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Araştırma Makalesi

Colors of Hearings: A Subjective Experience of Synesthesia Among Six Siblings

Leyla ALMA[1], Sami ÇOKSAN[2*], Müjde KOCA-ATABEY[3]

[1] Orta Doğu Teknik Üniversitesi, Fen-Edebiyat Fakültesi, Psikoloji Bölümü, Ankara, Türkiye

[2] Erzurum Teknik Üniversitesi, Edebiyat Fakültesi, Psikoloji Bölümü, Erzurum, Türkiye

[3] Ankara Medipol Üniversitesi, İktisadi, İdari ve Sosyal Bilimler Fakültesi, Psikoloji Bölümü, Ankara, Türkiye

Makale Bilgisi

Keywords:

synesthesia, synesthetic experience, grapheme-color synesthesia, interpretative phenomenological analysis

Abstract

The current research aimed to explore, understand and describe the subjective experiences of synesthesia among six self-reported synesthete siblings. For this purpose, we conducted one quantitative and one qualitative study. The first study aimed to measure whether six siblings actually had synesthesia experiences. Six synesthete siblings and their eighteen non-synesthete peers participated in Study 1. First, participants filled out the Eagleman Synesthesia Test Battery - Synesthesia Type Scale. Then, we asked the participants to match some words we randomly selected from the Turkish dictionary with colors on a color scale. Both cross-sectional and longitudinal comparisons showed that six siblings statistically and consistently matched words with specific colors compared to their non-synesthete peers, and these colors hardly changed over time. In study 2, we interviewed these siblings and aimed to investigate their synesthetic experiences using an interpretative phenomenological analysis approach. We verbatim transcribed the interviews, and the results showed that three main themes emerged, which were: (1) The nature of the synesthesia experience; (2) Aspects of the synesthesia experience; (3) Time and experience: It may change inter and intraparticipant. We discussed the findings in the context of the persistence and changeability of the synesthetic experience and the uniqueness seen among siblings, even when raised in a similar environment.

Anahtar Kelimeler:

sinestezi, sinestezik deneyim, grafem-renk sinestezisi, yorumlayıcı fenomenolojik analiz

Öz

Bu çalışma sinestezik deneyimleri olduğunu ifade eden altı kardeşin deneyimlerini keşfetmeyi, anlamayı ve betimlemeyi amaçlamaktadır. Bu amaç bir nicel ve bir nitel araştırma yürütülmüştür. Birinci araştırma, altı kardeşin sinestezik deneyimlerini görgül olarak sınamayı amaçlamaktadır. Bunun için sinestezi deneyimlediğini belirten 6 katılımcı ile bu deneyimi belirtmeyen 18 akran araştırmaya katılmıştır. Katılımcılar ilk olarak Eagleman Sinestezi Test Bataryası – Sinestezi Tipi Ölçeği'ni doldurmuşlardır. Ardından tüm katılımcılardan, araştırmacılar tarafından güncel Türkçe sözlükten seçkisiz olarak seçilmiş çeşitli kelimeleri bir renk yelpazesindeki renklerle ilişkilendirmeleri istenmiştir. Hem kesitsel hem de boylamsal karşılaştırmalar, sinestezik deneyim belirten altı kardeşin akranlarına kıyasla kelimeleri tutarlı ve istatistiksel olarak anlamlı biçimde, belirli renklerle eşleştirdiklerini ve bu eşleştirmelerin zaman içerisinde neredeyse hiç değişmediğine göstermiştir. İkinci çalışmada öznel sinestezik deneyimlerini ortaya koymak adına bu altı kardeş ile yarı yapılandırılmış görüşmeler gerçekleştirilmiş ve veriler yorumlayıcı fenomenolojik analiz ile irdelenmiştir. Bulgular, kardeşlerin yanıtlarının üç temel tema etrafında kümelendiğini göstermiştir: (1) Sinestezi deneyiminin doğası; (2) Sinestezi deneyiminin özellikleri; (3) Zaman ve deneyim: Deneyim katılımcılar arası ve katılımcı içi değişebilir. Bulgular, benzer bir ortamda yetiştirilse bile kardeşler arasında görülen sinestezik deneyimin kalıcılığı ve değişebilirliği bağlamında tartışılmıştır.

*Sorumlu yazar, Adres: Erzurum Teknik Üniversitesi, Ömer Nasuhi Bilmen Mah. Havaalanı Yolu Cad. No:53 Edebiyat Fakültesi, Psikoloji Bölümü, Oda No:333, Yakutiye/Erzurum/Türkiye
e-posta: sami.coksan@erzurum.edu.tr
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Introduction

Synesthesia is a condition that includes a rare and subjective way of sensing the world. It is defined as the production of a sense impression relating to one sense or part of the body by stimulation of another sense or part of the body, which means joined sensation can be exemplified as that the music is not only heard but also seen, taste sensation can also be felt like a physical touch (Cytowic & Eagleman, 2009). It is a rare perceptual condition in which a specific stimulus is experienced by at least more than one sensation (Beeli et al., 2008). The prevalence of synesthesia is 1/25.000 or 100.000 adults (Dann, 1998). Moreover, recent studies showed that approximately 2-5% of the population experience synesthesia (Simner & Hubbard, 2013; Simner et al., 2006). The researchers state that the conceptualization of synesthesia and the different measurements based on it reveal this ratio difference.

It has several forms defined from 60 to 150 versions, including auditory stimuli that trigger visual stimuli in the form of color, shape or tactual sensory, or tasting sensory (Cytowic & Eagleman, 2009). For instance, hearing stimuli may lead to the experience of a color, which means auditory stimulation can result in visual stimulation. This form of synesthesia is the most common form called grapheme-color synesthesia (Rich et al., 2005). In accordance with Day's self-reported research, 40% of synesthetes see with their ears (Day, 2005). Individuals with grapheme-color synesthesia can experience colorful visual displays due to the varied auditory stimuli, such as vowels, complete words, musical notes, and other sounds that non-synesthetes will find so fantastic even to imagine (Dann, 1998).

