ARTÍCULOS

EDICIONES
COMPLUTENSE

Establishing assessment criteria and breakthrough points for drawing ability[1]

Ma Hsiao Ying[2]

Abstract. The "ability of realistic drawing" especially realistic drawing ability has been an important measure in assessing the spiritual world of humankind; However, several points in individual teaching strategy remain yet to be clarified in the established practice of group teaching how to draw: 1. How does one assess the artist's skill level? 2. Which abilities should be included in the scale used to assess drawing ability? 3. Of these abilities, which ones can be learned in a short time and which ones require a long time? 4. How does drawing ability evolve to reflect quantitative and qualitative changes as the learning time accumulates? This study attempts to answer the four questions posed above in an analytical and quantifiable way by obtaining empirical data from three drawing experts and four student groups with the aim to establish a set of assessment criteria for drawing ability. With a comprehensive and effective set of assessment criteria established for drawing ability, that the contributions from this study could enable teachers to assist learners not only save time on guesswork, but also provide tailored and specific breakthrough teaching strategies.
Key Words: realistic drawing ability**;** teaching strategy; assessment criteria; breakthrough progress; drawing expert knowledge.

[es] Establecimiento de criterios de evaluación y puntos de avance para la habilidad de dibujo

Resumen: La "habilidad de dibujo realista " ha sido una medida importante para evaluar el mundo espiritual de la humanidad. No obstante, todavía quedan por aclarar varios puntos sobre la estrategia de enseñanza individual dentro de la práctica establecida de la enseñanza grupal acerca de cómo dibujar: 1. ¿Cómo uno puede evaluar el nivel de habilidad del artista? 2. ¿Qué habilidades deben incluirse en la escala usada para evaluar la habilidad para dibujar? 3. De estas habilidades, ¿cuáles se pueden aprender en poco tiempo y cuáles requieren mucho tiempo? 4. ¿Cómo evoluciona la habilidad de dibujar para reflejar cambios cuantitativos y cualitativos a medida que se acumula el tiempo de aprendizaje? Este estudio intenta responder a las cuatro preguntas planteadas anteriormente de forma analítica y cuantificable a través de la obtención de datos empíricos de tres expertos en dibujo y cuatro grupos de estudiantes con el propósito de establecer un conjunto de criterios de evaluación de la habilidad para dibujar. Con un conjunto completo y efectivo de criterios de evaluación establecidos para la habilidad de dibujo, las contribuciones de este estudio podrían permitir a los profesores ayudar a los estudiantes no solo a ahorrar tiempo en conjeturas, sino también a ofrecerles estrategias de enseñanza específicas y a la medida.

---

[2]   National Yang Ming Chiao Tung University (NYCU) Taiwan (R.O.C.).
      E-mail: shaouying.hs01@nycu.edu.tw
      ORCID: https://orcid.org/0000-0002-1659-4478

Summary: In this research, the chapters and contents are as follows:1. Introduction; 1.1. Particularity and importance of realistic drawings; 1.2. Study and motivation. 2. Research method; 2.1. Determination of target participants; 2.2. Task assignments by drawing abilities; 2.3. Data collection through the "three-constant" approach; 2.4. Assessment tools; 2.5. Content of the 15 assessment items; 2.6. Data analysis and weighting. 3. Results; 3.1. Group 1: junior high school students; 3.2. Group 2: senior high school students; 3.3. Group 3: college students; 3.4. Group 4: top fine art academy students; 3.5. Comprehensive analysis. 4. Conclusion; 4.1. Specific teaching strategies and contributions. References.

There were four major findings to achieve the goal: 1. Effective assessment items and skill aspects for drawing ability have been established; 2. The differences about the strengths and weaknesses between young learners and adepts were identified; 3. Skill-related items that can be learned in a short period of time and those requiring a longer time were identified based on the progress rate of drawing ability; 4. Specific teaching strategies were provided for teaching young learners, intermediates and adepts.

With a comprehensive and effective set of assessment criteria established for drawing ability, it can be ensured that the contributions from this study could enable teachers to break through the limitations of personal experience and to assist learners not only save time on guesswork, but also identify learners' strengths, weaknesses and barriers in a systematic approach, in result to provide tailored and specific breakthrough teaching strategies.

1. Introduction

1.1. Particularity and importance of realistic drawings

The ability to create figurative realistic drawing is a very special domain in the spiritual world of human beings and represents a peak of mental achievement; thus, the essence of this ability deserves thorough exploration. The major challenge in conventional teaching process for drawing is that it is usually conducted in groups rather than one-on-one. Lacking an individualized strength-weakness analysis and improvement strategies, learners must resort to their own insight and guesswork as they move along their learning journey. In order to overcome this kind of challenge, this study is initiated to develop a comprehensive set of assessment criteria for drawing ability so that teachers can observe and gauge the skill level of learners at different stages in a systematic approach, identify breakthrough points, and offer individualized and tailored improvement strategies.

Drawing ability has received far less scholarly attention than have intelligence (including mathematical, logical reasoning, and language abilities), athletic skills, emotional management skills (EQ), and even musical ability. Nonetheless, the body

of literature on drawing ability, including research conducted in laboratory settings, has grown considerably in the past 20-odd years. Psychology researchers have devoted substantial efforts to differentiating the differences in skill between artists and nonartists in aspects ranging from perception to movement, as well as the relationship between these differences and drawing technique. Psychology and neuroscientists are interested in asking the following questions: "What kind of strengths that people with realistic drawing ability can have? In terms of perception, spatiality, sense of rhythm and fluency of drawing motion?" (Chamberlain & Wagemans, 2016; Drake & Winner, 2011; Glazek, 2012; Kozbelt & Seeley, 2007; Tchalenko et al., 2014). Empirical research on this subject has adopted various approaches, including intergroup comparisons between groups of skilled painters and nonskilled painters in terms of perceptions of and performance on painting tasks (Chamberlain & Wagemans, 2015; Kozbelt, 2001; Perdreau & Cavanagh, 2011), correlation analysis on intragroup variability (Cohen & Jones, 2008; Drake & Winner, 2011; McManus et al., 2010; Ostrofsky et al., 2012), and case studies on individual artists and painting prodigies (Dr.ake & Winner, 2012; Miall et al., 2009; Ruthsatz et al., 2014). Furthermore, studies had applied functional brain imaging or brain wave analysis (Chamberlain et al., 2014; Miall et al., 2014; Schlegel et al., 2015; Solso, 2001) to reveal the basic foundation of drawing skills. Evidently, researches on drawing ability and the cognitive and perceptual functions involved are begun to thrive.

