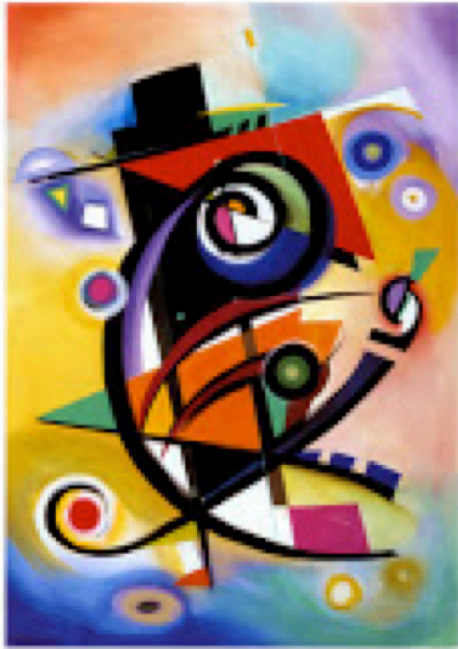


Kandinsky,1924



SYNESTHESIA- COLOR HEARING

ABSTRACT

THE SELF IS A PRODUCT OF BIOLOGY AND CULTURE. SYNESTHESIA DEMONSTRATES THAT THE INTERACTION OF BIOLOGY AND CULTURE CREATES MENTAL EXPERIENCE THAT IS STILL NOT WELL UNDERSTOOD. SYNESTHESIA IS ONE OF THESE FASCINATING MENTAL EXPERIENCES WHICH OCCURS AMONGST A MINORITY OF THE POPULATION. SYNESTHESIA IS A WORD OF GREEK ORIGIN MEANING UNION AND SENSATION .THUS,SYNESTHESIA IMPLIES TWO OR MORE SENSATIONS OCCUR AT THE SAME TIME .MOST HUMANS EXPERIENCE SENSATIONS SUCH AS SMELL,TASTE,HEARING AND VISION .FOR THE SYNESTHETE ,TWO OR MORE OF THESE SENSATIONS WILL BE EXPERIENCED AT THE SAME TIME .MANY CREATIVE PEOPLE HAVE EXPERIENCED THIS PSYCHO-PHYSIOLOGICAL PHENOMENON .THIS INCLUDE MUSICIANS ,FINE ARTISTS AND WRITERS SUCH AS : CHARLES BAUDELAIRE,ARTHUR RIMBAUD ,ALEXANDER SCRIBIN,VLADIMIR NABOKOV AND SERGIEI EINSTEIN.THIS ESSEY WILL DELVE IN TO ONE OF THE MOST FASCINATING TYPES OF THIS PHENOMENON COLOR-HEARING .IMPORTANTLY , THIS TYPE OF SYNESTHESIA HAS NOT ONLY BEEN EXPERIENCED BY MUSICIANS AND PAINTERS BUT AS SCIENCE EXPLAINS IT IS AN INHERENT PART OF LANGUAGE ACQUISITION AND DEVELOPMENTAL PROCESS IN CHILDREN. IT IS PRESENTLY BELIEVED THAT SYNESTHESIA OCCURS IN ABOUT 5% OF THE POPULATION .THE PARIETAL CORTEX IS INVOLVED IN THIS EXPERIENCE. CHILDREN ARE BELIEVED TO BE ABLE TO EXPERIENCE SYNESTHESIA MORE SO THAN ADULTS .THIS IS DUE TO COGNITIVE LEARNING COUPLED WITH THE IMAGINATION OF CHILDREN.THERE ARE MANY THEORIES ON HOW AN INDIVIDUAL ACQUIRES SYNESTHESIA.

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MALS 7000-INVENTING THE SELF
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SPRING 2015

Thesis: The Self is a Product of Biology and Culture .Synesthesia Demonstrates that the Interaction of Biology and Culture Creates Mental Experience that is Still Not Well Understood.

INTRODUCTION

“Now I call the proper object of each sense that which does not fall within the ambit of another sense , and about which there can be no mistake , as sight is of color , and hearing of sound , and taste of savor, while touch has several different objects . Each particular sense can discern these proper objects without deception: thus sight errs, not as to colors, nor hearing as to sound: though it might err about what is colored or where it is, or what is giving forth a sound. This, then is what is meant by the proper objects of particular senses” Aristotle, *De anima*, 2.5 (418a, 12-20

Man in nature possess very complicated interpretive mechanisms which engender one’s self to experience and make sense of the outside world. Synesthesia is a word derived from two Greek words .Syn means together or union and aesthesis means sensation .Thus, synesthesia implies that two or more sensations occur concurrently (Harrison, 2001). Most people experience sensations such as touch , taste , smell ,hearing and vision ,which are usually known as the five senses (Harrison,2011).However, there are people ,albeit a minority who experience two or more sensation at the same time , they are called synesthetes. It has been documented throughout history that insightful experiences of vision , audition , sight can engender a series of complex sensory associations, and just like many other phenomena in nature synesthesia is a very important concept because in understanding it we can better inform our perspective on why some of us perceive the world differently , and how this tool in the hands of creation can bring about aesthetic and spiritual ecstasy and most importantly gain a better understanding of the surrounding world. It is a well-known fact that the information our consciousness absorbs results from a constant interplay of the senses. Importantly, this constant dialog is largely a

subjective experience and most of the time completely independent from actual reality.

There are many different types of synesthesia. The four most common are the following grapheme color in which an individual perceives letters and number as being colored ;spatial sequence ,the sequence of numbers appear as points in space, sound taste –whereas a sound produces a taste in the mouth of the listener and sound color ,in which a sound produces a color in the mind of the listener (Cytowic,1993).

Since the beginning of time man sought to describe the self. The self is defined by professionals as the product of biology and culture .Synesthesia demonstrates that the interaction of biology and culture creates mental experiences. That is still not well understood. Many creative people throughout the history have been synesthetes. A musician such as Scriabin would compose musical pieces and see colors. Writers such as Nabokov equated different colors to different letters of alphabet. Perhaps synesthesia exists amongst people who are more artistic and creative than the rest of the population.

It was Descartes who claimed that”...mind or thought is active, knowing, alive and take up no space ; physical matter is reactive, unknowing , lifeless and extended in space ...”, and in his inquiries searched “.. .to edit sense experience so that superfluous or subjective details might be distinguished from real features of the world ...”(Grandy ,2004). With that said I would have to agree that physical matter holds no mind of its own and is quite primitive in nature. However , the phenomenon of sensing can never be truly separated from the observer, but is rather rooted in his individuality and hence developed “(Goethe 1907:254) . Therefore in case of hearing the ear echoes back (otioacoustic emission) and in case of seeing eye simply answers back by coloring our mental landscapes. So is there a distinction between what is real and what is an illusion?

One might argue, that the whole world is an illusion and that only by dissecting the

experience from experiencer can we fully understand the reality . Yet the experience needs an experiencer and vice versa. In order to have an experience our bodies are equipped with sensory pathways that enable us to perceive the world. Human senses are not only receptive but creative as well and they are not “.. empty of intelligence , the world’s expression is the world expressing itself , speaking directly to the human observer ...” (Grandy,2004:30) and “Comprehension does not take the form of a theory abstracted from the phenomena but rather the form of a seeing embedded in the fullness (Sepper,1988:71). Sensory seeing, feeling, hearing reinforces mind to understand and to trust the infinite pleasures in their manifold offerings (Grandy,2004). Being able to acknowledge the actual existence of series of mechanism from the observer point of view enables artists to draw inspiration for the creative processes. Taking in to consideration my own fascination with sound from a very young age I had a life time to research my own sensory association and the panoply of emotional and physical states that influence how the creative process happens and what happens .