Synesthetic experience may occur due to a genetic heritage monitored in the other family members (Baron-Cohen et al., 1996; Brang & Ramachandran, 2011). Heritage is carried with a sex-linked genetic mechanism which explains that women lead the sex ratio (6/1) in synesthesia according to some views (Baron-Cohen et al., 1996, Eagleman & Goodale, 2009; Ward & Simner, 2005). The studies which focus on synesthesia are mostly bringing neuroscientific explanations of the synesthesia mechanism by using neural measurement techniques and quantitative research methods (Beeli et al., 2008, Brang et al., 2010; Grossenbacher & Lovelace, 2001; Hupé et al., 2012; Rouw et al., 2011; Sinke et al., 2012). In other words, neurological studies mostly compare synesthetes and non-synesthetes to focus on the localization areas and communication flow among areas in the brain by using brain tomography, magnetoencephalography, and functional magnetic resonance imaging. Finally, the literature might be summarized that grapheme-color synesthesia states an automatic processing that indicates simultaneous activation of both the occipitotemporal cortex (visual functions) and parietal lobe (other sensory functions, such as hearing) (Beeli et al., 2008, Brang et al., 2010; Grossenbacher & Lovelace, 2001; Hupé et al., 2012; Rouw et al., 2011; Sinke et al., 2012).

On the contrary, few studies focus on the subjective meaning of synesthesia among people who share the same genetic heritage and similar environmental factors. Subjective synesthesia experience from a sample with similar genetic and environmental factors, such as siblings, may reveal similar and different characteristics of synesthesia that have not been expressed until now. In this research, we aimed to understand the shared similarities and differences in the synesthesia experience based on the subjective experiences of 6 synesthetic siblings who grew up in a similar environment and thus to describe the subjective synesthesia experience that has not been empirically tested among family members in the literature to the best of our knowledge.

Moreover, we aimed to describe these six siblings' experiences related to subjective well-being. Some current studies (e.g., Carmicihael et al., 2018; Simner et al., 2021) revealed that synesthetic experience might be related to anxiety; hence, synesthesia may be associated with low well-being. However, this assumption has not yet been examined with qualitative methods; moreover, whether the participants directly refer to well-being about their synesthetic experiences in the non-directed interviews has not been examined. In this study, we finally wanted to see if the participants would associate these experiences with their subjective well-being.

Study 1

Synesthetic perception is sometimes confused with people's own subjective experiences. Therefore, studies conducted with individuals who state that they have experienced synesthesia primarily examine whether these individuals have experienced synesthesia (Simner & Hubbard, 2013). In our first study, we wanted to investigate whether six siblings we reached through our personal connections and who stated that they had synesthesia (grapheme-color type) really had such an experience. To do this, after asking both groups to indicate whether they experienced synesthesia on a scale, we asked them to match the words in a list of 100 words with the colors on a 200-color chart at two different times. Here, we aimed to see if the synesthetes-experienced participants, compared to the non-synesthete group, consistently matched words to a specific color, that is, to test whether they actually experienced the words they read as a colored auditory stimulus.

Method

After obtaining ethical approval, six synesthete siblings (2 male, 4 female) aged between 24-42 (M_{age} = 32.83) and their 18 non-synesthete peers (5 male, 13 female) aged between 18-62 (M_{age} = 32.11) participated in Study 1. No statistical difference was observed between groups in terms of age ($t(22) = .124$, $p = .903$) and gender ($\chi^2(1) = .067$, $p = .795$). Non-synesthete participants reported they have no person with synesthesia in their family. All

participants are right-handed and spend most of their lives in a city. No participants indicated they were diagnosed with a brain tumor, epilepsy, migraine, or learning difficulties like dyslexia, dyscalculia, dysgraphia, or any psychological disorders.

Eagleman Synesthesia Test Battery - Synesthesia Type Scale was used to measure whether participants experienced any type of synesthesia (Eagleman et al., 2007). It is a self-reporting scale consisting of six culture-independent questions that have been used with direct translation without changing the content and context (Thorndike & Thorndike-Christ, 2013). The reliability of the scale was *KR*-21 = .79 in the current study.

A color-word matching list task was used to measure participants' consistency in matching some words with colors. For this, the participants were asked to associate the words in a word list with various colors, and this task was repeated 15 days later. The consistency between the two measures was considered as the synesthesia score, and the low deviation score between the measures was evaluated as high consistency, in other words, hearing the words in color. The word list that includes a hundred words was created by researchers to examine whether the participants with synesthesia made more consistent word and color matching than the other participants. The words were randomly selected from the current Turkish dictionary. Unified words (e.g., like ayakkabi, it means shoe, but in Turkish, it consists of 'foot' and 'container' words), words which directly include (e.g., bembeyaz, it means snow-white) or evoke (e.g., like aslanağzı, it means antirrhinum, but in Turkish, also there is a color called 'aslanağzı') color name, prepositions like to (in Turkish "için") and conjunctions like or (in Turkish "veya") were removed from the list. After that, the process of randomly selecting words continued until the list had 100 words. A simple HTML 5 color table with 20 columns, 10 lines, and 200 cells (i.e., 200 colors ranging from white to black, including different tones of main colors) was used to carve out the color chart. It was presented on a sheet of A4 size paper, and each cell covered approximately 220 square millimeters area (1.3 x 1.7 cm). The world list and color chart are presented on https://osf.io/r8c4g/?view_only=ddbbb153b0f547c093c5c3e9b26d8eb8.