1.2. Study motivation and scope

Findings in this paper were based on a study that attempted to quantify drawing ability. The goal was to establish a comprehensive set of assessment criteria in order to be able to assist instructors to improve their quality and effectiveness in teaching process so that tailored teaching strategies can be formed for interested learners at different stages.

This study investigated how realistic drawing ability is acquired and developed and attempted to understand the constitutive aspects and cultivation of such expert knowledge. The objectives were as follows: (1) to construct a standardized qualitative and quantitative recording and evaluation system for assessment of the drawing process; and (2) according to the evaluation system, to analyze the characteristics of the drawing process, and observed the differences between the most adept artists and still developing art students.

2. Research method

2.1. Determination of target participants

Members of the general public were not enrolled in this study because the goal was to examine those people who possess certain level of expert knowledge in realistic drawing. Four groups of art students from the first-choice junior high school, senior high school, university, and senior students from the Academy of Arts with various learning years and skill levels are invited to participate in this study. They had undergone 2, 4, 6, or 7–11 years of professional drawing, training and studied

in art education programs respectively. All participants ranged in age from 14 to 35 years.

This study collected the valid data of 65 participants were employed in the formal analysis.

The four participant groups are detailed as follows:

1. Junior high school students: students enrolled in the art program (16 students) Average drawing experience: 2 to 4 years (Number of student candidates for all junior high school art programs in Taiwan in 2020 = 250; number admitted = 30; average acceptance rate = 12%)
2. Senior high school students: students in the art program (30 students) Average drawing experience: 4-6 years (Number of student candidates for all senior high school art programs in Taiwan in 2020 = 820; number admitted = 40; acceptance rate = 4.9%)
3. College students: students from the Department of Fine Arts (10 students) Average drawing experience: 6-8 years (Number of student candidates for all colleges/university programs in Taiwan in 2020 = 2620; number admitted = 40; acceptance rate = 1.5%)
4. Top fine art academy students: 10 students from the world's highly esteemed realistic art academy; the selection criteria for these group of participants included: (1) painting experience and techniques approved and recommended by professors; and (2) more than 10 years of genuine drawing education, Average drawing experience: 7-14 years (80 admissions among 10,000 candidates; acceptance rate = 0.8%).

2.2. Task assignments by drawing abilities

Group 1 had to draw a still life; Group 2 and 3 had to draw a plaster cast; and Group 4 had to draw a nude model.

2.3. Data collection through the "three-constant" approach

Changes in the observation, error correction methods, sensory integration process, and depiction skills of the participants during the painting process were thoroughly recorded. This study was not only limited to observing the participants' final works, but also recording the painting process in details. In the design of experiment, data were obtained by ensuring that the following three types of conditions remained constant: (1) use of the same easel, still life or model(s), and lighting position; (2) use of the same digital device by the painter to record the drawing process captured every 20 minutes; and (3) ensuring that the participants were drawing in daylight during the same time of day, preventing a change in light source affecting the quality of drawings. All collected data and interview content were then coded and scored by three reviewers using the assessment tools detailed in the next section.

2.4. Assessment tools

Three experts were invited for discussion to develop methods for observing the drawing process and devise comprehensive assessment criteria. These three experts hold at least Master degree in artistic creation with more than 20 years of experience in creating art, and more than 15 years of teaching experience in the fine arts departments of colleges. These three experts have positive influence in the artistic field for long time.

Following a detailed discussion, the panel of experts developed an elaborated professional drawing assessment scale in which drawing technique is decomposed into the following 15 assessment items: (1) fluency of composition; (2) fluency of drawing motion; (3) outer contour; (4) inner structural line; (5) external tone; (6) internal tone; (7) shadow core; (8) overall contrast tone; (9) texture processing; (10) detail; (11) highlighting the subject ; (12) strengthening of the main composition axis; (13) softening; (14) details of varied contrasts; and (15) tone of varied strength contrasts. The scale was deployed to carefully analyze and track a participant's drawing technique and strategies by examining his/her paintings and photographs taken every 20 minutes.

The observation revealed whether a participant's diverse abilities were mature so as to create a favorable effect in a drawing; which techniques were emphasized; whether the participant adopted one or multiple techniques simultaneously; how the painter reflected artistic quality and created contrast and spatiality in a picture; and which items were ignored by the participants. Detailed and comprehensive drawing process data were obtained through the assessment scale and the three-constant approach.
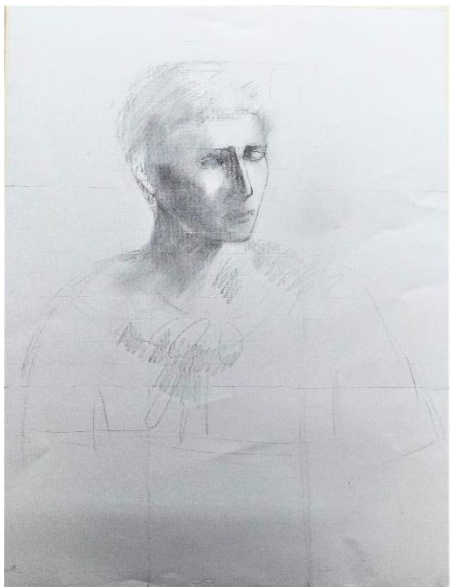
2.5. Content of the 15 assessment items