Importantly, the creative processes are no longer considered only aesthetic in nature but thanks to many interdisciplinary perspectives such as neurobiology and quantum mechanics can be investigated through physical and quantitative measures . However, staying connected to all of the components in the actual birthing process ultimately is not an end in itself, it has been and is one of the paths to reach a deeper spiritual understanding, thus in hopes that “...with care but not fear...a way that the physical might open out on the spiritual” (Blumenberg, 1993:185). With that said, the condition known as synesthesia is not just a muse of the arts but it has been also referred to as a global allegory (Galeyew,2003).However, lived synesthesia is when a person hears a sound ,for example a musician is playing a melody . To the listener the mental image he receives is a dark color –black or deep purple. Moreover, just like Galeyew states, that synesthesia in reality is part of fundamental aspects of language , figurative and imaginative thinking. All of us can understand veiled metaphorical expressions and conventional allegories (Galeyew, 2003). Yet, those who explore its realms deeper are granted insight to a separate dimension which would have been otherwise unknown

Sensory association between color and music have been scientifically investigated from the beginning of the twentieth century. However, the association between color and music can be traced back to ancient Greece. Plato was the pioneer in deliberations on the subjects of tone and harmony in regards to arts. However let's don't forget about Eastern thought analogy "...especially in its ancient Indian form-nada as an atom of sound, from which the universe was born,... primitive synesthetic reflections ;music, an audible phenomenon , compared to the visual world , and by extension , the cosmos."(Galeyew, 2003:129). However, the earliest mentions of synesthesia are known because of Pythagorean who assigned a particular color to each note, around the 6th century BCE.(Tyler, Iona, 2003). Therefore, in my opinion synesthesia is one of the most captivating phenomena of the human mind.

Among most interesting forms of synesthetic associations are the well-known connections between color and sound sensations. According to Spector and Maurer (2013) sound can generate perception of color. For example high C played by a trumpet will create a visual sensation of color vermilion ,albeit the same note played by a violin will generate a perception of color pink. Galeyew (2003) argued that the "...ability to see the plasticity of melodies and coloring of the melodies is a common property of human psychology: everyone can understand synesthetic transferences in poetic and ordinary language i.e.: bright sound or flat timbre..." (p.130). Moreover, in his view "...synesthesia is no more than a reflection in consciousness, in the psyche, of correlations between heteromodal properties of the perceptible world..." (Galeyew, 1982:129). This cross-modal interpolation has been considered for the longest time as neurologically abnormal,"...because it is at odds with the idea that we have five distinct senses, as codified by Aristotle."(Tyler, Iona, 2003:223). However, the recent developments of various techniques in brain exploration prove that,"...synesthesia is like other formerly misunderstood behaviors, and it opens doors to allow us to re-evaluate art, neural wiring and sensory relationships."(Tyler, Ione, 2003:225). Studies performed by Marks (1978):

Cytowic (1989), Somon Baron-Cohen & Harrison (1997): Ramachandran & Hubbard (2000, 2001) helped to re-identify this condition because they no longer considered it abnormal. Moreover, studies performed by Mattingley et al. (2001); Ramachandran & Hubbard (2001), showed that colors experienced by synesthetes are so clear that they hinder the identification of colored numbers (Ione, Tyler, 2003). Furthermore, other studies conducted by Ramachandran & Hubbard, (2001): Wagar et al. (2002) proved that "...colors may be used to penetrate the crowding effects of arrays of nearby shapes, letters and numbers." (Iona, Tyler, 2003:225).

ARTISTS AND SYNESTHESIA

In more recent years the documented list of those who have experienced synesthesia have grown immensely and it includes writers, musicians and painters. For example Charles Baudelaire, Arthur Rimbaud, Alexander Scriabin, Vassily Kandinsky, Vladimir Nabokov, Sergiei Eisenstein, David Hockney and Richard Feynman. Throughout the years many inferences have been drawn in regards to synesthesia based on fascinating comments and remarks which have been found in the list above by their compositions and writings. For instance Feynman (1988:59) stated "When I see equations I see the letters in colors". Alexander Scriabin associated the key F# major with the color violet (Mayers, 1914). Vladimir Nabokov in his book *Speak Memory* wrote "The long 'aaa' of the English alphabet has for me the tint of weathered wood, but a French 'a' evokes polished ebony." (Nabokov, 1947:21). And of course Beethoven who named B minor-the black key and D major the orange key or Schubert who associated E minor with a maiden robed in white with a rose red bow on her chest (Ward, 2003).

It is also imperative to mention Vassily Kandinsky who was instrumental in the formulation of the term synesthesia. He was well known to frequently use musical terminology, because in a way it helped him to "... tear down the surrounding walls of his own creation..." (Ward 2006:1). Being a musician explains his fascination with sound, hence he explored the medium of "color hearing". Across many mystical encounters color blue has

always been linked to some kind of communication with the numinous. Blue being Kandinsky's favorite color precisely depicted its symbolism in these words:

“The deeper the blue becomes, the more strongly it calls man towards the infinite, awakening in him a desire for the pure and for the supernatural; the brighter it becomes the more it loses its sound, until it turns into silent stillness and becomes white” (Kandinsky, 1913)

He also divided his work into three musical categories: Impressions, Improvisations, and Compositions and named particular pieces such as: Fugue, Opposing chords, Funeral March. Kandinsky stated that there were two instrumental events in his life that defined him as a synesthete. The first event took place during an exhibition of French Impressionists in Moscow in 1896. It was Monet's painting that made him realize that a painting can hold an observer's gaze, even if it cannot be identified (Tyler, Ione, 2004). The next event that changed the artist's view was a performance of Richard Wagner's Lohengrin in Moscow in 1896. His later depiction of the events accentuated the actual sensory experience engendered by the music (Tyler, Ione, 2003).

“The violins, the deep tones of the basses, and especially the wind instruments at the time embodied for me all the power of that prenocturnal hour. I saw all my colors in my mind: they stood before my eyes. Wild, almost crazy lines were sketches in front of me.” (Kandinsky, 1913, p.364)

This continuous interplay of music and color inspired Kandinsky throughout the years to paint not pictures but compositions. Tyler (2004) proclaimed that Kandinsky's paintings exuded a dynamic interaction of each “...point moving towards the evocation of its counterpoint, just as each series of lines appears to correlate with a sonic form” (p.224). Another interesting fact is that Kandinsky longed to introduce the core experience of cross modal association to larger audiences, explaining that “one can feel the multi-sensory consonances and dissonances in simultaneously performed color movements, musical movements and dance movements” (van Campen, 1997:224). The culminating point for these sensory consonances and dissonances was

the birth of a musical play “The yellow clang” which was “...conceived with composer Hartman and the dancer Scharoff... this production may well have been a springboard of the modern dance movement, from Isadora Duncan to Serge Diaghilev.”(Tyler, Iona 2003:224). In summary, his deepest desire was to translate sound through sight and conceive a magnum opus equal to symphony that would inspire not just the eyes but the ears as well (Ward, 2006).

Vladimir Nabokov acquainted himself with his gift in his childhood, while explaining to his mother that the colors on his wooden alphabet were inaccurate. In his writing he numerously indicated that “The confessions of a synasthate’s must sound tedious and pretensions to those who are protected from such leakings “(Ward,2006). For a French composer Oliver Messiaen melodies and rhythms came to him in “colored dreams”. His testimony of the experience was “When I hear music I see in the wind’s eye colors which move with the music, this is not imagination , nor is it a psychic phenomenon , it is simply an inward reality”(Ward,2006). Filippo Tommaso Marinetti who was best known for his Futurist Manifesto of 1909 hosted cocktail dinner parties in which guests”... would wear pajamas of cork, sponge and sandpaper, while eating foods without the use of their hands.”(Ward, 2003:1). He was also known for playing many “intoning “instruments which whispered , screeched and whistled (Ward,2006).

