

## **Looking for Color in All the Wrong Places: A Search for Synesthetic Responses from Color-Important Non-Synesthetes<sup>1</sup>**

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Grapheme-color synesthesia occurs when a word, letter, or number elicits a perception of color among certain individuals. Research examining grapheme-color synesthesia routinely uses non-synesthetes as a control group. Significant differences between the synesthetes and non-synesthetes are then revealed which are attributed to synesthetic behavior. We hypothesize that this may be an exaggeration. A potential problem in using non-synesthetes as a control group is that in addition to the potential difference in brain mechanisms, there is a confounding difference between groups with regard to the importance of color in their day-to-day lives. The present study took into account color experience among non-synesthetes to determine whether color-important non-synesthetes (*coloristas*) behave in ways similar to synesthetes.

### **Introduction**

While most people have five separate senses that rarely overlap one another, some people experience a phenomenon known as synesthesia in which two of the sensations cross (Hornik, 2001). Synesthesia comes from the Greek meaning “joined perception” and can occur in a variety of forms (Hochel & Milán, 2008). There have been cases of synesthesia in which people sense colored taste, feel or taste sounds, or even hear or taste shapes (Hornik, 2001).

Prior to the 1800’s there are no recorded instances of synesthesia; synesthetes must have thought that they were mentally ill compared to non-synesthetes because they saw the world differently (Hornik, 2001). The first recorded symptoms of synesthesia were by Dr. Sachs in 1812 who described his and his sister’s experiences with color (Hochel & Milán, 2008). Seen then but also seen now, synesthesia seems to run in families (Hornik, 2001). During the 1800’s often the only synesthetes to discuss their symptoms were researchers and physicians who were simply curious to learn more (Hornik, 2001). Many people did not believe that synesthesia was a true phenomenon, some people even thought that synesthetes were “mentally defective” (Hornik, 2001). As more and more synesthetes are beginning to discuss their symptoms and experiences with the phenomenon there are more possibilities for research on the subject.

One type of synesthesia often studied by researchers is grapheme-color synesthesia also referred to as colored-speech synesthesia. This type of synesthesia occurs when graphemes such as words, letters, or numbers elicit an automatic perception of a color (Brang, Edwards, Ramachandran, & Coulson, 2008). For instance, a person may see the number 5 and sense the color lime green.

Researchers became interested in this phenomenon because grapheme-color synesthetes were showing consistency within their color associations over time, even to be as specific as to combine color terms (such as yellowish orange) to best describe the color associated (Grossenbacher & Lovelace, 2001). Grossenbacher and Lovelace (2001) used a computer program with very specific color choices on a color wheel to test synesthetes on their associations with graphemes. The responses from synesthetes in Grossenbacher and Lovelace’s (2001) study showed very specific responses to graphemes, even down to the specific shade or hue of the color. Subjects struggled to find the specific color for the word, letter, or number presented (Hornik, 2001).

In the article from the Smithsonian, one synesthete claimed “*It’s not enough to say it’s orange;*” her interpretation of the letter A is a tangerine color (Hornik, 2001). These responses from synesthetes may suggest that the phenomenon is not merely a memorization of colors to

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graphemes or due to mental deficiencies rather a true perceptual experience.

### What causes synesthetic experiences?

Researchers are interested in studying the brain mechanisms of a synesthete compared to a non-synesthete. Hubbard and Ramachandran (2005) found that the synesthetic experience occurs when there is an abnormal cross-activation in the fusiform gyrus (FG) of the brain. This cross-activation is between the grapheme area and the color area of the FG which would create the synesthetic or crossing of senses experience (Hubbard & Ramachandran, 2005).

Synesthesia is often difficult to study scientifically due to its subjective nature (Hochel & Milán, 2008). Questions continue to arise about the cause of the phenomenon, whether it is something one is born with or develops over time (Jäncke, Beeli, Eulig, & Hänggi, 2009). Baron-Cohen, Harrison, Goldstein, and Wyke's research in 1993 tested for "genuineness" in synesthetes. Baron-Cohen et al. gave a list of 130 spoken letters, words, and phrases to both synesthetes (experimental group) and non-synesthetes (control group) and asked them to describe the color or shape associated with those letters, words, and phrases (Baron-Cohen, Harrison, Goldstein, & Wyke, 1993).

