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Understanding Synesthesia and Impact for Learning

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Understanding Synesthesia and Impact for Learning

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Signature Page

This thesis, written under the direction of the candidate's thesis advisor and approved by the coordinator of the master's program, has been presented to and accepted by the Faculty of Education in partial fulfillment of the requirements for the degree of Masters of Science. The content and research methodologies presented in this work represent the work of the candidate alone.

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Abstract

Synesthesia is a neurological disorder that has to do with the 'union of the senses.' The literature reveals that students with synesthesia are affected with various degrees of severity. Students may hear a bell ring. Their brain is wired to take that sound and interpret it differently, through color, texture, taste, sound or temperature among other things. While some people hear a bell, others may also experience the activation of another sense. The difficulties these students exhibit involves longer processing or thinking time to sort out the extra stimulus. Limiting sound environments and other visual cues like color coding to help these students to comprehend what is going on around them, particularly in the classroom. The purpose of this study is to identify and document the experience through the use of a case study, and describe the challenges an individual faces under these circumstances.

Jessica, a young adult who served as the focus of this case study, shares her first person experience of what it is like to cope with synesthesia. Jessica exhibits other forms of synesthesia including grapheme to color, time units to color such as weekday to color, month to color, spatial sequences, pain to color and numbers to personalities.

Data from her first person experience and childhood was the subject of the study. Data of her experiences from childhood into adulthood were gathered and analyzed. The findings suggest that Jessica continues to consistently demonstrate over a period of 12 years grapheme to color synesthesia. Jessica was tested and retested her over a period of five months and the results demonstrated that her alphabet and numbers to colors stayed consistent during that period of time as well. Jessica's numbers to personalities stayed consistent although she used different words to

describe the numbers, but the general personalities stayed consistent over the five-month test and retest.

When tested and retested over a six month period Jessica also stated the same time units to color such as weekday to color and month to color. Although this study did not have the capabilities to measure Jessica's claims of spatial sequences and pain to color Jessica did report it in the test and retest constantly over the five-month period.

Chapter 1 Introduction

Jessica first became aware that she was synesthetic when she was in high school. During a tutoring session after school for algebra, while solving some math problem she recalls that orally she started mixing up numbers with colors. This made her math tutor very confused. The tutor stopped the lesson and asked several questions. The tutor was working towards her teaching credential and had heard of a neurological disorder called synesthesia.

Jessica then had a name for what she had been experiencing her whole life. She was surprised to discover that not everyone experienced the world the same way she did. She understood people learned through different modalities and people see the world differently. What Jessica did not know that the way she viewed the world is drastically different from others around her.

Since high school Jessica examined the research literature and has found that she is not alone. Finding others who share similar experiences and hearing their stories was remarkable. Recently Jessica obtained a multiple subject and education instruction special credential, which has enabled her to learn how to teach through different taxonomies and teaching styles. This experience taught her about how she best learns and how other synaesthetes with a similar diagnosis learn as well. This knowledge is something she anticipates carrying into her classroom and will use to help other educators create appropriate accommodations if they have a student who is synesthetic.

Statement of Problem

Synesthesia can be considered both a marvelous gift and an overwhelming bombardment of the senses. Most synesthetic individuals enjoy their extra sensory inputs and often describe their experiences as beautiful. Some say that synesthesia makes them creative and helps them with memorization tasks. The problem for individuals with synesthesia is that they may experience too much sensory input and have longer processing time due to having to process extra sensations.

Synesthesia is not a common disorder and many educators do not know it exists. Many students are not diagnosed, therefore, classroom accommodations are not made and students then struggle in school. Another area of difficultly for individuals with synesthesia is the emotional component. Many synaesthetes feel isolated until they find others like themselves. Many synaesthetes feel they will be viewed as liars, crazy, or over dramatic if they share their honest and organic experiences.

Purpose

The purpose of this study is to describe the nature of synesthesia. It is important for educators to know about this rare and wonderful disorder. Hearing first person encounters of synesthesia opens one's eyes about how we as individuals experience the same world around us.

It is important for educators to be aware of synesthesia, to be able to explain it to parents, to be able to teach to different taxonomies, and to implement appropriate accommodations in the classroom. Educators need to have a developed set of techniques and strategies to help teachers and caregivers educate synaesthetes.

Theoretical Rationale

Starting with PL142 U.S.C Section 1400(d), Free Appropriate Public Education (FAPE) researchers began to focus on understanding learning differences in children. The field of special education, established by law, helped educators learns how to identify and serve a variety of children and adults with learning differences, (Turnbull, Stowe, & Huerta, 2007). Individuals with Disabilities Education Act (IDEA), Federal legislation that was reauthorized in 2004 served to define the purpose:

> - disability is a natural part of the human experience;
> - disability alone in no way diminishes the right of an individual to participate in or contribute to society;
> - improving educational results for students with disabilities is an essential part of our national policy; and
> - our national policy includes ensuring equal opportunities, full participation, independent living, and economic self-sufficiency. (Turnbull, Stowe, & Huerta, 2007, p. 36)

Background and Need

Researchers such as Baron-Cohen and Harrison (1997) helped shape the current understanding and research about synesthesia. Although the ability to diagnose someone who experiences synesthesia remains a challenge, these researchers take advantage of the latest technology such as, EGG, functional Magnetic Resonance Imaging (fMRI) Scans and have helped design other methods to diagnosis. Additionally, they have worked towards discovering the reason why humans experiences the world the way we do.

Chapter 2 Review of Literature

Introduction

In gathering information on the topic of synesthesia, I examined academic research in databases to establish background information in this emerging area. Key information came from one source that documented early research in the area of synesthesia.

Review of Previous Research

Understanding Synesthesia

Baron-Cohen and Harrison (1997) created a context for understanding synesthesia. The researchers established the historical context in the writings of John Locke in 1690. During the closing years of the 1800s, scientists and artists understood the field on some level. However, it is only recently that synesthesia has gained a presence from authors representing various fields of study.

The ability to diagnose someone who experiences synesthesia remains a challenge. Researchers look for consistent results of two or more occasions. Diagnosis is still somewhat subjective, relying on the first person experience. Valid assessment relies on a subject's consistent description across two or more occasions, when the subject has no prior warning in being retested. Taking advantage of this method typically brings results as high as 90% even when retested on clinical symptoms.

