

# Visual object recognition ability is not related to experience with visual arts

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**Visual arts require the ability to process, categorize, recognize, and understand a variety of visual inputs. These challenges may engage and even influence mechanisms that are also relevant for visual object recognition beyond visual arts. A domain-general object recognition ability that applies broadly across a range of visual tasks was recently discovered. Here, we ask whether experience with visual arts is correlated with this domain-general ability. We developed a new survey to measure general visual arts experience and use it to measure arts experience in 142 individuals in whom we also estimated domain-general object recognition ability. Despite our measures demonstrating high reliability in a large sample size, we found substantial evidence ( $BF_{01} = 9.52$ ) for no correlation between visual arts experience and general object recognition ability. This suggests that experience in visual arts has little influence on object recognition skills or vice versa, at least in our sample ranging from low to moderately high levels of arts experience. Our methods can be extended to other populations and our results should be replicated, as they suggest some limitations for the generalization of programs targeting visual literacy beyond the visual arts.**

that can help individuals navigate, understand, and analyze our increasingly visual world (Kozbelt, 2001). An important limitation in evaluating such claims lies in the paucity of sensitive and reliable measures of visual abilities. Recent developments in the field of object recognition make it possible to measure a domain-general object recognition ability that generalizes across tasks and categories (Gauthier, 2018; McGugin, Richler, Herzmann, Speegle, & Gauthier, 2012; Richler, Tomarken, Sunday, Vickery, Ryan, Floyd, Sheinberg, Wond, & Gauthier, 2019). To assess the correlation between domain-general object recognition ability and experience in visual arts across a wide array of domains, we developed a new measure of experience in general visual arts.

The idea that visual perception may be influenced by experience with visual arts is one of several claims within the broad field of visual literacy, a multifaceted concept that includes affective, cognitive, linguistic, and perceptual components (Avgerinou & Pettersson, 2011; Kędra, 2018; Michelson, 2017). Many of the programs that use visual arts to target visual literacy focus on linguistic activities relevant to the subsequent linguistic appreciation and description of art works (e.g. Kim, Wee, Han, Sohn, & Hitchens, 2017; Lopatovska, Carcamo, Dease, Jonas, Kot, Pamperien, Volpe, & Yalcin, 2018; Slota, McLaughlin, Bradford, Langley, & Vittone, 2018). The effectiveness of these training strategies is sometimes evaluated by participants showing greater endorsement of statements like “I understand the role of visual intelligence on perception” following training (Slota et al., 2018). Other studies, conducted with children (e.g. Kim et al., 2017) or adult students (e.g., Naghshineh, Hafler, Miller, Blanco, Lipsitz, Dubroff, Khoshbin, & Katz, 2008), reported improvement in the number and detail of descriptions of art and clinical images alongside more detailed descriptions of the mood in a piece or the artist’s

## Introduction

Every day, most individuals receive a wealth of complex visual inputs from physical objects to images of objects appearing on billboards, packaging, printed materials, and screens; this input can be attended, categorized, recognized, and critically interrogated to guide behavior. Whereas visual experience is generally quite varied, special interests can influence what we look at and how we look at it. Visual arts training programs, in formal training settings or art museums, often claim to provide experience and knowledge

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intentions. In general, the effect of visual training is measured in both subjective and objective linguistic methods. Whereas changes in perceptual abilities are also consistent with the general framework of visual literacy, we suspect that they are rarely assessed because they are more difficult to measure – in fact, until recently, there were very few tests available for this purpose. For this reason, it is largely unknown whether experience with visual arts can influence perceptual abilities. In other domains of expertise, for instance, in wine appreciation, differences between novices and experts are often considered more cognitive than perceptual (Spence, 2019). Such differences are not trivial, reflecting advantages in semantic knowledge and memory as well as changes in attention to relevant perceptual dimensions – but they are not the same as improvements in perception. Although a better vocabulary to describe images or a stronger interest in doing so have real implications, differences in object recognition ability would be a more surprising and potentially more influential effect. The perceptual factors are more distal from the experience itself and, by definition, domain-general effects generalize to more situations.