Just a week after the initial color test, non-synesthetes were only 37.6% accurate in their responses, while a year and half after the initial test, synesthetes were 92.3% accurate in their associations (Baron-Cohen et al., 1993). It is thought, then, that perhaps memory is strengthened in synesthetes as they seem to have a deeper experience that readily involves color in their day-to-day lives (Rothen & Meier, 2010). As a consequence of practice and experience, perhaps, synesthetes have more retrieval cues that could be beneficial to memory (Rothen & Meier, 2010). Hochel and Milán (2008) also claim that frequent associations with a stimulus in synesthetes may act to enhance their memory and serve as cues to help them remember later.

More recently, research is being done to see if there are anatomical cerebral differences between synesthetes and non-synesthetes. Jäncke et al. (2009) found that there was increased cortical

thickness, cortical volume, and cortical surface areas in synesthetes compared to non-synesthetes. Jancke et al.'s (2009) research was obtained with MRI scans and turbo field echo scans to measure field of view, echo-time, and repetition time. Although Jancke et al. (2009) found that there were anatomical differences in the cortical thickness, volume, and surface areas; they caution that it may not be enough to assume that those anatomical differences explain grapheme-color synesthesia (Jäncke et al., 2009).

It should also be noted that with Jancke et al. (2009) concluded that they are unclear if practice has played a role in the anatomical reorganizations in synesthetes. The fact that Jancke et al. (2009) mentions experience as a possible factor in the anatomical differences leads us to believe that heavy experience and exposure to color may play a role in synesthetic responses for both synesthetes and non-synesthetes who feel that color is very important in their lives. We will refer in this study to non-synesthetes who are greatly influenced by color in their day to day lives as *coloristas*.

One possible issue with previous research on synesthesia is that there has been no regard for artistic and color inclinations (practice) in synesthetes. Perhaps synesthetes simply have more practice embedding color into their thinking, which would explain their consistency when being retested for color associations. It is possible that synesthetes are not much different than any other non-synesthete who is heavily influenced by color (*coloristas*).

The importance of color has not been examined within synesthetic research except for perhaps to help pick out the people who find color extremely important and call them synesthetes. Even within the non-synesthete control group, they are only in this group because color is not as important to them. We hypothesize that *coloristas* may also respond in ways similarly to so-called synesthetes due to their experience with color. In Baron-Cohen et al.'s research (1993), they used non-synesthetes as a control group. We think that experience and exposure to color among *coloristas* may also result in synesthetic responses but perhaps not quite as pronounced because color is less important to these *coloristas* in comparison with "synesthetes."

# A search for synesthetic responses

## Method

### Participants

This study included 60 subjects who voluntarily participated. Subjects were students in classes from Robert Morris University. Subjects ranged in age from 18-24. There were no specific requirements for participation, subjects only needed to be fluent in the English language.

### Design

The independent variable was the score from the Artistic and Color Inclinations (ACI) test that helped to differentiate the *coloristas* from the non-*coloristas*. The dependent variable was the number of words that were consistently labeled with the same color between the two color surveys.

### Materials

The *Unusual Test of Color* (UTC) survey was created with 49 non-chromatic (not obviously associated with color) words. The survey included words such as *create* and *complete* and required participants to record a color that, to them, best represented each word (see appendix).

The test of *Artistic and Color Inclinations* (ACI) was created to identify *coloristas* (people who self-reported that color was important to their day-to-day lives). The ACI included both positive and negative phrased statements related to color exposure and influence. For example, “*When I listen to music on my computer, I like to watch the colorful visualizations that play at the same time.*” Also, “*I am **not** very artsy; I avoid or have no interest in coloring, painting, etc.*” Subjects were asked to indicate the degree to which they agreed with each statement on a 5 point scale (1 = Definitely NOT; 5 = Definitely YES). It was possible for scores on this test to range from as low as 19 to no higher than 95 (see appendix).

### Procedure

Subjects were asked to complete the first survey, the *Unusual Test of Color* during class time. Subjects were not informed that they would later be retested. Three weeks later, subjects were surveyed again with the UTC (the same 49 non-chromatic words). After the completion of the second UTC, subjects were given the *Artistic and Color Inclinations* test which was later used to identify *coloristas* and non-*coloristas*. Consistency

was calculated for each participant by comparing color choices for the non-chromatic items on the UTC between the first and second testing.