The aim of the research was announced on the internet page of the department to find non-synesthetes participants. After the appointment, we invited them to the departmental lab. After their consent, participants filled out the demographic information form and the Eagleman Synesthesia Test Battery. Second, they matched words with colors using the color table and word list. This data collection procedure has done in the lab and took approximately 45 minutes. Figure 1 presents the procedure. We gave them another appointment for a second measurement of word color matching at the end of this process. In order to minimize the recall effect, the positions of the words in the word list in the second word-color matching task were randomly changed and read after the duration of at least 15 days to be able to test test-retest

realiability. In this way, it was assured that participants did not remember and recalled the matched color and word pairs by the aid of the 15-day time gap between two measurements.

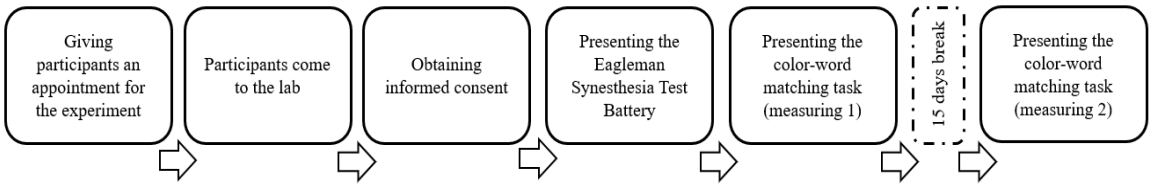

Figure 1. *The Procedure of Study 1*

Results

Six siblings (100%) expressed that they experienced grapheme-color type synesthesia, although only five participants among non-synesthetes (%28) stated it. The z-ratio test indicated that participants with synesthesia stated more grapheme-color type synesthesia experience, $z = 3.07$, $p < .01$. The difference between the first and second word-color matching measurements of the participants was assessed as a score of the synesthesia experience. The lower difference between the two measurements indicates a higher probability of synesthesia. The difference between six siblings who experience synesthesia and their eighteen peers in terms of the score of synesthesia was analyzed by an independent sample t-test. Results showed that six siblings' word-color matching score consistency between time 1 and time 2 is greater than the non-synesthete group, $t(22) = 10.77$, $p < .001$. Moreover, we examined consistency among six siblings, and found that it changes within siblings, Selim (ΔWCM = .99), Sevgi (ΔWCM = 1.11), Ahmet (ΔWCM = 1.82), Hale (ΔWCM = 1.97), Gülhan (ΔWCM = 3.49) and Deniz[1] (ΔWCM = 3.64).

Discussion

Findings from both the Synesthesia Type Scale and the word-color matching task suggested that they experience grapheme-color type synesthesia, as six siblings self-reported. As stated in the literature (Dann, 1998; Simner & Hubbard, 2013), the most common type is grapheme-color type synesthesia. In this study, participants who experienced grapheme-color type synesthesia, the most common type, were reached. Even if they did not experience synesthesia, 5 people on the scale stated that they may have experienced simple type synesthesia in their past. In the literature, it is stated that there may be people who can express that they have had such experiences, even if they are not synesthetes (Dann, 1998; Simner &

[1] Names are presented as pseudonyms to protect participants' anonymity.

Hubbard, 2013). Therefore, using matching tasks instead of self-report measurements may give more accurate results in such studies.

Six siblings gave nearly the same answers in the word-color matching tasks at two different times. For instance, if a sibling preferred a shade of green among 200 colors for the word *ayıplamak*, which means to shame in Turkish, she or he preferred almost the same shade in the second measurement. The lowest deviation mean was .99 and the highest deviation mean was 3.64 in a score with a range of 0 and 27. This finding may show that grapheme-color type synesthesia is not a side effect of subjective experience or simple word-color matching depending on their memory and that participants actually experience the words they read intensely in color (Baron-Cohen et al., 1993).

Study 2

Very few studies describe synesthetes' subjective experiences (Fernay et al., 2012), while there is a great deal of focus on topics such as their memory and perception processes (Simmonds-Moore, 2016). However, revealing the synesthesia experiences of people who share similar genetic and environmental factors may enable the neuropsychology field to focus on the commonalities and differences in these experiences. For instance, are negative words perceived in similar colors? Do verbal concepts differ more among individuals with similar genetics than mathematical ones? Does autobiographical memory differentiate the color perception of words among synesthetes? Such questions can only be answered and described by in-depth analysis of qualitative data to be obtained through face-to-face interviews; thus, future studies may focus on the function of different brain regions in individuals experiencing synesthesia. Therefore, in the second study, we conducted semi-structured interviews with the participants and aimed to describe the participants' subjective synesthesia experiences from different perspectives.

Method

As described below, synesthesia is a subjective perception of sensations that can rarely be understood by people who do not experience it, making it hard to study. As synesthesia is a phenomenon involving so many mysterious sides that need to be enlightened, interpretative phenomenological analysis (IPA) was chosen as an appropriate tool to analyze the data. Phenomenology is described as a philosophical approach to the study of experience. Husserl, Heidegger, Merleau-Ponty, and Sartre were stated as phenomenological philosophers (Smith et al., 2009). According to Smith (2004), IPA is an idiographic (i.e., detailed analysis of each case), inductive (i.e., bottom-up analysis), and interrogative (i.e., integrated with the literature) method that aims to explore the respondents' personal experiences in a particular way and how they give meaning to their experiences.

