Comparison of Danish and American Children

on the

Groffman Visual Tracing Test

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The requirements for reading and writing abilities have changed a lot over time. In modern society it is almost impossible to find an occupation which does not demand both good reading and writing abilities. Many studies have been done which look at the relationship between eye movements and educational performance. From these studies have emerged several clinical measuring tools which are used by optometrists for the diagnosis of learning related visual problems. One such test, widely used in the United States, Canada, and Australia, is the Groffman Visual Tracing Test, created by Dr. Sidney S. Groffman. This test is easy to administer and is used in several visual screenings and in formal investigations into understanding learning-related visual problems. The norms derived from the early studies were done with children in the United States. As behavioral vision care is spreading into Europe, and in particular into Denmark, we anticipate that this test will be used more and more with Danish children. We wanted to see how a random sample of Danish children would do in comparison to their American counterparts. Our hypothesis is that Danish children would perform the same as age-matched American children.

We obtained permission to work with students from three different schools. Due to time and personnel resources and to use large enough numbers of students to enable formal comparisons with Groffman's work, we chose to test only four different ages: 7-, 8-, 10- and 11-year olds. Our testing samples were equally divided between boys and girls. We tested 136 subjects in all.

A stopwatch was used to accurately measure the time taken to track each line to its endpoint. Copies of the standard Groffman Visual Tracing Record Forms, the Groffman Visual Tracing Demonstration Card[A], and the Groffman Visual Tracing Test Card Form "A"[B] were used.

Since we were testing the similarities and differences between the Danish and the American children we chose to use only sample test form "A" rather than using both forms "A" and "B". Two people were used to administer all the testing. One did the timing and recorded the results while the other instructed the subject in how to perform the test. The one who administered the test also made direct observations of the child's' behavior including the following observations:

1. Amount of head movement
2. Working distance from paper
3. Attempted use of the finger
4. Unusual body movements
5. Unusual verbal comments

The Groffman Visual Tracing Test form consists of 5 separate continuous and intersecting lines in a tangled pattern on an 8½" x 11" card. Each line begins at a letter at the top of the card and follows a random twisting path terminating at a number at the bottom of the card. The task of the subject is to visually trace each line from its beginning to its end as rapidly as possible. The subject was told that accuracy was important in that if he did not get to the correct endpoint, he would not score any points. The subject was seated comfortably at a table with normal room lightning. If the subject used near point lenses they were worn and the test was done binocularly. The subject was not allowed to use a pencil, finger, or tracing device of any kind.

We handed the demonstration card to the subject and said, "This is a test to see how quickly and accurately you can follow a line using only your eyes. Look at the line that starts at the letter 'A'. Try to follow it and when it reaches another line [we pointed to the first intersection] follow it straight ahead and do not turn off onto the line that crosses the line you are traveling on. Then you have to tell us where you end up. Do you understand that?" If the subject seemed confused we repeated the explanation of whichever part of the instructions that seemed confusing. "Now follow the line starting at 'A' and tell me where it ends up." When path "A" was completed we repeated the demonstration with the path from letter "D". Now we added the knowledge of the timing aspect of the test by saying, "We will now be timing you. The most important thing for you to do is to be as accurate and fast as possible but without making any mistakes. If you get lost during tracing a line just start all over again on the same line."

Then we placed the test card in front of the subject and timed each trial individually. During the recording between each test sample we covered the test card with our hands so that the subject was not able to trace the next line until we were ready to begin again.

If the subject reached the correct number, he received points according to the following scale (table 1) based on time elapsed in seconds. If he reached the incorrect number he received no points. If the subject attempted to use a finger to trace the line we stopped and started the test again. If he persisted in using his finger, he received no points for that letter, even if he did reach the correct endpoint. We then added the individual scores for each trial and compared the total for that subject to the average score for his age.

Seconds Elapsed	Number of Points
Below 16	10

16-20	9
21-25	8
26-30	7
31-35	6
36-40	5
41-45	4
46-50	3
50-60	2
Over 60	1

Results

We tested 136 subjects. The following table shows the number of subjects at each of the different age groups.