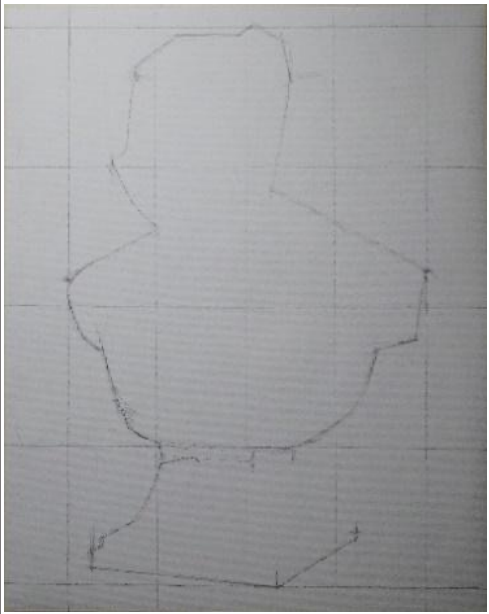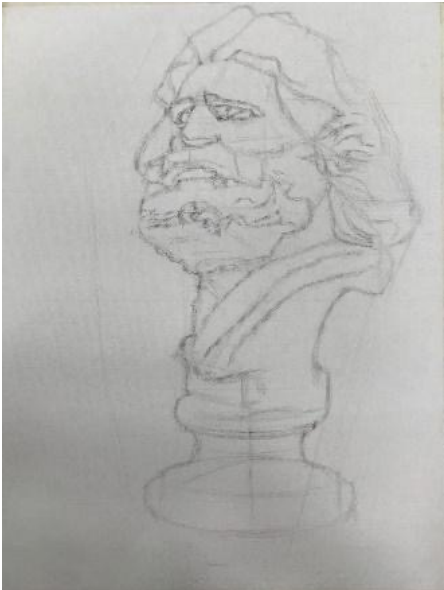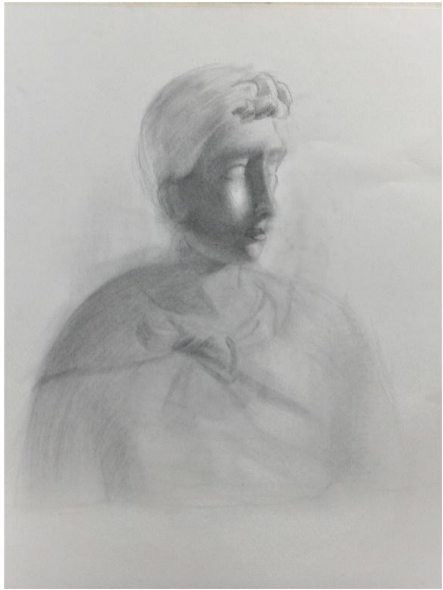The fifteen assessment items and evaluation criteria defined are explained and listed in the Table 1 below:

Table 1. The abilities corresponding to the 15 scoring ítems
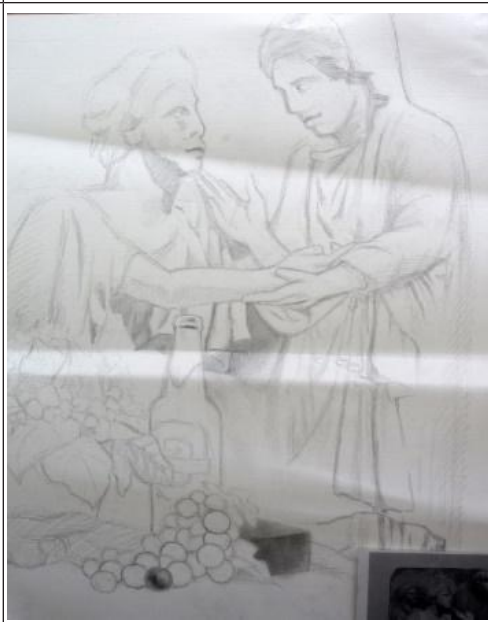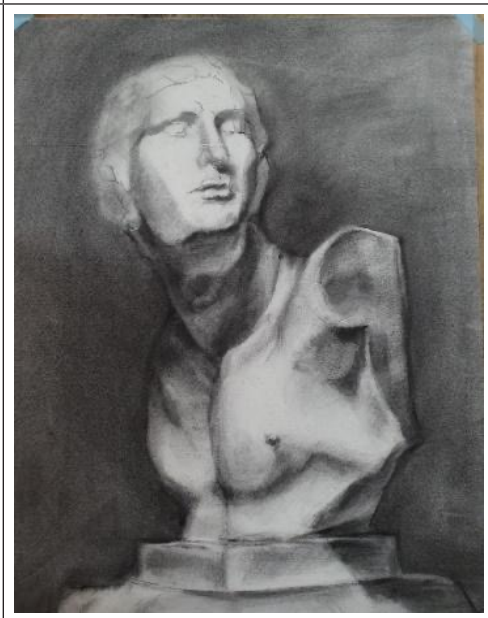
1. Fluency of composition	1. Whether the central axis runs through or is only partially connected. 2. Whether the perspective lines and vanishing point are coherent or perspective is lacking. 3. Whether the subject and subordinate(s) are coordinated in size and shape (in a cube or circle) or the deployment of farness and proximity of the subject and subordinate(s) is chaotic.
2. Fluency of drawing motion	1. Whether the strokes are connected smoothly or are stiff, discontinuous, and jagged. 2 Whether the strokes are rhythmically strong and weak or slow and sluggish
3. Outer contour	1. Whether the outer contour is clear and neat or fragmented.
4. Inner structural line	1. Whether an object's internal structural line is analyzed rationally or barely analyzed and only the contour line is present.

5. External tone	1. Whether tones are deployed only along the contour lines or the contour and background are treated in coordination.
6. Internal tone	1. Whether shifts of tones are made according to structural changes or variation of tone is present only in two-dimensional details.
7. Shadow core	1. Whether the shadow core runs throughout or emerges only locally in the form of spots or blocks. 2. Whether emphasis or understatement is made along the shadow core or the border is monotonous, unnuanced, and indifferent to emphasis or understatement.
8. Overall contrast tone	1. Whether brightness contrast in the background is connected or treated separately to that in the subject. 2. Whether farness and proximity are linked and differentiated using light and shade.
9. Texture processing	1. Whether particular means such as sponging, rubbing, or brush work are used to produce effects not produced by strokes.
10. Detail	1. Whether details are vivid or lacking. 2. Whether details are matched to the spatiality or flat and stiff. 3. Whether details enhance or weaken the subject.
11. Highlighting the subject	1. Whether the focus in the picture is strong or weak. 2. Whether any emotion or no emotion is imbued in the subject.
12. Strengthening of the main composition axis	1.Whether the subject and subordinate(s) are linked with an axis. 2.Whether the subject and subordinate(s) are concentrated around an axis or portrayed loosely.
13. Softening	1. Whether traces of stroke have been erased through softening or strokes everywhere have been kept intact.
14. Details of varied contrasts	1. Whether the details are depicted intensely or weakly and all details have the same brightness contrast. 2. Whether the depiction of details is integrated in the spatiality.
15. Tone of varied strength contrasts	1. Whether the brightness varies and exhibits contrasts or is dull and uniform.

Table 2. The abilities corresponding to the 15 scoring items. From the left side of the table is perfect performance with 10 marks, and from the right side is poor performance with 0 mark. For each item, 0 means no attention is paid by the student, 4–6 points an intermediate rating, 7–9 points a high rating, and 10 points is the perfect score.

1. Fluency of drawing motion	
Full marks: 10 With smooth strokes and diverse variation.	The lowest mark: 1 Often contradicted and altered.

