

Influence of Regular Visual Thinking Strategies Activities on Sustained Attention Abilities of Quebec Primary School Students: A Developmental Perspective

Pedro Mendonça¹, Vincent Grenon², Alain Savoie²

¹Université du Québec en Abitibi Témiscamingue, Rouyn-Noranda, Canada

²Université de Sherbrooke, Sherbrooke, Canada

Email: pedro.mendonca@uqat.ca

How to cite this paper: Mendonça, P., Grenon, V., & Savoie, A. (2023). Influence of Regular Visual Thinking Strategies Activities on Sustained Attention Abilities of Quebec Primary School Students: A Developmental Perspective. *Creative Education*, 14, 400-416.

<https://doi.org/10.4236/ce.2023.142026>

Received: January 25, 2023

Accepted: February 25, 2023

Published: February 28, 2023

Copyright © 2023 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Background: Visual Thinking Strategies (VTS) are an art appreciation method known to improve students' quality of attention and sense of observation. Although great importance is attached to attentional skills, few studies attempt to measure and verify interventions that improve development of attentional processes in school aged children. **Objective:** Using a small-scale quantitative approach, verify the potential development of sustained attention of Quebec (Canada) primary school students following VTS practice spread over one school year. **Participants:** 125 primary school students (fourth and fifth graders/7 to 9 years old). **Intervention:** Experiments were conducted in five classrooms at two primary schools including control groups. **Measurements:** Kids Test for Attentional Performance (KiTAP) was used repeatedly throughout the school year on two sub-groups of 49 randomly selected participants. **Results:** KiTAP results showed statistically significant differences for sustained attention development of pretest/post-test participants having received VTS lessons. **Conclusion:** Regular VTS practice favours the maturation of sustained attention in primary school students.

Keywords

Art Appreciation, KiTAP, Maturation, Primary School, Sustained Attention, Visual Thinking Strategies

1. Introduction

The goal of this study is to measure the influence of regular art appreciation ac-

tivities, using Visual Thinking Strategies (VTS), on children's sustained attention, throughout a school year. Attention is the ability to devote oneself to an object, a practice or an action (Anderson, 2015). The term is also used to refer to vigilance, concentration and interest (Klösch et al., 2022). It goes without saying that attentional skills are essential in the educational context. In the visual arts in particular, research in aesthetic art appreciation often mentions the involvement of attentional processes (Leder et al., 2004; Leder & Nadal, 2014; Mullennix, 2019; Pelowski et al., 2016). Being observant and paying attention to details is a skill that students learn not only when they make art, but also when they study and discuss works of art (Greene et al., 2013, 2014). In that sense, the VTS method of art appreciation could significantly improve attentional skills and bring a lot to education (Baylen & D'Alba, 2015; Herman, 2016; Housen, 2002; KV & Venukapalli, 2021; Naghshineh et al., 2008; Yenawine, 2013). Research involving adults also supports the idea that art appreciation activities could significantly improve the quality of attention (Herman, 2016). Art appreciation is also used to expand attentional skills in other fields than education, as in medicine (Klugman et al., 2011; Naghshineh et al., 2008; Shapiro et al., 2005); engineering (Campbell et al., 2021) or police work (Lyll, 2016). Given the importance of attention in the school context and since little research has investigated the impact of artistic appreciation activities in young children's attention, we decided to specifically investigate them. Our hypothesis was that regular art appreciation activities using the VTS method in two Quebec primary school classrooms of fourth and fifth graders might favour the development of their attentional processes. Our results confirm this hypothesis.

Visual Thinking Strategies

VTS is an art appreciation teaching method that was first developed in the late 1980's by museum curators (Housen, 2002; Yenawine, 2013). VTS is built upon three simple questions used by the educator/facilitator to incite discussions within a group of people about artworks: 1) What is going on in this picture? 2) What do you see that makes you say that? 3) What more can you find? The protocol firstly requires a minute of silent observation, then the educator-facilitator initiates the discussion using the three basic questions, pointing out and paraphrasing observations of the audience and making links between the gradually observed contents of the artwork by the group, while keeping a neutral attitude throughout the session¹. Nowadays, VTS is a method used in museums, schools, colleges and universities, mainly in the United States. In educational contexts, VTS became an art teaching method that improves critical thinking skills through discussions of visual images facilitated by the teacher, both in adults (Jasani & Saks, 2013), school-aged children (Campos, 2018; Connolly et al., 2019; Köksal & Çöğman, 2019; Smolkowski et al., 2020) and undergraduate students (Ishiguro et al., 2021). According to researchers involved in VTS, this art appreciation method encourages participation of students in a group prob-

¹The method of art appreciation called Visual Thinking Strategies (VTS) is fully detailed on the Website: <https://vtshome.org/>.

lem-solving process. VTS uses art to teach thinking and communication skills, and to develop critical thinking as well as visual literacy skills (Yenawine, 2013). VTS facilitates learner-centred discussions of visual art and engages learners in a rigorous process of examination and meaning-making through visual art. VTS increases observation skills, evidential reasoning, and speculative abilities. It engenders the willingness and ability to find multiple solutions to complex problems, and facilitates discussion to enable students to practice respectful, democratic and collaborative problem-solving skills that can be transferred eventually to other classroom disciplines and in everyday life (DeSantis & Housen, 2007; Yenawine, 2013). VTS uses thoughtful participation to nurture verbal language skills and writing assignments to assist transfer from oral to written ability. VTS is known to produce growth in all students, from challenged and non-English language learners to high achievers (DeSantis & Housen, 2007); however, to date few studies focus specifically on the influence of VTS over attentional processes, and even fewer focus on children.

Sustained Attention

The general concept of “attention” has historical foundations (Darwin, 1872; James, 1890). Already, in 1890, William James was working out a relevant definition of the concept:

“Everyone knows what attention is. It is the taking possession by the mind, in a clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others.” (James, 1890, p. 403-404)

Attention enables one to memorise, select, control objects and information or actions in a voluntary or involuntary manner. These actions are essential for learning to occur. Inattention is often put forward by teachers as one of the major causes of student’s difficulties (Ajiboye et al., 2020). Inattention is also singled-out as a characteristic of dropout students (Parviainen et al., 2020). Research shows as well that inattentive children have lower income in adulthood (Vergunst et al., 2019), underlining the importance of attention in a myriad of contexts.