Technological advances promise to move the diagnostic process forward in the use of neuroimaging. Researchers are starting to obtain interesting results from Positron Emission Tomography (PET), and fMRI scans of the brain of individuals with synesthesia. Previously Cytowic and Wood (as cited in Baron-Cohen & Harrison, 1997) used the xenon inhalation

technique to obtain images of the brain of a single subject. This technique was implemented by having the subject inhale Xenon mixed with Oxygen. The compound would then enter the blood stream and doctors were able to use a Computed Tomography or CT scan to observe the blood vessels and blood flow through the brain. This early technique was used to determine normal blood flow patterns from abnormal ones that could be indicators of certain diseases.

There are several characteristics that are common in the developmental onset of synesthesia. The first is that it appears to have a childhood onset, in all cases before age four. The second is that it is different than delusion, hallucinations, other psychotic phenomena, or other imagery arising from the imagination, which are not induced by drugs. The authentic synesthesia experiences are vivid, automatic, involuntary and, unlearned. Synesthesia is a neurological dysfunction.

The authors discussed developmental synesthesia, neurological dysfunction, connections with drug use, and also pseudo-synesthesia in terms of metaphor and association. Many individuals reported acquiring synesthesia as a consequence of neurological disorder resulting from drug use. This is called pseudo-synesthesia. Cytowic (as cited in Baron-Cohen & Harrison, 1997) states that there is a clear distinction between developmental synesthesia and pseudo-synesthesia, which is induced by neurological factors or by psychomimetic drug use.

There are speculations that many famous authors, poets, musicians and artists may have had synesthesia. These individuals have never been tested so there is no data, but a typical list of synaesthetes could include artists Kandinsky and Hockney; musicians Lizt, Rimsky-Korsakov, Messiaen and Scriabin; author Nabokov; and poets Basho, Rimbaud and Baudelaire. Harrison and Baron-Cohen continue into further detail on each artist, musician, author, and poet

that were mentioned above and review the data is available to infer that these individuals may have had synesthesia.

In conclusion science is in need of a specific taxonomy for investigating developmental synesthesia because many individuals may experience pseudo-synesthesia. Another struggle with diagnosing or authenticating developmental synesthesia is that some further discrimination may be required due to the objective view of science and the 'subjectiveness' of the first person experience of individuals with synesthesia.

Understanding the General Features of Synesthesia

Cytowic (1997) created a context for understanding the general features of synesthesia, a brief history, a clinical diagnosis and neural basis. It is estimated that one in 25,000 people have synesthesia. Synesthesia means the 'joined sensations.' The experience of blending of the senses is often projected outside the individual's body, rather than in the mind's eye. Synesthesia is a lifelong inter-sensory experience that remains consistent. Individuals with synesthesia are often called synesthetic. Synaesthetes become surprised when they find out others do not experience the world around them in the same way.

A general feature that Cytowic (1997) cites about synesthesia is that synesthesia is a genetic condition and can be passed from parents to children with either autosomal or x-linked dominant transmission. This means that synesthesia runs in families. It can be passed down from either males or females to multiple generations and siblings within the same generation in different ways. The only transmission that Cytowic has not come across is a case of father to son transmission of synesthesia. Synaesthetes are predominantly females, and in the United States Cytowic (1997) found the ratio to be 3:1. In the United Kingdom Baron-Cohen (Cytowic, 1997) found a synaesthetes female ratio of 8:1. Additionally, synaesthetes are primarily left-handed.

The brain of a synaesthete is normal in the conventional sense. They are well balanced and come from all walks of life, although many would say there is an inherent artistic trend. Synaesthetes are typically artists, musicians, composers, poets, writers, etc. Clinically, scores of synaesthetes who took the Minnesota Multiphasic Personality Inventory (MMPI), except for non-stereotypical male and female scales, are unremarkable. This concludes that standard neurological scale examinations are normal.

Most synaesthetes claim to have excellent memories and cite their sensations as the cause. Some examples are, 'I know it is 4 because it is green' or 'Her name starts with a J because she is blue'. Typically, synaesthetes can often recall in great detail past conversations, prose passages, movie dialogue and verbal instructions. Synaesthetes can also remember the precise location of furniture arrangements, floor plans, text blocks in specific books, or even the order of books on shelves due to their spatial location of objects being remarkably strong. Many synaesthetes who experience these types of strong memory skills often feel the need to stay organized. They tend to preform in the superior range of the Wechsler Memory Scale (Cytowic, 1997).

Synaesthetes tend to have an overall high intelligence and have uneven abilities in several domains. The majority of synaesthetes experience deficiencies in mathematics such as, lexial-to-digit transcoding. Small minorities of synaesthetes have dyscalculia. Synesthesia may also be coupled with other disabilities most commonly, dyslexia, autism and attention deficit disorder. The presence of dyslexia, autism, or attention deficit disorder coupled with synesthesia shows in about 15% of families. Also common are allochiria (right-left confusion) and lack of sense of direction (Cytowic, 1997).

In Cytowic's (1997) brief history of synesthesia he discusses how synesthesia has been known to science for almost 300 years. Interest peaked between 1860 and 1930, but slipped because neurology and psychology were premature areas of science. Shortly after this time the inner life was deemed taboo and subjective experiences such as synesthesia were unacceptable to study. Synesthesia intrigued the art movement in the mid-nineteenth century. Many artists were interested in expressing and experiencing the union of the senses as an idea (Cytowic, 1997). Artists started creating art with multiple mediums across multiple modalities such as creating art with light, sounds, and music (Cytowic, 1997).

One such artist was Alexander Scriabin, 1872-1915. He composed music about his synesthesia and had a mute keyboard to control the corresponding lights to accompany his notes. The lights formed many shapes, beams, and clouds along with a white light. His masterpiece was called *Prometheus, the Poem of Fire* (Cytowic, 1997).

One the most famous synaesthetes is Vasilly Kandinsky (1866-1944). He used musical terms to describe his paintings, compositions and improvisations (Cytowic, 1997). He enjoyed exploring the harmonious relationships between different mediums such as paint, charcoal, sound, music and light. Kandinsky created an opera in 1912 called *Der Gelbe Klang (The Yellow Sound)* that explored the fusion of the senses with dance, light, color and sound.

As artisans pushed synesthesia to the forefront, the art community became intrigued with the idea that synesthesia was an unconscious experience or a direct link to the unconscious mind (Cytowic, 1997). Shortly after this artistic movement the art and science community shifted, the individual was abandoned and, humans returned to being subjects. Science was interested in objective behavior that could be experienced by a third party and measured by a machine (Cytowic, 1997).