The utilization of two sensory mediums (color and sound) in music has become popular in the late nineteenth century . One of the most fascinating composers of that time was Alexander Scriabin .Most of his creations where done both in sound and color “...by means of polysensory works he hoped to give expression to his mystic world view.”(Marks, 1975:313). As cited in Marks (1975:313) in 1915, Scriabin orchestration “Prometheus” required from Carnegie Hall to provide color organ,”...colors where played on a keyboard and projected onto a screen behind the orchestra...the correlation between tone and color was systematic in that C was accompanied by red, D by yellow , E and F# by blues , A by green , and B flat by gray.” (Plummer, 1915). Moreover, the actual history of color organs begins in 1725, when a Jesuit priest L.B Castel constructed an instrument which could concurrently create sound through

colors (Marks, 1975). His synesthetic experience of sound was explained in these words:

“For we are born in music ,& we have only to open our ears in order to taste it ...and one has only to open one’s eyes in order to taste a Music of colors & to judge it”(Castel,1735:1621).

Castel believed that “...colors form a harmonic series ... like that of the notes ...” (Marks, 1975:313).Through these amazing biographies and personal confessions that have been chronicled for the benefit of the future seekers and those who will be lost we can only hope they will find their way back home. Presently, we have a wealth of knowledge about synesthesia to understand the interaction of biology and culture creating wondrous descriptions of the self.

PHONETICS AND SYNESTHESIA

It is a well-known fact that babies can remember their mother’s voices from a very young age. However this voice must be accompanied with a correct face (DeCasper &Fifer, 1980: Ock-leford,Vince ,Layton,&Reader,1988). As the development takes place babies learn how to associate the sound “be” with the written letter B, and sounds of bird’s songs with the actual two legged feathered vertebrae. If we learn by association fascinating question has been raised in regards to colored hearing and particularly colored vowels ; Is there a relation between sound (vowel quality) and associated visual sensation (color)? Marks (1975:304) argued that so far evidence suggests that there is a prominent synesthetic connection between color and sound, ”When people are asked to match brightness of lights to loudness of sounds, they align increasing luminances with increasing sound pressure in a systematic manner that is similar from person to person(Marks &J. C.Stevens ,1996; J .C.Stevens &Marks ,1965). Poet Rene Ghil (1887/1938) have tried to build a literary system pertaining to colors of sounds. His system classified vowels accordingly;”.../a /as black,/ e/ as white ,/i/ as blue , /o/ as red and /u/as yellow...”(Marks,1975:307). Marks further suggested that there is a clear correlation between

sound composition and color and between auditory pitch and visual brightness. Another words, "...the higher the pitch the higher the frequency of a sound, the greater tends to be the brightness of the photism."(Marks, 1975:307). A cited in Marks (1975:304), Suarez de Mendoza (1890) elucidated vowel colors in this way" Thus, they appear darker when are struck on lower notes; but so much more clear and brilliant when they are formed of higher notes "(p.140). Marks, argued further that there is a distinct relation between the sound structure of vowels and the secondary visual sensation. Because "...the differences among colors aroused synesthetically by various speech sounds might be due to phonetic differences among the sounds"(1975:309). Moreover, according to Marks (1975) it was Wehofer (1913) and Masson (1952) who emphasized that other factors that need to be taken into consideration are formant structures that might induce the experience of synesthetic coloring of vowels. Importantly, Donders (1875), Helmholtz (1863) and Koenig (1870), have performed studies in which tried to determine the actual resonant frequencies of the vocal tract during vowel production. These inquiries showed that /o/ and /u/ to have the lowest frequencies and /e / and /i/ have the highest. In, summary the order of"... increasing vowel...brightness is /u/,/o/,/a/,/e/,/i/, the same order that defines increasing vowel pitch"(Marks,1975:309). It was Bleuler and Lehmann (1881) that created the "Helligheitsgesetz" –law of brightness, which stated that"... bright sounding vowels induce bright auxiliary visual sensations..." (Marks, 1975: 309).

Phonetic symbolism conveys the idea that words carry meaning and it goes back to Plato and later mentioned by Balzac (1832-1961) whose asked a simple question "Are not words colored with the idea that they represent externally?"(Marks, 1975). According to Marks (1975) the mere act of speech is not an end itself. It is a physiognomic system of symbols, where words belong to particular objects , which carry a lots of audible and inaudible information. Because our bodies produce acoustic signal therefore also depend on body's ability to produce it via speech . I would call it a sonic way of nurturing the microorganism of the being. In this acquisition our neuronal connections multiply in contrast giving us a tool to heal oneself, communicate as well awaken numinous fields within our psyche. It is not a coincident

therefore that children learn how to read through books that expressively emphasize the connection between letter and its sound and a corresponding color.

THE MIND AND THE SENSORY PERCEPTION

Studies performed by Piaget in 1952 and Gibson in 1966 produced numerous results which supported the belief that "...some cross modal associations are readily grasped by young infants, whereas others emerge later: researchers have explained the differences on the basis of the integration of schemas (Piaget) or amodal versus arbitrary correspondences (Spector, Mauer, 2013:108). Adults with synesthesia when presented with one form of a stimulus activates additional sensory pathways (Spector, Mauer, 2013). Behavioral studies conducted by Hubbard Arman, Ramachandran & Boynton (2005): Muggleton, Tsakanikos, Walsh & Ward (2007): Simner et al (2006) indicated that synesthesia occurs in about 5% of the population. Until now it has been documented that there are about fifty types of this condition, and a greater number of which comprise a visual percept of color (Spector, Maurer, 2013). Another fascinating fact cited in Spector and Mauer (2013) and documented by Dixon, Smilek & Merikle (2004), Ward & Sagiv, (2007) was that "Some synesthetes indicate that the extra percepts are projected into specific locations in space, where they may be superimposed on real world stimuli (projectors), whereas others report that the extra percepts are in the mind's eye." (p.109). Instantly, one might think through simple association of mescaline, out of body experience, hypoxia, or even flagellation (So insistently practiced by the aesthetes, because self-mutilation changes body physiological processes, thus, enhances communication with the spirit world-divine)..

Studies performed by Marks 1978 showed that LSD causes multimodal synesthesia (Tyler, Iona, 2003). Aldous Huxley who used the substance mescaline is most likely best known for his book "Doors of Perception" in which he documented how his perception have changed upon the usage of this drug. However, according to Marks (1975) mescaline and hashish are

known to induce synesthetic sensation in non-synesthetic subjects .Furthermore, the French poet Theophile Gautier (1834) and Charles Baudelarie (1860-1923) wrote extensively about how they would hear colors speak to them under the influence of hashish (Marks, 1975) . Therefore, if mescaline can enhance” color hearing” points to the fact neurologically speaking that there must be a strong connection between hearing and vision, “...at least to the extent that the auditory –visual forms dominate both normal and drugged synthesesiae ...” (Marks,1975:317), thus, clearly explaining why Kandinsky’s longing to create a masterpiece that would “translate sound through sight” was more natural than out of ordinary .

Inducive substances have been used from the beginning of mankind either to awaken the only muse “ la vena “ or gain spiritual enlightenment (i.e. ,famous ayuhasca used in rituals by Amazon Indians is one of many examples). However, synesthesia is more of a state of being, rather than a neuronal malfunction .We may all long for it .Secretly whispering for it to occur .Yet ,it is however, unfortunate that only a few of us are bestowed with this gift /grace.

One of the many methods used to study the actual specificity and consistence of synasthesia is over time .The results yielded by Baron-Cohen ,Harrison ,Goldstein, & Wyke (1993) showed that synesthetes picked the same color 92% of the time when presented with another test after one year. In 1893.Other experiments, conducted by Kelly in 1934 and Howells in in 1944 investigated the ability of pairing of colors with sounds showed that Kelly’s experiment proved only that learning takes place only to some extent. Howell’s experiment questioned whether pairing of C note with red enables the subject to recognize red instead of blue green also yielded mixed results (Marks,1975). However, studies performed by Ellson (1941a,1941b), Leuba (1940),and Leuba and Dunlap (1951) which investigated if sensation is possible through “...repeatedly pairing a 1000Hz tone with a white light ... found that auditory hallucinations develop”(Marks,1975:322). Recent development in magnetic resonance imaging (MRI) have shown that”...during synesthetic percepts there is activation in the expected brain areas ...which are normally activated by the inducing

stimulus.”(Spector, Maurer, 2013:110).