Attentional processes are related to executive functions (Best & Miller, 2010; Dawson & Guare, 2012; Nelson & Luciana, 2008), namely the cognitive control in focusing on, selecting and successfully monitoring behaviours that enable completing steps to achieve a goal (Chan et al., 2008; Diamond, 2013). Attention is a multidimensional concept that involves specific abilities. Experts generally agree on four types of attention: 1) selective, focusing on one thing at a time; 2) divided, on two events at once; 3) sustained, for a long period of time; and 4) joint attention, to coordinate one’s attention with the attention of another individual (Cohen, 2014). The aim of our study is to verify the potential development, in some primary school pupils subject to regular VTS activities, of the third type, “sustained attention”, which is the ability to maintain attention over time in goal directed behaviours (Cristofori & Levin, 2015). Sustained attention

is key to all teaching and learning processes, including the basic ability to observe, listen to, think and engage in classroom tasks over a long period of time. New learning becomes difficult without sustained attention, which is also an essential component of executive functions (Ahmed et al., 2018; Stins et al., 2005). Therefore, teaching strategies that can be implemented to improve students' sustained attention are of the utmost importance (Dawson & Guare, 2012).

2. Methodology

Our study comprises two stages: firstly, some regular VTS interventions are made in groups of children in their classrooms, and secondly some individual attention tests precede and follow these interventions. Following sections describe the procedural details.

Sample Randomisation

Target population ($n = 13,000$) comprised French-speaking primary school students from Sherbrooke school district containing 38 schools, in the province of Quebec, Canada. Schools' participation was voluntary. Two schools expressed their interest in participating in our study following a solicitation on the Web via an art teacher's Facebook group page. A total of five classrooms² ($n = 125$) from the two schools ($n = 900$) agreed to participate. Experimental and control groups within each participating school were selected based on convenience, since more participation time for VTS lessons was required from students and teachers in the experimental groups than in the control groups. The choice for this selection was left up to teachers in preparatory meetings. Three out of five classrooms benefited from regular VTS interventions as we will describe them later. The other two classrooms made up our control group. Because of limited time and resources, we focused on a limited number of 49 participants from the experimental and the control group (five classrooms) on which to administer the individual attentional performance test following our series of VTS interventions. The selection of 49 test participants was done by a random drawing of alpha numeric numbers assigned to participation envelopes, which also contained parental consent forms and socio-demographic data for all participants.

Demographic Data

Demographic data was collected via questionnaire forms distributed to responding parents along with the consent forms distributed before the beginning of testing. No socio-demographic statistical differences were found between the experimental and control groups, both including the tested samples.

Table 1 provides results of socio-demographic data for experimental and control groups. Some elements of data were missing in forms (no response to item), as two participants consent forms were present in the envelope, but no socio-demographic form was filled out. To ensure representativity of randomly selected participants ($n = 49$) for testing (pretest/post-test and T1, 2 and 3) in both control and experimental groups, *t*-tests and similarity reports were performed. No significant statistical differences in demographic data were found.

²3 classrooms of fourth graders ($n = 75$) and 2 classrooms of fifth graders ($n = 50$).

Table 1. Socio-demographic characteristics of study participants (n = 125).

Characteristics	Experimental (n = 84)	Control (n = 41)	Test type for representativity in tested participants (n = 49)	p-value
Spoken language at home	French 81 Other 1	French 39 Other 2	Fisher's exact test	.257
Parent age	40.14	40.80	t-test	.459
Student age	8.89	8.75	t-test	.930
Student sex	M 32 F 50	M 15 F 26	Fisher's exact test	.476
Responding adult	Father 16 Mother 65	Father 12 Mother 29	Fisher's exact test	.170
Parent schooling	College 31 College 24 University 27	College 12 College 12 University 14	Likelihood ratio (Chi-2)	.801
Job type (responding parent)	Full time 67 Part time 2 No job 12 Other 0	Full time 33 Part time 2 No job 3 Other 3	Likelihood ratio (Chi-2)	.053
Revenue	\$118,653	\$112,878	t-test	.620

3. The Design of Our Study

The design of our study is built on models proposed by Shadish et al. (2002). Two subgroups were created, where pretest and post-test participants differ from Tests 1, 2 and 3 participants, for both the experimental and control groups. Pretest and post-test results provide information about the development of sustained attention before and after the experiment on tested participants, following VTS group interventions in the classrooms. Pretests took place two weeks before the first VTS lesson, and post-tests three weeks after the last VTS lesson. As for Tests 1, 2 and 3, they provided answers on the development of sustained attention throughout the experiment on tested participants. Test 1 took place after the third VTS lesson, Test 2 took place after the sixth VTS lesson and Test 3 took place after the ninth VTS lesson. An average of two weeks was allowed between lessons. Design structure and layout protect against habituation bias while allowing repeated measures.

Figure 1 provides a layout of the study design over the school year and the number of participants involved for each testing stage.

VTS Interventions in the Classroom

In both schools, VTS interventions started two weeks after pretests took place in control and experimental groups. A total of nine (9) VTS interventions-lessons, took place in each experimental group (three classrooms) during the school year at a frequency of every two weeks or so. Interventions were always delivered by the same researcher-facilitator while the regular teacher of the group remained present in the classroom without intervening. The facilitator

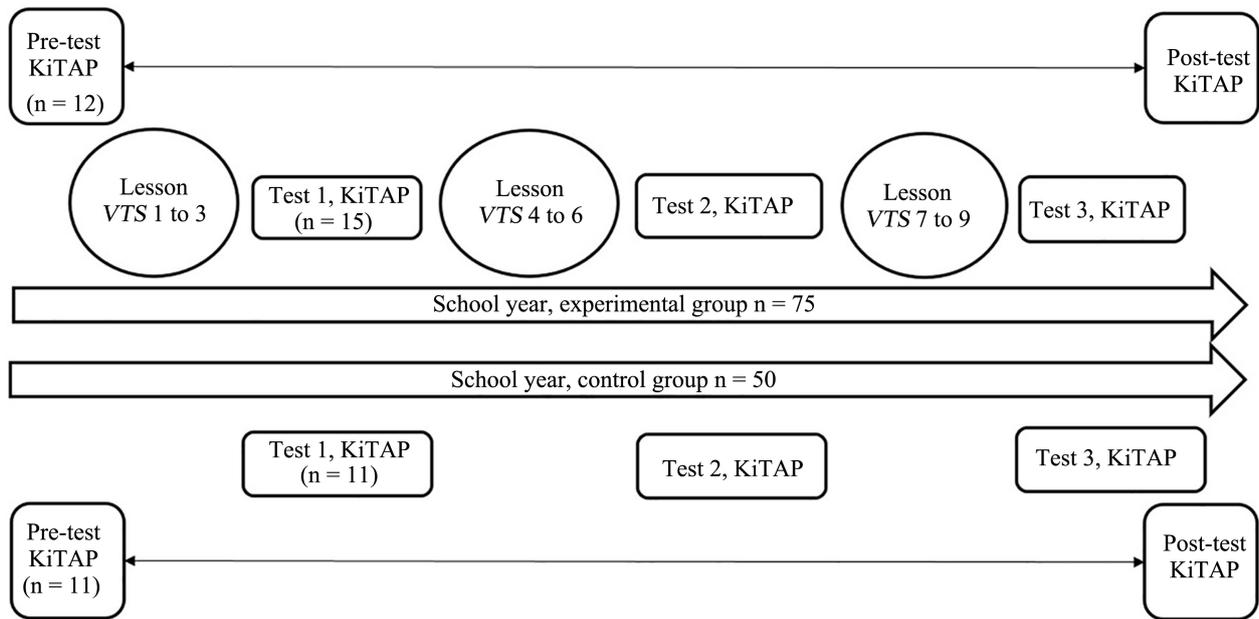


Figure 1. Layout of study design and tested sample $n = 49$.

rigorously followed the VTS protocol elaborated by the method's creators. Participants responded well to VTS lessons, although during the first few sessions, some participants seemed to question VTS practice and wondered why artworks were shown to them. However, once the participants understood the protocol and a routine was established, they all enjoyed the activity and eagerly participated.