2. Fluency of composition	
Full marks: 10 points Appropriate deployment of compactness, voids, and fullness as well as density.	The lowest mark: 1 Empty, crowded, and oblique.

| 3. Outer contour	
Full marks: 10 Complete and coherent; the subject is drawn to display distinct characteristics.	The lowest mark: 1 Broken and oblique.
4. Inner structural line	
Full marks: 10 Precise proportion; the inner structure is built.	The lowest mark: 1 No internal structural line.

5. External tone	
Full marks: 10 Black, white, and gray blocks are consistent and coherent.	The lowest mark: 1 Color blocks are broken and fragmentary
6. Internal tone	
Full marks: 10 The overall volume is strong and solid-looking.	The lowest mark: 1 Sunken and chaotic.

7. Shadow core	
Full marks: 10 Complete and continuous shadow core.	The lowest mark: 1 Fragmentary and vague shadow core.
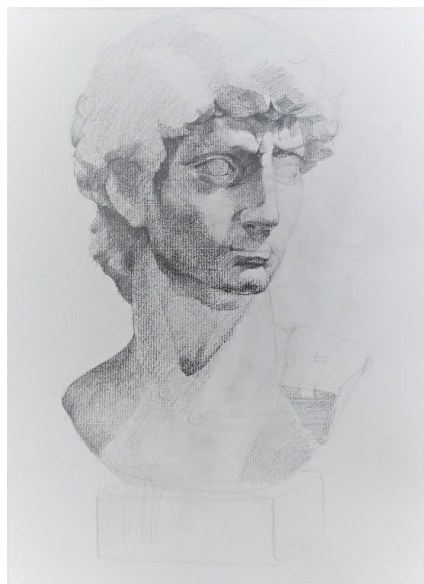
8. Overall contrast tone	
Full marks: 10 Uniform light source.	The lowest mark: 1 Loose and messy light source.

9. Texture processing	
Full marks: 10 The material beauty is fully represented in a clean and smooth manner.	The lowest mark: 1 Smeared and broken
10. Detail	
Full marks: 10 The volume and space are enhanced through details.	The lowest mark: 1 The volume is flattened through details

11. Highlighting the subject	
Full marks: 10 The subject is foregrounded.	The lowest mark: 1 The focus is indeterminate.
12. Strengthening of the main composition axis	
Full marks: 10 Alterations of emphasis and understatement are linked by the central axis.	The lowest mark: The axis is scattered.

13. Softening	
Full marks: 10 The coordination between the subject and subordinate is treated as a whole.	The lowest mark: 1 The subject and subordinate interfere with each other.

14. Details of varied strength contrasts	
Full marks: 10 The details are emphasized or understated appropriately.	The lowest mark: 1 The details are stiff and expressionless.

15. Tone of varied strength contrasts	
Full marks: 10 The tones are emphasized or understated propriately, demonstrating contrast and rhythm.	The lowest mark: 1 The brightness contrast is dull and smeared.

2.6. Data analysis and weighting

To further clearly outline the major skill aspects to the drawing ability, the 15 assessment items were weighted and condensed into the following 8 major aspects as shown in Table 3 below including: (1) fluency of composition; (2) fluency of drawing motion; (3) planarity; (4) spatiality; (5) detail; (6) softening; (7) artistic quality; and (8) contrast and rhythm.

Table 3. 8 skill aspects and weighting methods

Skill aspects	Weighting
fluency of composition	Same as item 1
Fluency of drawing Motion	Same as item 2
Planarity	Comprising of Item 3: Outer contour (50%) and item 5: External tone (50%)
Spatiality	Comprising of item 4: Inner structural line (20%), item 6: Internal tone (10%), item 7: Shadow core (40%), and item 8: Overall contrast tone (30%)

Detail	Comprising of item 9: Texture processing (50%) and item 10: Detail (50%)
Softening	Same as item: 13
Artistic quality	Comprising of item 11: Highlighting the subject (50%) and item 12: Strengthening of the main composition axis (50%)
Contrast and rhythm	Comprising of item 14: Details of varied contrasts (50%) and item 15: Tone of varied strength contrasts (50%)

3. Results

After all the experimental data being collected, a result profile for the progress of each student group was created and the evaluation data were sorted into charts and analyzed as follows.

3.1. Group 1: junior high school students

Figure 1. Assessment score versus time in the group 1 student.

The x-axis, representing time, has increments of 20 minutes, and a score was accordingly awarded for each aspect. In total, 20 photographs were obtained and the drawing took 400 minutes; the overall number of working hours was 6.5. The y-axis represents the assessment score (0–10); the highest score was 2.1, and the lowest score was 0.

The scores obtained by Group 1 students in general were low (< 2 points) (please see Figure 1). It was observed that *Planarity and detail* were the two major aspects on which the most drawing time was spent. Participants held the ultimate goal of being attentive to detail rather than coordinating with the others.

Group 1 obtained particularly low scores (~0.5 points) in *spatiality, artistic quality, softening, and contrast and rhythm*. Regarding changes in the low-score area, the data result curves for *artistic quality and contrast and rhythm* were low gentle slopes in the low-score area, with the average score being approximately 0.2 and 0.3.

Group 1 students appeared to pay enduring attention to one aspect. Few intersection points indicate a participant's equal attention toward several aspects over a time span.

Curves without intersection points imply low attention to several aspects simultaneously, with the participant performing the drawing by proceeding in an indeterminate manner.

In summary, Group 1 students concentrated on (1) *planarity* and *detail* (2) in the low-score area, with few intersection points in the curve of score versus time.

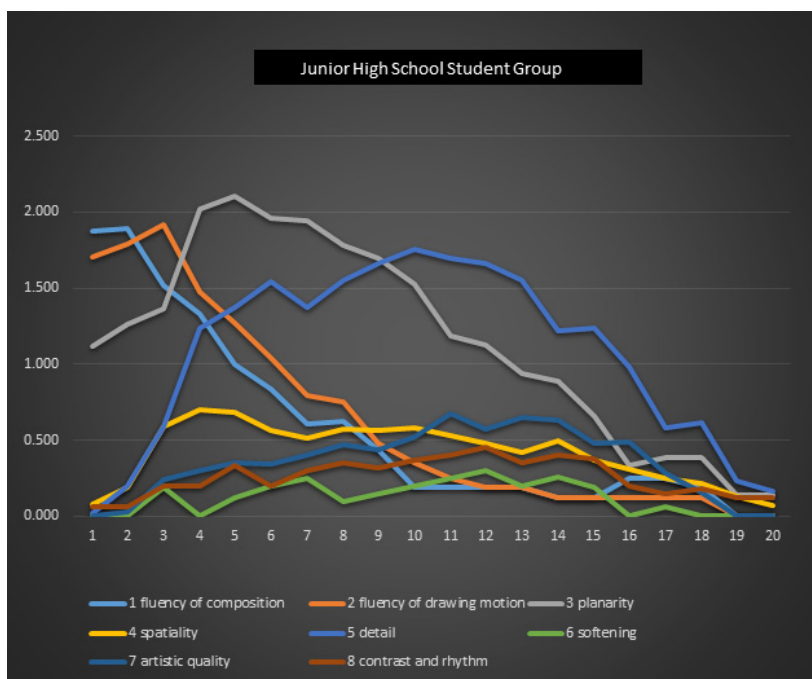## 3.2. Group 2: senior high school students

Figure 2. Assessment score versus time in the group 2 student.