We recently reviewed the literature examining effects of arts training on visual perception and observed a lack of controlled experimental studies (Benear, Sunday, Davidson, Palmeri, & Gauthier, 2019). As part of that review, we surveyed cross-sectional studies relevant to the simpler question of whether visual artists see the world differently than non-artists (regardless of whether any difference might be due to self-selection into the arts or arts training). Several found evidence of differences in high-level perception and attention associated with training, often in drawing skills (e.g. Kozbelt, Seidel, El Bassiouny, Mark, & Owen, 2010; Perdreau & Cavanagh, 2013). For instance, drawing ability was related to both better local and global processing, as well as a better ability to flexibly switch between the two levels of processing (Chamberlain & Wagemans, 2015). In contrast, studies that target differences in abilities that involve low-level perception, such as resisting some visual illusions or perceiving differences in simple properties like color or contour, find little evidence of a relation to art experience (e.g. Kozbelt & Ostrofsky, 2018; Perdreau & Cavanagh, 2014). However, general methodological concerns limit conclusions from this body of research: these include small sample sizes (typically less than 20, and often as few as 10) with no consideration of a priori power, a tendency to dichotomize artists versus non-artists instead of quantifying experience with art, and the reliance on measures with poor or unproven reliability.

An important development that can contribute to our understanding of these questions is the concept of domain-general visual ability, or *o*. Evidence for *o* was initially obtained using structural equation modeling, supporting a higher level factor accounting for

performance in three different visual object recognition tasks with five different novel object categories (Richler et al., 2019). The initial work found that *o* could account for almost 90% of the variance in lower order factors, and another study replicated this result with novel objects and extended it to show that *o* represents an ability that equally applies to familiar objects like birds or planes (Sunday, Tomarken, Cho, & Gauthier, 2022). Importantly, *o* is only weakly related to general intelligence, and it is not correlated with individual differences in visual working memory capacity or global/local perceptual style (Richler et al., 2019). In recent applications, *o* has been estimated using the common variance across two different tasks (e.g. one with long-term memory demands and another with more speeded short-term perceptual demands) with different object categories (e.g. Chow, Palmeri, & Gauthier, 2022; Sunday, Donnelly, & Gauthier, 2018). When both measures are highly reliable, the correlation between two such tasks is expected to be moderate ( $r = 0.3\text{--}0.4$ ) because it excludes variance due to specific task demands or object category. The remaining shared variance is expected to have broad relevance to other visual judgments, across tasks and across object categories. For instance, *o* accounted for 15% of the variance in learning to detect lung nodules in chest radiographs, after controlling for both experience in this domain and for general intelligence (Sunday et al., 2018). It is therefore reasonable to ask whether *o* is related to experience with visual arts.

Our new measure of experience with visual arts intends to broadly target visual arts across many mediums. In the same vein as general object recognition ability, experience with visual arts can span across a variety of mediums and domains, such as drawing, painting, sculpting, photography, and graphic design. We aimed to measure a construct that is sufficiently general to capture a variety of experiences in visual arts. This contrasts with other arts measures that focused more on interest in art (Specker, Forster, Brinkmann, Boddy, Pelowski, Roseberg, & Leder, 2020) or response to artworks (Schlotz, Wallot, Omigie, Masucci, Hoelzmann, & Vessel, 2020). To be clear, we are not targeting artistic production skills, such as the ability to produce realistic drawings that have been previously linked to perceptual advantages (e.g. Kozbelt et al., 2010; Perdreau & Cavanagh, 2013). Artists are likely to have considerable experience with visual arts, but the opposite is not necessarily true (many with high experience with visual arts may not be artists themselves). By focusing on a more general measure of visual arts experience, we set the stage for a construct tapping into factors under the umbrella of visual literacy.

Because this is a new empirical question, we acknowledge several plausible outcomes. On one hand, in the tradition of studies that suggest an effect of arts training on visual perception, one prediction is that

experience with visual arts will influence visual processes that are captured by  $o$ . Clearly, a positive correlation would not rule out selection biases, but correlational support could motivate further experimental tests of how arts training might improve  $o$ . Even if the causal direction is reversed, it would be a novel and interesting relationship. The ability to predict interest in, or even success in, visual arts with a high-level domain of general ability would be useful. On the other hand, as there is currently no evidence and, indeed, no existing test of the idea that  $o$  is malleable, it is possible that experience with visual arts is completely unrelated to this visual ability. In the absence of a strong prediction, it is particularly important that we can evaluate the confidence in whatever result we obtain. For this reason, we chose to analyze our results using a Bayesian framework because it can quantify support in favor of no correlation as well as in favor of a positive (or negative) correlation (Wagenmakers, Marsman, Jamil, Ly, Verhagen, Love, Selker, Gronau, Šmíra, Epskamp, Matzke, Rouder, & Morey, 2018).