Our selection of artworks was made from the proposed visual art collection of the VTS organization's website³. In preparation for VTS sessions, the researcher adapted shown artworks' collection to reflect Quebec's distinctive culture. Some artworks containing overly iconic American cultural references were removed, such as flag images or American historical figures. They were replaced by familiar Quebec artworks of similar complexity. All artwork selections were approved by a jury of experts.⁴

Each VTS group intervention in the classroom lasted about 45 minutes and was the same for both fourth and fifth graders. As shown in **Figure 1**, randomly selected participants of each group ($n = 49$) were given the attention test before (pretest), between (tests 1, 2 and 3) and after all interventions-lessons (post-test). Selected participants were called on to individually pass the attention test in a quiet room of their school with the researcher present.

Testing of Attention and Statistical Methods

To measure sustained attention in our 49 selected participants, we used the Kids Test of Attentional Performance (KiTAP), which comprises a battery of computerized tests that measure several attention-related abilities and concepts (distractibility, alertness, sustained attention, flexibility, divided attention, go/no

³<https://vtshome.org>.

⁴Jury was composed of two art teachers (Ph.D.) and the researcher.

go, vigilance and visual scanning) (Zimmermann & Fimm, 2002). For the purposes of the study, we only used the test for sustained attention. KiTAP was created to ensure optimal motivation during testing by providing a design that is suitable for young children. The sustained attention test is named the “The Ghosts Ball”. The measurements are taken through a simple video game that requires the participants to maintain an effort of sustained attention throughout the test. The conditions of sustained attention or concentration are characteristic of the demands of daily life, such as reading, completing chores or riding a bicycle. The computerized test task requires the comparison of a stimulus with a subsequent stimulus to determine whether the two have a predetermined feature in common. The stimuli to be compared take the form of comic-type characters of little ghosts of diverse colours that appear successively at a different window of a ruined castle. Test results are normalized ($N = 200$) to a population of typically healthy 8 to 10-year-old children. Results take into account reaction times and missing or erroneous responses. Test scores are provided by KiTAP application on a 0 to 100 scale. Statistical analyses for mean comparisons between experimental and control groups were performed using independent sample t -tests.

Attention Test (KiTAP) Results

Figure 2 represents averages for subsamples tested in both experimental and control groups. For sample results using a paired t -test, no statistical differences were found between pretest and post-test ($t(22) = -.99$; $p = .335$) nor between Test 1 and Test 2 participants ($t(24) = -.47$; $p = .640$), Tests 1 and 3 ($t(24) = .20$; $p = .844$) as well as Test 2 and Test 3 ($t(25) = -2.40$; $p = .458$). Scores for all tested participants show a progression, with the exception of Test 3 participants (post lesson VTS #9) with a small reduction in group averages.

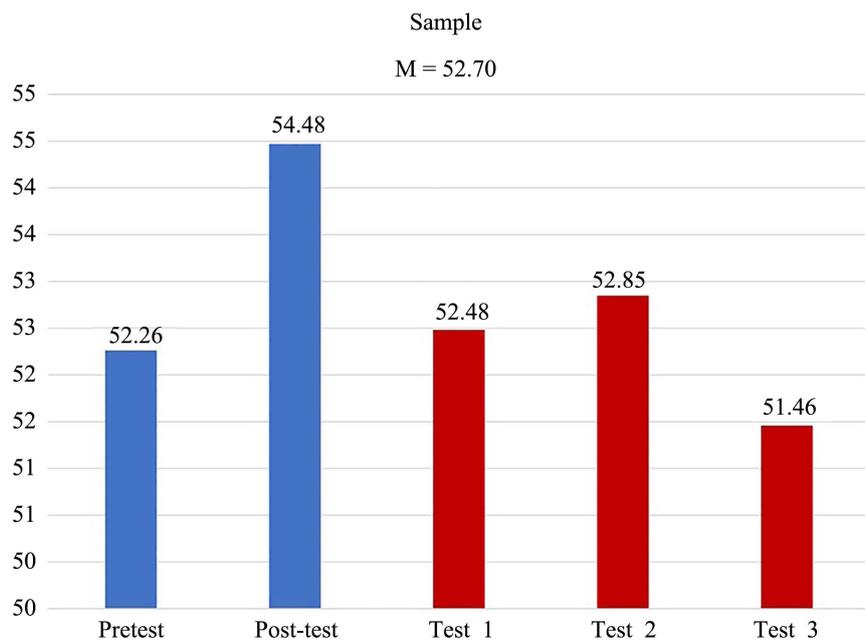


Figure 2. Average distribution of KiTAP scores for tested sample ($n = 49$).

For pretest participants in the experimental group ($n = 12$), average KiTAP scores are ($M = 52.08$; $s-d = 10.40$) for pretested participants in the control group ($n = 11$) ($M = 52.45$; $SD = 9.75$). A t -test was completed, showing no significant results between groups (experimental and control) ($t(20.99) = -.09$; $p = .931$). **Figure 3** represents results obtained three weeks before VTS interventions started.

For post-test participants in the experimental group ($n = 12$), average KiTAP scores are ($M = 58.42$; $SD = 9.53$) for post-test participants in the control group ($M = 50.18$; $SD = 9.15$). A t -test is completed with significant results between groups (experimental and control) ($t(21) = 2.11$; $p = .047$). Eta Squared was completed to determine size effect. Results indicate a large-size effect ($\eta^2 = .17$) (Cohen, 1988). **Figure 4** shows results, three weeks after the last VTS intervention was completed.