Importantly, parietal cortex involvement in synesthesia has been affirmed by studies which used transcranial magnetic stimulation in which specific brain regions were deactivated (Spector, Maurer, 2013:111), and these results showed that “Silencing the right parietal – occipital area ...reduced the interference between synesthetically induced and real colors, for converging evidence of increased parietal connections in the left parietal cortex of grapheme color synesthetes” (Esterman, Verstunen, Ivry ,&Robertson,2006;Muggleton et al.,2007; see Rouw&Scholte, 2007). Even though it is argued that synesthesia is rooted in normal developmental processes , the cross –activation theory emphasizes that this condition arises when neuronal synapses fail to reach certain brain regions (Maurer&Maurer,1988: Ramachandran &Hubbard, 2001). According to Spector and Maurer (2013:112), the disinhibited feedback theory claims that”...synesthesia arises when the reentrant feedback that develops postnatally from higher cortical areas onto lower sensory cortical areas is not strong enough to inhibit effects from connections between primary sensory cortical areas.”(Gorsenbacher &Lovelace, 2001). On the other side, as cited by Spector and Maurer (2013:112) synesthesia could also be caused by “...altered feedback from higher cortical areas onto lower sensory cortices.”(Gsorsenbacher &Lovelace, 2001). According to Marks (1974) defined synesthesia as a “rubric of imagery” ,because in essence cognitive development can only take place trough imaginary games (Marks,1964). The cross activation theory explains that across all animal kingdoms all of the sensory cortical areas are not fully specialized, as they become later in to the adulthood. Therefore, dialog between sensory cortical areas is very much so dependent on experience (Spector, Maurer, 2013).

Wolff, Matsumiya, Abrohms,van Velzer,& Lombroso (1974) through their studies indicated that “...in the newborn , tactile stimulation of the wrist evokes activity over the somatosensory cortex, as it does in adults ..”. When an infant is being spoken to auditory and visual cortex is stimulated concurrently, over time this activity lessens and at about three year of

age completely dissipates (Neville, 1995). As stated earlier, synesthesia occurs when wiring between sensory cortical areas is not pruned (Ramachandran & Hubbard, 2001). Despite the fact that the actual reason for low pruning is not quite known yet, genes might play an instrumental role (Spector, Maurer, 2013).

According to Spector and Maurer (2013: 113), in the events of blindness or deafness "...the primary sensory cortex missing its input does not develop normal specialization, but instead responds to input from other sensory modalities." (Maurer, Lewis & Mondloch, 2005). In summary, all of these studies direct attention to the fact sensory cortical areas are shaped by the experience from the specific sensory modality. However, if the input is missing or operates inadequately due to developmental factors it will most likely induce conditions like synesthesia, thus, wrong neuronal connections will simply influence different kinds of perception (Spector, Maurer, 2013).

Lastly, I would like to delve deeper in to the actual of sound itself, because sound in its fundamental qualities is the carrier of all life. Music has always been utilized by men as a medium to communicate with consciousness. Sound at its basics is simply vibration and all matter in the universe vibrates and responds to vibration, thus music in its purity carries a power to set up series of events in the mechanism of the nervous system i.e.; affect cognitive processes and most importantly alter states of consciousness. Therefore, color-hearing can be thought of as disordering of the senses through which cross sensory association gives a glimpse to other realities.

It was Andre Breton who founded the art movement Surrealism, which came to be known as "the most powerful mental explosive ever invented" (Carrouges, 1974:92). It was the most extraordinary idea to use "reasoned disordering of the senses", to simply "disintegrate and reintegrate the mind." (Vickers, 1977:1). Despite the fact that surrealism techniques have been predominantly utilized in literature and visual arts, its extension can be found in music as well.

The use of rhythmic patterns with systematic repetition of words, chants have been known to cause changes in consciousness by introducing the brain with excess of sensory input which have been used across many ancient cultures such as :Australian aborigines , native American tribes and Siberian shamans .In a way it is more effective in music because , “...an auditory stimulus is more likely to slip past our conscious awareness than a visual one , ...sight speaks more directly to the conscious, sound speaks more directly to the unconscious .”(Vickers, 1977:1).Intentional confusion of illusion and reality by superimposed sounds will cause vacillation between realities, because of the overload by an excess of sensory input. A perfect example of this is polyphony either through singing two three notes concurrently, or through the use of multiple independent melodies, “Polyphony, because it cannot be followed by the conscious rational part of the mind ,it has a confusing ,ear wondering effect”(Ehrenzweig,1953: 42).

(Vickers, 1977) stated, that timbre, or tone quality is a function of the harmonics of the tone. Yet, Ehrenzweig point view was that the brain needs to suppress the harmonics because of the survival instincts and that “In the repression of the overtone chord usually the lowest of the sounds emitted by a particular thing remain consciously audible , while the higher ones undergo repression.”(1953: 151). Moreover, Vickers clarified further that, the fundamental speaks to conscious mind but the harmonics are absorbed by the unconscious mind . Importantly, the harmonics are recognized not “...as separate tones , but as tone color or even directly as emotion.”(1977:1).

CONCLUSION

Despite the fact that humans are shaped by and dependent on interactions between biological and sociological factors, in essence, human endeavors and culture are also affected by the undiscovered realms of our minds. Protagoras stated that “Man is the value of all things.” To closely examine these words, we would have to admit that to search for other realities than the human would be pointless because it would not hold any significant meaning. Moreover, the acquisition of knowledge holds value only when humanity is at its center. The role of nurturing is clear and the new forms of knowledge about this process is critical, yet exploring these various perspectives does not simplify our understanding of nurturing, but rather points to the complexity of the human condition and mysteries that lie ahead.

The true essence of what it means to be human is still a great mystery, an enigma, which holds undiscovered secrets to this day. Synesthesia demonstrates a phenomenon that is the interaction of biology and culture. It is not a medical condition but rather a fascinating subject of what constitutes the “self“, that is how human beings experience perception. Many creative and artistic people have had synesthesia and they illustrated this with poems, music, novels, paintings and filmmaking. Philosophers and scientists have been interested in this topic since the beginning of history as they grappled with what makes us “human” .Plato and Aristotle and Newton to name a few. Presently ,with MRI and other instruments ,what transpires in the mind can be seen .Perhaps in the near future synesthesia will be explored more so ,giving us information about the secrets of the mind and how these biological factors have affected

humankind culturally ,which thus enhanced the endeavors of mankind. Therefore, if synesthesia occurs within the body, or not, whether it is a true psychological experience, or simply biological artifacts, the meaning and value that people distill from it, is in reality comparable to the function of an organ that produces a mechanism for how people think, perceive and experience life.

REFERENCES

ARISTOTLE .De ANIMA, (1931).In the works of Aristotle (4th cent. B.C) (W. D. Ross, Ed.)Oxford: Clarendon Press, 1931.

This quote was presented in the Neurochemistry and the Arts. Was Kandinsky a Synesthete? Written by Amy lone and Christopher Tyler. Journal of the History of the Neurosciences, 2003. The Authors presented investigation of the phenomenon synesthesia, and have called upon the works of philosopher; Aristotle and the painter Kandinsky, and finally supported their research with science. This quote was instrumental my paper because it enabled me to understand that this cross sensory association has been investigated and marveled upon almost from a very beginning of mankind.

BALZAC, H .de. LAMBERT (1961, originally published in 1832).In G .Le Prat (Ed.), oeuvres completes (Tome20) Paris; Le Prat.

This source was cited in the Psychological Bulletin, Vol., 82, No.3.On Colored –Hearing Synesthesia: Cross-Modal Translations of Sensory Dimensions by Lawrence E. Marks, 1975. The quote which was

written by Balzac was very relevant to the essay because metaphorically it explained how language and its words are colored with an idea that they represent externally.