As a result of technological advances in modern medicine today, educators have gained a perspective on the nature of synesthesia. Scientists now have PET and fMRI. Researchers are starting to obtain varying results from scans of the brains of individuals with synesthesia (Cytowic, 1997). Modern society is now open to discussing first person experiences of synesthesia.

Cytowic (1997) discusses how to clinically diagnose synesthesia. Some of his factors to determine clinical diagnosis of synesthesia give outsiders a clearer window into the synaesthetes mind. Cytowic (1997) goes into detail stating that synesthesia is an insuppressible, involuntary, passive experience. Two different synaesthetes with the same kind of synesthesia will experience synesthesia differently. One individual may say 'four is green' while another would argue 'that four is blue'. Synaesthetes are not able to conjure or dismiss the their synesthetic experiences at will (Cytowic, 1997). "It is perceived externally in peri-personal space, the limb-axis space immediately surrounding the body, never at a distance as in the spatial teloreception of vision or audition" (Cytowic, 1997, p. 23).

Cytowic goes on to discus how synesthesia is durable and generic. Durable, meaning that it is consistent over time and is tested and retested. Generic refers to experiences, which are never pictorial and not elaborate. These generic experiences can often be seen as lines, blobs of color, spirals and lattice shapes (Cytowic, 1997). Another generic experience can be taste. They are typically agreeable or disagreeable such as metallic, salty, or sweet (Cytowic, 1997). Generic textures may feel smooth or rough, and temperatures may feel cold, cool or hot (Cytowic, 1997).

"Synesthesia is emotional. The experience is accompanied by a sense of certitude (the 'this is it' feeling) and a conviction that what synaesthetes perceive is real and valid. This

accompaniment brings to mind that transitory change in self-awareness known as ecstasy. Ecstasy is any passion by which the thoughts are absorbed and which the mind is, for a time, lost" (Cytowic, 1997, p. 25).

In conclusion the neural basis of synesthesia takes place in the left hemisphere of the brain and large metabolic shifts coexist away from the neocortex (Cytowic, 1997). These co-occurring actions result in enhanced limbic expression (Cytowic, 1997). The neural structures that generate the synesthetic experience probably employ nodes in the hippocampus (Cytowic, 1997). Scientists are still exploring how the synaesthetes brain varies from a person with a typically developed brain.

Different forms of Synesthesia

Chapter 2, entitled A Kaleidoscopic World, of *Wednesday is Indigo Blue*, Cytowic and Eagleman (2009) open with a broad view of statistics and facts about synesthesia. Of the 25,000 genes that make up the human body a staggering two-thirds are expressed in the brain. Synesthesia can occur in an assortment of ways because these genes can be interrupted in multiple ways and epigenetic, external forces, may also influence the genes in the brain (Cytowic & Eagleman, 2009). Below is a table of the different types of synesthesia and how frequently they occur. This sample of synaesthetes was made up of 783 people in the US, 72% female and 28% were male (Cytowic & Eagleman, 2009).

Relatively Frequency of Different Types of Synesthesia:

Grapheme to color	66.50
Time Unit to colors	22.80
Musical sound to colors	18.50
General sound to colors	14.50
Phonemes to colors	9.90
Musical notes to colors	9.60
Smells to colors	6.80
Taste to colors	6.60
Sound to taste	6.20
Pain to colors	5.80
Personalities	5.50
Touch to colors	4.00
Sound to touch	4.00
Temperatures to colors	2.40
Vision tastes	2.10
Sounds to smell	1.80
Vision to sounds	1.50
Orgasm to colors	1.00
Emotion to colors	1.00
Vision to smell	1.00
Vision to touch	1.00
Smells to touch	0.60
Touch to tastes	0.60
Smells to sounds	0.50
Sounds to kinetics	0.50
Sound to temperatures	0.50
Tastes to touch	0.50
Kinetics to sounds	0.40
Personalities to smells	0.40
Touch to sounds	0.40
Touch to smells	0.30
Vision to temperature	0.30
Musical notes to tastes	0.10
Personalities to touch	0.10
Smells to tastes	0.10
Smells to temperatures	0.10
Tastes to sounds	0.10
Tastes to temperatures	0.10
Temperatures to sound	0.10
Touch to temperatures	0.10

Note. Comparative frequencies of different kind of synesthesia. Data are based on Sean's Day's tabulation of 738 self-reported cases from a nonrandom sample. In Day's sample, 72% were female and 28% were male. (Data are reproduced with permission from http:home.comcast.net/~sean.day/html/types.htm.) (Cytowic & Eagleman, 2009)

As the results demonstrate, the most common type of synesthesia is grapheme to colors, seeing letters in colors, at 66.50 % and time units to color, seeing months and days of the week in color, at 22.80% (Cytowic & Eagleman, 2009). Seeing music is one of the popular varieties of synesthesia and of this sample of synaesthetes only 18.50% are able to see color when hearing musical sounds (Cytowic & Eagleman, 2009). When synaesthetes hear musical notes only 9.60% are able to see color and only .10% were able to taste the musical notes (Cytowic & Eagleman, 2009).

Eagleman (2009) conducted a battery of 1,067 synesthetic subjects that all experienced grapheme to colors synesthesia. Many of these synaesthetes reported additional types of synesthesia such as having colors for months of the year and weekdays, spatial sequences, emotional colors, colors for pain, and musical sound colors. This chart describes in detail the different varieties of synesthesia often not spoken about such as odor to color, touch to color, vision to smell, and orgasm to color (Cytowic & Eagleman, 2009).

Other Forms of Synesthesia Experienced by Grapheme to Color Synaesthetes:

Weekdays Colors	77.8
Month Colors	71.9
Musical Sounds Color	51.7
Spatial Sequences	49.3
Personality Colors	33.5
General Sounds Color	31.5
Emotion Color	31.5
Pain Color	22.7
Odor Color	22.2
Orgasm Color	19.2
Taste Color	17.7
Temperature Color	12.8
Touch Color	12.3
Sound Color	12.3
Sound Taste	9.4
Vision Taste	9.4
Vision Sound	8.4
Sound Smell	6.4
Vision Smell	5.4
(Cytowic & Eagleman, 2009)	

As the results show on this remarkable study the most common additional varieties of synesthesia to coexist with grapheme to colors synesthesia was weekday to color at 77.8% and month to color at 71.9% (Cytowic & Eagleman, 2009). Researchers were not surprised by these results due to weekday to color and month to color being common forms of synesthesia. Musical sounds to colors coexisted with 51.7% of grapheme to colors synaesthetes, whereas spatial sequences was 49.3% and emotional colors was 31.5% (Cytowic & Eagleman, 2009). Often not discussed forms of synesthesia were reported such as, odor to color in 22.2% of subjects, touch to color was 12.3%, vision to smell was 9.4% and orgasm to color occurred in 19.2% of subjects (Cytowic & Eagleman, 2009).