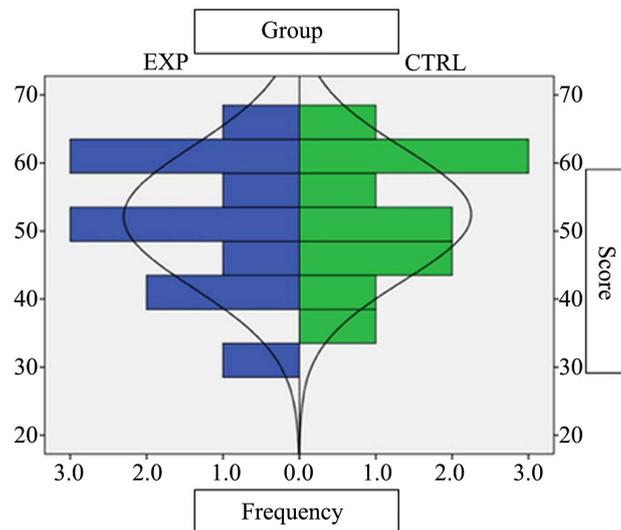


Figure 3. KiTAP pretest scores distribution between groups.

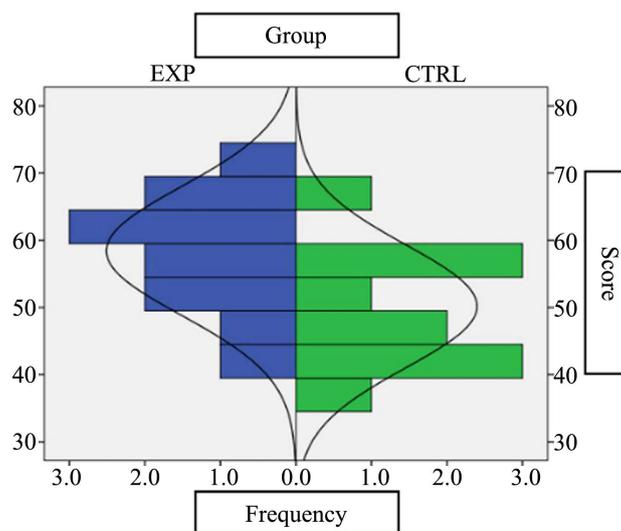


Figure 4. KiTAP post-test scores distribution between groups.

For Test 1 participants in the experimental group ($n = 14$), average KiTAP scores are ($M = 52.43$; $SD = 9.97$). For Test 1 participants in the control group ($n = 11$), average KiTAP scores are ($M = 52.55$; $SD = 11.63$). A t -test was completed showing no significant results between groups (experimental and control) ($t(19.80) = -.03$; $p = .979$). **Figure 5** shows results after three VTS interventions.

For Test 2 participants in the experimental group ($n = 15$), average KiTAP scores are ($M = 54.13$; $SD = 9.24$) and for Test 2 participants in the control group ($n = 11$) ($M = 51.09$; $SD = 12.67$). A t -test was completed with no significant results between groups (experimental and control) ($t(24) = -.71$; $p = .485$). **Figure 6** shows results after six VTS interventions.

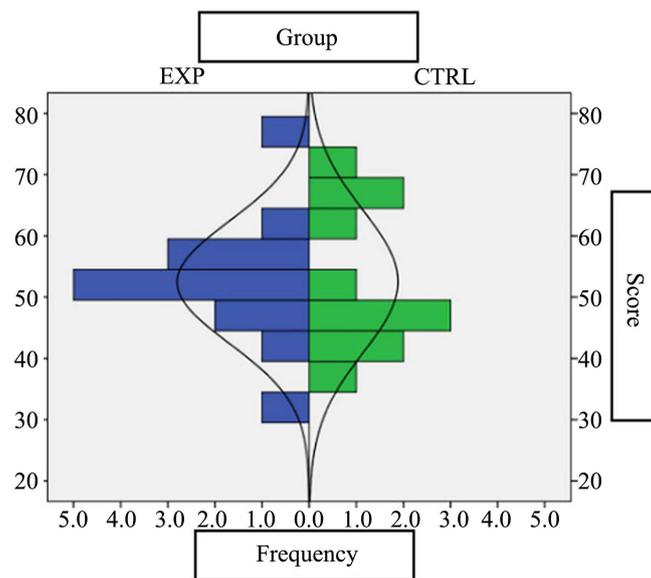


Figure 5. KiTAP test 1 scores distribution between groups.

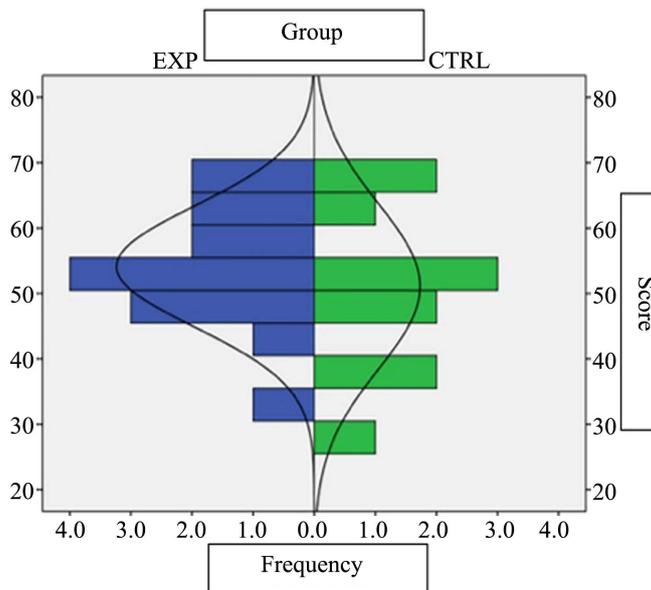


Figure 6. KiTAP test 2 scores distribution between groups.

For Test 3 participants in the experimental group (n = 15), average KiTAP scores are ($M = 53.73$; $SD = 10.60$), and for Test 3 participants in the control group (n = 11) ($M = 48.36$; $SD = 10.07$). A t -test was completed showing no significant results between groups (experimental and control) ($t(24) = -1.30$; $p = .205$). **Figure 7** shows results after nine VTS interventions.

In order to better identify the evolution of KiTAP results over the school year, **Figure 8** shows participants' scores obtained for pre/post-test and Tests 1, 2 and 3 independently. Results show a significant progression for experimental groups participants in pre/post-test, and non-significant progression for Tests 1, 2 and 3. The control group results show a non-significant loss in pre/post test and Tests 1, 2 and 3.

4. Discussion

Figure 9 summarizes participants scores obtained for pretest, Tests 1, 2 and 3 and post-test in chronological order (display respects the order of data collection).