## Results

A correlation was performed between consistency (UTC) scores and scores on the ACI. The relationship was not significant,  $r(58) = -0.14$ ,  $p = 0.29$ . In addition, an analysis of variance (ANOVA) was conducted on mean ACI scores as a function of responses to the question asking participants to self-report whether they believed that they were synesthetes. There was a significant main effect,  $F(3,56) = 9.58$ ,  $p < 0.01$ . As can be seen in Table 1, as self-reported degree of synesthesia increased, so did subjects’ reported degree of the importance of color in their day-to-day lives.

Table 1. Main effect of self-reported degree of synesthesia on mean ACI scores.

Reported Synesthesia	n	ACI Score (SD)
1 = Definitely not	9	58.1 (10.6)
2 = Disagree	18	66.3 (9.9)
3 = Neutral	19	70.7 (9.8)
4 = Agree	14	78.5 (6.8)

An ANOVA was also conducted on mean UTC scores as a function of self-reported synesthesia. The main effect was not significant,  $F(3,56) = 0.66$ ,  $p > 0.55$  (see Table 2).

Table 2. Main effect of self-reported degree of synesthesia on mean UTC scores.

Reported Synesthesia	n	UTC Score (SD)
1 = Definitely not	9	18.3 (5.7)
2 = Disagree	18	16.6 (4.2)
3 = Neutral	19	18.6 (5.0)
4 = Agree	14	18.1 (4.0)

### Other Findings

We also observed that some words elicited the same color for many subjects. For instance, 63% of participants associated the color blue with the word

*flowing* and 62% of participants associated the color red with the word *hate* while nearly all of the rest associated the same word with the color black. The word *believe* triggered the color blue for 48% of participants.

### Discussion

The purpose of this study was to examine whether color importance has an effect on word/color associations among color important non-synesthetes (*coloristas*). Our hypothesis was that the more important color seemed to be to our subjects, the more similarly they would perform to synesthetes (greater consistency in color associations after a delay than non-synesthetes). Or, another way to put it would be that we expected our *coloristas* to outperform non-*coloristas* in the present study.

Anatomical differences seen through Jancke et al.'s (2009) research with the question of whether practice with color may have played a role in the differences in fusiform gyrus anatomy primed us to wonder if practice or experience with color in non-synesthetes could also affect memory and create similar synesthetic responses. The present study failed to find a difference in color association consistency as a function of color importance. Our expectation that perhaps synesthetes are just well-practiced with color in their day-to-day lives was not confirmed. In fact, our *coloristas* responded similarly to non-*coloristas* which suggests that color importance does not seem to improve memory for color associations over time. Taken together, these conclusions tentatively support the view that people who claim to have synesthesia behave in a manner that is qualitatively different from those with no such identification. This difference goes beyond the simple variations in the day-to-day importance of color across individuals. It seems that although people do vary in how important color is to them, color does not aid in memory as it appears to do for true synesthetes (Baron-Cohen et al., 1993; Hochel & Milan, 2008).

Interestingly, however, it seems as though the more important color is to people, the more likely they appear to believe that they may be synesthetic. This tendency might have implications on tests of synesthesia. That is, the frequency of synesthesia might be over-estimated if people tend

to overestimate their personal degree of synesthetic response to stimuli. Also, in opposition to the Grossenbacher and Lovelace (2001) study done with synesthetes, we did not see complete consistency with our non-synesthetic subjects as some people that associated the same color with words were not as specific as to say green-blue or neon orange when retested. Although we did see some consistency over time in responses there was some variability in responses such as light blue to dark blue. This may show that our *coloristas* are not as specific as synesthetes.

Because the present study did find that some effects are related to color-importance, it is recommended that further research be done to learn more about artistic inclinations and experience and the effects on memory for non-synesthetes. It is possible that because the surveys were given in groups that people could have looked at or heard their neighbors' responses which may have momentarily biased subjects' true color inclinations. It may be worthwhile to collect all surveys individually to eliminate the possible influence of peers. Another suggestion would be to apply the use of a computer program similar to the one used by Grossenbacher and Lovelace (2001) to test for true color associations over time. It would be helpful for retesting to see if the specific colors were consistent over time.