Our goal in this study was to assess the correlation between experience with visual arts and  $o$ , in a sample ranging from individuals with little arts experience to those with moderately high levels of arts experience (testing those with the highest levels of arts experience, such as renowned artists, was beyond the practical scope of this work). We tested all individuals online, sampling from a college community and on the online platform Amazon Mechanical Turk. Because we found no existing measure of general arts experience with good psychometric properties, we designed a survey to quantify experience in visual arts and demonstrated its reliability in this adult sample from online testing. We estimated  $o$  using the shared variance between two different tasks with novel objects to avoid idiosyncratic effects from either test (Rushton, Brainerd, & Pressley, 1983). To preview our results, we found substantial evidence in support of no correlation between experience with visual arts and  $o$ . For those unfamiliar with Bayesian statistics, such a result provides a stronger inference than simply a failure to find statistical evidence in support of a correlation in a standard frequentist statistical framework.

## Methods

### Participants

We report data from 142 participants (97 women, 41 men, and 4 others; mean age = 23.0 years,  $SD = 7.95$  years). An additional 14 were excluded because they were at chance or below chance on one of the tasks. A total of 114 individuals (82 women, 28 men, and 4 others; mean age = 19.7 years,  $SD = 1.61$  years) were recruited from the Vanderbilt University community by

tapping into the psychology subject pool (for course credit) and advertising in the History of Arts and Architecture department (for monetary compensation). Although our recruitment advertisement mentioned visual arts, we did not explicitly require participants to be interested in or have experience in visual arts. We also recruited 28 individuals on Amazon Mechanical Turk for monetary compensation (15 women and 13 men; mean age = 36.4 years,  $SD = 9.34$  years). Amazon Mechanical Turk participants are generally older than our mostly undergraduate subject pools to ensure that our results generalize across age. The sample size from both pools of participants was subject to a Bayesian optional stopping rule; we collected data until we reached a threshold of evidence for ( $BF_{10} = 3.0$ ) or against ( $BF_{10} = 1/3$ ) our primary hypothesis. To ensure we obtained comparable and high-quality data, participants from Amazon Mechanical Turk were required to be in the United States and have a task approval rate of at least 95% with at least 100 completed tasks on the website. Of the total 142 participants, eight reported not being an undergraduate student or completing an undergraduate education. Of the 134 students, 18 reported a major that involved visual arts (e.g. Fine Art, Photography, Graphic Design, and Art History), 107 reported a major that did not (e.g. Economics, Psychology, and Computer Science), and 10 were undecided. Informed consent was obtained and procedures were approved by the Vanderbilt University Institutional Review Board.

### Procedure

All participants performed the experiment online on their own computer; we prevented participation using mobile devices. The entire experiment was expected to be completed in approximately 40 minutes. At the start of the experiment, participants completed a brief questionnaire about their demographics and college education.

The Arts Experience survey immediately followed. Before the survey, we specified that “*we broadly define visual arts as including drawing, painting, sculpting, photography, graphic design, and other similar disciplines. If you are only experienced in one such discipline, please answer questions with respect to only that specific discipline. If you are experienced in multiple disciplines, answer for those disciplines in general.*” The Arts Experience survey included eight questions:

1. How experienced are you in visual arts? (1: not very experienced; 7: extremely experienced)
2. How many years of formal visual arts training have you had? (free response in number of years)
3. How many years have you been interested in visual arts (respond 0 if you have no interest)? (free response in number of years)