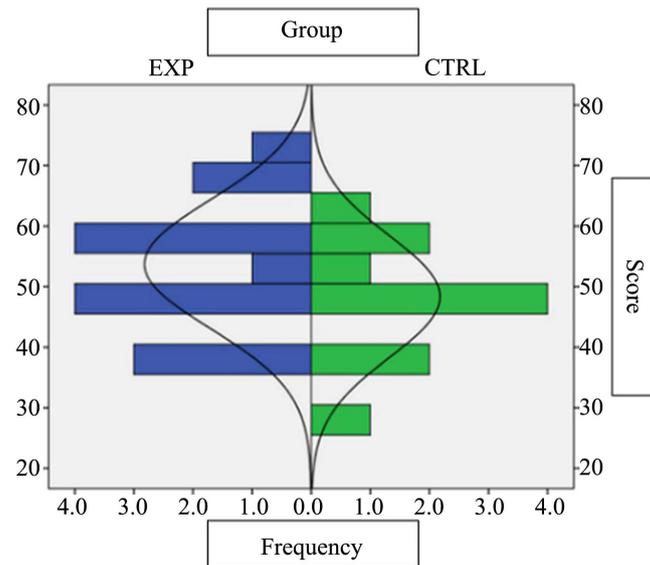


Figure 7. KiTAP test 3 scores distribution between groups.

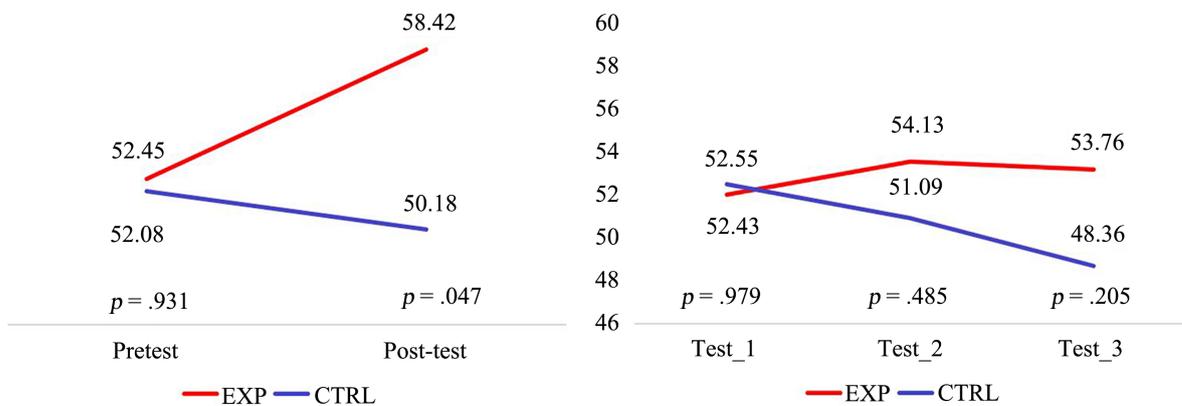


Figure 8. KiTAP participants scores evolution in time throughout a school year, pretest, post-test and tests 1, 2 and 3.

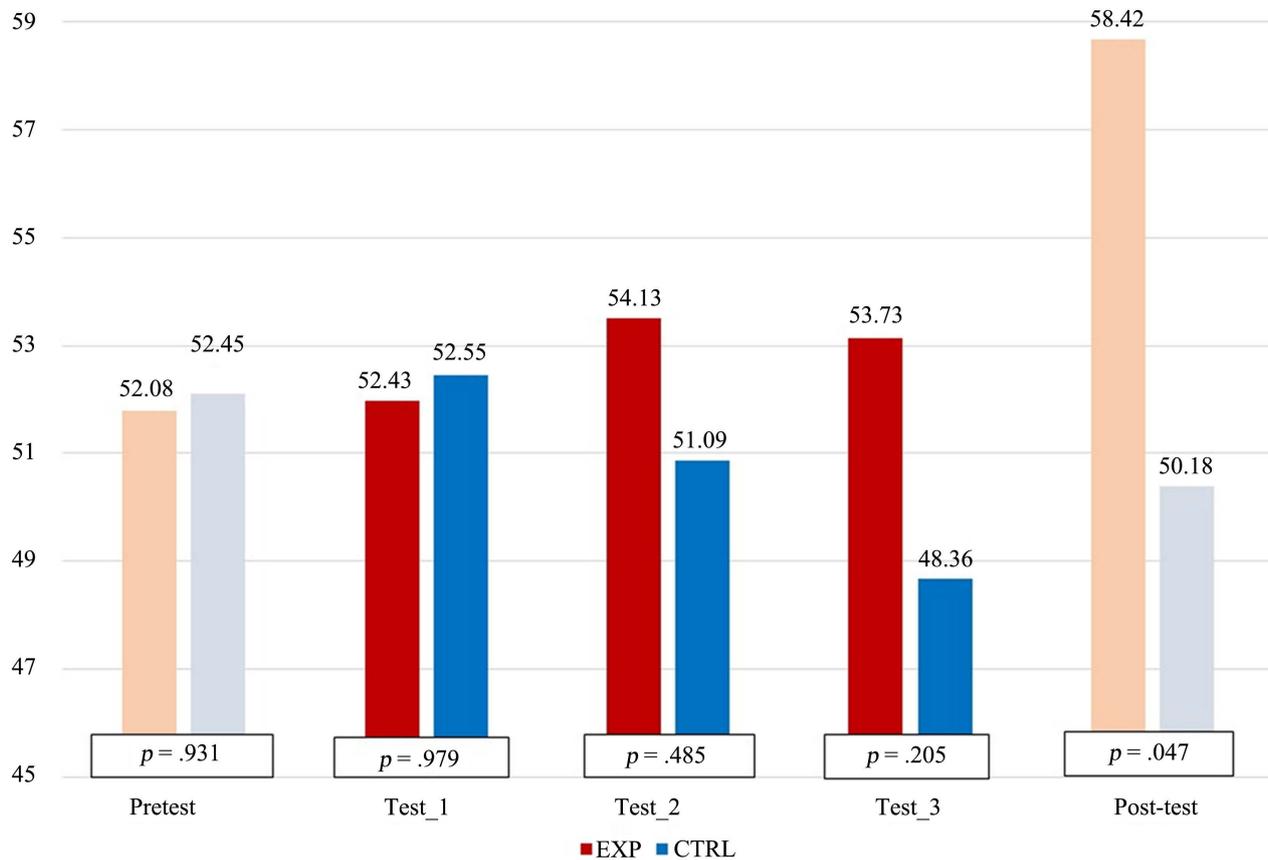


Figure 9. Evolution over time of KiTAP scores for all tested participants throughout a school year (Pretest, Tests 1, 2, 3, and Post-test-Control in blue, experimental in red). Increment favoring experimental participants after sixth lesson, following Test_2.