### References

- Baron-Cohen, S. Harrison, J., Goldstein, L., & Wyke, M. (1993). Coloured speech perception: Is synaesthesia what happens when modularity breaks down? *Perception*, 22, 419-426.
- Brang, D., Edwards, L., Ramachandran, V.S., & Coulson, S. (2008). Is the sky the 2? Contextual priming in grapheme-color synaesthesia. *Psychological Science*, 19(5), 421-428.
- Grossenbacher, P. G. & Lovelace, C. T. (2001). Mechanisms of synesthesia: Cognitive and physiological constraints. *Trends in Cognitive Sciences*, 5(1), 36-41.
- Hornik, S. (2001). (2001, February). For some, Pain is orange. *Smithsonian*, 48-56.
- Hochel, M. & Milán, E. G. (2008). Synaesthesia: The existing state of affairs. *Cognitive Neuropsychology*, 2008, 25(1), 93-117.

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- Hubbard, E. M. & Ramachandran, V.S. (2005). Neurocognitive mechanisms of synesthesia. *Neuron*, 48(3), 509-520.
- Jäncke, L., Beeli, G., Eulig, C., Hänggi, J. (2009). The neuroanatomy of grapheme-color synesthesia. *European Journal of Neuroscience*, 29, 1287-1293.
- Ramachandran, V. S. & Hubbard, E. M. (2001). Psychophysical investigations into the neural basis of synaesthesia. *The Royal Society*, 979-983.
- Rothen, N. & Meier, B. (2010). Grapheme-color synaesthesia yields an ordinary rather than extraordinary memory advantage: Evidence from a group study. *Memory*, 18(3), 258-264.

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## Appendix A

### **AN UNUSUAL TEST OF COLOR**

**Instructions:** For each word below, imagine it printed in a specific color in your mind. That is, in your opinion, what would be the best color of ink to use to print each word? The goal is to find out what you believe would be the best color to represent each word. [You may re-use colors.]

- |                |       |               |       |
|----------------|-------|---------------|-------|
| 1. Flowing     | _____ | 26. Hate      | _____ |
| 2. Connected   | _____ | 27. Crazy     | _____ |
| 3. Work        | _____ | 28. Pain      | _____ |
| 4. Ready       | _____ | 29. Worry     | _____ |
| 5. Relaxed     | _____ | 30. Aroma     | _____ |
| 6. Achieve     | _____ | 31. Normal    | _____ |
| 7. Spin        | _____ | 32. Inspired  | _____ |
| 8. Wary        | _____ | 33. Dream     | _____ |
| 9. Nervous     | _____ | 34. Complete  | _____ |
| 10. Life       | _____ | 35. Justice   | _____ |
| 11. Awkward    | _____ | 36. Sound     | _____ |
| 12. Drunk      | _____ | 37. Friday    | _____ |
| 13. Late       | _____ | 38. Ordinary  | _____ |
| 14. Empathetic | _____ | 39. Parade    | _____ |
| 15. Mix        | _____ | 40. Education | _____ |
| 16. Create     | _____ | 41. Proof     | _____ |
| 17. Worth      | _____ | 42. Explore   | _____ |
| 18. Abstract   | _____ | 43. Action    | _____ |
| 19. Art        | _____ | 44. Play      | _____ |
| 20. Believe    | _____ | 45. First     | _____ |
| 21. Trust      | _____ | 46. Equal     | _____ |
| 22. Savory     | _____ | 47. Pride     | _____ |
| 23. Reflect    | _____ | 48. Serious   | _____ |
| 24. Monday     | _____ | 49. Release   | _____ |
| 25. Music      | _____ |               |       |

## Appendix B

**TEST OF ARTISTIC & COLOR INCLINATION**

*For each of the following, please indicate the degree to which you agree with each statement.*

- 1) I enjoy drawing pictures, doodles, or designs in my notebook during class.  

1	2	3	4	5
Definitely NOT	Disagree	Neutral	Agree	Definitely YES
- 2) There have been times in my life when I would paint pictures in my free time.  

1	2	3	4	5
Definitely NOT	Disagree	Neutral	Agree	Definitely YES
- 3) I do **not** have a favorite color; I don't really care about the different colors.  

1	2	3	4	5
Definitely NOT	Disagree	Neutral	Agree	Definitely YES
- 4) When I listen to music on my computer, I like to watch the colorful visualizations that play at the same time.  

