The beginning of research on synaesthesia in children: Searching for traces in the 19th and early 20th century

Jörg Jewanski[1], Julia Simner[2], Sean A. Day[3] & Jamie Ward[2]

Abstract

Given what we know from current research, Georg Tobias Ludwig Sachs was the first documented synaesthete in history. His medical dissertation, principally about albinism but including a self-description of his synaesthesia, was published in 1812. At that time, Sachs was 26 years old. Subsequent single case reports of synaesthetes mostly concerned adults. Where are the children? Four sets of open questions will be answered in this article: 1) When did the first documented case of a child with synaesthesia appear? Who discovered it, and when? 2) Who carried out the first empirical study on synaesthesia in children? When was this done and what were the results? 3) Who carried out the first longitudinal study with a child to test whether synaesthesia is consistent over years? When was this and how did they approach the question of whether synaesthesia is congenital or learned? 4) How old were the youngest children with synaesthesia documented in the 19th and early 20th century?

Keywords: synaesthesia, children, single case report, longitudinal study, 19th century

Die Anfänge der Synästhesieforschung bei Kindern: Spurensuche im 19. und frühen 20. Jahrhundert

Zusammenfassung

Dem aktuellen Stand der Forschung entsprechend war Georg Tobias Ludwig Sachs der erste dokumentierte Fall eines Synästheten. Seine 1812 veröffentlichte Dissertation in Medizin thematisierte zwar eigentlich den Albinismus, enthielt aber auch eine Selbstbeschreibung seiner Synästhesie. Zu diesem Zeitpunkt war Sachs 26 Jahre alt. Auch darauf folgende Einzelfallstudien betreffen fast ausschließlich Erwachsene. Inwiefern sind auch Kinder betroffen? In diesem Beitrag werden vier Fragengruppen beantwortet: 1) Wann gab es den ersten dokumentierten Fall eines Kindes mit Synästhesie? Wer entdeckte diesen und wann war das? 2) Wer führte die erste empirische Studie zu diesem Thema durch? Wann fand diese statt und was waren die Ergebnisse? 3) Wer führte die erste Längsschnittstudie mit einem Kind durch, um herauszufinden, ob die Synästhesie über mehrere Jahre weiterbesteht? Wann fand diese statt und wie wirkte sie sich auf die Frage aus, ob Synästhesie angeboren ist oder erlernt wird? 4) Wie alt waren die jüngsten Kinder mit dokumentierter Synästhesie im 19. und frühen 20. Jahrhundert?

Schlüsselwörter: Synästhesie, Kinder, Einzelfallstudie, Längsschnittstudie, 19. Jahrhundert

Introduction

At least four percent of the population report sensations of colours, tastes, odors, etc., triggered by unusual stimuli. These unusual stimuli include cognitive concepts like letters of the alphabet, days of the week, months of the year, or sensations like hearing sounds or

[1] Department Musikhochschule, Universität Münster, Germany
[2] School of Psychology, University of Sussex, Brighton, United Kingdom
[3] Department of English and Journalism, Trident Technical College, Charleston, SC, USA

tasting food. This fascinating phenomenon, of which we know at least 80 different types (Day, 2017), is named synaesthesia (Simner & Hubbard, 2013). Today, we know that Georg Tobias Ludwig Sachs was the first documented case of a synaesthete in history (Sachs, 1812; Jewanski, Day & Ward, 2009; enlarged 2012 and 2014). His medical dissertation about albinism, including a description of himself as a synaesthete, was published in 1812. At that time, Sachs was 26 years old. As our knowledge stands in 2017, all succeeding single case reports of synaesthetes during the next six decades, until the famous case of the Nussbaumer brothers in 1873 (Nussbaumer, 1873; Jewanski et al., 2013), mostly concerned adults (Jewanski et al., 2011; enlarged in Jewanski, 2013). Where are the children?

In 1873, Fidelis Alois Nussbaumer reported having synaesthesia since he and his brother, who was two years older, were children, but he did this retrospectively as an adult. In addition, one student of the physicist Élie Wartmann, in 1850, reported in an unpublished letter that he had had his synaesthesia since childhood (cited in Cornaz, 1851). But neither none of these individuals were questioned about synaesthesia while still a child, and neither case was a child when his synaesthesia was reported. We might assume that Sachs (born 1786) was probably also a synaesthete when he was a child given that most synaesthesias appear to emerge in childhood (Simner et al., 2009). One anonymous reviewer reported his own synaesthesia in 1849, although we do not know his age (Anonymous, 1849). In this article, we want to answer the following four sets of open questions.

1) *When did the first documented case of a child with synaesthesia appear? Who discovered it, at which occasion?*

There were no documented cases of children who were also synaesthetes between 1812 and the middle of the 19th century. There is no reason why there should not be such children in this period, but we have no sources about them. The first known case is from 1848. And even this child had been totally forgotten from the history of synaesthesia until the present day, being presented for the first time in public at the conference *Synaesthesia with Children* (Ulm, Germany, May 2012, www.uni-ulm.de/en/einrichtungen/synaesthesia-conference), and first published the following year (Jewanski, 2013). The name of the child is Ellen Tucker Emerson, and we have a source describing her synaesthesia, when she was eight years old.