Cytowic and Eagleman (2009) explored the a kaleidoscopic world by going into greater detail about the five most common forms of synesthesia: number forms; colored letters, both spoken and written; tasted words; colored hearing; and the personification of letter and numbers. When synaesthetes 'see' number forms around their body they are experiencing spatial sequence synesthesia, also called number forms. These numbers or other ordered concepts are typically on a line that can twist, zig zag, or loop in the synaesthetes personal space (Cytowic & Eagleman, 2009). Often these number forms may go behind the synaesthete and may be straight, angled, curved or bent (Cytowic & Eagleman, 2009). A student once complained to her math teacher that the number 'kept going up to their place' (Cytowic & Eagleman, 2009). These number forms are often calendars, time lines, number lines, the alphabet, and they may have dates such as holidays and birthdays highlighted on them (Cytowic & Eagleman, 2009).

The second most common type of synesthesia is colored graphemes, which is colored letters (Cytowic & Eagleman, 2009). More commonly synaesthetes have colors for letters and

rarely have colors for phonemes (Cytowic & Eagleman, 2009). The difference between colored graphemes and colors for phonemes may shed light on when the synesthesia gene is expressed (Cytowic & Eagleman, 2009). Perhaps the synesthesia gene is expressed in a critical period in childhood when the brain is developing, or maybe there are different synesthesia genes that play a different role in the brains development (Cytowic & Eagleman, 2009). These individuals often say that the colors aid in remembering peoples' names, telephone numbers, and words that are uncommonly spelled (Cytowic & Eagleman, 2009). Every letter and number has a color and often the first letter in the word shades the color of the word where as vowel colors lighten or darken the word.

Graphemes may conjure color, but phonemes tend to activate taste, which brings us to the fourth most common form of synesthesia, tasting words (Cytowic & Eagleman, 2009). Synaesthetes who are able to taste words are often able to taste written and spoken words in their mouths (Cytowic & Eagleman, 2009). Common words are more likely to produce taste rather than made-up words or infrequently used words (Cytowic & Eagleman, 2009). The tastes are often basic and general such as, sweet, salty, metallic or bitter (Cytowic & Eagleman, 2009). One individual claimed that when he hear the word 'Steve' he could taste poached eggs and another individual said that when he hears the word 'jail' he tastes bacon, cold and hard (Cytowic & Eagleman, 2009).

Colored hearing can be triggered by music, voices, and sounds in the everyday environment such as doing the dishes, the doorbell, dogs barking, and fireworks. When evoked by these triggering sounds, synaesthetes may see shapes, colors, blobs and movement by sound. These shapes and colors may appear, move around a little, then fade away to be replaced by the appearance of other colored shapes, referred to as photisms (Cytowic & Eagleman, 2009). This

kaleidoscopic montage could be very over-stimulating to an individual with colored hearing synesthesia.

The fifth most popular variety of synaesthetes is personification of letter and numbers (Cytowic & Eagleman, 2009). This is when letters and numbers may have personalities, gender and color. A synaesthete with personification of numbers may say 'he reminds me of a 4, so kind'.

Cytowic and Eagleman (2009), further discuss uncommon forms of synesthesia and the automatic involuntary nature of synesthesia. They discussed how if words or letters are printed in the 'incorrect' colors for a synaesthete, it may slow down their processing time (Cytowic & Eagleman, 2009). In one study when the subject read a passage in her particular colored alphabet her processing time increased (Cytowic & Eagleman, 2009). These eye-opening studies about synesthesia have helped pave the way for future research and helped validate the experiences and emotions of synaesthetes.

Effects of Color

Synesthesia Affects Verification of Simple Arithmetic Equations, (Ghirardelli, Mills, Zilioli, Bailey, & Kretschmar, 2010) is an investigation to explore the effects of color to numbers, or color digits, in synaesthetes while completing simple arithmetic equations. Researchers want to compare the response of synaesthetes to correct colors for digits to all black numbers and to random colors to see if these different factors would improve or hinder the accuracy and fluency of the completion simple arithmetic equations. This study used two synaesthetic subjects and compared them to a control group of 15 non-synaesthetic subjects.

The results showed that the two synaesthetes were significantly affected by color conditions (Ghirardelli et al., 2010). Both synaesthetes were able to complete simple arithmetic

equations more accurately and fluently when the numbers were in their 'correct' colors (Ghirardelli et al., 2010). When completing the arithmetic equations in black and random colors the results were different. They were not as accurate and significantly slower than when the numbers were in the 'correct' colors (Ghirardelli et al., 2010).

The article, *The Colors of the Alphabet: Naturally-Biased Associations between Shape and Color*, by Spector and Maurer (2011) opens with a discussion about the natural bias of the synaesthetes letter to color correlation. The 1935 Stroop study (Spector & Maurer, 2011) concluded that when a color word, such as 'green', is printed in a different color ink, such as red, the synaesthete will have difficulty naming the color of ink. Spector and Maurer (2011) found Stroop's study interesting and wanted to find if there were natural color biases for some letters and shapes. The term 'naturally biased' refers to the associations that can be easily explained by learning associations within the environment. Spector and Maurer (2011) conducted six different experiments with three subject groups. The groups' subjects consisted of toddlers, older children, who were literate, and adults, who were literate.

The researchers found that some letters have common color associations among synaesthetes and non-synaesthetes who were in the older children and adult groups. These common colors were, O as white, X as black, A as red, and G as green. The toddler group who could not read did not consistently associate letters to colors. Researchers believe there are common color associations amongst synaesthetes and non-synaesthetes because of the ability to identify other objects with the letter and/or color (Spector & Maurer, 2011). One example of this is; 'A' is red because 'A' is for apple and apples are red. Another similarity in color associations is that the first letter of a color word often is associated with the color itself. For example, 'G' is

green, ‘B’ is blue and ‘Y’ is yellow. It has been suggested that these color letter/word associations may be developed in the brain after a child learns to read (Spector & Maurer, 2011).

Research findings also demonstrated natural biases towards certain shapes and colors. Spector and Maurer (2011) found that toddlers are able to associate jagged shapes with black and non-jagged shapes with white. Perhaps this is due to black and white being very polarized, black representing bad and white representing good. In another experiment toddlers consistently put letters Z and X in the black box and I and O in the white box. When adults were put to the test of association between jagged shapes and non-jagged shapes, the adult group was slower and less accurate. However, the adults came up with the similar results that sharp jagged lines are potential threats and black while curved non-jagged shapes should be safer and white (Spector & Maurer, 2011).