The x-axis, representing time, has increments of 20 minutes, and a score was accordingly awarded for each aspect. In total, 30 photographs were obtained, and the drawing took 600 minutes; the overall number of working hours was 10. The y-axis represents the assessment score (0–10); the highest score was 4, and the lowest score was 0.

The scores for Group 2 were in the area below 4 points (please see Figure 2); higher scores were obtained in fluency of drawing motion, fluency of composition, detail, and spatiality compared with Group 1.

The Group 2 participants paid attention to their fluency of composition and fluency of drawing motion only at the initial drawing stage, then dropped off rapidly.

The score for spatiality was considerably improved for Group 2 compared with Group 1. In addition, the scores for overall contrast tone and internal tone were slightly improved.

The group 2 students obtained slightly higher scores in contrast and rhythm, artistic quality, and softening.

In the drawing strategies represented by jagged curves and gentle slopes, the clear difference is the repeated shifting of attention among different items versus attention remaining on the same aspect over time. The jagged shapes indicate attention on various aspects at the moment of drawing. The participants were inferred to attempt to coordinate diverse items, such as how the lines, brightness contrast, and tone should be coordinated as a whole or processed separately; whether one of these three aspects should be accentuated; or how to emphasize or understate lines or spatiality. Repeated considerations and comparisons between these items had a positive effect on their works.

In summary, Group 2 participants demonstrated two most significant characteristics as follows:

1. Detail and spatiality took up most of the participants' drawing time; the spatiality scores were higher than the ones in Group 1.
2. The students gained preliminary experience in geometrical aesthetic, as indicated by their slightly improved artistic quality, contrast and rhythm, and softening scores.
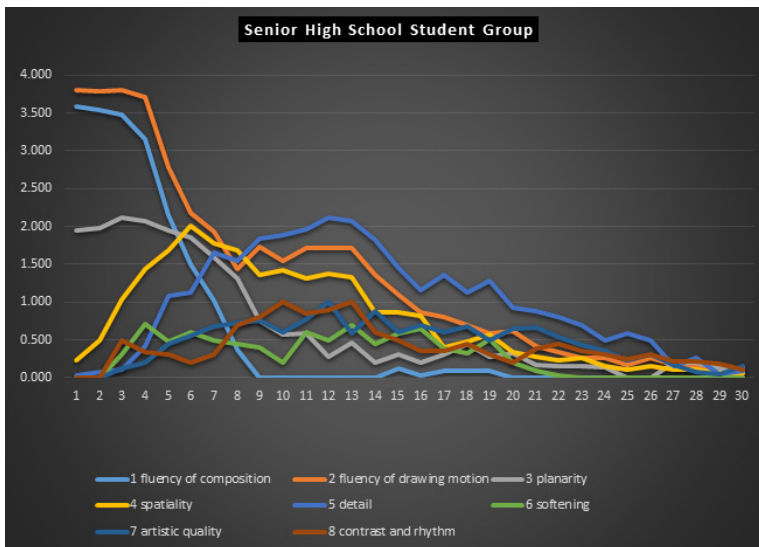
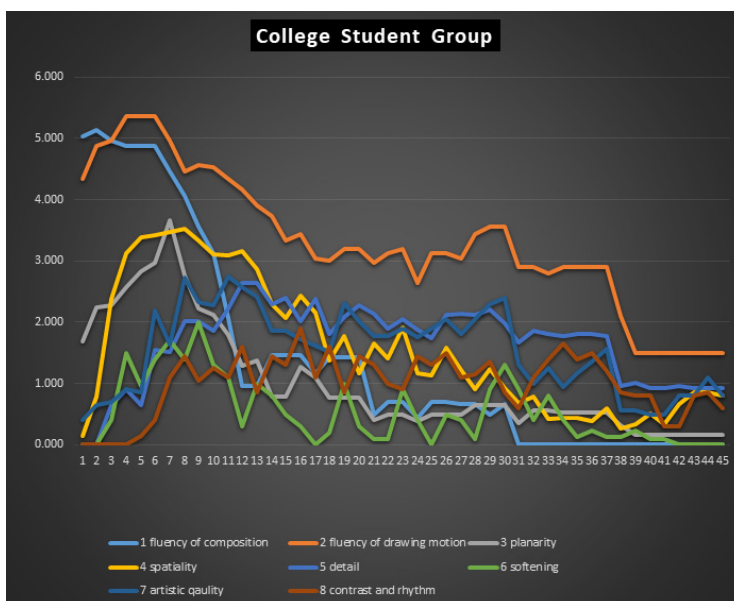### 3.3. Group 3: college students

Figure 3. Assessment score versus time in the group 4 student.

The x-axis, representing time, has increments of 20 minutes; a photograph was captured every 20 minutes, and a score was accordingly awarded for each aspect. In total, 45 photographs were obtained, and the drawing took 900 minutes; the overall number of working hours was 15. The y-axis represents the assessment score (0–10); the highest score was 5.5, and the lowest score was 0.

The scores of Group 3 were in the area below 5 points. The most distinct characteristic of this group was the considerably higher scores *in fluency of drawing motion* than the ones in Groups 1 and 2; such smoothness ran from the initial to the final stage of drawing.

The Group 3 data result curves for *detail, spatiality, artistic quality*, and *contrast and rhythm* have shown distinct jagged shapes around the level of 3 points. These jagged shapes indicated that participants' attention had switched from one to several aspects, and pay more attention to coordinate among each other.

Fluency of drawing motion can be regarded a key aspect of the transition from an intermediate-level to an adept drawer. It signified smoothness unaffected or uninterrupted by frequent revisions or alterations during drawing; higher fluency of drawing motion scores indicated greater coordination of hand muscle movement on drawing process.