Age	Number of Subjects
7	36
8	36
10	32
11	32

The following table shows the data for each of our age groups compared to the scores found by Groffman on the children from the United States.

Age	Danish Score	Danish std.	US Score	US std.
7	9.44	+/- 9.36	10	+/- 3.5
8	17.61	+/- 11.42	17	+/- 3.0
10	23.34	+/- 13.74	26	+/- 2.5
11	27.97	+/- 10.97	28	+/- 3.0

It can be seen that the scores from the Danish and the American populations have very similar data. Three of the four age groups scores are within a single point of being identical. Only the 10-year-old scores are different and these are still within one standard deviation of each other, using the American standard deviation scores that are much tighter.

The only significant difference is that the standard deviations on the Danish scores are much wider that the standard deviations found by Groffman. We are uncertain as to why our standard deviations are so much wider than those of Groffman. Our sample sizes were very similar. Groffman reports that he tested 215 children in his 6 different age groups that would, if evenly distributed, place his individual age group size at an average of 35.8 subjects per group.

It is possible that his groups were taken from a single school in a single area where the children are somehow grouped by abilities therefore setting the stage for very narrow standard deviations. Our testing was done on children randomly chosen from three different schools in different economic areas in the city of Copenhagen as well as from a smaller town well outside of Copenhagen.

It is also possible that the very wide variations in the Danish samples versus those found in the American samples are significant and do not represent sampling errors. In order to know this, one would have to perform this study again with much larger samples. The larger samples would allow deeper analysis that might help to identify the differences between the groups if the same results are found again. Testing should be done on both sides of the Atlantic with as many factors matched between the groups as possible. Unfortunately, Dr. Groffmans' original data is not available for us to perform any additional statistics on, or for more in-depth comparisons between the groups.

Clinically it has been observed that patients with binocular difficulties show certain patterns in their test results. Typically they show progressively longer times on each trial as the test progresses. Additionally, it has been observed that they tend to get the first few samples correct and to then have more difficulty as the test progresses. We thought that as the children age they would tend to demonstrate more of these types of visual difficulties secondary to the increases in demands with sustained near visual tasks as they get older. Since this test requires sustained near visual attention, it provided us a window into seeing, in a short period of time, how a person's visual performance changes over time.

For the sake of comparing the older and younger children together we chose to group the seven- and eight-year-olds' times together in one group and the ten- and eleven-year-olds' times together in another group. The following table of times shows our data. Each box has the combined averages for all children at those ages for each of the trials. For example, the 7 & 8 year olds averaged 24.89 seconds on the first trial that began at letter "A". The trend we were looking for was for the times to get longer and longer as one moved down each of the columns in the table. Our hypothesis is that we would not see this pattern in the younger children but would see the pattern in the older children.

Trial	Ages 7 & 8 (seconds)	Ages 10 & 11 (seconds)
A	24.89	18.33
B	34.34	27.19
C	34.03	28.83
D	33.29	24.91
E	23.61	19.11

Our hypothesis was not confirmed here. Both age groups showed fastest times on the first and last trials with slower times in the middle sets. Of course the older group showed faster times at every age group. This is what gives them the higher overall score on the test. Thus, although clinicians often see individual patients with binocular vision difficulties who show a pattern of slower and slower performance on this test, we did not see this as a pattern shown by either our younger or older groups.

Previous reports on the Groffman Visual Tracing Test have concentrated their attention on the actual time and accuracy of the subject's responses. Over the years clinicians have made many other observations relative to understanding their patients' visual behavior. The test has been an excellent stage on which many additional behaviors of the patient can be observed. Until now we are unaware of attempts to quantify these additional qualitative measures. We report here on our additional behavioral observations.

Observations were made in the areas of head movements, working distance significantly closer than the persons Harmon distance, use of the finger to help keep place, movements in the entire body, and finally extraneous vocalizations during the testing.