BARON-COHEN, S., S., HARRISON, J., GOLDSTEIN, L.H., & WYKE, M. (1993). Colored speech perception: Is Synesthesia what happens when modularity breaks down? *Perception*, 22, 419-426.

This source was cited in the *Journal of Psychology of Consciousness: Theory, Research and Practice*, 2013. Vol.1(S).108-129. Synesthesia: A New Approach to Understanding the Development of Perception by Ferrine Spector and Daphne Maurer. Baron and Cohen studied synesthesia overtime. They have discovered that synesthetes picked the same color most of the time when tested a year later. This source is important because it shows that synesthetic experiences are pretty constant over time.

BAUDELAIRE, C. *Les correspondances* (1857). *Les fleurs du mal*. Paris: Calmann-Levy.

This source was cited in the *Psychological Bulletin*, Vol., 82, No3. On Colored –Hearing Synesthesia: Cross-Modal Translation of Sensory Dimensions by Lawrence E. Marks, 1975. Baudelaire was known to experiment with hashish to awaken his senses, however his testimony is relevant because to the research essay because his take on synesthetic experience was that it is a natural state albeit it becomes more vivid under the influence of the drug.

BLEULER, E., & LEHMANN, K. *Zwangs massive Light-empfindungen durch Schall und verwandte Erscheinungen*. Leipzig, Germany; Fues' Verlag, 1881.

This source was cited in the *Psychological Bulletin*, Vol., 82, No3. On Colored –Hearing Synesthesia: Cross-Modal Translation of Sensory Dimensions by Lawrence E. Marks, 1975. It was Bleuler that created the law of brightness, which stated that bright sounding vowels induce bright visual sensations. This source is important because it relates to the fact that vowel as sounds are connected to the secondary sensation such as color.

BLUMENBERG, HANS. 1993. *Light as a Metaphor for Truth*. In *Modernity and the Hegemony of Vision*, ed. David M. Levin. Berkley, CA; University of California Press: 30-62.

This source was cited in the *Journal of Interdisciplinary Studies* 17. No. 1/2 2005, *Goethe on Color and Light* by David Grandy. The quote used in my essay was used by Blumberg who explained that Goethe just like many others believed that the physical matter could open up the door to the spiritual. It is very important to utilize this quote because most of the synesthetes described in this essay through their art hoped to gain a deeper understanding of the reality and the truth for that matter.

CARROUGES, MICHAEL. *Andre Breton and the Basic Concepts of Surrealism*. University of Alabama Press, 1974.

This source was cited in the essay *Music and Consciousness 1977*, by Earl Vickers. Carrouges wrote extensively about Andrew Breton who founded the art movement Surrealism and that it was considered to be the most powerful mental explosive ever invented. This source was relevant because the reasoned disordering of the senses has been widely utilized in music as well as in literature. This has been utilized by many cultures to cause changes in consciousness thus the perception of the world. Therefore,

Carrouges' statement was relevant not only to cross modal associations but because through achieving different states of consciousness one can experience different perception of the world and that this state has been sought and longed for across many cultures throughout the history.

CASTEL, L.-B. *Nouvelles expériences d'optique & d'acoustique. Mémoires pour l'Histoire des Sciences et des Beaux Arts, 1735, 1444-1482, 1619-1661, 1807-1839, 2018-2053, 2335-2375, 2642-2768.*

This source was cited in the *Psychological Bulletin*, Vol., 82, No3. *On Colored –Hearing Synesthesia: Cross-Modal Translation of Sensory Dimensions* by Lawrence E. Marks, 1975. Jesuit Castel is considered the pioneer in constructing an instrument that translated sound through colors and he believed that colors form harmonic series just like the notes. Therefore, the mention of his work was very important in this research paper.

CYTOWIC, R., (1993). *The Man Who Tasted Shapes*. New York: G.P. Putnam's Sons.

This source was cited in *The Liberation of the Senses: An Exploration of Sound –Color Synesthesia in the Music of Alexander Scriabin and Olivier Messiaen* by Evan Norcross Flynn, December 8, 2014. Cytowic in this essay described numerous types of synesthesia such as: grapheme-color –the perception of letters and numbers as being colored; spatial sequence –sequences of numbers appearing as points in the space; sound –color –a sound producing a color in the mind of the listener. He also stated that the interest in the phenomenon of synesthesia peaked between 1860 and 1920 which coincided with the development of brain imaging technology. After the Second World War, interest in the subject faded and only to resurface again later, because of the development of digital technologies of image and sound which have created new research opportunities in this subject. Therefore, his historical insight was very important in this essay.

DECASPER, A. J., & FIFER, W.P. (1980, June 6). *Of human bonding: Humans prefer their mothers' voices*. *Science*, 208, 1174-1176.

This source was cited in the *Journal of the Psychology of Consciousness: Theory, Research, and Practice* 2013. Vol.1(S).108-129. DeCasper and Fifer studied development of perception in infants which led to discover that babies recognize the mother's voice at birth however in addition they must learn to associate that voice with the correct face. Moreover, this explains how later on in life they learn how to associate the sound "ay" with the written letter A.

DIXON, M.J., SMILEK, D., & MERIKLE, P. (2004). *Not all synesthetes are created equal: Projector versus associator synesthetes*. *Cognitive, Affective & Behavioral Neuroscience*, 4,335-343.

This source was cited in the *Journal of Psychology of Consciousness: Theory, Research and Practice* 2013. Vol.1(S).108-129. Dixon and Smilek conducted a study of synesthetes in which they have discovered that some subjects would experience synesthesia as projected into specific location in space, where they may be superimposed on real world stimuli and others reported that the extra percepts are in the mind's eye. Thus source was relevant because it explained that sound can induce all kinds of synesthetic experiences.

DONDERS, F.C. Ueber die Natur der Vokale. *Archiv für die Hollandischen Beiträge zur Natur und Heilkunde*. 1857, 1, 157-162.

This source was cited in the *Psychological Bulletin*, Vol., 82, No3. On Colored- Hearing Synesthesia: Cross-Modal Translation of Sensory Dimension by Lawrence E. Marks, 1975. Donders studies in determining the vocal tract resonant frequencies during vowel production are of importance because they have showed which vowels have the lowest and the highest frequencies.

EHRENZWEIG, ANTON. *The Psycho-Analysis of Artistic Vision and Hearing*. New York: Julian Press, 1953.

This source was cited in the *Music and Consciousness*, 1977 by Earl Vickers. Ehrenzweig point of view was that the brain needs to suppress the harmonics because of the survival instincts and that in the repression of the overtone chord usually the lowest of the sounds emitted by a particular instrument or voice remain consciously audible, while the higher ones undergo repression. He also clarified that the fundamental frequency speaks to the conscious mind, while the harmonics are absorbed by the unconscious mind. This clarification was very crucial because it explained that sound itself does not only participate in development but also serves as a medium to communicate with the unconscious mind.

ELLSON, D.G. Experimental extinction of a hallucination produced by sensory conditioning. *Journal of Experimental Psychology*, 1941, 28, 350-361. (a).

This source was cited in the *Psychological Bulletin*, Vol., 82, No3. On Colored –Hearing Synesthesia: Cross-Modal Translation of Sensory Dimension by Lawrence E. Marks, 1975. Ellson is known for pairing a 1000Hz tone with a white light and in the process discovering that auditory hallucinations develop and that conditioned auditory sensations appeared quite resistant to extinction.

ELLSON, D.G. Experimental extinction of and hallucination produced by sensory conditioning. *Journal of experimental Psychology*, 1941, 28, 1-20(b).

This source was found in the *Psychological Bulletin*, Vol., 82, No3. On Colored –Hearing Synesthesia: Cross-Modal Translation of Sensory Dimension by Lawrence E. Marks, 1975. This source is important as Ellson studies proved that conditioning of sensation is possible and through his experiment with a 1000Hz tone paired with a white light he discovered that auditory hallucinations develop.