In *Is the Sky 2? Contextual Priming in Grapheme-color Synesthesia*, by Brang, Edwards, Ramachandran, and Coulson (2008) the research suggests that synaesthetes experience grapheme-color synesthesia, or seeing a letter or digit and experiencing a color. Brang et al., (2008) set out to discover if bidirectional connections exist in the brain of synaesthetes who experience grapheme-color synesthesia. Their example was ‘The lake was the most beautiful shade of …’ and the synaesthete or person from the control group had two choices at the bottom of the screen to chose from (Brang et al., 2008). The choices included words such as ‘blue’ or ‘yellow’ or two rectangles of different colors or two numbers. One of the numbers would always be the appropriate color choice for that participating synaesthete.

These results support the idea that for synaesthetes, the altered perceptual experience has little detectable impact on the contextual integrated processes. For the synaesthetes that experience grapheme-color it is just as natural and automatic to say ‘the sky is 2’ as it is to say

'the sky is blue'. The brain of a synaesthete treats the '2' as meaningful stimuli. Their findings support that bidirectional connections between colors, numbers exist (Brang, et al., 2008).

Reading and Music

Synesthesia for Reading and Playing Musical Notes by Ward, Taskanikos and Bray (2006) is an original research paper discussing the link between musical notation, graphemes and hearing music. The researchers conducted four different experiments with three different participants who are synesthetic. The article opens with 10.8% of synaesthetes (in a self-referred sample) reporting experiencing colors when seeing written music (Day, as cited in Ward et al., 2006). Researchers discussed the study by Mill (as cited in Ward et al., 2006) that multi-lingual grapheme-color synaesthetes who spoke English as their first language, when learning a second language, experienced letter-color association. This is where the colors for letters in one alphabet system transfer to the second alphabet the student is learning. This includes letter reversals as well, Myles and Dixon (as cited in Ward et al., 2006). Often stimulus such as letters, numbers, or symbols can have color migration Myles and Dixon (as cited in Wood et al., 2006). One example of this is 'S" and '5' often take on the same color or shade for grapheme-color synaesthetes.

The first two experiments explored the standard synesthetic Stroop effect (as cited in Ward et al., 2006). In this investigation the musical notes were printed in colors that either matched or did not match the synaesthetes grapheme-color alphabet. The results demonstrated that there was no evidence that musical notation elicits a color sensation (Ward et al., 2006). In the second experiment the evidence showed the expected Stroop inference. When the synaesthetes were asked to name the note that was in the incorrect color for the synaesthetes' grapheme-color alphabet, some synaesthetes experienced no inferences, most showed a slower

processing time and one showed inference even though she was trained in reading music (Ward et al., 2006).

The third experiment and fourth experiments are similar to the first and second experiment. In the third experiment the synaesthetes were asked to play colored notes silently using a five-finger keyboard. This task required the synaesthetes to process the note and ignore the color rather than the focusing on the color and ignoring the note (Ward et al., 2006). In the fourth experiment the synaesthetes were asked to name their synesthetic color that corresponded with the letter for the note, ignoring the color displayed on the screen. This 'reverses' the Stroop effect and the task requires the synaesthetes to process and identify the note more deeply (Ward et al., 2006).

Results for the third experiment and fourth experiment need to be contrasted with the first and second experiment. The third experiment results demonstrate reliable interference effect of seeing notes that do not match the synaesthetes colored alphabet, which made the synaesthetes find this task challenging. In the fourth experiment that 'reverses' the Stroop effect; where the synaesthetes were asked to name their synesthetic color that corresponded with the note, the evidences found a significant effect for all three synaesthetes (Ward et al., 2006).

Overall, when reflecting on these four experiments, the researchers found that they replicated and supported previous studies, and found that graphemes are not linked to musical notes, expect in experiment two with MM. The results suggest that by using two modifications of Stroop's task this form of synesthesia is genuine (Ward et al., 2006). When synaesthetes played music with notes printed in incongruent colors the synaesthetes were significantly slower. When synaesthetes were asked to name their synesthetic color and ignore the color shown on a screen and thus demonstrated Stroops inference (Ward et al., 2006). The researchers concluded

that when the identity of a note required processing, this form of synesthesia was most strongly evoked. Their results also suggested that synesthesia could be triggered from the conceptual processing of a stimulus (Ward et al., 2006). The study concluded that synesthetic associations might migrate across modalities and from one visual-symbolic representation to another.

Effect on One's Life

Tactile –Emotion Synesthesia by Ramachandran and Brang (2008) is an enlightening view into how synaesthetes experience their lives and is a breakthrough in the science of synesthesia. Ramachandran and Brang (2008) conducted an experiment to prove that two synaesthetes who feel a texture were truly experiencing an organic emotion.

Their subjects were AW (22 years old) and HS (20 years old). Both were female, right-handed university students. These individuals claimed no prior history of neurological or psychiatric disorders. The subjects claimed that touching a particular texture with their hands, and one subject stated that touching a particular texture with feet, would cause them to feel an emotion. The subject who said she could experience emotions with her feet explained that the emotions were often not as strong as compared to those felt when using her hands. Both synaesthetes have reported experiencing this type of synesthesia as far back as they could remember (Ramachandran & Brang, 2008).

This study was conducted over an eight-month period of time. It consisted of an initial test and a retest. Both tests consisted of giving the individuals a texture for ten seconds, and then allowing them two minutes between textures. The tests used twenty-four different textures. To measure the subjects experiences Ramachandran and Brang (2008) used Skin Conductance Response (SCR), which measured the impact of the tactile input on autonomic arousal. In addition the synaesthetes were not told a hidden camera would be recording them. AW and HS

were also asked to rate how they felt while feeling a particular texture on a scale of 1-10, identifying pleasant, neutral, or unpleasant feelings, as well as the emotion that texture evoked (Ramachandran & Brang, 2008).

The facial expressions seen from the hidden camera, SCR results, the rating scale and the recorded emotions that were evoked by the textures came back with many strong correlations (Ramachandran & Brang, 2008). The facial expressions from the hidden camera and the rating scale demonstrated a highly significant correlation. The SCR results and the rating scale demonstrated a significant correlation with negative and neutral emotions, but not for positive emotions. Researchers did not find this surprising due to typical SCR results for pleasant emotions usually yielding weaker and less reliable results (Ramachandran & Brang, 2008).