Research conducted among adults (Naghshineh et al., 2008) show that the improvement of observational skills arises after the sixth VTS lesson (Figure 10). Similar results show up in our study since attentional performances increase in experimental participants after the sixth VTS lesson. Since research tools and methodologies are not the same in both studies, quantitative comparison, being limited, remains challenging. However, visual inspection of scores for all tested samples, when compared to the results obtained by Naghshineh et al. (2008), shows a similar increase for experimental participants, especially after the sixth VTS lesson or session.

Our results confirm observations made by Naghshineh et al. (2008) on a quantitative and psychometric perspective, with at least one insignificant result in the post-test stage ($t(21) = 2.11$; $p = .047$).

It appears that our participants exposed to VTS improved their sustained attention skills when compared to those who did not receive VTS lessons. Likewise, according to DeSantis and Housen (2007), VTS seems potentially to improve critical thinking and writing abilities. Moreover, other research in adults shows gains in participants sense of observation and attention to details. These skills can be transferred to other domains beyond art observation (Jasani & Saks, 2013; Klugman et al., 2011). For example, Campos (2018) uses VTS to improve

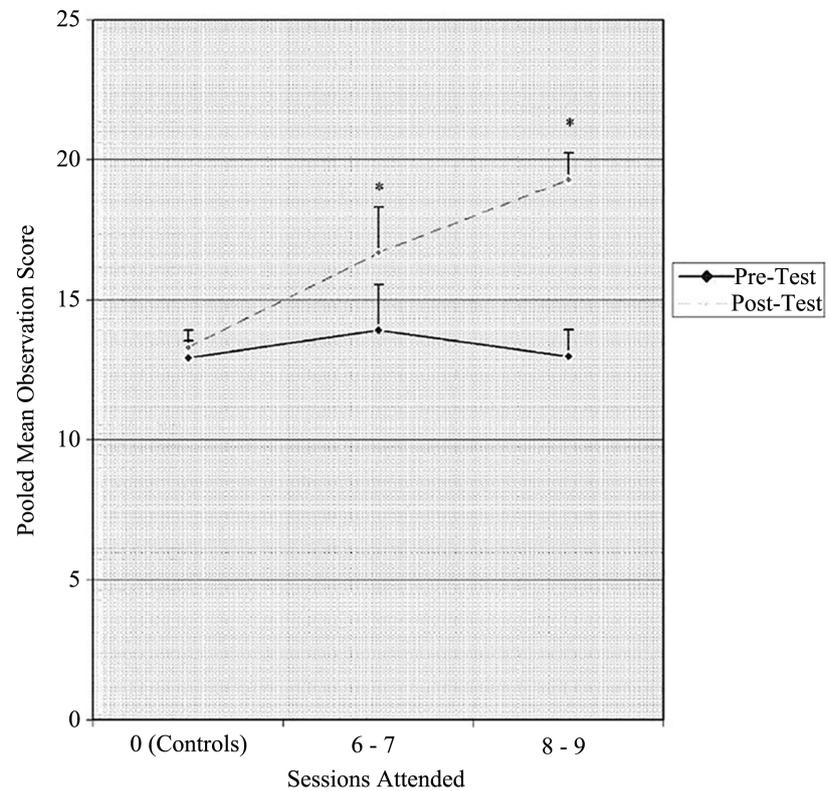


Figure 10. Visual inspection of results in adults by Naghshineh et al., 2008, increment favoring experimental participants following sixth session.

skills in math classes. Since all these measured skills imply a good attentional quality, improvement of sustained attention could hypothetically be considered implicit in these VTS studies. In light of our classroom observations throughout the school year, and following teachers' and student's positive feedback, it can be hypothesised that VTS can be a good developer of aesthetic experiences (Chatterjee, 2014) in the classroom, which among other things, awakens and anchors students to the present moment (Robinson, 2015). Aesthetic experiences can have a positive influence on the child's entire personality (Sotiropoulou-Zormpala & Argyriadi, 2014) including developing their sustained attention ability.

To understand the influence of demographics on KiTAP scores, statistical tests were conducted. KiTAP scores were correlated with collected sociodemographic data. This operation yielded no significant results. It shows that effects on students' attention are the result of VTS being performed and are not due to a sociodemographic factor. Nevertheless, other external factors may have had an impact on KiTAP results, such as teachers' absenteeism on occasion, which was disturbing for the children. We noticed negative fluctuations in the scores of school groups that coincided with a teacher's departure, as well as with the fact that some tested students were known to be under attention-deficit-disorder medication and had continuously low scores on tests throughout the school year. These two factors reflect a typical Quebec primary school classroom and may

have impacted results for participants of Tests 1, 2 and 3 in one school. However, since KiTAP scores are normalized, these factors may have been countered or attenuated.

KiTAP is a relatively recent tool to measure attention, providing reliable and useful outcome measures for the assessment of attention/executive functions abilities (Knox et al., 2012). We also noticed that the application of the protocol was simple. Moreover, children enjoyed being tested because KiTAP design is ludic and playful.

Our experimentation and KiTAP results corroborate findings by other VTS research (Campos, 2018; DeSantis & Housen, 2007; Köksal & Çöğman, 2019; Smolkowski et al., 2020) or art appreciation activities (Greene et al., 2013, 2014) with metric results showing improvements in participants sustained attention.

However, it is important to note that joint attention, that is the ability to coordinate one's attention with the attention of another individual is implicitly involved in VTS, because it is a group activity. Joint attention may also be fostering participants sustained attention. Future research should explore and verify this hypothesis.

For educational purposes, following the entire experimentation, we also decided to give three VTS lessons to the control group that had not received any lessons during the school year. Thus, the control group members also gained some benefit from VTS sessions. Meetings also took place with schoolteachers and directors to inform them of our results and follow up on what could be proposed for future curriculum integration of VTS.

5. Limitations

Although our study is of small scale, its strategies rely on repeated direct measures (Hintze, 2005) implemented over a period of one school year with a control group, thus increasing its validity (Shadish et al., 2002) from a developmental perspective. Furthermore, research shows that testing related to executive functions, as is the case in our research, contains better predictive indicators than those related to IQ, memory or language (Burgess et al., 1998; Finnanger et al., 2022). In light of our results, we argue that regular VTS sessions favoured the development of sustained attention in both fourth and fifth graders.

Having said that, current results can only be generalized in the two schools where interventions took place and for the same school grades (roughly estimate at $n = 300$). No further generalizations should be attempted because of two main limitations. Firstly, the sample size is too small when compared to the larger population⁵, and secondly, current study design must be deployed for all primary school grades to include a broader range of ages. To cover the full spectrum of development, future studies should ideally cover a longer span of time, from preschool years to late teen development.

⁵The Sherbrooke school district (in the province of Quebec, Canada) is composed of 13,000 primary school students in 38 schools.

We also suggest that future research would benefit from focusing on the quantitative aspect of attentional processes as well as evaluating and measuring other aspects such as VTS implementation in the curriculum, teacher's observations, students' scores in other subjects or observations related to metacognition during VTS sessions.