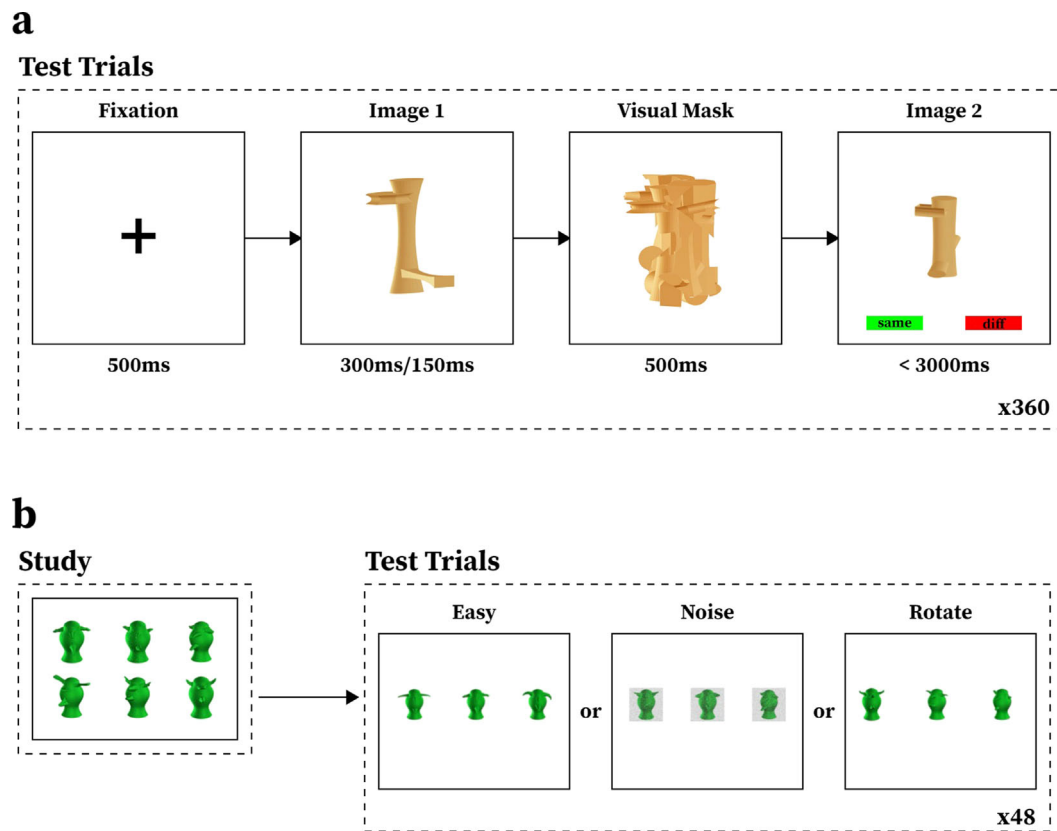


Figure 1. **Schematics of visual object recognition tests.** (a) Matching Test with Ziggerins. Participants are judged whether two serially presented images were the same object regardless of rotation and size changes. (b) NOMT with Grebbles. Participants first studied six targets and then were instructed to select the targets against two distractors. Objects during test could be rotated and/or overlaid with noise.

4. During the academic year, on average, how many hours a week do you spend producing/practicing/viewing visual arts? (*free response in number of hours*)
5. Outside of the academic year, on average, how many hours a week do you spend producing/practicing/viewing visual arts? (*free response in number of hours*)
6. Given a piece of art you have never seen before by a new artist, how confident would you be discussing what makes the piece interesting? (*1: not confident at all; 5: extremely confident*)
7. Given a piece of art you have never seen before by a new artist, how confident would you be discussing what techniques were used in the piece? (*1: not confident at all; 5: extremely confident*)
8. Given a piece of art you have never seen before by a new artist, how confident would you be discussing how the piece related to works by other artists you know? (*1: not confident at all; 5: extremely confident*)

The survey was designed to capture a range of arts experiences both in terms of artistic domains and how an individual would acquire or judge arts experience;

the goal was to capture experience with a broad range of visual arts.

After the survey, participants completed two tests of object recognition ability to estimate  $\sigma$ . Participants performed the Matching Test with Ziggerins and then the Novel Object Memory Test (NOMT) with Grebbles. All participants performed these tests in this order to avoid confounds of order effects in the measured individual differences. We have used similar tests in online formats successfully in several studies (e.g. Richler, Wilmer, & Gauthier, 2017), including some that demonstrate such visual tests that measure the same ability online as in the laboratory (Cho, Wilmer, Herzmann, McGugin, Fiset, Van Gulick, Ryan, & Gauthier, 2015).