Ellen Tucker Emerson (1839-1909) was the child of Lidian Jackson Emerson (1802-1892) and Ralph Waldo Emerson (1803-1882), the famous American poet and philosopher. Both had married in 1835 and had four children: Waldo, Ellen, Edith, and Edward Waldo. Today, we know that synaesthesia runs in families (first in detail: Bleuler & Lehmann, 1881), but we know of no source stating if Ellen's siblings or her parents were also synaesthetes. What do we know about Ellen? She was born in Concord, Massachusetts, 15 miles Northwest of Boston, near the East Coast of the United States. She was an active member of the community, where she stayed her whole life, was in contact with many important people through her family, and wrote a biography about her mother (Emerson, 1980).

A close friend of the family, who lived with them at various times, was the philosopher and poet Henry David Thoreau (1817-1862), famous for his book *Walden; or, Life in the Woods* (1854). In 1848, when Ralph Waldo Emerson was in Europe, Thoreau cared for the family. In a letter, dated January 12, 1848, he wrote to Ralph Waldo Emerson: 'I was struck by Ellen's asking me, yesterday, while I was talking with Mrs. Brown, if I did not use "coloured words". She said that she could tell the colour of a great many words, and amused the children at school by so doing' (Thoreau, 1848, p. 745).

Although only two sentences, we can be quite confident that Ellen was a synaesthete: Coloured words are typical indicators of synaesthesia, as is her wondering whether others do the same. And since Thoreau was 'struck', we can assume it was not just the amusing game of a child: Thoreau was hearing this type of report apparently for the first time, and it was something unusual to him. What other explanations can be given for an eight-year-old girl talking about coloured words than her being a synaesthete? We do not know any more about Ellen's synaesthesia. There is no further trace of it, not even in her letters, which deal with the life of the Emerson family, and were published by the great-granddaughter of Ralph Waldo Emerson (Gregg, 1982). These letters start in August 1846, when Ellen was seven years old, and end in 1892 with the death of her mother. In some, one can find a sensitivity for colours (e.g., March 27, 1861, January 3, 1866), but nothing extraordinary which would lead us to suspect synaesthesia. It is not surprising that Thoreau was 'struck' by Ellen's comment, because in 1848 nothing was known in the US about synaesthesia. The first known synaesthete so far in the US is the poet Hannah Reba Hudson, who had a number-form-synaesthesia, also visualized the alphabet pictorially, and published an article about it in 1873, 25 years after Ellen's letter (Hudson, 1873).

For the history of synaesthesia, Ellen Tucker Emerson is remarkable for a number of reasons. She is the first documented case of

a) a child with synaesthesia;

b) a female synaesthete;
c) a synaesthete outside of Europe;
d) a synaesthete in the US; and
e) a synaesthete of whom we have a photo (Figure 1).

If we arrange Ellen in the list of known synaesthetes of the 19th century, she is second one: First is Sachs (source: Sachs, 1812), second is Emerson (source: Thoreau, 1848), third is the reviewer noted above (source: Anonymous, 1849). The two dates of the letter about Ellen's synaesthesia (written 1848, published 1892) coincided with two accidentally important publications in the history of synaesthesia: In 1848, synaesthesia research in general started – far away in Switzerland with a medical dissertation by Édouard Cornaz (1848; Jewanski et al., 2012). In 1892, synaesthesia research in the US started with an article by the psychologist William O. Krohn, who mentioned Ellen's letter in his bibliography (Krohn, 1892). Three years before Krohn's article, synaesthesia had its own symposium for the first time as part of an international congress (Jewanski et al., 2015).

In this line of synaesthetes, where Ellen Emerson is the second one, we can add two (or more?) people, of whom we have no names and know of no details. One was mentioned by Sachs, who wrote: 'I recently found a trace of it [synaesthesia] in a very famous man […]'[1] (Sachs, 1812, § 167). Another one was mentioned by the German poet and philosopher Johann Gottfried Herder, who wrote in his *Abhandlung über den Ursprung der Sprache* (Treatise on the origin of language, 1772): 'I am familiar with more than one example in which people, perhaps due to an impression from childhood, by nature could not but through a sudden onset [schnelle Anwandlung] immediately associate with this sound that colour […]' (Herder, 1772, pp. 94-95; cited after the English translation by Forster, 2002, p. 106)[2].

The only reason we know of Ellen and her synaesthesia at all is because her father and the friend of her father were so famous that their private letters were published. But this did not happen until 44 years later, in June 1892, in *The Atlantic Monthly: A Magazine of Literature, Art and Politics,* a literary and cultural commentary magazine with a national reputation (Rahn, 1963).

