant. None of the moderator variables we examined had a significant effect on eye fixation duration.

Taking into account the findings of the meta-analysis, in the next step (2nd Study) we examined the meaning making processes of distorted objects. Objects were presented in three contexts: the object without context, in a context that stimulates recognition, and context that inhibits recognition. Instructions were separated as bottom-up and top-down task instructions. Based on the results, we can say that the object recognition and meaning making processes of art students were faster and more accurate. From this, we can conclude that knowledge in art facilitates meaning making processes, resulting in a more accurate and faster response.

In the next study (3rd Study), we examined the visual semantic priming effect between artists and non-artists. Semantic priming was presented along two conditions. Based on the results, we can say that there is a significant difference concerning the reaction times of artists and non-artists. While the reaction time of students majoring in art was longer, the results do not show a significant difference in the correctness of response between the two groups. Based on the results, we can conclude that art expertise influences the semantic priming effect, resulting in an increase in reaction time. However, the reaction time experts is much more uniform concerning the priming condition, suggesting that visual stimuli are processed more uniformly by artists regardless of condition.

Due to the nature of the priming paradigm and implicit memory, implicit meaning making processes appear during the experiment, which are automatic (Lin, Meng, Lin, 2019). Based on our results, we can conclude that domain specific knowledge emerged as an inhibitory process during recall from implicit memory. Since this inhibitory process becomes neutral after 600ms (Lin, Meng, Lin, 2019), the increased reaction time can also be interpreted as neutralization of the inhibition process, supported by task performance results; we found no significant difference between the answers art and non-art students concerning correctness. In conclusion, the longer reaction time of art students is a consequence of domain specific knowledge, where activation of knowledge from expertise does not allow for holistic processing against unknown stimuli.

In the 4th Study, we examined the interaction between visual grouping illusions and artistic expertise. Based on the reaction time patterns, we can conclude that the reaction time of art students was significantly longer than that of non-art students but again we could not detect significant differences in the correctness of the response, which suggests that visual grouping illusions universally affect the quality of response, so the quality of the responses cannot be modified by visual art expertise either. A possible explanation for the increased time in the reaction of art students is to be found in the acquisition of drawing skills acquired during art training as well as in the processes of reporting. During drawing training, artists learn which properties of the stimulus to highlight for a realistic representation, which even means manipulating illusions.

As fine arts training involves the interpretation of art works, this associate meaning with abstract works, so increased reaction time may suggest activation of domain specific knowledge. Our assumption is confirmed by the nature of the stimulus material we use, and the geometric shapes could thus activate the meaning making processes acquired during the abstract works. All in all, domain specific knowledge delays the response time to visual grouping illusions, however, expertise does not affect the quality of response.

During the fine arts training, the acquisition of domain specific knowledge is achieved in both theoretical and practical forms. Since the difference between artists and non-artists can be clearly seen in drawing performance, which represents the practical form, we next examined the effect of art history knowledge on visual search processes (5th Study), which plays the role of theoretical training. We held a series of four 90-minute art history training where famous works of art created in different ages were analyzed. The results of the pre-and-post measurements show that the reaction time of the persons participating in the training was more uniform, and fluctuated less along the measurement conditions. This result can also be interpreted as a consistent application of the specific search techniques learned during the training. The significant difference in the pre-test response time between the trained and not trained groups disappears in the post-test results. From the result, we can also conclude that four interventions are not sufficient to form expertise. In conclusion, therefore, we can say that the visual search techniques developed during the art history training resulted in a uniform reaction time along the condition of stimulus presentation.

Theoretical contributions to the literature

Based on the findings of the present doctoral thesis, the theoretical contribution of the dissertation to the literature is the examination of the effect of artistic expertise on visual perception. In this sense, we can say that the effect of domain specific knowledge such as fine arts expertise can be noticed in the results of visual perception tasks. In cases where task performance activates object recognition, that is, meaning making processes, students majoring in art perform better and faster. In contrast, when task performance does not explicitly include meaning making, the task performance of art students is slower but there is no difference between art and non-art students in terms of accuracy of response. Another theoretical contribution of the present study to the literature is the meta-analysis we have conducted, which is the first in the literature concerning the studies on eye fixation duration when comparing artists and non-artists.

Methodological contributions to the literature

Although the study of the relationship between art and psychology is not new, few studies have focused on examining features in visual perceptual processes. Research in the literature focuses mainly on aesthetic and drawing processes. The methodological contribution of this doctoral thesis is the tools we have developed and used. The computer programs we used contained stimulus materials and tasks in which we examined general visual perception processes. In order to ensure that the nature of the task did not favor students majoring in art, the stimulus materials we used did not include drawing or aesthetic evaluation, or aesthetic decision-making processes.

Practical contribution to the literature

The art history training we compiled is a practical contribution to the literature. The application of image analysis techniques learned during the art history training resulted in a uniform pattern in reaction time regardless of the time limit for stimulus presentation. As a practical benefit of the findings, the importance of art history education can be emphasized, in which case not only do people learn techniques that enable optimal search, but also enrich their general education. In addition to the primary nature of art history education, which means theoretical knowledge and knowledge in art history, we can also mention an additional benefit as another practical contribution. By additional benefit, we mean that the knowledge acquired during the training can be applied to some extent in other areas as well but more exploratory research is needed with regard to this.

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