Group 3 participants began the drawing by forming spatiality in a picture by using lines; equal attention was paid to the two aspects. Integrated consideration of plane and space implied that the group 3students' understanding of the pictorial space was mature, and they did not consider planarity and spatiality to be in opposition, which was a major breakthrough.

Group 3 obtained considerably improved *artistic quality* scores, whereas their *contrast and rhythm* scores were lower than their *artistic quality* scores.

In summary, Group 3 participants demonstrated two most significant characteristics as follows:

1. The college students paid considerable attention to *artistic quality*; the overall score for this aspect was approximately 2 points.
2. Four jagged shapes can be observed in the segment between Photographs 15 and 30 (the middle stage after the drawing began). The *contrast and rhythm* score was slightly low; six jagged shapes can be observed in the area near 0.5 points. These jagged shapes implied drastically changing levels of the participants' attention, which was sometimes high and sometimes low or shifted to other aspects.

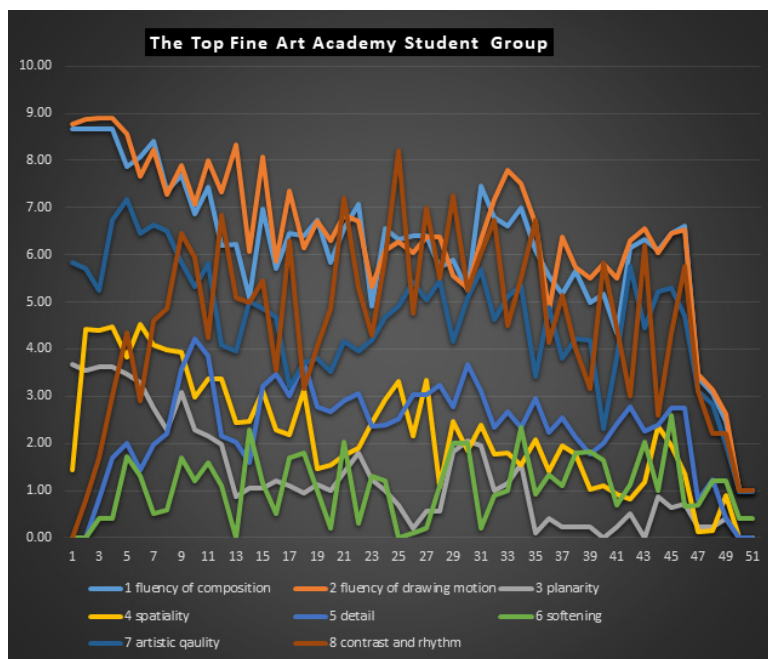## 3.4. Group 4: top fine art academy students

Figure 4. Assessment score versus time in the world's top fine art academy student group.

The x-axis, representing time, has increments of 20 minutes; and a score was accordingly awarded for each aspect. In total, 51 photographs were obtained, and the drawing took 1020 minutes; the overall number of working hours was 17. The y-axis represents the assessment score (0–10); the highest score was 9, and the lowest score was 0.

Group 4 received high scores in the area around 9 points. From the result data from Group 4, the most distinct trait was discovered to be vastly higher scores overall compared with the ones in Groups 1–3. In addition, two characteristics were observed:

1. Their *fluency of composition* and *fluency of drawing motion* scores were in the high-score area around 9 points. The data result curves for these two aspects contained jagged shapes oscillating in high-score areas for the whole drawing process, indicating that except in the initial drafting stage, they continually modified and revise their composition and sustained their *fluency of drawing motion*.
2. Their *artistic quality* and *contrast and rhythm* scores were greatly higher than those of the other groups, being in the high-score area between 6 and 9 points. The score for *highlighting the subject* (pertaining to *artistic quality*) was in the high-score area even in the initial drawing stage; the curve *for details of varied strength contrasts* (pertaining to *contrast and rhythm*) had numerous intersections in the middle stage of drawing. *Contrast and rhythm* was the ability to enhance or weaken brightness contrast, providing higher impact to visual concentration or looseness of entire work.

The interaction between *artistic quality* and *contrast and rhythm* during drawing was the key indicator of advanced drawing ability, showing that a person can depict the reality they perceive to ensure that the drawing is close to reality and have the urge to spontaneous express themselves, with the resultant image thus outshining the reality.

The data show that the *fluency of composition, fluency of drawing motion, artistic quality*, and *contrast and rhythm* scores were all higher than 5 points.

Among the scores in the area under 5 points, the *planarity, spatiality, detail*, and *softening* scores fluctuate in the median-low score areas, whereas the *spatiality* and *detail* scores fluctuate in the area between 2 -4.5 points. The *softening* scores are the lowest scores achieved.

1. In the top fine art academy student group, the mode was majorly transformed into an intersection mode of free and flexible shifting among all aspects.

    A high level of attention was paid throughout the entire painting process to *fluency of composition, fluency of drawing motion, artistic quality*, and *contrast and rhythm*, which could be regarded as key indicators of skill and signify coordination among hand muscle movement. Such ability to flexibly shift among aspects could be termed a complete coordination mechanism.

    In the Group 4 data, the most mysterious and interesting results showed that Aspect 8 *contrast and* rhythm and Aspect 7 *artistic quality* appeared to be complementary. *Contrast and rhythm* and *artistic quality* could be regarded as key indicators for their advanced drawing skill.

3.5. Comprehensive analysis

Figures 1–4 indicate the most obvious changes from the young learners to the adepts, with scores shifting from the low-score area to the high-score area; the main change, however, was the shift from concentrating on one item at a time to frequent switching among multiple items.

The act of shifting among aspects determined the participant's overall coordination, and the painting process shifted from groping in the dark to repeated determining and embodiment of ideas.

Adepts breaking away from the conventional strategy and inventing a flexible working mode

Breaking away from the conventional steps, the adepts were motivated by coherence and internal coordination to frequently switch among tasks. Such alternation among 8 aspects denotes the ability to predict the effect in a picture, an advanced ability that cannot be accomplished by young learners.