6. Conclusion

Our results show that regular art appreciation activities using the VTS method, when implemented according to the recommendations of its creators, improve the quality of sustained attention in fourth and fifth graders of two Quebec primary schools. By inviting participants to think about what others are feeling or thinking through works of art, VTS can be seen as a metacognitive strategy facilitating the development of cognitive abilities related to executive functions. As mentioned previously, sustained attention is an important part of executive functions and plays an essential role in learning. We consider that such strategies should be established in the early years of learning and reinforced until the end of secondary school. VTS, when rigorously and consistently established throughout a school year, has the potential to facilitate the ability to extract meaning from visual imagery and favour the development of student's visual literacy. In fact, VTS activities can possibly be considered as a form of attentional coaching that improves students' sustained attention by increasing the maturation of this cognitive skill over time.

Acknowledgements

We wish to thank Professor Anne-Marie Émond of the *Université de Montréal* for her help in our research work, as well as all the teachers and students who generously participated in this study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- Ahmed, S. F., Tang, S., Waters, N. E., & Davis-Kean, P. (2018). Executive Function and Academic Achievement: Longitudinal Relations from Early Childhood to Adolescence. *Journal of Educational Psychology, 111*, 446-458. <https://doi.org/10.1037/edu0000296>
- Ajiboye, S., Adebayo, D., & Abubakar, S. (2020). Teachers' Assessment of Inattentive Classroom Behavior among Primary School Students in Ilorin City, Kwara State, Nigeria. *Mimbar Sekolah Dasar, 7*, 172-183. <https://doi.org/10.17509/mimbar-sd.v7i2.24101>
- Anderson, J. R. (2015). *Cognitive Psychology and Its Implications* (8th ed.). Worth Publishers. (Original Work Published in 2000)
- Baylen, D. M., & D'Alba, A. (2015). *Essentials of Teaching and Integrating Visual and Media Literacy: Visualizing Learning*. Springer. <https://doi.org/10.1007/978-3-319-05837-5>

- Best, J. R., & Miller, P. H. (2010). A Developmental Perspective on Executive Function. *Child Development, 81*, 1641-1660. <https://doi.org/10.1111/j.1467-8624.2010.01499.x>
- Burgess, P. W., Alderman, N., Evans, J., Emslie, H., & Wilson, B. A. (1998). The Ecological Validity of Tests of Executive Function. *Journal of the International Neuropsychological Society, 4*, 547-558. <https://doi.org/10.1017/S1355617798466037>
- Campbell, R. C., Nguyen, N. T., Kim, J., Duke, L. A., Taraban, R., & Reible, D. D. (2021). Visual Thinking Strategies (VTS) for Promoting Reflection in Engineering Education: Graduate Student Perceptions. In *2021 ASEE Virtual Annual Conference Content Access*. <https://peer.asee.org/38032>
- Campos, T. (2018). *Using Visual Thinking Strategies to Improve Mathematics Instruction*. Doctoral Dissertation, University of Missouri-Kansas City. <https://mospace.umsystem.edu/xmlui/handle/10355/66833>
- Chan, R. C., Shum, D., Touloupoulou, T., & Chen, E. Y. (2008). Assessment of Executive Functions: Review of Instruments and Identification of Critical Issues. *Archives of Clinical Neuropsychology, 23*, 201-216. <https://doi.org/10.1016/j.acn.2007.08.010>
- Chatterjee, A. (2014). *The Aesthetic Brain. How We Evolved to Desire Beauty and Enjoy Art*. University Press. <https://doi.org/10.1093/acprof:oso/9780199811809.001.0001>
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Lawrence Erlbaum Associates. (Original Work Published in 1969)
- Cohen, R. A. (Ed.) (2014). Focused and Sustained Attention. In *The Neuropsychology of Attention* (pp. 89-112). Springer. https://doi.org/10.1007/978-0-387-72639-7_6
- Connolly, T., Skinner, R., & Harlow, D. (2019). Sparking Discussion Visual Thinking: Strategies for Adapting Visual Thinking Strategies for Use in Science Classroom. *Science and Children, 57*, 44-49. <https://www.jstor.org/stable/10.2307/26901563>
https://doi.org/10.2505/4/sc19_057_04_44
- Cristofori, I., & Levin, H. S. (2015). Traumatic Brain Injury and Cognition. In *Handbook of Clinical Neurology* (Vol. 128, pp. 579-611). Elsevier. <https://doi.org/10.1016/B978-0-444-63521-1.00037-6>
- Darwin, C. (1872). *The Expression of the Emotions in Man and Animals*. D. Appleton & Cie. <https://doi.org/10.1037/10001-000>
- Dawson, P., & Guare, R. (2012). *Coaching Students with Executive Skills Deficits. Practical Intervention in the Schools Series*. Guilford Press.
- DeSantis, K., & Housen, A. (2007). *Highlights of Findings—San Antonio. Aesthetic Development and Creative and Critical Thinking Skills Study*. Visual Understanding in Education. <https://www.issuelab.org/resources/15725/15725.pdf>
- Diamond, A. (2013). Executive Functions. *Annual Review of Psychology, 64*, 135-168. <https://doi.org/10.1146/annurev-psych-113011-143750>
- Finnanger, T. G., Andersson, S., Chevignard, M., Johansen, G. O., Brandt, A. E., Hypher, R. E., Risnes, K., Rø T. B., & Stubberud, J. (2022). Assessment of Executive Function in Everyday Life—Psychometric Properties of the Norwegian Adaptation of the Children’s Cooking Task. *Frontiers in Human Neuroscience, 15*, Article 761755. <https://doi.org/10.3389/fnhum.2021.761755>
- Greene, J. P., Kisida, B., & Bowen, D. H. (2013). Learning to Think Critically: A Visual Art Experiment. *Educational Researcher, 43*, 37-44. <https://doi.org/10.3102/0013189X13512675>
- Greene, J. P., Kisida, B., & Bowen, D. H. (2014). The Educational Value of Field Trips. *Education Next, 14*, 78-86. <https://www.educationnext.org/the-educational-value-of-field-trips/>