The Matching Test with Ziggerins is a same-different visual perception task where participants judge if two serially presented objects are the same object or not (Figure 1a). Ziggerins are novel objects with a shared structure of a single vertical rod with two attachments, one at the top and the bottom; the shape of the vertical rod and the attachments define each unique Ziggerin (Wong, Palmeri, & Gauthier, 2009). The test began with six practice trials followed by 360 test trials. On each trial, a fixation cross was presented for 500 ms, the first



Ziggerin image was then presented for either 300 ms or 150 ms, then a visual mask of scrambled Ziggerin parts was presented for 500 ms, then a second Ziggerin image was presented alongside two on-screen buttons labeled *same* or *different*. Participants made their response by a mouse click on a button dependent on if they judged the two Ziggerins as same or different, regardless of variations in presentation. The two Ziggerin images could differ in size and/or viewpoint. The first Ziggerin image was presented for 300 ms in the first 180 trials of the test and for 150 ms in the latter 180 trials (decreasing viewing time makes those latter trials more difficult). The trial ended either when the participant made a response or 3000 ms had passed after the second image was presented. Participants were instructed to respond as quickly and accurately as possible. Trials where participants did not respond were counted as incorrect. Every 90 trials, participants were offered a break. This test was scored using sensitivity ( $d'$ ), with chance level performance at a  $d'$  of 0.

The NOMT with Greebles is a visual memory task where participants studied six target objects and then selected those targets against similar distractors in test trials (Figure 1b). Greebles are a set of novel objects, each with a central spheroid body and protrusions at set locations; the shape of the body and the protrusions define each unique Greeble (Gauthier & Tarr, 1997). The test began with the presentation of the six target Greebles simultaneously. Participants were instructed to remember the Greebles to recognize them later; they could study the Greebles for as long as they wanted. After studying the target Greebles, participants performed six easy test trials. On each test trial, an array of three Greebles was presented: one target and two distractor Greebles. The target could appear in any position (left, middle, or right) and participants responded by clicking on the Greeble they believed was a target. After the first six easy trials, the target Greebles were presented again for participants to study before moving to more test trials. Some test trials would present Greebles overlaid with translucent noise. Half-way through the test, participants were presented with the target set of Greebles again to study as before and instructed that the remaining trials would present Greebles from a slightly rotated viewpoint, but that this rotation was irrelevant (rotation makes those latter trials more difficult). There was a total of 48 test trials used to score this test using percent correct, with chance equal to 33%.

## Analyses

For the reliability of our individual differences measures, we report Macdonald's omega ( $\omega$ ), which has a similar interpretation to Cronbach's alpha but is more robust across deviations from simple assumptions

Question	Mean	SD	Range	Skewness	Kurtosis
Q1	3.18	1.90	(1, 7)	0.53	-0.77
Q2	2.56	4.26	(0, 32)	3.42	16.78
Q3	6.69	8.07	(0, 41)	1.79	3.67
Q4	1.77	1.01	(1, 5)	1.53	2.02
Q5	2.35	1.09	(1, 5)	0.45	-0.72
Q6	3.32	1.10	(1, 5)	-0.15	-0.78
Q7	2.25	1.33	(1, 5)	0.76	-0.62
Q8	2.20	1.38	(1, 5)	0.83	-0.67
Q2'	0.84	0.84	(0.00, 3.17)	0.34	-1.16
Q3'	1.42	0.98	(0.00, 3.45)	-0.23	-1.05
Q4'	1.18	0.20	(1.00, 1.71)	0.90	-0.02

Table 1. Descriptive statistics for each of the questions on the arts survey. Q4 (denoted by Q2', Q3', and Q4').

(McNeish, 2018). Essentially, it measures how well the tests correlate with themselves. When correlating tests, low reliability of each test can attenuate the magnitude of possible correlations and potentially mask true correlations.

We use a Bayesian statistics framework for our correlation analysis using a default Jeffreys-Zellner-Sior prior with an unbiased scale factor of one (Wetzels & Wagenmakers, 2012). Bayesian hypothesis testing encourages the use of competing models to test which hypothesis is best supported by the data. Here, our first model is that arts experience relates to object recognition ability (a correlation in either direction;  $H_1$ ), and the alternate model is that arts experience does not relate to object recognition ability (no correlation;  $H_0$ ). We report  $BF_{10}$  to index the likelihood of one model over the other. For example, a  $BF_{10} = 3.00$  would mean that  $H_1$  is three times more supported by the data than  $H_0$ ; in other words, the larger the  $BF_{10}$  value, the better. Bayes factors can be interpreted without any arbitrary cutoff as they index relative evidence between the two hypotheses. However, we follow conventions set out by Jeffreys (1961) to describe the magnitude of evidence: anecdotal ( $BF_{10} = 1-3$ ), substantial ( $BF_{10} = 3-10$ ), strong ( $BF_{10} = 10-30$ ), very strong ( $BF_{10} = 30-100$ ), and decisive ( $BF_{10} > 100$ ). For ease of interpretation, when data are more consistent with  $H_0$  than with  $H_1$ , we report  $BF_{01}$ , which is simply the inverse of  $BF_{10}$  (interpreted in the same manner, as support for  $H_0$  against  $H_1$ ). We also report highest posterior densities as 95% credible intervals (95% CIs) for our point estimates of correlation magnitude (the true correlation value has a 95% probability of being within the interval).