Artistic quality and contrast and rhythm sustained throughout the drawing process

Appreciation and mastery of artistic quality and contrast and rhythm were indeterminate whereas for Group 4, the attention scores for these two items peaked throughout the time span of drawing. The drawings of Group 4 were richer and had fuller effects

throughout the process. This indicated that the participants' extremely high mental power could be sustained from the start to the end.
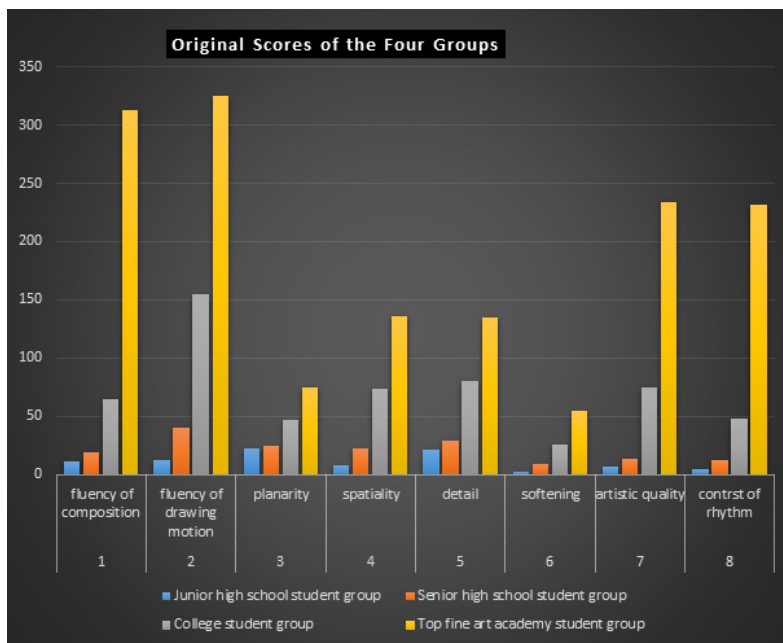

Figure 5. Original scores of the four groups.

Examining the progress rate of learning through data wavebands

Two graphs were obtained by normalizing the differences in the groups' total scores for individual item. Figure 5 (the scores from eight aspects obtained through condensation) and Figure 6 (progress rates between groups) were produced to have discussion of issues such as which abilities can be improved rapidly versus slowly through learning.

Figure 5 reveals that the scores of Groups 1 and 2 were all low, the *planarity* and *detail* scores started at slightly higher points, indicating that these two aspects are related to drawing abilities of less difficulty—aspects that even young learners can master. By *contrast and rhythm*, *artistic quality* and *softening* were the most difficult skills for the young learners to master. *Contrast and rhythm* was the aspect with the lowest scores among items in group 1 and group 2 students.

Figure 5 also indicated considerably improved *fluency of drawing motion* in Group 3, and Group 4, excelled the most at the following four aspects (in order from highest to lowest scores): *fluency of drawing motion*, *fluency of composition*, *artistic quality*, and *contrast and rhythm*.

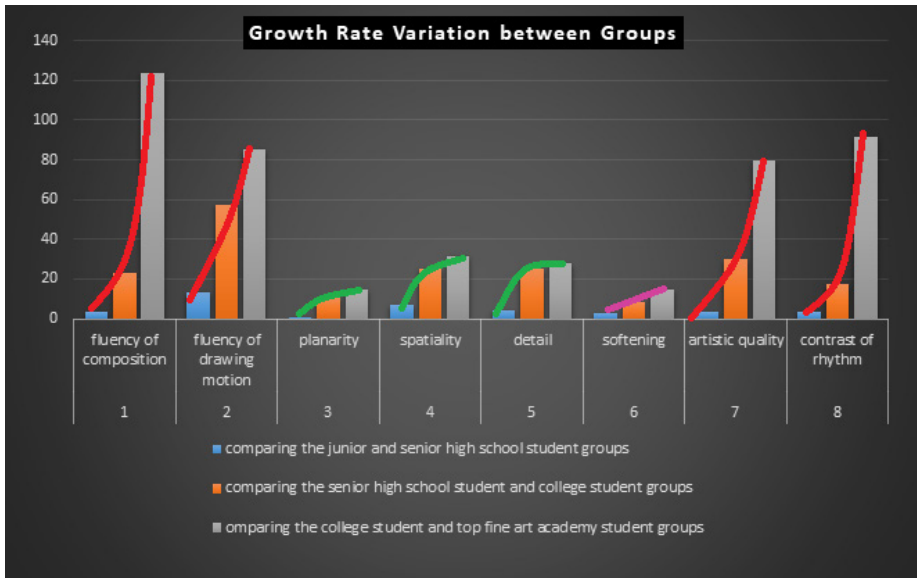**Gentle, greater, and groundbreaking progress**

Figure 6 illustrated the Growth rates between groups.

In Figure 6: The blue bar graph which means comparing the junior and senior high school students group was the lowest; the orange bar graph which means comparing the senior high school students and college group was slightly greater. The progress rate in grey bar

graph which means comparing the college students and top fine art academy group was the highest and the largest progress was made. The 7th to the14th year of training thus results in the most considerable progress.

In Figure 6, three different patterns of growth path can be identified, namely, an accelerating, a decelerating, and a linear path.

1. The item "Softening" shows a liner growth path, indicating that the learner's abilities associated with this item improve steadily with time (mark with pink line).
2. The item "Fluency of composition", "Fluency of drawing Motion", "Artistic quality", "Contrast and rhythm" 4 aspects show accelerating growth path, indicating that the learner's abilities associated with this item improve tremendous with time (mark with red line).
3. The item" Planarity", "Spatiality", "Detail" 3 aspects show decelerating growth path, indicating that the learner's abilities associated with this item improve slowing down with time (mark with green line).

Even for gifted children, the realization of such coordination requires 6 to 10 years. In 6 years, these highly gifted children progress only slightly; it is not until the seventh year that they achieve groundbreaking progress.

Given the analysis result, the following summaries can be made:

1. Young learners emphasize planarity and detail, while adepts emphasize spatiality.
2. Senior high school students begin to analyze the form and structure and demonstrate partial fluency.
3. College students begin to demonstrate fluency in composition and strokes.
4. The working method of adepts are characterized by rapid switching of attention across various items throughout their whole working process.
5. Adepts attach greater importance to contrast and rhythm and artistic quality.

4. Conclusion

There were four major findings in this study: 1. Effective assessment items and skill aspects for drawing ability have been established; 2. The differences about the strengths and weaknesses between young learners and adepts were identified; 3. Skill-related items that can be learned in a short period of time and those requiring a longer time were identified based on the progress rate of drawing ability; 4. Specific teaching strategies were provided for teaching young learners, intermediates and adepts.

It was noted that young learners endeavored to master "*planarity*" and yet show apathy and unfamiliarity about "*artistic quality, contrast and rhythm*, and *spatiality*". Adepts maintained a high level of agility and rapidly switch between aspects throughout the drawing process, excelling especially in "*contrast and rhythm*" and "*artistic quality*", and often had "flattened volume".