Observations were made during the testing by a tester in each of these areas. A score of 0 was given if the qualitative observation was not present. For example, if no head movement was observed the subject was given a score of 0 for that observation. If some head movement was noticed, he was given a score of 1. If the amount of head movement was determined to be a moderate to a large amount then a score of 2 was recorded. The above table summarizes the average scores of all the children at each age in each of the characteristics. The following is a table of the scores assigned by the tester in each category.

Head Movement 0	No head movement observed
Head Movement 1	Some head movements observed
Head Movement 2	Moderate to large amount of head movements observed

Close Distance 0	Normal working distance
Close Distance 1	Closer than normal working distance
Close Distance 2	Much too close working distance
Finger 0	Did not attempt to use finger at all
Finger 1	Used finger, when asked to stop using finger they did stop
Finger 2	Used finger, but continued even after prompting
Body Movement 0	Did not move body during test
Body Movement 1	Moved body some
Body Movement 2	Moved body a lot
Vocalization 0	Did not talk out loud or make sounds
Vocalization 1	Did talk while doing test or made sounds some
Vocalization 2	Talked a lot or made lots of verbal sounds

The following table shows the average scores of our observations for each age group and for each type of observation.

Age	Head Movements	Close Distance	Finger	Body Movements	Vocalized
7	0.50	0.39	0.22	0.06	0.14
8	0.47	0.36	0.28	0	0.06
10	0.53	0.41	0.13	0	0
11	0.03	0.28	0.13	0	0

It can be seen from the above that some head movements are observed to about the same degree up until the age of 10 and then, head movements during the testing drop out almost completely. Thus, anyone over the age of 10 that is seen to move his head during the testing can be said to have a problem in using his eyes free from the support of the head. This is associated with long term fatigue and loss of sustained concentration.

It appears that at all ages some children tend to get close to the paper during the testing and that there is no significant differences in age. It might be very interesting to do a follow-up study looking into the use of the appropriate plus lens for each child in the study and observing changes in working distances with the plus lenses during this testing.

It is apparent that the younger children use their fingers more than the older children do in helping to keep their place. Remember that this was not allowed to continue so we cannot make any statements about how much better they might have done if the use of the finger was allowed to continue. We only observed the attempt to use the finger. The difference does not seem to be too significant, which was surprising to us as we expected that as the children grew older there would be less use of the finger until at the oldest age there would be little or no use of the finger.

We observed so little overall body movement that we don't recommend this being a formal observation made in future studies. It should be apparent however, that any child who moves his torso or legs to a significant degree during this testing may have a visual problem and should be checked further. We were not able to control the type of chair that was used during the testing. Many clinicians in their offices use a swivel stool on castors for seating the subject. Using this type of chair increases the probability of seeing even small amounts of body movement. It is possible that the fact that standard school chair with four legs and a back which we used did not allow the child as much freedom of movement. It might be interesting to look at the differences between the performance in this area between a standard chair versus a swivel stool on castors.

It can be seen from the data that the youngest children did make noises or talked to themselves out loud during the testing. This was not observed in many children at age 7 but in a few. However, at age 8 we saw this in only one child and none of the older children made noises or spoke out loud during the testing. Therefore, we conclude that when a child older than 7 makes noises or talks out loud during this testing, some visual performance difficulties should be suspected and investigated further.

Conclusion

According to our data the norms collected by Groffman on the Groffman Visual Tracing Test in the United States can be used in Denmark without additional need for large group random sample testing. Some additional testing should be done, in a coordinated way on both sides of the Atlantic to look further into the differences in the standard deviations between the two groups.

References

- Groffman, Sidney, "Visual Tracing", Journal of American Optometric Association Vol. 37, No. 2 February 1966 P. 139-141.
- Groffman, Sidney, Visual Tracing, Keystone View 1967

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Appendices

A. Include copy of Groffman's demonstration card.
B. Include copy of Groffman's test form A.

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