## Results

Table 1 presents the descriptive statistics for each question on the survey. We applied a cube-root

	Q1	Q2'	Q3'	Q4'	Q5	Q6	Q7	Item-rest r
Q1								0.83
Q2'	0.74							0.67
	[0.64, 0.80]							
Q3'	0.76	0.67						0.72
	[0.67, 0.82]	[0.56, 0.75]						
Q4'	0.44	0.31	0.38					0.54
	[0.30, 0.56]	[0.15, 0.44]	[0.23, 0.51]					
Q5	0.61	0.41	0.57	0.63				0.62
	[0.49, 0.70]	[0.26, 0.53]	[0.44, 0.67]	[0.51, 0.71]				
Q6	0.54	0.40	0.44	0.39	0.39			0.64
	[0.40, 0.64]	[0.25, 0.53]	[0.29, 0.56]	[0.24, 0.52]	[0.24, 0.52]			
Q7	0.73	0.55	0.54	0.43	0.52	0.66		0.82
	[0.63, 0.79]	[0.42, 0.65]	[0.41, 0.65]	[0.29, 0.56]	[0.38, 0.62]	[0.55, 0.74]		
Q8	0.58	0.43	0.49	0.45	0.47	0.63	0.80	0.71
	[0.41, 0.67]	[0.28, 0.55]	[0.35, 0.60]	[0.31, 0.57]	[0.33, 0.59]	[0.52, 0.72]	[0.73, 0.85]	

Table 2. Zero-order correlations across arts survey questions and item-rest correlations. *Note.* The 95% CIs are reported below point estimates.

transformation to three of the free numeric response questions because the raw data produced a highly right-skewed distribution.

The correlations across questions on the survey ranged from 0.31 to 0.80 (see Table 2). The item-rest correlations (between each item and the average of the other items) were high. An exploratory factor analysis suggested a unidimensional scale, with the first factor accounting for 54.4% of the variance (eigenvalue was 4.35). The second factor only accounted for 5.8% of the variance (eigenvalue of 0.47). We Z-scored all questions and averaged them for a total Arts Experience score that had very high reliability ( $\omega = 0.90$ ). A known-group approach provided validation for the scale, with the 18 individuals reporting a major in a discipline related to visual arts (e.g. fine arts, photography, and art history) possessing higher scores ( $M = 0.93$ ,  $SD = 0.79$ ) than the others ( $M = -0.14$ ,  $SD = 0.70$ ;  $BF_{10} > 100$ ).

As expected, based on prior work (Richler et al., 2019; Sunday et al., 2018), the two visual tests had high reliability (NOMT with Greebles,  $\omega = 0.93$ ; Matching Test with Ziggerins,  $\omega = 0.96$ ). Scores on the two tests were correlated ( $r = 0.50$ , 95% CI [0.36, 0.61],  $BF_{10} > 100$ ) and therefore we averaged the Z-score of both tests to form an aggregate  $o$  (Rushton et al., 1983). The resulting reliability of the aggregate  $o$  was high ( $\omega = 0.96$ ).

Figure 2 shows the correlation between the Arts Experience score and  $o$ . There was substantial evidence in favor of a null correlation ( $r = 0.00$ , 95% CI [-0.16, 0.17],  $BF_{01} = 9.52$ ). In fact, there was evidence in favor of a null correlation with  $o$  for six of the individual questions on the survey (Q1, 2, 4, 5, 6, and 7;  $r < 0.12$ ,  $BF_{01} > 3.63$ ) and anecdotal evidence in favor of a null correlation for the last two (Q3:  $r = 0.16$ , 95% CI [-0.01, 0.31],  $BF_{01} = 1.79$ , Q8:  $r = -0.016$ , 95% CI [-0.31, 0.01],  $BF_{01} = 1.65$ ). This suggests that