1	2	3	4	5
Definitely NOT	Disagree	Neutral	Agree	Definitely YES
- 5) I am **not** very artsy; I avoid or have no interest in coloring, painting, etc.  

1	2	3	4	5
Definitely NOT	Disagree	Neutral	Agree	Definitely YES
- 6) I am terrible when it comes to finding clothes that match the colors in my wardrobe or even just mixing and matching the colors of my clothes that I already own.  

1	2	3	4	5
Definitely NOT	Disagree	Neutral	Agree	Definitely YES
- 7) I enjoy (or I think that I would enjoy) editing the lighting and colors in my photographs on a computer program like Photoshop.  

1	2	3	4	5
Definitely NOT	Disagree	Neutral	Agree	Definitely YES
- 8) I think I would hate it if I was required to color in pictures as part of a class assignment.  

1	2	3	4	5
Definitely NOT	Disagree	Neutral	Agree	Definitely YES
- 9) Color is an important part of my life. I prefer places that are very colorful and cannot imagine how I would survive if I lost the ability to see color.  

1	2	3	4	5
Definitely NOT	Disagree	Neutral	Agree	Definitely YES
- 10) I enjoy going to art shows and museums to experience the colorful art.  

1	2	3	4	5
Definitely NOT	Disagree	Neutral	Agree	Definitely YES
- 11) I tend to add color to my notes in class with highlighters and colored pencils to help me organize concepts.  

1	2	3	4	5
Definitely NOT	Disagree	Neutral	Agree	Definitely YES

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- 12) I don't mind a white or dull colored room; I don't need much color in my life.
- |                |          |         |       |                |
|----------------|----------|---------|-------|----------------|
| 1              | 2        | 3       | 4     | 5              |
| Definitely NOT | Disagree | Neutral | Agree | Definitely YES |
- 13) When it comes to eating, how the food is presented (colors, arrangements, etc.) is an important part of my overall dining experience.
- |                |          |         |       |                |
|----------------|----------|---------|-------|----------------|
| 1              | 2        | 3       | 4     | 5              |
| Definitely NOT | Disagree | Neutral | Agree | Definitely YES |
- 14) When I think about my own name, there is a specific color that I think would be best to represent it.
- |                |          |         |       |                |
|----------------|----------|---------|-------|----------------|
| 1              | 2        | 3       | 4     | 5              |
| Definitely NOT | Disagree | Neutral | Agree | Definitely YES |
- 15) When I eat colorful candies, I am **not** one of those people who like to separate them into piles by color or shape. I just eat them as they come.
- |                |          |         |       |                |
|----------------|----------|---------|-------|----------------|
| 1              | 2        | 3       | 4     | 5              |
| Definitely NOT | Disagree | Neutral | Agree | Definitely YES |
- 16) I do not tend to make purchases based on color; for example, it doesn't matter what color water bottle I buy, I don't care either way.
- |                |          |         |       |                |
|----------------|----------|---------|-------|----------------|
| 1              | 2        | 3       | 4     | 5              |
| Definitely NOT | Disagree | Neutral | Agree | Definitely YES |
- 17) I do **not** associate colors with emotions or feelings.
- |                |          |         |       |                |
|----------------|----------|---------|-------|----------------|
| 1              | 2        | 3       | 4     | 5              |
| Definitely NOT | Disagree | Neutral | Agree | Definitely YES |
- 18) When I remember my dreams, they are always in vivid colors.
- |                |          |         |       |                |
|----------------|----------|---------|-------|----------------|
| 1              | 2        | 3       | 4     | 5              |
| Definitely NOT | Disagree | Neutral | Agree | Definitely YES |
- 19) One of the things that I really enjoy about buying clothes is looking for a wide range of colors and fabric textures to add to my wardrobe.
- |                |          |         |       |                |
|----------------|----------|---------|-------|----------------|
| 1              | 2        | 3       | 4     | 5              |
| Definitely NOT | Disagree | Neutral | Agree | Definitely YES |
- 20) There is a phenomenon called "*color-graphemic synesthesia*" in which some people who see words or even single letters or digits tend to automatically think of them as being strongly associated with colors. I believe that I am one of these types of people who experience this color-word phenomenon.
- |                |          |         |       |                |
|----------------|----------|---------|-------|----------------|
| 1              | 2        | 3       | 4     | 5              |
| Definitely NOT | Disagree | Neutral | Agree | Definitely YES |