Furthermore, although there can be similarities between IPA and case studies in terms of being based on a rare phenomenon and also generating hypotheses about the possible causes (Barker, Pistrang, & Elliott, 2016), IPA is more than a traditional description of a patient depending in clinician's notes, ideas and memories like Freud (1905, 1953) conducted in the cases of "Dora" or "Little Hans" (as cited in Barker, Pistrang, & Elliott, 2016). IPA can be explained as giving a voice to the respondents' concerns from the eye of the researchers (Larkin et al., 2006), not necessarily to the patients with a mental illness. As IPA includes two worldviews of both respondents and researchers, it is conducted in a double hermeneutic way, in which the researchers seek to interpret the world of the respondents (Smith, 2011). Smith (2004) defined IPA as a tool that initiates the curiosity of researchers and gives them a starting point helping them to begin with an understanding of the experience. Even though IPA was initially designed for use in health psychology (Smith, 2011), it enlarged its broad in a more comprehensive range of areas such as experiences of psilocybin-assisted psychotherapy (Belser et al., 2017), war experiences (Badri et al., 2013), or corporeal posttraumatic growth as a result of breast cancer (Gorven, & du Plessis, 2018), or the strike experiences of a firefighter (Brunsden & Hill, 2009). Moreover, studies that associate cognitive experiences and IPA are rare even if the sample is not restricted to family context as in the current study. One rare study that links the two investigates the perceptual deprivation paradigm via IPA (Lloyd et al., 2012)[2].

Participants

The sample consisted of six synesthetes, the members of a family who agreed to participate in the current study. Pseudonyms were given to the participants. All respondents declared that they had spent their childhood and adolescent periods together as a family in a rural area of Turkey. No participants indicated they were diagnosed with any psychological or neurological disorders. The demographic characteristics of the participants are summarized in Table 1. No participant self-reported they have another experience, indicating other types of synesthesia, such as sound from kinetics and temperature from odors.

[2] Here we would like to point out the difference between case study and IPA. The case study is mainly for diagnostic and descriptive purposes and covers psychopathological issues. IPA, on the other hand, aims to examine experiences in depth. IPA, also, includes double interpretation. The initial one is the interpretation of the participants, and the other one is the researchers' (Smith, 2011).

Table 1.

Demographic Characteristics of the Participants

Pseudonyms	**Gender**	**Age**	**Marital Status**	**Education Level**	**Occupation**	**Perceived Level of SES**
Selim	Male	28	Single	Undergraduate	Psychologist	Middle
Hale	Female	24	Married	Undergraduate	Teacher	Middle
Deniz	Female	30	Married	Elementary School	Housewife	Low
Gülhan	Female	27	Married	Elementary School	Housewife	Low
Sevgi	Female	38	Married	Elementary School	Housewife	Low
Ahmet	Male	42	Married	Elementary School	Worker	Low

Procedure and Data Analysis

Initially, ethical approval for the study was received from the Human Subjects Ethics Committee of the university. The semi-structured interviews were conducted among the six participants. Each interview began with demographic questions and continued with the specific synesthesia experience. We contacted one of the participants, and he became the gatekeeper of the study; his pseudonym is Selim. Except for one, all of the six siblings consented to be interviewed and to be audio-recorded. Interviews lasted between 35 and 55 minutes. The researchers transcribed the interviews verbatim. The authors then revealed the subthemes, and the superordinate themes for that are mainly related to the synesthesia experience.

The interpretative phenomenological analysis revealed the superordinate themes and sub-themes manifested by the transcripts. The sample size (n = 6) was congruent with the IPA guidelines (for appropriate examination, up to 10 participants were recommended). As IPA is an intensive and detailed analysis of cases, small and homogeneous samples are preferred (Smith & Osborne, 2003). As our sample consisted of the members of a family, it may be regarded a genetic pool, the members of which also shared environmental factors, thereby increasing the homogeneity of the sample.

Results

The analysis revealed three superordinate themes, which are: 1) The nature of the synesthesia experience; (2) Aspects of the synesthesia experience; (3) Time and experience: It may change inter and intraparticipant.

The Nature of the Synesthesia Experience

The nature of the experience was somehow different among participants. There were variations among participants in terms of being unaware of the frequency of the experience, as well as denying the rarity of the experience, as they took it for granted.

The respondents were unaware of their dual sensation experience before their brother told them it was an unusual way of sensing the world.

> I realized it while reading the chapter related to synesthesia in a cognitive psychology book. Actually, I was aware of my experience; however, I was not aware that the others were not experiencing it this way. Ordinary people do not have it (Selim, male, 28).

The participants stated that each sibling learned that they have synesthesia from Selim:

> I realized that I had synesthesia when my brother was studying psychology. Then, he shared it with us in our family group on WhatsApp. If my brother had studied law instead of psychology, for instance, maybe we would never learn anything about synesthesia (Hale, female, 24).

The participants of the study denied that there was something particularly outstanding about their experiencing colors by means of hearing. Even after the respondents learned that their experience was unique and rare, they denied the idea that the others around them did not experience the world the way they did each day. They all assumed that each person had some kind of multi-sensing.

> I have learned that others do not have it like us. I was assuming that everybody had it. I still do not believe that. I cannot believe that they do not associate a word with a color when it is said. How can they not associate a word with a color? If I say ten words, how come none of them are associated with a color? (Sevgi, female, 38)

Another example of denying the synesthesia experience was stated as follows:

> I was sure that the others had it, even if my brother said the opposite. Then I realized that they really do not have it. I did not believe this for a while. Then, I told my friends that I had such an experience. Most of them reacted to me like, what are you talking about, and told me it was nonsense. Mainly, my husband, when we were just friends, did not even want to talk about it. For instance, I do not want to talk about these issues with my older brother, as he thinks things like that are nonsense (Hale, female, 24).

Aspects of the Synesthesia Experience

The second superordinate theme of the analysis involves the determinants of associated colors for the words. Even though synesthetes had difficulty in explaining what may determine the color what they hear, we found that there were particular factors that affected the color

associations, including the dominant letter, the frequency of hearing, the style of the stimulus, the meanings of words, a phoneme of the words and past experience.