ESTERMAN, M., VESTYNEN, T., IVRY, R.B., & ROBERTSON, L.C. (2006). Coming unbound: Disrupting automatic integration of synesthetic color and graphemes by transcranial magnetic stimulation of the right parietal lobe. *Journal of Cognitive Neuroscience*, 18, 1570-1576.

This source was cited in the *Journal of Psychology of Consciousness: Theory, Research, and Practice* 2013. Vol.1(S).108-129. *Synesthesia: A New Approach to Understanding the Development of Perception* by Ferrine Spector and Daphne Maurer. Esterman and Vestynen studied brain of the synesthetic subjects. Their results showed that silencing the right parietal-occipital area reduced the interference between synesthetically induced and real colors for converging evidence of increased parietal connections in the left parietal cortex of grapheme color synesthetes. This source was important in this research essay because gave an insight to the neurological processes involved in the cross sensory associations.

FEYMAN, R. (1988): *What Do You Care What Other People Think?* London, Unwin Paperbacks.

This source was cited in the *Journal of the History of the Neuroscience* 2003, Vol.12.No.2, pp.223-226 *Neurohistory and the Arts*, Was Kandinsky a Synesthete? Amy Ione and Christopher Tyler. This source was very informative because it gave a brief history of synesthesia through the eyes of the famous artists. Feynman was known for stating that when he saw equations he saw letters in colors.

GALEYEV, BULAT, M. *Evolution of Gravitational Synesthesia in Music: To Color and Light*. Leonard LEONARDO, Vol.36, No 2, pp. 129-134, 2003.

This Journal was very informative, because the author presents a detailed history and theory of a basic form of synesthesia, little studied to date, connected with the associative perception of gravity in music, This Journal also indicates that synesthesia appears to be very common to all other kinds of art and everyday language as well. Galejev called the synesthetic experience a global allegory because we all use it in everyday life as well as possess the ability to understand it.

GAUTIER, Th. *Le club des hachichins*, La Presse, Paris 10 Juli 1843.

This source was cited in the *Psychological Bulletin*, Vol.,82, No.3. *On Colored-Hearing Synesthesia; Cross-Modal Translation of Sensory Dimensions* by Lawrence E. Marks, 1975. He was a French poet who wrote extensively about how colors spoke to him under the influence of hashish. This source is important because if narcotics can enhance color hearing, neurologically speaking there must be a strong connection between hearing and vision.

GHIL, R. *Traite du verbe* (Originally published, 1887). In A. Messein (Ed.), *Oeuvres completes* (Tome 3). Paris: Messein, 1938.

This source was cited in the *Psychological Bulletin*, Vol., 82, No.3. *On Colored-Hearing Synesthesia: Cross-Modal Translation of Sensory Dimensions* by Lawrence E. Marks, 1975. Rene Ghil built a literary system pertaining to colors of sounds. In his findings he paired vowel sounds with a corresponding color.

GIBSON, J.J. (1966). *The senses considered as perceptual systems*. Boston: Houghton Mifflin.

This source was cited in the *Journal of Psychology of Consciousness: Theory, Research and Practice* 2013. Vol.1(S).108-129. *Synesthesia: A New Approach to Understanding the Development of Perception* by Ferrine Spector and Daphne Maurer. Gibson conducted a study in which he determined that some cross modal associations are readily grasped by young infants, whereas others emerge later in life. He has determined the differences on the basis of the integration of schemas.

GOETHE, JOHANN WOLFGANG VON. 1907. *Maximen und Reflexionen*. Weimar: Verlag der Goethe – Gesellschaft.

This source was cited in the *Journal of Interdisciplinary Studies*, 17.no1/2, 2005 by David Grandy. Grandy supported his argument in the essay stating that Goethe stepped off the premise that a common principle of intelligence informs mind and matter, and this prompted a more subjective attitude towards nature. Therefore, in his view human reason was not a light in the dark, but it is an organ of perception in a sentient world.

GRANDY, DAVID. Goethe on Color and Light. *Journal of Interdisciplinary Studies*, 17. No 1/2, 2005

This essay explores Wolfgang von Goethe's reaction to Newtonian science and its quantification of nature. Grandy described how Goethe insisted that Newton's portrayal of light and color was but a partial account of the reality. In essence Goethe developed ideas that presuppose mind-world intimacy and the consequent need to acknowledge the limited utility of mathematical modeling and theory construction. Importantly, Goethe believed that science may expand our spiritual horizons by helping us see the many ways we are patterned into the phenomenological splendor of the world.

GROSSENBACHER, P., & LOVELACE, G. (2001). Mechanisms of synesthesia: Cognitive and psychological constraints. *Trends in Cognitive Sciences*, 5, 36-41.

This source was cited in the *Journal of the Psychology of Consciousness: Theory, Research and Practice* 2013. Vol.1(S).108-129. Grossenbacher has conducted neurological studies during which he has discovered that synesthesia could also be caused by the altered feedback from higher cortical areas onto lower sensory cortices. Neurological studies are important because they help us understand the underlying processes that take place during the cross sensory association.

HARRISON, J., (2001). *Synesthesia: The Strangest Thing*. New York: Oxford University Press.

This source was cited in the *Liberation of the Senses: An exploration of Sound-Color Synesthesia in the Music of Alexander Scriabin and Olivier Messiaen*, December 8, 2014, by Evan Norcross Flynn. In this essay Harrison described the origins of the term synesthesia. According to him synesthesia is a blend of the Greek *syn*, meaning together or union and *aesthesia* meaning sensation, which implies two or more sensations occurring simultaneously. He also described what differentiates synesthetes from other people. Most people experience sensations such as touch, taste, smell, hearing and vision, which is usually known as the five senses. However, there are people who experience two or more sensations concurrently and they are called synesthetes.

HELMHOLTZ, H. von *Die Lehre von den Tonempfindungen*. Braunschweig, Germany; Vieweg und Sohn, 1863.

This source was cited in the *Psychological Bulletin*, Vol., 82, No.3. *On Colored Hearing Synesthesia: Cross-Modal Translation of Sensory Dimensions* by Lawrence E. Marks, 1975. Helmholtz has performed studies in which he tried to determine the actual resonant frequencies of the vocal tract during vowel production. His inquiries showed which vowels have the highest and the lowest frequencies.

HOWELLS, T.H. *The experimental development of color-tone synesthesia*. *Journal of Experimental Psychology*, 1944, 34, 87-103.

This source was cited in the *Psychological Bulletin*, Vol., 82, No.3. *On Colored Hearing Synesthesia: Cross-Modal Translation of Sensory Dimensions* by Lawrence E. Marks, 1975. Howells is known for conducting experiments in 1944 which investigated the pairing of colors with sounds. He paired C note with red color to see if the subjects would constantly recognize red instead of blue or green.

HUBBARD, E.M., ARMAN, A.C., RAMACHANDRAN, V.S., & BOYTON, G.M. (2005). Individual differences among grapheme – color synesthetes: Brain behavior correlations. *Neurons*, 45,975-985.

This source was cited in the *Journal of Psychology of Consciousness: Theory, Research and Practice* 2013. Vol.1(S).108-129. Synesthesia: A new Approach to Understanding the Development of Perception by Ferrine Spector and Daphne Maurer. This source was cited in my essay because it included the actual percentage of occurrence of synesthesia in population.

IONE, AMY & TYLER, CHRISTOPHER. Neurohistory and the Arts. Was Kandinsky a Synesthete? *Journal of the History of the Neurosciences*, 2003. Vol 12.No.2. pp .223-226

This *Journal of the Neuroscience* was very instrumental in obtaining first relevant information that pertained to color hearing. Ione and Tyler explored the association between color and music from the perspective of many cultures in the history. They have cited great artists to support their hypothesis. They have also wrote about synesthesia from the neurological perspective and how under certain drugs experience of synesthesia becomes more vivid.

KANDINSKY, V (1912): On the spiritual in art. In:Lindsay KC,Vergo P.eds. and trans., *Kandinsky: Complete Writings on Art* .London ,Faber & Faber,1982.