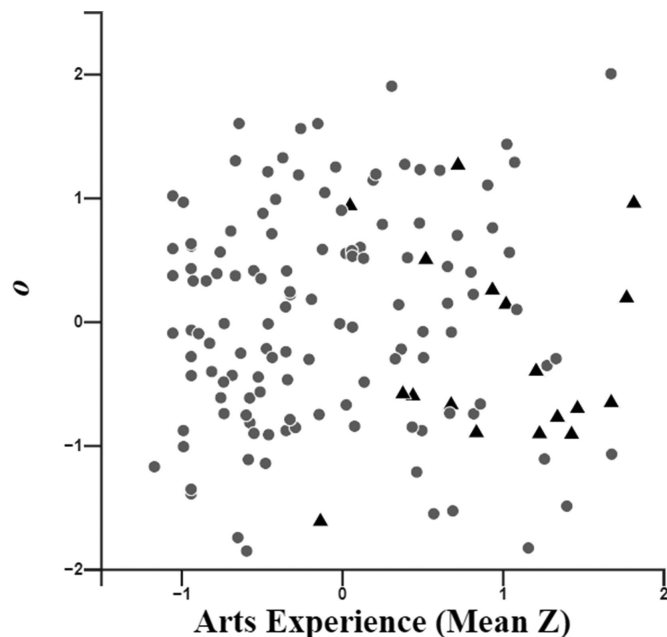


Figure 2. Scatterplot of Z-scored Arts Experience and  $o$ . Each marker represents an individual participant. Black triangles are participants with an undergraduate major related to visual arts, gray circles are other majors or no undergraduate education.

our results do not depend on the specific visual arts experience questions we used or the manner of their aggregation into an Arts Experience score.

## Discussion

We created a new short visual arts experience survey and found that the responses obtained in a diverse sample of adults tested online load on a

reliable, unidimensional, factor related to general visual arts experience. Using proven methods to estimate domain-general object recognition ability (e.g. Chow et al., 2022; Sunday et al., 2018), we find substantial evidence that  $o$  and visual arts experience are not related in this sample.

This study improves on previous work relating visual arts and visual perception in a variety of ways. Our relatively large sample size ( $n = 142$ ) provided adequate precision to detect and characterize even small effect sizes. Importantly, we created a new arts experience survey for a continuous measure of arts experience that is not reliant on experimenter coding or any specific aspect of arts experience (e.g. art production or arts knowledge). Despite these strengths, we root the discussion of our results in the common critique that null results are difficult to interpret. Indeed, their interpretation requires the evaluation of a study and of its results according to several different considerations – we review those that are most relevant to our study here.

One common problem limiting the interpretation of a so-called null correlation stems from the dominant use of frequentist statistics, which only allows rejection of the null hypothesis and therefore providing no evidence for the null. Accordingly, if our results were analyzed within a frequentist framework ( $r = 0.00$ ,  $p = 0.98$ ), the lack of a significant correlation could not be taken as evidence for the absence of a correlation, regardless of sample size. In contrast, the Bayesian framework that we used here allows us to quantify support for no correlation over that of a correlation. Another advantage of this framework is that if the support in favor of either  $H_0$  or  $H_1$  was too small (generally agreed to be the case when both  $BF_{10}$  and  $BF_{01}$  are below 3), it is acceptable to collect more data until the results are sufficiently decisive one way or the other, without violating assumptions of the test or changing its interpretation (Schönbrodt, Wagenmakers, Zehetleitner, & Perugini, 2017). We note that, in our case, even the results restricted to the 18 individual who reported a visual arts major was sufficient to support  $H_0$  over  $H_1$  ( $r = 0.06$ ,  $BF_{01} = 3.34$ ). In summary, insofar as statistical validity is concerned, our result is not an absence of evidence, but evidence for an absence of a correlation between arts experience and general object recognition ability.

A second concern that can limit the correlation between two variables would stem from the limited reliability of the measurements used to calculate that correlation. Measures are rarely perfectly reliable and measurement error in each individual variable reduces their observed bivariate correlation (by the square root of the product of their respective reliability; Spearman, 1907). However, both of our variables (arts experience and  $o$ ) had internal reliabilities that were very high ( $>0.9$ ). We note that this is not an accident, but a result of choices in measures and scale development that emphasize good psychometric properties (often

not achieved in the arts and perception literature; Benear et al., 2019). This means that even if we correct for attenuation for measurement error (Spearman, 1907), the true correlation that would be expected without measurement error remains essentially the same ( $r' = 0.00$ ).