> I have realized that the color is a combination of the dominant letters most of the time; however, there are also (colors that manifest independently) from those dominant letters. Maybe sometimes it is just related to the meaning of the words (Selim, male, 28).

Some respondents stated that the color associated with what they hear is more likely to depend on the dominant letter rather than the meaning of the words, unlike the associations of non-synesthetes. The following excerpt from Ahmet illustrates this:

> The color of the word 'bravery' [in Turkish 'cesur'] mostly depends on the dominant letter of it. Such as 'C' or 'R'. If the letters exist and if there are more in it, they determine the color of it. However, they are not the main colors; they are just in between the main colors (Ahmet, male, 42).

Additionally, some participants declared that the associated color of the digits may vary when seeing them written as a digit, such as 3, and three and also when they hear the phoneme three. As this situation is just ascribed to certain specific numbers ranging from 1 to 10, we regard this as experiencing color differently than what they are hearing (seeing) may also be related to the frequency of hearings the stimulus.

> Thirteen 'as a word' was not associated with any color, but 13 'as a number', is associated with white, black, and the color of water (Deniz, female, 30).

Meaning and phoneme are the other determinants of the associated colors, according to the participants of the research. While some were affected by the meaning of what they hear, some others were more likely affected by the phoneme of the hearings when it comes to what determines the associated colors. The following excerpt from Deniz exemplified this:

> 'Yüz' [a homonym for the words hundred and face] has a different associated color when I hear it.... 'Yüz' [meaning hundred] is white, but 'yüz' [meaning face] is more likely a golden color (Deniz, female, 30).

Deniz and Selim clearly stated that they were also affected by the meaning of the words from time to time. Besides, this does not mean that words with the same meaning have similar associated colors.

> 'Gül' [a homonym for the words meaning laugh as a verb and rose as a noun] has been associated with different tones of brown. Sometimes, the words, which have very different meanings, may mix in my mind as they are similarly associated. It also happened while I was learning English. In the beginning, there was no associated color. The colors became more accurate with time.

> Then, the words became blended in my mind as they have similar associated colors (Selim, male, 28).

On the other hand, some respondents stated that they were affected by the phoneme or what they were hearing.

> When I hear that 'meow' sound from a cat, it is yellow; however, if I hear someone say the word 'meowing', it is blue (Hale, female, 24).

Time and Experience: It May Change Inter and Intraparticipants

The dynamic nature of the phenomenon was also emphasized by the participants. For instance, Selim stated that the frequency of the words they hear may affect the accuracy (possibly the specificity) of the associated color. In addition to the frequency, Selim also adds that abstractness and length of the heard word may also determine the accuracy of the associated color. Selim stated that:

> If the words are abstract, too long, or not frequently used or heard by me, the colors become less accurate. I can say that most of the time, this ambiguity is going to result in brown or black. Especially if they are abstract rather than concrete, they become more ambiguous. The words used frequently in daily life, and the names are the ones that I can quickly respond to. For instance, I can tell the colors of the names within a short period. However, if they are abstract or too long like the word unpretentious, I cannot imagine the color in my mind. A color appears, but it is very unclear. Alternatively, for instance, digits and frequently used numbers have specific colors. I mean sixty, ninety, fifty have colors; however, eight hundred and sixteen does not (Selim, male, 28).

Another determinant of associated colors is the experiences that they had. For instance, Sevgi claimed that experiences may affect perceptions of associated colors:

> Colors might change with the experience, whether it is something good or bad. Not really much; however, it changes over time. It might also turn out to be another color. For instance, while it is red, it might be green, or while it is red, it might be a lighter red (Sevgi, female, 38).

Hale had a specific example of how the associated color of a word can change:

> Even though most of the names are still the same for me, I have a specific example for you. My husband's name is 'Cem'. I think of 'Cem Yilmaz' [a famous comedian in Turkey]. The word 'Cem' was a light color for me. However, after I started to date my husband, it started to 'become darker' for me (Hale, female, 24).

Moreover, Selim speculated that some other shared experiences may be responsible for the associations:

> Especially the words I had learned before I went to school might determine the colors of letters and digits for me. For instance, 'Rasim' [a male name in Turkish] is blue. Light blue is 'R' for me. Rasim is the name of my father. Alternatively, Ankara [the capital city of Turkey] is blue, İstanbul [the most crowded city of Turkey] is yellow for me. For example, Ankara might be affected by the colors of 'Ankaragücü' [the football team of Ankara City] and İstanbul from 'Istanbul Spor' [the football team of İstanbul City] (Selim, male, 28).

Stability of the Associated Colors within Participants

Synesthesia experience is stable, but it may or may not change within and between individuals over time. Most of the respondents of the study clarified that the associated colors of their hearings are stable over time.

> Ankara [capital city of Turkey] was red when I was a little girl. Because the letter 'A' was red. It was a dark red when I was a little girl. However, now, Ankara is more likely associated with the color black. Maybe I was not stressing the letter 'K' like I am doing it today. It was red when I was 8 or 10 years old, but now I am saying it as anKara. ['Kara' means black in Turkish]. Maybe this is because of that meaning can affect the change of associated colors over time (Sevgi, female, 38).

> My experience is stable and will never change. So, there is no need to argue about it with others. I have never experienced it as if the brightness of colors has changed. When I looked back, yeah sickness is yellow and still yellow for me. So, the colors are not changing (Gaye, female, 27).

We shared coding of transcriptions, subordinate themes, and superordinate themes with Selim as he is also a psychologist experiencing the phenomena to increase trustworthiness. He declared that the themes that emerged in the data analysis process are appropriately covered their synesthesia experience.