- Herman, A. E. (2016). *Visual Intelligence. Sharpen Your Perception, Change Your Life*. Mifflin Harcourt.
- Hintze, J. M. (2005). Psychometrics of Direct Observation. *School of Psychology Review*, 34, 507-5019. <https://doi.org/10.1080/02796015.2005.12088012>
- Housen, A. (2002). Aesthetic Thought, Critical Thinking and Transfer. Visual Understanding in Education. *Arts and Learning Research Journal*, 18, 99-132.
- Ishiguro, C., Sato, Y., Takahashi, A., Abe, Y., Kakizaki, H., Okada, H., Kato, E., & Takagishi, H. (2021). Comparing Effects of Visual Thinking Strategies in a Classroom and a Museum. *Psychology of Aesthetics, Creativity, and the Arts*, 15, 735-745. <https://doi.org/10.1037/aca0000326>
- James, W. (1890). *Principles of Psychology*. Henry Holt. <https://doi.org/10.1037/10538-000>
- Jasani, S. K., & Saks, N.-S. (2013). Utilizing Visual Art to Enhance the Clinical Observation Skills of Medical Students. *Medical Teacher*, 35, e1327-e1331. <https://doi.org/10.3109/0142159X.2013.770131>
- Klösch G., Zeithofer, J., & Ipsiroglu, O. (2022). Revisiting the Concept of Vigilance. *Frontiers in Psychiatry*, 13, Article 874757. <https://doi.org/10.3389/fpsy.2022.874757>
- Klugman, C. M., Peel, J., & Beckmann-Mendez, D. (2011). Art Rounds: Teaching Inter-professional Students Visual Thinking Strategies at One School. *Academic Medicine*, 86, 1266-1271. <https://doi.org/10.1097/ACM.0b013e31822c1427>
- Knox, A., Schneider, A., Abucayan, F., Herve, C., Tran, C., Hessel, D., & Berry-Kravis, E. (2012). Feasibility, Reliability, and Clinical Validity of the Test of Attentional Performance for Children (KiTAP) in Fragile X Syndrome (FXS). *Journal of Neurodevelopmental Disorders*, 4, Article No. 2. <https://doi.org/10.1186/1866-1955-4-2>
- Köksal, N., & Çoğman, S. (2019). Visual Thinking Processes and Interactions of Sixth Grade Students. *Journal of Qualitative Research in Education*, 7, 826-844. <https://doi.org/10.14689/issn.2148-2624.1.7c.2s.15m>
- KV, L., & Venukaplli, S. (2021). Art and Aesthetic Appreciation in Children. *International Journal of Scientific and Research Publications*, 11, 112-117. <https://doi.org/10.29322/IJSRP.11.01.2021.p10911>
- Leder, H., & Nadal, M. (2014). Ten Years of a Model of Aesthetic Appreciation and Aesthetic Judgments: The Aesthetic Episode—Developments and Challenges in Empirical Aesthetics. *British Journal of Psychology*, 105, 443-464. <https://doi.org/10.1111/bjop.12084>
- Leder, H., Belke, B., Oeberst, A., & Augustin, D. (2004). A Model of Aesthetic Appreciation and Aesthetic Judgments. *British Journal of Psychology*, 95, 489-508. <https://doi.org/10.1348/0007126042369811>
- Lyall, S. (2016). Off the Beat and into a Museum: Art Helps Police Officers Learn to Look. *The New York Times*. <https://www.nytimes.com/2016/04/27/arts/design/art-helps-police-officers-learn-to-look.html>
- Mullennix, J. W. (2019). The Role of Attention, Executive Processes, and Memory in Aesthetic Experience. In M. Nadal, & O. Vartanian (Eds.), *The Oxford Handbook of Empirical Aesthetics Oxford Handbooks* (pp. 751-769). Oxford Academic. <https://doi.org/10.1093/oxfordhb/9780198824350.013.35>
- Naghshineh, S., Hafler, J. P., Miller, A. R., Blanco, M. A., Lipsitz, S. R., Dubroff, R. P., Khoshbin, S., & Katz, T. (2008). Formal Art Observation Training Improves Medical Students' Visual Diagnostic Skills. *Journal of General Internal Medicine*, 23, 991-997.

<https://doi.org/10.1007/s11606-008-0667-0>

- Nelson, C. A., & Luciana, M. (Eds.) (2008). The Development of Executive Function in Childhood. In C. A. Nelson, & M. Luciana (Eds.), *Handbook of Developmental Cognitive Neuroscience* (2nd ed., pp. 553-574). MIT Press.
<https://doi.org/10.7551/mitpress/7437.003.0041>
- Parviainen, M., Aunola, K., Torppa, M., Poikkeus, A. M., & Vasalampi, K. (2020). Symptoms of Psychological Ill-Being and School Dropout Intentions among Upper Secondary Education Students: A Person-Centered Approach. *Learning and Individual Differences, 80*, Article 101853. <https://doi.org/10.1016/j.lindif.2020.101853>
- Pelowski, M., Markey, P. S., Luring, J. O., & Leder, H. (2016). Visualizing the Impact of Art: An Update and Comparison of Current Psychological Models of Art Experience. *Frontiers in Human Neuroscience, 10*, Article 160.
<https://doi.org/10.3389/fnhum.2016.00160>
- Robinson, K. (2015). *Creative Schools: The Grassroots Revolution That's Transforming Education*. Penguin.
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Houghton Mifflin Company.
- Shapiro, J., Reilly, J. M., Ring, J., & Duke, L. (2005). Visual Thinking Strategies: A New Role for Art in Medical Education. *Literature and the Arts in Medical Education, Family Medicine, 7*, 250-252.
<https://fammedarchives.blob.core.windows.net/imagesandpdfs/fmhub/fm2005/April/I0250.pdf>
- Smolkowski, K., Strycker, L. A., Anderson, L., Marconi, P., & Abia-Smith, L. (2020). The Visual Thinking Strategies Approach to Teaching Argument Writing. A Professional Development Model. *The Elementary School Journal, 121*, 100-124.
<https://doi.org/10.1086/709984>
- Sotiropoulou-Zormpala, M., & Argyriadi, A. (2014). Identifying the Features of “Aesthetic Flow Experience Activities” in the Kindergarten and the First Years of Primary School Education. *Croatian Journal of Education, 17*, 227-259.
- Stins, J. F., Tollenaar M. S., Slaats-Willemse, D., Buitelaar, J. K., Swaab-Barneveld, H., Verhulst, F. C., Polderman, T. C., & Boomsma, D. I. (2005). Sustained Attention and Executive Functioning Performance in Attention-Deficit/Hyperactivity Disorder. *Child Neuropsychology, 11*, 285-294. <https://doi.org/10.1080/09297040490916938>
- Vergunst, F., Tremblay, R. E., Nagin, D., Beasley, E., Park, J., Galera, C., Vitaro, F., & Côté, S. (2019). Association between Childhood Behaviors and Adult Employment Earnings in Canada. *JAMA Psychiatry, 76*, 1044-1051.
<https://doi.org/10.1001/jamapsychiatry.2019.1326>
- Yenawine, P. (2013). *Visual Thinking Strategies. Using Art to Deepen Learning across School Disciplines*. Harvard Education Press.
- Zimmermann, P., & Fimm, B. (2002). A Test Battery for Attentional Performance. *Applied Neuropsychology of Attention, 20*, 110-115.