A third consideration in interpreting a null correlation, stems from evaluating the validity of the constructs. A measure can be reliable yet not be a valid operationalization of the construct of interest. At least in one sense, our measures have demonstrated validity. Measures of  $o$  highly similar to ours (using the same objects and tasks) have shown good divergent validity relative to measures of  $g$  and other cognitive constructs as well as personality traits (Richler et al., 2019) and convergent validity with recognition of decisions about groups of objects (Sunday et al., 2022) and with haptic object recognition (Chow et al., 2022). Indeed,  $o$ , which is typically measured using novel objects, as in this study, is nearly perfectly correlated in latent variable modeling with object recognition ability measured with familiar objects (Sunday et al., 2022). In addition,  $o$  has good predictive validity for learning to recognize nodules in chest radiographs (Sunday et al., 2018). Therefore, whereas  $o$  is a relatively recent construct, it is behaving in expected ways within a growing network of far-reaching relations with other meaningful variables.

Our measure of experience with visual arts is novel, but it has strong face validity and its ability to separate novices from experts was confirmed by higher scores in individuals reporting visual arts education. Importantly, we did not want to use a binary distinction (such as those with or without any visual arts training), because a continuous measure offers greater statistical power and the ability to examine the existence of nonlinear relationships (Preacher, Rucker, MacCallum, & Nicewander, 2005). Nonetheless, even among participants without formal arts education, a range of arts experience emerged; we are not specifically targeting any specific type of arts experience. By design, we used questions that tap into many facets of arts experience to capture how different individuals may interpret arts experience. Questions such as Q4 focus on formal education with a specifically measurable indicator of experience, whereas questions such as Q6 focus on more subjective judgments of arts experience. As a whole, the survey can capture a wide range of arts experience that could potentially correlate with general object recognition. This is in contrast with more specific measures like drawing accuracy, a measure of artistic production skill that is likely associated with experience with visual arts, but not a necessary part of the construct as we defined it. Future work may compare our measure to other measures of experience with art across a variety of samples, but a clear criterion for the best way to measure such experiences is currently lacking.

Despite these methodological strengths, we acknowledge the limitations of our work. It is possible that experience with visual arts of a specific kind (e.g. photography but not art history) would relate to  $o$ , or that a relationship would be observed in a different population (e.g. including more individuals who produce art). There is evidence that art experience specifically in the context of a museum results in better recall and memory for art (Brieber, Nadal, & Leder, 2015). However, parceling out components of art experiences were not the goal of this study. It is possible that visual arts experience would relate to perceptual abilities that are more basic than those measured by  $o$  (based on processes mediating the encoding, maintenance, and retrieval of shape information, and the discovery of and selective attention to features that distinguish objects within a category). However, a recent review of the literature (Benear et al., 2019) found little support for the idea that artists have better low-level perception than non-artists (such as the perception of grouping or discriminating simple properties). Additionally, the self-report nature of our survey invites different interpretations of what constitutes engagement in visual arts across individuals. Although such differences may similarly bias the responses to related questions in the survey (e.g. what constitutes in the engagement of visual arts in Q4 and Q5), it is unlikely that such variation in interpretations would systematically bias the entire survey as other questions target arts experience differently such as formal training in visual arts.

There remains work to further develop understanding of how arts experience may relate to visual object recognition ability, despite the presented null correlation. A similar study targeting specific types of arts experiences could interrogate how specific types of experience relate to  $o$ . For example, the production of realistic figures is often linked to perceptual advantages (e.g. Kozbelt et al., 2010; Perdreau & Cavanagh, 2013) and, therefore, may relate to  $o$ . Additionally, demonstrating convergent validity of our arts experience measure with similar measure would be useful (Specker et al., 2020). Conversely, we could assess divergent validity relative to subscales that focus on response to artworks (Schlotz et al., 2020). Finally, despite the evidence we obtained for a null correlation between visual object recognition ability and general visual arts experience, it remains possible that other domains of experience could be related to object recognition ability.

## Conclusions

In closing, it is worth pointing out an important strength of a convincing null correlation: whereas

a positive correlation between  $o$  and experience in visual arts would not indicate the causal direction of the relationship, evidence of its absence offers equal support against causal inferences in both directions. That is, our results suggest that experience with visual arts does not influence  $o$  and it also suggest that a greater  $o$  does not lead to stronger interest in visual arts.

*Keywords:* artistic experience, object recognition, individual differences

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