In conclusion, the researchers consistently found across two sessions that were eight months apart, for the reported emotions, (although different words were used to describe the emotions) that both subjects demonstrated 100% reliability (Ramachandran & Brang, 2008). This study demonstrated the first experimental investigation of synesthesia between automatic emotion from a tactile experience.

Interview of a Professional in the Field

Autistry Studios is designed to help teens and adults with autism, Asperger's and other learning disabilities become successfully independent through utilizing their client's interests and talents, while creating a community. This 5019c03 non-profit organization offers a Filmmaking Workshop, Theater Core Workshop, College Support Workshop and a Build Stuff Workshop. Within this framework Autistry Studios offers additional services such as, individual, group and family counseling, job/life coaching and mentoring, pre-vocational therapeutic workshops, college support groups, parent support groups, and sibling support groups. Currently, Autistry

Studios (2012) is serving 50 clients, ages 13-44. The group size is typically limited to 6-10 students per group and the clients and staff cook a full and healthy meal during every workshop. Clients learn to cook a variety of foods from different cultures and indirectly learn and practice social skills by eating together as a class.

Janet Lawson (personal communication, April 25, 2013) is the Executive Director of Autistry Studios. Janet and her husband started Autistry Studios in their home seven years ago for their son who has autism. In the tour of the studio and interview with Mrs. Lawson she demonstrated an energetic passion for her work. She takes on many different roles such as working directly with clients during workshops, helping prepare the meals, managing the studio, meeting with perspective clients, holding therapy sessions in her office, and writing grants late at night.

During the interview Janet demonstrated an inspiring passion for her work and offered a different perceptive on reality. She discussed how typically developed individuals and individuals who have autism view the same things in contrasting ways. She purposed the question 'Who is to say that individuals who have autism need to change their view?' There are many diverse ways to view the same reality. Similarly, with individuals who have synesthesia, their reality and life experiences are very different as well. We discussed how everyone in the world is vastly different and how an individual needs to view their own abilities and disabilities as unique strengths to help them be successful in life.

Summary

The common thread that runs through these articles, is that synesthesia is expressed in different ways in an individual and that no one human experiences the world the same way. Synesthesia is a broad topic that mankind has been discussing for centuries and seems to materialize as a

popular topic when science will allow the first person experience to be valid. Researchers have now created a context for understanding the general features of synesthesia. Recent research and new developments in technology that explore the neural basis has opened the door to validate the synaesthetes experiences, to change the modality of clinical diagnosis, and identify a wider variety of synesthesia. What once was thought to be a one in a million experience is now is estimated to be a one in 25,000 Cytowic (1997). Synesthesia is typically viewed by synaesthetes as a beautiful, organic experience that 'unites the senses'.

Chapter 3 Method

Introduction

My research is designed to gather data to describe the general features of synesthesia and explore the first person experiences of being a synesthetic. This study is non-experimental and focuses on an extended interview in the form of a case study. The aim of this research is to document the experiences of a young woman who was diagnosed with synesthesia. The data collected is qualitative, including question and answer responses and oral narrative responses, which were recorded by the researcher.

Sample and Site

As the researcher, I utilized a sample of convenience. The incidence of synesthesia is relatively new in terms of documentation. The researcher has personal contact with the young woman, and approached her about serving as a subject for the case study. This student is a Caucasian female.

Ethical Standards

My advisor approved this research proposal and the results are summarized in a report. In order to preserve confidentiality and ensure anonymity, no names or identifying information is used. Participation in this study was voluntary. Information was gathered through personal communication.

Data Gathering Strategies

The data gathering strategies consisted of a summary of the interview with Janet Lawson. Also documents were gathered about a young adult female with synesthesia. Information from school records, narrative reports from the subject and family members were reviewed and analyzed to

create a snapshot view of the academic coping skills of a person dealing with manifestations of synesthesia at a time when school specialists had a limited understanding of this challenge to learning.

Data Analysis Approach

The researcher interviewed the subject and documented responses to questions. Data from the subject's school experiences were reviewed and analyzed according to documentation on synesthesia available in the research literature.

Once the interviews were archived and transcribed, the researcher reviewed the documents and looked for common patterns and similarities that emerged from the research literature.

Chapter 4 Findings

Introduction

For the purpose of this case study, to keep the subject's identity confidential, this report refers to her as Jessica (anonymous, personal communication, December 10, 2012). Jessica is a 29.5-year-old female who was diagnosed as dyslexic in first grade and self reports that she has synesthesia. As discussed previously, she discovered that she learned and viewed the world differently compared to others in high school during an algebra tutoring session. Since high school she has been interested in hearing about other cases and reviewing current research in the related field. She was willing to participate in this case study to help further research and gain more knowledge about synesthesia.

Jessica says that she thought most of her learning differences came from being dyslexic, but when she realized she may be a synaesthete, she started to reexamine how she organized her life and school work, how she learned, why she did many of the things she did, and why she reacts the way she does. She says that it was extremely eye opening, and a huge relief to find out that she is a synaesthete.

Major Findings

Jessica's forms of synesthesia include graphemes to color, time units to color such as weekday to color, month to color, spatial sequences, pain to color and numbers to personalities. Jessica's alphabet colors are individual to her. When asked if she had an alphabet chart in her bedroom as a child with colored letters on it, she shared that she had two as a baby. However, the colors on the alphabet charts did not match Jessica's perceived colors of letters. She did report that in her little brother's room there was a number line, and many of her numbers were the same colors as

those on the chart. Jessica reported an early memory of her synesthesia when she enjoyed looking at the colors and animals on that chart and feeling that the numbers were the correct colors. Jessica explained "You know when a misspelled word, it feels wrong. That is what it is like to see a number in the incorrect color." Jessica went on the share that she had a similar reaction to the colors on the number chart when she felt the colors were 'wrong'. On a similar note she said that she remembers looking at the alphabet chart her mother had embroidered for her and staring at the letter 'T'. She thought, ''How could a 'T' be pink? It is green. Could a 'T' be wrong?"

Jessica showed me many examples of her work from elementary and junior high school. As typical children do when they write a letter or a birthday card, they make every letter a different color or alternate letters. On many of her cards the letter 'H' in the word 'happy' was always red, the 'A' always pink. The first 'P' was always purple while the second 'P' had to be blue so that she could alternate colors like all of the other children. Jessica remembered as a child feeling uncomfortable because the second 'P' was supposed to be purple but to fit in she chosen the color closest to purple, which was blue. The 'Y' was always orange. Her mother showed me all the birthday and thank you cards that she had saved from Jessica's childhood that, to the untrained eye, appeared drawn in random colors. At closer study one can see that over the years the colors that Jessica chose were always consistent, and documents her graphemes to color synesthesia.