Discussion

The findings were primarily coherent with the literature. Many individuals with synesthesia become adults without becoming aware that their experience is something unusual (Cytowic & Eagleman, 2009). In this study, respondents were not aware of their way of multi-sensing until their brother (Selim) told them about synesthesia. The rate of experiencing synesthesia in the nuclear family was high (7/10; i.e., seven of eight siblings stated that they experience synesthesia). One sibling expressed that he did not feel any synesthetic experience. We did not have enough information about the parents' synesthesia status. They may be assuming that most people have it, and a few of them do not have it, or they may be too shy to be explicit about it.

On the other hand, the literature also indicates that some synesthetes have been shocked to realize that most people do not experience this kind of multi-sensing (Cytowic & Eagleman, 2009). Cytowic (2002) gave an example in which a color-hearing synesthete could not believe that there were more people with the same condition. She assumed that she insanely imagined hearing colors. She also denied her way of experiencing sounds by blaming herself for being insane or imagining. Moreover, such rejection may result from not wishing to see themselves as members of society deviating from the norms associated with perceptions of the world and reality.

Similarly, people were prone to denying the diagnosis upon learning that they have synesthesia (Haupt, 2018). The participants insisted that the others were also seeing colors whenever they heard something and that this was not peculiar to them. They not only did not see themselves as a part of a minority through the denial strategy but also refused to see themselves as deviating from the norms of society.

Moreover, the available research supports the claim that there can be individual differences from one person to another in grapheme-color synesthesia (Cytowic & Eagleman, 2009; Rogowska, 2011), which was corroborated by our respondents' way of experiencing and the way they interpreted their experience. They were able to experience colors in their mind's eye or on an internalized space which is called associators, rather than seeing colors outside, which is called projectors (Rogowska, 2011). The participants declared that they do it with their mind's eye. Even if our respondents were members of a family, shared a similar genetic pool and environment, determinants of associated colors varied among participants. Some studies revealed that the genetic pool of synesthesia is heterogeneous and polygenetic (Brang & Ramachandran, 2011). The answer might be related to shared childhood experiences, which our participants also mentioned that they were grown up together and in the same village. Chin and Ward's (2018) study on autobiographical memory revealed that childhood memories might have particular neurodevelopment importance in synesthesia. In addition, Dixon et al. (2006) also claimed that the associated colors were determined by the subjective meanings of the words, not only by the graphemes themselves. It might be inferred that synesthesia is a condition affected by the sum of individual, environmental, and neurodevelopmental factors rather than just genetic ones.

Similarly, the color associated with the sound for the word '*Cem*' changed when Hale married a man named '*Cem*'. Root et al. (2018) claimed that some letters are associated with the same color in many languages. Even though our respondents were siblings with a shared genetic pool and environment, they experienced varied associated colors when they heard the same sounds. However, Mankin and Simner (2017) claimed that the colors of the prototypic words represented some letters; for example, 'A' for 'apple' can be associated with red. Selim declared that a similar association existed between the colors of the football teams and the

relevant cities' colors. In addition to the individual differences, Drew et al. (2018) stated that synesthesia is a two-way process, which means that seeing a letter not only causes the experience of a color, but that seeing a color also causes the experience of letters, words, and their meanings.

Moreover, Miozzo and Laeng (2016) declared that Saturday can be associated with a different color depending on whether it was regarded as a day within a week or as a day within a month. The research also supports the idea that written and spoken words can differ in terms of their associated colors. In another study, Hamada et al. (2017) declared that visual shape, ordinality, and frequency are the factors that affect the associated colors in grapheme-color synesthesia. Some of the respondents also reported that they were affected by the meaning, and some of them reported being affected by what they heard as a phoneme. Similarly, the literature supports that synesthetes can be sensitive to the polysemic variability of homographs that are also homophones; for instance, '*yüz*' elicits one color when it means '*face*' and another when it means '*100 (hundred)*'. In addition, some of the participants in this study stated that they are not just affected by the language that they hear but that they can also be triggered by animal sounds (e.g., a cat's meow). The literature supports that sounds like dog barks, clattering dishes, and especially music can trigger synesthetes. However, there was no clear explanation of why synesthetes were triggered by some sounds but not by others (Cytowic & Eagleman, 2009). Miozzo and Laeng (2016) stated that the way the sounds are experienced, such as by hearing or reading, might also cause the experience of different colors, even if the words are the same.

In a quantitative study by Baron-Cohen et al. (1993), it is claimed that synesthesia is consistent over time. On the other hand, in the longitudinal study of Simner et al. (2017), supports the idea that the quality of the synesthesia experience changes over time. The findings of both studies are congruent with our own findings. Moreover, Rogowska (2011) declared that while most of the synesthetes' experiences of associated colors were congruent across time, some stated that those experiences could be changed, weakened, or strengthened, as shown by examples in our study. Supporting that claim, Simner et al. (2017) claimed that the saturation of colors decreases as age increases.

Although some current studies (e.g., Carmicihael et al., 2018; Simner et al., 2021) stated that synesthesia might be associated with subjective well-being among synesthetes, we had no clue that pointed out participants' experience in the context of well-being. However, it should be noted that, unlike other studies, the participants in our study were siblings; that is, they grew up in a similar environment and were unaware of their decades of experience. Because of this unawareness, the participants did not pass on their experiences to non-synesthetes for years; thus, they did not realize that they had a different experience than society, that is, they were experiencing different things. This may have had a protective effect. Therefore, unlike the

literature indicates, a relationship between the participants' synesthetic experiences and their subjective well-being may not have been expressed during the semi-structured interviews.

For most of the participants, it was their first time thinking about how they perceived the colors of what they hear and how they evaluated this experience. As this phenomenon characterized their way of sensing from the time they were born, it seemed like they never needed to mention about this experience to non-synesthetes about this experience to. Furthermore, we observed that as the education level of the participants declines, the length of interviews and quality of responses decreased. Therefore, we inferred that education level might be related to giving meaning to their experiences and explaining them in a detailed and structured manner.