This source was cited in the *Journal of the History of the Neuroscience* 2003, Vol. 12.No.2.pp.223-226 *Neurohistory and the Arts. Was Kandinsky a Synesthete?* Kandinsky is considered a pioneer in synesthetic associations between color and sound which he widely utilized in his art. Through his art and writing science was able to delve much deeper in to the phenomenon of synesthesia. Therefore, he and his memoirs are very crucial to this research paper.

KELLY, E.K. An experimental attempt to produce artificial chromesthesia by the technique of conditioned response .*Journal of experimental Psychology*, 1934, 17,315-341.

This source was cited in the *Psychological Bulletin*, Vol., and 82 .No.3. *On Colored-Hearing Synesthesia: Cross- Modal Translation of Sensory Dimensions* by Lawrence E. Marks, 1975. Kelly conducted experiments in 1934 which investigates consistency of color recognition when pairing C note with red

KOENING, R. Sur les notes fixes caracteristiques des diverse voyelle ,*Comptes Rendus de l'Academie des Sciences* ,1870 ,70,931-933.

This source was cited in the *Psychological Bulletin*, Vol., 82, No.3, *On Colored-Hearing Synesthesia:Cross-Modal Translation of Sensory Dimension* by Lawrence E.Marks,1975. Koenig conducted studies in 1870 in which he tried to determine the actual resonant frequencies of the vowels the order of increasing frequencies were matched with the increasing vowel brightness.

LEUBA, C. Images as conditioned sensations .*Journal of Experimental Psychology*, 1940, 26, 354-351.

This source was cited in the *Psychological Bulletin*, Vol., 82, .No. 3, *On Colored-Hearing Synesthesia: Cross-Modal Translation of Sensory Dimension* by Lawrence E. Marks, 1975. Leuba in his studies

wanted to prove that pairing a 1000Hz tone with a white light would cause hallucinations. Therefore, indicating that there is a strong connection between the two senses hearing and seeing.

LEUBA, C., & DUNLOP, R. Conditioning imagery, *Journal of experimental Psychology*, 1951, 41, 352-355.

This source was cited in the *Psychological Bulletin*, Vol., 82, No.3, On Colored-Hearing Synesthesia: Cross-Modal Translation of Sensory Dimension by Lawrence E. Marks, 1975. Leuba in his studies wanted to prove that pairing a 1000Hz tone with a white light would cause hallucinations. Therefore, indicating that there is a strong connection between the two senses hearing and seeing.

MARKS, L.E. & STEVENS, J.C. Individual brightness functions *Perception & Psychophysics*, 1966, 1, 17-24.

This source was cited in the *Psychological Bulletin*, Vol., and No.3. On Colored-Hearing Synesthesia: Cross-Modal Translation of Sensory Dimension by Lawrence E. Marks, 1975. Marks with Stevens in their studies discovered when subjects are asked to match brightness of lights to loudness of sounds they align increasing brightness with increasing sound pressure in a systematic manner that is similar from person to person. Therefore, proving that there is a neurological connection between sound and color,

MARKS, L.E. (1975). On Colored-Hearing Synesthesia: Cross-Modal Translations of Sensory Dimensions. *Psychological Bulletin*, Vol., 82, 303-331.

This journal explored color hearing through the multidisciplinary perspective. Marks explored the issue of colored vowels and their corresponding sounds through other studies as well through the memoirs of famous writers, theories. This journal was also important in my essay because it delved deeper in to the issue of colors of musical patterns and how sounds can produce visual sensation. Moreover, it has provided many other sources which I was able to incorporate in my research paper.

MARKS, L. E. (1978). *The Unity of the Senses; Interrelations among the Modalities*. New York, Academic Press, pp.99-100.

This source was cited in the *Journal of the History of the Neuroscience* 2003, Vol.12, No.2, pp.223-226 *Neurohistory and the Arts. Was Kandinsky a Synesthete?* By Amy Ione and Christopher Tyler. Marks was cited in this Journal because he Marks studies revealed that multimodal synesthesia is experienced by most who take LSD thus it is a latent facility that takes only the specific effects of the miniscule dose of this drug to release. Moreover, there seems to be a similar pattern of experiences between all who have taken hallucinogenic drugs indicating that human wiring has inherent predisposition for cross sensory associations.

MAURER, D., & MAURER, C. (1988). *The world of the newborn*. New York: Basis Books.

This source was cited in the *Journal of Psychology of Consciousness: Theory, Research, and Practice* 2013. Vol.1(S).108-129, *Synesthesia : A new Approach to Understanding the Development of Perception* by Ferrine Spector and Daphne Maurer. Maurer and Maurer citation was very important because it stated synesthesia arises when neuronal synapses fail to reach certain brain regions. Thus, indicating that cross association is largely dependent and shaped by the experience.

MASSON, D.I. synesthesia and Spectra. *Word*, 1952, 8, 39-41.

This source was cited in the *Psychological Bulletin*, Vol., 82, No.3, On Colored-Hearing Synesthesia: Cross-Modal Translation of Sensory Dimensions by Lawrence E. Marks, 1975. Masson in his studies looked to find if there are other factors that need to be taken in to consideration when connecting color and sound. His studies examined the formant structures of vowels and how does that pertain to synesthetic coloring of the vowels.

MUGGLETON, N., TSAKANIKOS, E., WALSH, V., & WARD, J. (2007). Disruption of synesthesia following TMS of the right posterior parietal cortex. *Neuro-psychologia*, 45, 1582-1585.

This source was cited in the *Journal of Consciousness: Theory, Research and Practice* 2013. Vol.1(S), 108-129, Synesthesia: A New Approach to Understanding the Development of Perception by Ferrinne Spector and Daphne Maurer. Muggleton and Tsakanikos have studied the actual percentage of the occurrence of synesthesia in a population. According to their data 5 % of population experiences cross sensory associations. This source is importance because it gives actual prevalence numbers.

MYERS, C. (1914). A case of synesthesia. *British J Psych* 6:228-232.

This source was cited in the *Journal of the Neuroscience*, 2003, Vol.12.No.2, pp.223-226. Neurohistory and the Arts. Was Kandinsky a Synesthete? This source was important because, Myers was mentioned in the Journal describing the way composer Alexander Scriabin associated the key of F# with the color violet.

NABOKOV, V. (1947). *Speak, Memory*. New York, Knopf.

This source was cited in the *Journal of the Neuroscience*, 2003, Vol.12.No.2, pp 223-226. Neurohistory and the Arts. Was Kandinsky a Synesthete? Nabokov was quoted in this source because of his synesthetic association between letters and the smell of weathered wood and polished ebony. It is important because Nabokov being a writer obviously experienced all kinds of synesthetic association in regards to language, which I have touched upon in my essay.

NEVILLE, H. (1995). Developmental specificity in neurocognitive development in humans. In M. Gazzaniga (Ed.), *The cognitive neuroscience* (pp.219-231). Cambridge, MA: Bradford.

This source was cited in the *Journal of the Psychology of Consciousness: Theory, Research, and Practice* 2013. Vol.1(S).108-129. Synesthesia: A New Approach to Understanding the Development of Perception by Ferrine Spector and Daphne Maurer. Neville studies indicated that when an infant is being spoke to auditory and visual cortex is simulated concurrently, over time this activity lessens and at about three years of age completely dissipates. This source is important because it indicates that infants are pretty much born with inherent cross association abilities through which they learn and develop. However, in the developmental process certain neuronal wiring changes because it is shaped the experience.

OCKLEFORD E.M., Vince, M.A., LAYTON, C., & READER, M.R. (1988). Responses of neonates to parents and others voices. *Early Human Development*, 18, 27-36.

This source was cited in the *Journal of the Psychology of Consciousness: Theory, Research and Practice* 2013, Vol. 1(S).109-129. Synesthesia: A New Approach to Understanding the Development of Perception by Ferrine Spector and Daphne Maurer. Ockleford and Layton studied infants and in the process discovered that babies from a very young age can remember mother's voices but this voice must be accompanied with the correct face. This source is important as it indicates that auditory and visual cortex in the brain work together and participate together in the development.