Jessica also showed me her colored alphabet and numbers 0-9 which was dated summer of 2001. The numbers and letters were the same as the colors she had demonstrated on December 24, 2012 and five months later on April 24, 2013 (Eagleman, 2013). The only letter or number that was different was the letter 'V'. Jessica said that because when the letter 'V' is

used in her maiden name it is pink but when it is listed in her alphabet, the dark blue of the ‘W’ bleeds into the ‘V’.

Jessica's Letters and Colors:

A	dusty, rose, pink
B	medium sienna brown
C	black or dark blue
D	Black
E	bright sky, flat, blue
F	spring green
G	spring green
H	bright red
I	light yellow
J	deep blue
K	spring green
L	White
M	mars black
N	medium sienna brown
O	White
P	royal purple
Q	Gray
R	spring green
S	ebony black
T	spring green
U	light orange
V	pink (in words or purple gray in other context)
W	medium to dark deep blue
X	spring green (in words) (black or purple grayish in alphabet)
Y	bright orange
Z	bight red/orange

Jessica's Numbers, Colors and Personalities:

0	white	matter of fact attitude but smiles, wholesome
1	White	young, playful, happy, lots of energy
2	bright sky, flat, blue	male, stable, quite, a little shy, young
3	light pink	female, party animal, not always a good friend, flaky
4	spring green	female, family oriented, balanced, stable person
5	black	a little confused, unhappy, serious, quite, withdrawn
6	dark-spring green	most often male, smart, serious, balanced and responsible
7	Yellow	happy, light hearted, social butterfly
8	black (sometimes gray)	serious, older, wise, hardworking
9	Orange	young, fun, kind, happy, a great friend

Jessica reported that some of her letters keep the same color but the shade changes depending on the color of the letter next to it. It also depends on where the letter is placed in a word as well. The first letter in a word is dominant and shades or influences the rest of the word. She says, "it s the tone, mood of the word". Some letters such as 'C' are influenced by the second letter in the word. 'C' as in cat is blue, but 'C' as is city is black. Jessica was unsure if this had to do with the color of the second letter influencing the color of the "C' or if it had to do with the hard and soft sound of the 'C'. She wonders if 'C' is graphemes to color or possibly phonemes to color. Since she is also dyslexic Jessica does not always hear her letter sounds properly and has difficulty spelling.

When questioned about spelling Jessica stated that sometimes when spelling a difficult word she will not know what letter should come next, but might get a sense of what colors could take that place. She continued to say that when she starts to think of a color it is not always helpful. If she thinks green comes next in a word the letter could be a 'F', 'G', 'K', 'R', 'T' or 'X'. This is a lot of extra processing that the typical adult does not have to do, therefore she is very slow and spelling and writing can become very tedious tasks.

Over the years Jessica has learned to compensate so this does not affect her professional life. She uses a spell check and dictionary on her smart phone. She keeps a running list of large and difficult words to spell on her computer that she can copy and paste from the list to a document.

Another letter that changes color is 'X'. 'X' is always a bold, spring green in words but when thinking about "X' in the alphabet it is often black or grayish-light purple. Jessica thinks this color change could be due to context or possibly she could be thinking of 'X' as a symbol

rather than a letter in an alphabet. When she plays tic-tac-toe her 'X' is black or grayish-purple. She say when she makes the 'X' sound by itself she thinks of light, cool, mint, green.

Jessica reports, as many synaesthetes describe, that color helps her remember people's names. When she meets someone she remembers his or her "name color". "He is 'green' because his name is Tom." Jessica stated that she is deep blue because her 'J' shades 'Jessica' and her dog is dusty, rose, pink because her dog's name starts with 'A'.

As reported in the chart above Jessica experiences number to color and she also experiences numbers to personalities. She says that numbers feel similar to people and "she just knows them". When questioned about any changes in personalities or aging Jessica shared that her numbers do not age and the personalities of the numbers do not change at all.

One of Jessica's other forms of synesthesia is time-units to color. See chart below. When Jessica thinks of a weekday or month she experiences a color. The color of the month correlates with the first letter in the word. Similar to other words, the first letter is dominant and shades the word. For weekdays and months the words take on the color in a more solid and dominant way than the first letter in a word typically influences the rest of the word. Jessica says she often does not know the date but knows that today is 'blue'. Jessica stated during an interview, "I know it is only Monday (black), but it feels green."

Jessica's Weekdays and Colors:

Monday	mars black
Tuesday	spring-green
Wednesday	deep blue
Thursday	dark spring-green
Friday	dark spring-green
Saturday	ebony black
Sunday	ebony black

Jessica's Months and Colors:

January	bright sky, flat, blue
February	spring-green
March	mars black
April	Light, rose, pink
May	mars black
June	bright sky, flat, blue
July	deep blue
August	dusty, rose, pink
September	ebony black
October	White
November	dark-brown
December	bright sky, flat, blue

Jessica explains her spatial sequences as a way of organizing her yearly calendar and a way to find her age. Her calendar is not a traditional shape. Jessica explains that when she thinks of a year it is part oval, rectangle and triangle. She states, "It is a shape that can not be described." There are different sections that represent the months in the month's colors. The months are not equal in shape or length. Jessica went on to describe how the calendar feels in her head but her age is projected outside her body. She stated that there is a running timeline above her head at about an arms length away from her. Her age appears in the upper, right hand corner of her peripheral view and her age time line reads left to right. Her age stays in the same spot every year and the one, from her first birthday, moves further away.

Pain to color is a very rare form of synesthesia that Jessica also experiences. Only 22.7% of synaesthetes experiences pain to color (Cytowic, 1997). She says she has only experienced it fewer than ten times in her life, and only when in extreme pain. Jessica threw her back out in high school and said she 'saw' a neon blue, vertical line, that seemed to be glowing, accompanied by her intenseness pain. When the pain lessened the blue line was no longer apparent. "It was shocking and frightening the first couple times I experienced it. I remember yelling for mom and saying I hurt my back and I can't see well."