IPA is based on transcriptions, which means the methodology is based on verbal data. The participants' education levels were low, which might negatively affect the length of interviews and data quality. Therefore, further studies might investigate synesthesia among different samples, specifically, participants from higher educational backgrounds.

Synesthesia is a complicated, subjective way of multi-sensing phenomenon which awakens similar feelings in people who have it. On the other hand, the way of experiencing it and the factors contributing to it are unique, and grasping the phenomena is still complicated. Though many studies focused on the brain mechanism of synesthetes by using neurological measurement methods, few are investigating the experience of synesthesia (Simmonds-Moore, 2016). Hence, there is room for more investigation and a better understanding of individual differences in synesthetic experiences. Qualitative methods, especially IPA, facilitate understanding experience by in-depth interrogation.

In addition to those, Selim, the key participant, was like a bridge between researchers and his family as he is both a member of the family and a reliable source of scientific knowledge and psychology. When denying of their synesthetic experience is taken in consideration, this role might be seen as quite crucial for the siblings' participation to the research. Even though synesthetic individuals participated in the research (Brang et al., 2010; Hupé et al., 2012), this study can be considered special by Selim's aid by including synesthetic family members in the entire literature. On the other hand, even though he is a psychologist, his expertise in the area was not considered as a limitation or confounding variable as he was not familiar with the qualitative research methods.

The non-synesthetic siblings were unwilling to participate in Study 1 can also be seen as a limitation. If they could have participated the Study 1, their condition could have been confirmed to be able to discuss about possible genetic factors carrying synesthesia, as Study 2 includes the synesthetic family members. Besides, this study can be seen as an opportunity to consider both relational and environmental factors by narrowing its participants to siblings. On the other hand, the findings of the first study, based on the participants' experiences, may

not have emerged as a result of familiarity due to the participants' environmental or cultural similarities, rather than to the synesthetic experience. Moreover, these behaviors of the participants may be compensated by their environment. Intraparticipant consistency may have also been observed due to this reinforcement. Other studies that will use the findings of the first study should consider this limitation. Future studies may circumvent this limitation by reaching synesthetic participants with similar genetic material but raised in different environments. This autobiographical memory problem is also valid for the second study. This limitation can be overcome by supporting methods such as IPA through the clue word technique.

Another limitation of the study is that Study 1 lack of control of synesthetes' memory capacity and skills in the word-color matching task. This is why in the second time measurement; the word list was randomized to be able to decrease the recall effect for both groups. However, there is still the possibility that the consistency between the two measures is due to the participants' associative memories. The confounding effect of this situation should be considered during the evaluation of the findings of the first study. Further studies to conduct word-color matching task for synesthetes might also check recall effect and associative memory to prevent this possible confounding variable.

This study initially provides shreds of evidence of how synesthetes experience synesthesia by using IPA. Exceedingly, the homogeneity of participants, siblings sharing genetic compounds, and similar environmental factors strengthened the study's sampling while demonstrating broad individual variability in synesthesia even among them. The current study also aims to demonstrate that the effects of individual's perceptions can be interrelated, which may contribute to many different fields such as cognition or communication. Besides these, to the best of our knowledge, this study is the first one, which investigates synesthesia within a family from an IPA perspective. Further studies might investigate the synesthetic experience from different perspectives. Their experiences might contribute to different disciplines such as physics, neurology, or engineering.

Authors' contribution:
L.A. and S.Ç. developed the idea, S.Ç collected the data, L.A., S.Ç. and M.K.A analyzed the data and wrote the manuscript.
Declaration of conflicting interests:
The authors have no conflicts of interest to declare.
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Seslerin Renkleri: Altı Kardeşin Öznel Sinestezi Deneyimleri

Özet

Sinestezi, herhangi bir duyu organının sorumlu olmadığı uyaranca algılandığı deneyimine verilen genel isimdir. Örneğin işitsel uyaranların renkli deneyimlenmesi, koku uyaranlarının hareketli deneyimi ya da görsel uyaranların tat ile deneyimlenmesi sinestezik deneyimlerdendir (Beeli ve diğerleri, 2008; Cytowic ve Eagleman, 2009). Farklı araştırmalar bulunsa da sinestezinin dünyada yaklaşık %2 oranında gözlendiği düşünülmektedir (Simner ve Hubbard, 2013; Simner ve diğerleri, 2006).

Sinestetik deneyimler genetik meteryal ile ilişkilendirilmektedir (Baron-Cohen ve diğerleri, 1996; Brang ve Ramachandran, 2011; Eagleman ve Goodale, 2009; Ward ve Simner, 2005). Ayrıca sinestezi ağırlıklı olarak nöropsikolojik perspektifte incelenmektedir (örn., Beeli ve diğerleri, 2008, Brang ve diğerleri, 2010; Hupé ve diğerleri, 2012; Sinke ve diğerleri, 2012; Rouw ve diğerleri, 2011). Öte yandan çok az çalışma hem nicel hem de nitel yöntemler kullanarak benzer genetik materyale sahip ve benzer çevrede yetişmiş örneklemlere odaklanmıştır. Oysa bu noktanın aydınlatılması kalıtım–çevre tartışmasının ötesine giderek öznel deneyimlerin ne yönden farklılaştığı veya benzeştiğini ortaya çıkarabilir. Bu amaçla ilki nicel ikincisi ise nitel paradigma çerçevesinde iki çalışma yürütülmüştür.