PIAGET, J. (1952). *Origins of intelligence in children*. New York: International Universities Press.

This source was cited in the *Journal of the Psychology of the Consciousness: Theory, Research and Practice* 2013, Vol. 1(S). 109-129. Synesthesia: A New Approach to Understanding the Development of Perception by Ferrine Spector and Daphne Maurer. Piaget studies produced lots of results which supported the belief that some cross modal associations are readily grasped by young infants, whereas others emerge later. Researchers have explained the differences on the basis of the integration of schemas (Piaget) or amodal versus arbitrary correspondences (Gibson). Therefore this source indicated that infants are born with cross modal sensory associations, indicating that neuronal wiring is built that way on purpose.

PLUMMER, H.C. Color music-A new art created with the aid of science .*Scientific American*, 1915, 112,343; 350-351.

This source was cited in the *Psychological Bulletin*, Vol., 82, No.3, On Colored –Hearing Synesthesia: Cross-Modal Translations of Sensory Dimensions by Lawrence E. Marks, 1975. Plummer wrote about Alexander Scriabin and his composition *Prometheus* which was performed at Carnegie Hall where a special color organ needed to be provided for the artist. He further explained that the colors were played on a keyboard and projected on to the screen. The correlation between tone and color was systematic and C note was matched to red color, D by yellow, E and F# by blues. This source is important because it shows us how the medium of color hearing has been utilized by the arts before science started to investigate the neurological bases for the synesthesia.

RAMACHANDRAN, V .S.HUBBARD, E.M. (2000): Psychophysical investigations into the neural basis of synesthesia. *Proc R Soc Lond B* 268; 979-983.

This source was cited in the *Journal of the History of the Neuroscience*, 2003, Vol.12.No.2.pp.223-226, *Neurohistory of the Arts .Was Kandinsky a Synesthete?* By Amy Ione and Christopher Tyler. Studies conducted by Ramachandran and Hubbard have been very helpful because they allowed to reevaluate synesthesia as an abnormality in the brain. Thus allowing us to think of it as normal.

RAMACHANDRAN, V.S., & HUBBARD, E .M. (2001).Synesthesia: A window into perception, thought and language, *Journal of Consciousness Studies*, 12, 3-34.

This source was cited in the *Journal of the History of the Neuroscience*, 2003, Vol.12.No.2.pp.223-226, *Neurohistory of the Arts .Was Kandinsky a Synesthete?* By Amy Ione and Christopher Tyler. Studies done by the Ramachandran and Hubbard in which they have determined that colors may be used to penetrate the crowding effects of arrays of nearby shapes, letters and numbers. This source was important in the essay because it gave an insight into the neurology of the condition known as synesthesia.

ROUW, R., &SCHOLTE, H.S. (2007).Increased structural connectivity in grapheme-color synesthesia. *Nature Neuroscience*, 10,792-797.

This source was cited in the *Journal of the Psychology of Consciousness: Theory, Research, and Practice* 2013, Vol 1(S).108-129, *Synesthesia: A New Approach to Understanding the Development of Perception* by Ferrine Spector and Daphne Maurer. Rouw and Scholte conducted neurological studies of subject who experienced synesthesia. Their results showed that silencing the right parietal –occipital area reduced the interference between synesthetically induced and real colors, for converging evidence of increased parietal connections in the left parietal cortex of grapheme color synesthetes. This source is important because it indicates which parts of the brain participate in cross sensory associations.

SEPPER. DENNIS, L. 1988.Goethe contra Newton: Polemic and the Project for a New Science of Color, Cambridge, UK: Cambridge University Press.

This source was cited in the *Journal of Interdisciplinary Studies*, 17 .no1/2, 2005, *Goethe on Color and Light* by David Grandy. Sapper’s understanding of the Goethe’s outlook was that staying with the phenomena will allow nature’s innate order and intelligence to mingle into their thinking .Thus the understanding grows as the mind learns to trust the senses and take pleasures in their manifold offerings.

SPECTOR, FERRINE & MAURER, DAPHNE, *Synesthesia; A New Approach to Understanding the Development of Perception. Psychology of Consciousness: Theory, Research and Practice*, 2013. Vol.1(S), 108-129.

In this Journal the authors investigated the fundamentals for understanding intercessory development. They have supported their thesis with studies gained from adults who experience synesthesia, in whom sensory stimuli induce extra cross-modal or intermodal percepts. They review evidence on the perceptual reality and most importantly the neural basis of synesthesia. Moreover, they illustrate how sensory association in adults predicts the development of perception in toddlers. Importantly,how cross sensory association influences language and perception .

SUAREZ de MENDOZA.F. L’audition coloree. Paris: Octave Dain, 1890.

This source was cited in the *Psychological Bulletin*, Vol., 82, No.3, *On Colored-Hearing Synesthesia: Cross-Modal Translation of Sensory Dimensions* by Lawrence E. Marks, 1975. Suarez in his studies discovered that there is a clear connection between color and auditory pitch. He stated that the lower the frequency of a note the darker the color and the higher the notes the more clear and brilliant colors become.

Van CAMPEN, C. (1997): *Synesthesia and artistic experimentation* .*Psyche*, 3. <http://psyche.cs.monash.edu.au/v3/psyche-3-06-vancampen.html>

This source was cited in the *Journal of the History of the Neurosciences*, 2003, Vol .12 .No.2 .pp.223-226, *Neurohistory and the Arts .Was Kandinsky a Synesthete?* By Amy Ione and Christopher Tyler.Van Campen stated that Kandinsky longed to bring the essence of cross modal experience to a wider audience, because one can feel the multisensory consonances and dissonances in simultaneously performed color movements , musical movements and dance movements. Van Campen quote was important because it

emphasized the belief that synesthesia is a natural state that can be understood by everybody, albeit experienced by a few.

VICKERS, EARL, 1977. Music and Consciousness.

www.sfxmachine.com/docs/musicandconsciousness.html

This source was found at the www.sfxmachine.com/docs/musicandconsciousness.html. An essay originally written in 1977, Music and Consciousness. Earl Vickers essay was very informative because it elaborated on the fact that music has always been used as a medium to communicate with the consciousness. Vickers went back in history and explored the use of sound in hypnotic states, in dreams and how music /sound has been used by shamanic healers as an integral part of their healing rituals. Importantly, changes in consciousness can also be triggered by polyphony as he stated. Therefore, this source was important because it clearly explained how sound in its fundamentals is a major factor cross modal associations.

WARD, OSSIAN, (2006). www.telegraph.co.uk/culture/art/3653012/the-man-who-heard-his-paintbox-hiss.html

Ossian Ward reviewed the exhibition of Kandinsky's work. He thoroughly examined artist work and explained how his synesthetic abilities helped him create amazing art. Kandinsky is considered a pioneer in the synesthetic associations and because of him science could take a closer look at this phenomenon. Ward also gave examples of other artists that have utilized this ability in their arts.

WEHOFER, F. "Farbenhoren" (Chromatische Phonopsien) bei Musik. *Zeitschrift für Angewandte Psychologia*, 1913, 7, 1-54.

This source was cited in the *Psychological Bulletin*, Vol. 82, No.3, On Colored-Hearing Synesthesia: Cross-Modal Translation of Sensory Dimensions by Lawrence E. Marks, 1975. Wehofer in his studies explained that there are other factors that enable synesthetic coloring of vowels such as formant frequencies of vowel. Therefore this source was important because it explained that there are underlying acoustic components that affect the perception of sound through color.

WERNER, H *Comparative psychology of mental development*. New York; Harper, 1940.

This source was cited in the *Psychological Bulletin*, Vol., 82, No.3, On Colored-Hearing Synesthesia: Cross-Modal Translations of Sensory Dimensions by Lawrence E. Marks, 1975. Werner claimed that language and speech are not an end in itself. It is a system of symbols, where words belong to particular objects. Therefore, through this association can a synesthetic experience take place on a neurological level.