Overall Themes

Overall, Jessica views her synesthesia as a gift now that she understands the general features of her synesthesia. She has learned to organize her life, knows what to expect and how to self accommodate for her synesthesia if needed. When she first told people about what she was experiencing, Jessica saw irritated faces and suffered unwelcomed comments about being crazy or was accused of lying, and or seeking attention. Jessica quickly learned about her differences and also learned not to discus them. Now that the public is learning about synesthesia and

synesthesia is now in the mainstream and a popular topic in social media as well as in science, Jessica is less fearful about sharing her synesthesia with others.

She hopes that someday that it will be recognized by the Diagnostic Statistic Manual, DSM so that the synaesthetes that need accommodations and services are able to receive services that they need. Jessica says she has read cases about synaesthetes who are bombarded by their senses and over stimulated to the point where they do not leave their houses. One synaesthete woman said that colors made her feel textures. She felt constantly bombarded, feeling prickly sensations among other perceived experiences. She did not enjoy leaving her home in England. The interior of her house was gray as well as everything inside her home because she did not want to see color and feel some many different textures constantly.

Jessica thinks that synesthesia is one of the things that makes her unique and has helped shape her into the strong, motivated person. Growing up as a dyslexic child was very difficult for her but she feels it it taught her to overcome obstacles and self-advocate for her education. Her synesthesia was unknown. Her parents did not know what she was experiencing and she was unable to share because she was unaware that it was not typical.

Now that Jessica is an adult navigating the world as a professional educator she is able to see the world with a new perspective. Jessica wants to help bring awareness and a general understanding to the public about synesthesia. That is one of the reasons she was willing to participate and be the subject of this case study.

Strategies Used

The strategies used in this report included the interviewing of Jessica and comparing her alphabet against itself over time. This study analyzed Jessica's grapheme alphabet on December 24, 2012 and again in April 24, 2013 and compared those results to the grapheme alphabet Jessica self

recorded in the summer of 2001 (Eagleman, 2013). The researcher also reviewed Jessica's work samples from her elementary to high school art to see if there were any similarities to her grapheme alphabet now to earlier years. Jessica also shared video footage and photos of Jessica's and her brother's childhood bedrooms to see if it was possible that the colors in any of their alphabet or number charts had influenced her own grapheme alphabet.

Chapter 5 Discussion/Analysis

Summary of Major Findings

The aim of this research was to determine whether Jessica, who served as the focus of this case study, exhibits forms of synesthesia including graphemes to color, time units to color such as weekday to color, month to color, spatial sequences, pain to color and numbers to personalities over a five-month period of time where she was tested and re-tested. The results of these tests over a five-month period demonstrated that Jessica's alphabet and numbers to colors stayed consistent during that period of time. Data of her experiences from childhood into adulthood were gathered and analyzed. The findings suggest that over a 12-year period Jessica's grapheme to color synesthesia remained stable with only slight changes.

Jessica's numbers to personalities stayed consistent although she used different words to describe the numbers. The general personalities of the numbers stayed consistent over the five-month test and retest. Jessica's time units to color, such as weekday to color and month to color, remained consistent over the five-month period. Jessica's claims of spatial sequences and pain to color were reported in the test and retest and remained consistent over the five-month period.

Comparison of Findings to Previous Research

My findings support the previous research in determining that synesthesia is expressed in a variety of forms in an individual and is natural and uncontrollable. Everyone experiences the world in a different way and no one diagnosis of synesthesia is the same. Jessica and many other synaesthetes view their synesthesia as a 'union of the senses'; that is an organic experience.

Jessica has many similarities to that the articles discussed. She is female, consistent with the reported research Cytowic (1997). Her synesthesia developed naturally when she was a

small child (Baron-Cohen & Harrison, 1997). Jessica also explains that her synesthetic experiences match that of others. Jessica's grapheme to color synesthesia has remained constant over many years.

Limitations/Gaps in the Study

This study involved utilizing Jessica's first person experiences that were recorded. This study also reviewed Jessica's work samples from her elementary to high school art. Other elements of Jessica's personal life were reviewed such as video footage and photos of Jessica's and her brother's childhood bedrooms. This limitation involves trusting Jessica's first person experiences and that her family photos and work samples are authentic.

Another limitation of this study is that the researcher did not have the capabilities to measure Jessica's claims of spatial sequences and pain to color. Jessica did report it in the test and retest over a five-month period consistently.

Overall Significance of the Study

This study is significant because Jessica's first person experiences relates to pervious research in the field. Jessica shared many challenges she faced in life as well as in the classroom. Documentation through a case study approach may serve to increase public awareness of synesthesia. If this condition is commonly understood, then, perhaps synaesthetes will not be viewed as "imaginative" and be able to receive appropriate accommodations and services.

The purpose of this study is to help identify this population and help educators create appropriate individualized accommodations. The difficulties these students may exhibit is longer processing time due to having extra stimulus to process. A synaesthete may need more time in class to complete work and tests. While working, some synaesthete students may need

limited sound environments such as no music while in class, testing or while learning to drive. Providing visual clues as an accommodation, may help a synaesthete in the classroom. If the student has trouble organizing classwork or locating their homework a color-coding organization system may help with process and facilitate the ability to locate their materials efficiently.

Jessica shared how difficult keeping track of seven classes was in junior high. She created a personalized color-coded system for each class. Each class had a color that corresponded with the color name of the subject. For example math was black and history was red. All the history folders, binders and tabs for history classes were red. This process of limiting the colors in her history binder helped her organize her classwork. Jessica stated that it also helped her think about her day on a global scale such as, "First I go to my green class, then I walk to red and after lunch. Then I have black and pink class." She said that thinking by color is simpler than thinking of the color and then processing what each color represents to her and then additionally processing the names of the subjects in order. This new color-coded system helped Jessica comprehend her seven period school day schedule and keep track of her assignments. What may sound confusing to the typical person is clear and concise to Jessica in her world of colors.

An educator could help a student by asking them what color the letters, words, and subjects are to their grapheme to color synaesthete student. Putting a class schedule on the board and utilizing the color-coded system that corresponds with the student's grapheme to colors alphabet is a simple way to help the student comprehend what the class will be doing and aid in transitions. The student will know that the red is history and will be next and that they should gather their history materials and red binder.

The key is to learn about a student who has synesthesia. It is important to understand sensory needs, likes and dislikes. It is important for a teacher to ask the student questions and record the answers to see if they change over time. Every student learns differently and synaesthetes are no exception. As educators we need to monitor our learning environments to make sure they are safe and comfortable so that all student are able to learn and grow in his or her own unique way.

About the Author

Kateri Wheeler has been teaching special education for 2 years in Northern California. She is currently working with severely emotionally disturbed children and youth. She became passionate about at-risk students during her credential program at Dominican University of California.

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