Birinci çalışmanın amacı sinestezik deneyim ifade eden katılımcıların deneyimlerini görgül olarak sınamak ve bu katılımcılar arasındaki sinestezik kelime–renk algısı tutarlılığını incelemektir. Bu amaç doğrultusunda akranlarına kıyasla kelimeleri renkli algılayıp algılamadıklarını incelemek için sinestezik deneyimlerinin olduğunu ifade eden katılımcıların, bu yönde herhangi bir ifadesi bulunmayan akranlarına kıyasla çeşitli Türkçe kelimeleri belirli renklerle eşleştirmeleri arasında tutarlılık açısından anlamlı bir farklılık olup olmadığı incelenmiştir. Kurumsal etik iznin alınmasının ardından 24-42 yaş aralığında 6 sinestetik kardeş ile 18-62 yaş aralığında 18 sinestetik olmayan gönüllü araştırmaya katılmıştır. Katılımcıların hangi tip sinestezik deneyim yaşadıklarını ölçmek için Eagleman Sinestezi Test Bataryası–Sinestezi Tipi Ölçeği (STÖ; Eagleman ve diğerleri, 2007) kullanılmıştır. Kelime – renk eşleştirme testi için ise araştırmacılar tarafından güncel Türkçe sözlükten seçkisiz olarak seçilen 100 kelimeden oluşan bir kelime listesi ile 20 sütun ve 10 satırdan oluşan (200 hücre) HTML5 renk tablosu kullanılmıştır. Gönüllü akranlara erişmek için araştırma çağrısına yanıt veren katılımcılara randevu verilerek bölüm deney odasına davet edilmişlerdir. Tüm katılımcılar bilgilendirilmiş onamın ardından demografik bilgi formunu doldurmuş, ardından STÖ'yü yanıtlamıştır. Daha sonra kelime listesinden kelimeler seçkisiz olarak sunularak gönüllülerden kelimenin hangi renk ile eşleştiğini renk tablosundan göstermeleri istenmiştir.

Yaklaşık 15 gün sonra tüm katılımcılara tekrar randevu verilerek kelime – renk eşleştirme görevi tekrar ettirilmiştir.

STÖ'den elde edilen bulgular sinestezik altı kardeşin kontrol grubuna kıyasla anlamlı olarak daha yüksek oranda grafem-renk tipi sinestezik deneyim ifade ettiklerini göstermiştir, $z = 3.07$, $p < .01$. Öte yandan ilk ve ikinci kelime – renk eşleştirme görevlerindeki tutarlılık sinestezi deneyimi puanı olarak ele alınmış ve düşük puanlar yüksek sinestezik deneyim olarak kavramsallaştırılmıştır. Bağımsız örneklemler için t-test sonuçları sinestezik deneyim ifade eden altı kardeşin kelime – renk eşleştirme tutarlılığının kontrol grubuna kıyasla anlamlı olarak daha yüksek olduğunu göstermiştir, $t(22)= 10.77$, $p <.001$. Altı kardeş arasında ise kelime–renk tutarlılığının farklılaştığı gözlenmiştir. Yüksek tutarlılıktan düşüğe doğru sıralama Selim (ΔWCM= .99), Sevgi (ΔWCM= 1.11), Ahmet (ΔWCM= 1.82), Hale (ΔWCM= 1.97), Gülhan (ΔWCM= 3.49) ve Deniz (ΔWCM= 3.64) şeklindedir.

İkinci çalışmanın amacı nitel paradigma perspektifinden katılımcıların öznel sinestetik deneyimlerini incelemek ve betimlemektir. Bunun için araştırmacılar tarafından hazırlanan yarı yapılandırılmış görüşme formu kapsamında yapılan görüşmeler yorumlayıcı fenomenolojik analiz (Smith, 2004) ile incelenmiştir. Analiz sonuçları, sinestetik altı kardeşin öznel deneyimlerini açıklamak için üç temanın kullanılabileceğini göstermiştir. İlk tema sinestezi deneyiminin doğası olarak isimlendirilmiştir. Tema, kardeşlerin sinestetik deneyimlerinin nadir olduğuna yönelik reddedişlerini işaret etmektedir. Kardeşler bu deneyimi aslında herkesin yaşadığını ancak farkında olmayabileceklerini ifade etmektedir. İkinci tema sinestezi deneyiminin özellikleri olarak isimlendirilmiştir. Bu tema sinestetik deneyimleri çeşitli açılardan betimlemektedir. Örneğin bazı kardeşler kelimelerdeki baskın fonemin algıladıkları rengi belirlediğini ifade etmektedir. Bazı kardeşler ise bir kelimenin rakam ile yazılışını gördüklerinde algıladıkları renk deneyimlerinin, harf ile yazılandan farklılaştığını dile getirmektedir. Üçüncü tema zaman ve deneyim: Deneyim katılımcılar arası ve katılımcı içi değişebilir olarak isimlendirilmiştir. Tema, bazı kardeşlerin zaman içerisinde ya da deneyime bağlı olarak kelimeleri farklı renklerde işitebildiklerini, bazılarının ise tutarlı olarak kelimeleri hayat boyunca aynı renkte deneyimlediklerini işaret etmektedir.

Alanyazınla paralel olarak bu araştırmada da grafem-renk sinestezisinin daha yaygın olarak gözlendiği görülmüştür. Bulgular, benzer genetik materyal ve sosyal çevreye sahip kardeşlerin renk deneyimlerinin farklılaşabileceğini, dahası bu deneyimlerin zaman içerisinde değişebileceğini göstermiştir. Alanyazın bu kişilerde çeşitli psikolojik stres fenomenlerinin daha çok gözlendiğini işaret etmesine rağmen yarı yapılandırılmış görüşmeler katılımcıların sinestetik deneyimlerinin iyi oluşlarını etkilemediğini göstermektedir. Katılımcıların bu deneyimlerinin nadir olduklarını reddetmeleri koruyucu bir faktör göstermiş olabilir.