The senior high school group began to exhibit an analysis of space and volume. The college group, they began to demonstrate an attention to "fluency of composition" and " fluency of drawing motions". Another clear trait was they altered their attention between aspects, their works started to display overall coordination.

The group of Academy of Arts, their data evidenced even more frequent switching of their focus of work, revealing a high level of attention to coordination between skill aspects, especially in terms of integrating "*artistic quality*" and "*contrast and rhythm*".

In conclusion, skill aspects used to assess drawing ability can be ranked in the following order from easy to difficult: *1. softening, 2. planarity, 3. detail, 4. spatiality, 5. artistic quality, 6. fluency of drawing motion, 7. contrast and rhythm, and 8. fluency of composition*. The first three may be described as low in difficulty, 5 and 6 mid-level, and 7 and 8 most advanced.

These skill aspects can be combined to form a crucial scale for judging drawing ability. The conclusions from this study can assist drawing experts and instructors to save exploration time and more objectively and quickly grasp students' levels and identify difficulties and breakthrough opportunities.

4.1. Specific teaching strategies and contributions

Based on the conclusion of this study, teaching strategy can be recommended to reinforce the following aspects for each stage:

1. Young learners: a) structural analysis and b) fluency of composition
2. Senior high school students: a) spatiality and b) artistic quality
3. College students: a) artistic quality, b) contrast with rhythm, and c) coordination between skill aspects.
4. Adepts: a) aesthetic experience and b) invention of unique skills.

With a comprehensive and effective set of assessment criteria established for drawing ability, it can be ensured that the contributions from this study could enable teachers to assist learners not only save time on guesswork, but also identify learners' strengths, weaknesses and barriers in a systematic approach, in result to provide tailored and specific breakthrough teaching strategies.

References

Chamberlain, R., Drake, J. E., Kozbelt, A., Hickman, R., Siev, J. & Wagemans, J. (2019). Artists as experts in visual cognition: An update. *Psychology of Aesthetics, Creativity, and the Arts, 13*(1), 58–73. https://doi.org/10.1037/aca0000156

Chamberlain, R., McManus, I. C., Brunswick, N., Rankin, Q., Riley, H. & Kanai, R. (March 2014). Drawing on the right side of the brain: A voxel-based morphometry analysis of observational drawing. *NeuroImage, 96*, 167–173. https://doi.org/10.1016/j.neuroimage.2014.03.062

Chamberlain, R. & Wagemans, J. (October 2015). Visual arts training is linked to flexible attention to local and global levels of visual stimuli. *Acta Psychologica, 161*, 185–197. https://doi.org/10.1016/j.actpsy.2015.08.012

Drake, J. E. & Winner, E. (2011). Realistic drawing talent in typical adults is associated with the same kind of local processing bias found in individuals with ASD. *Journal of Autism and Developmental Disorders, 41*(9), 1192–1201. https://doi.org/10.1007/s10803-010-1143-3

Drake, J. E. & Winner, E. (2012). Predicting artistic brilliance. *Scientific American Mind, 23*(5), 42–49. https://doi.org/10.1038/scientificamericanmind1112-42

Glazek, K. (2012). Visual and motor processing in visual artists: Implications for cognitive and neural mechanisms. *Psychology of Aesthetics, Creativity, and the Arts, 6*(2), 155–167. https://doi.org/10.1037/a0025184

Kozbelt, A. (2001). Artists as experts in visual cognition. *Visual Cognition, 8*(6), 705–723. https://doi.org/10.1080/13506280042000090

Kozbelt, A. & Seeley, W. P. (2007). Integrating art historical, psychological, and neuroscientific explanations of artists' advantages in drawing and perception. *Psychology of Aesthetics, Creativity, and the Arts, 1*(2), 80–90. https://doi.org/10.1037/1931-3896.1.2.80

McManus, I. C., Chamberlain, R., Loo, P. W., Rankin, Q., Riley, H. & Brunswick, N. (2010). Art students who cannot draw: Exploring the relations between drawing ability, visual memory, accuracy of copying, and dyslexia. *Psychology of Aesthetics, Creativity, and the Arts, 4*(1), 18–30. https://doi.org/10.1037/a0017335

Miall, R. C., Gowen, E. & Tchalenko, J. (2009). Drawing cartoon faces – a functional imaging study of the cognitive neuroscience of drawing. *Cortex, 45*(3), 394–406. https://doi.org/10.1016/j.cortex.2007.10.013

Miall, R. C., Nam, S. H. & Tchalenko, J. (November 2014). The influence of stimulus format on drawing—a functional imaging study of decision making in portrait drawing. *NeuroImage, 102*, 608–619. https://doi.org/10.1016/j.neuroimage.2014.08.015

Ostrofsky, J., Kozbelt, A. & Seidel, A. (2012). Perceptual constancies and visual selection as predictors of realistic drawing skill. *Psychology of Aesthetics, Creativity, and the Arts, 6*(2), 124–136. https://doi.org/10.1037/a0026384

Perdreau, F. & Cavanagh, P. (December 2011). Do artists see their retinas? *Frontiers in Human Neuroscience, 5*(171). https://doi.org/10.3389/fnhum.2011.00171

Ruthsatz, J., Ruthsatz, K. & Stephens, K. R. (July-August 2014). Putting practice into perspective: Child prodigies as evidence of innate talent. *Intelligence, 45*, 60–65. https://doi.org/10.1016/j.intell.2013.08.003

Schlegel, A., Alexander, P., Fogelson, S. V., Li, X., Lu, Z., Kohler, P. J., Riley, E., Tse, P. U. & Meng, M. (November 2014). The artist emerges: Visual art learning alters neural structure and function. *NeuroImage, 105*, 440–451. https://doi.org/10.1016/j.neuroimage.2014.11.014

Solso, R. L. (2001). Brain activities in a skilled versus a novice artist: An fMRI study. *Leonardo, 34*(1), 31–34. https://doi.org/10.1162/002409401300052479

Tchalenko, J. (2007). Eye movements in drawing simple lines. *Perception, 36*(8), 1152–1167. https://doi.org/10.1068/p5544

Tchalenko, J. (2009). Segmentation and accuracy in copying and drawing: Experts and beginners. *Vision Research, 49*(8), 791–800. https://doi.org/10.1016/j.visres.2009.02.012

Tchalenko, J. S., Nam, S. H., Ladanga, M., & Miall, R. C. (2014). The gaze-shift strategy in drawing. *Psychology of Aesthetics, Creativity, and the Arts, 8*(3), 330–339. https://doi.org/10.1037/a003613