2) *Who carried out the first empirical study on synaesthesia in children? When was this done and what were the results?*

Figure 1
Ellen Tucker Emerson at the right side, her younger sister Edith at the left side (Courtesy Concord Free Public Library, Concord, Massachusetts, USA)

Sir Francis Galton, a British polymath, was, inside of synaesthesia research, mainly interested in number forms, a special kind of synaesthesia, where numerals, letters or words are visualized with a specific location in space (Sagiv et al., 2006). In 1879, he developed a questionnaire about 'the degree and manner in which different persons possess the power of seeing images in their mind's eye' with 20 questions (cf. Burbridge, 1994, pp. 448-449). Between November 1879 and April 1880, Galton distributed several hundred copies of his questionnaire. During the following years, he evaluated the questionnaire step by step.

In March 1880, Galton published a first article, *Visualised numerals* (without statistics), mentioning children, and concluded: 'These forms […] are survivals of a very early mental stage, and must have originated before the child learnt his letters. There is no nursery book or diagram that could suggest their fantastic shapes. Their very variety shows them to be derived from no common origin' (Galton, 1880a, p. 495). From this quotation, we see that Galton concluded that number forms are not learned during childhood.

In 1880, Galton published a first evaluation of 172 'Charterhouse boys', in which he concluded there was a ratio of 1:4 with synaesthesia (= 25%), while he also proposed a ratio of 1:30 synaesthetes (= 3.3%) in English male adults. From this, he hypothesised that synaesthesia partially vanishes during one's lifetime: 'No doubt as the years go by, most of these will be wholly forgotten as useless and even cumbrous, but the rest will serve some useful turn in arithmetic and become fixed by long habit, and will gradually and insensibly develop themselves' (Galton, 1880b, p. 318). Galton's

[1] All translations from French and German are done by the authors, if not otherwise marked.

[2] We want to thank Steve Conway (The Open University, U.K.), who in 2016 drove our attention to this source by Herder.

high prevalence of 25 percent within schoolboys fits with the same figure given some years later by Charles Peabody (1915) via a questionnaire survey (600-700 sent questionnaires). This same ratio was proposed several times: Granville Stanley Hall (1883) found 21 out of 53 children (= 40%) entering primary school who described the tones of instruments as coloured, but with no agreement concerning colour, intensity and saturation. Auguste Lemaître (1901) examined 112 pupils of a sixth grade class and found 40 synaesthetes (= 36%). Géza Révész (1923) reported nine of 20 children (6-9 years) with coloured hearing, which is nearly 50 percent. It is interesting to see the same conclusions repeated in different studies although of course these figures may not be valid by today's scientific criteria. In particular, we now know that cohorts of self-reported 'synaesthetes' will include not only genuine synaesthetes but also a number of non-synaesthetes (Simner et al., 2006) and so objective testing is required by modern standards.

In September 1880, Galton stated: 'The power of visualising is higher in the female sex than in the male, and is somewhat, but not much, higher in public schoolboys than in men' (Galton, 1880c, p. 314). The following year, he described a ratio of 1:30 (= 3.3%) of synaesthesia in men and 1:15 (= 6.7%) in women (Galton, 1881; confirmed: Galton, 1883, p. 119). This led to a comparison between boys and girls. Galton received answers from girls only in a small number, but concluded: 'The tendency to see Number-Forms is certainly higher in girls than in boys' (Galton, 1883, p. 133).

This investigation of whether there is a higher ratio of synaesthesia in girls/women in comparison with boys/men is given here for the first time and was proposed regarding adults by Bleuler and Lehmann in the same year 1881, when they produced a ratio of 59.2 percent women and 40.8 percent men. Édouard Cornaz (1851) had very carefully assumed a higher ratio of synaesthesia in women 30 years previously. Modern methods now show that the number of male and female synaesthetes is in fact equal, at least for coloured letters and numbers (and that sex differences likely arise only from reporting biases; e.g., Simner et al., 2006). However, the debate of whether synaesthesia is found more often in men or women has nonetheless formed a central question in synaesthesia research ever since these earliest times. Finally, the question of whether synaesthesia is found more in children than adults still has no modern answer. Earlier estimates are not reliable if based on only self-reporting (as above). But modern studies have not yet applied improved methodologies to a sufficient number of participants to know for sure (see Simner et al., 2009 for discussion).

In number forms in particular, Galton's last analysis in this area was published in 1883, based on a total return of 337 questionnaires from boys, within which were 18 with what Galton considered to be well-defined number-forms: This is a ratio of one in 20 (= 5%) (Galton, 1883, p. 132), much smaller than the figure of 25 percent he had published three years earlier, but similar to a ratio of three percent Alfred Binet found in 1892, based on 300 children from ten to twelve years (unpublished, cited in Flournoy, 1893, p. 16). Galton's ratio is similar also to one of 7.6 percent reported by Phillips (1897). This was based on 1,306 children (332 normal school students plus 974 school children 10-16 years), of whom 99 had number forms. A higher ratio, with 1 in 16 (= 16.7%) in adults, was given by George T. W. Patrick (1893), who supposed a higher rate in children than in adults. A clearly lower ratio was found by Karl Lenzberg, reported in his medical dissertation (1923), who discovered two synaesthetes within 218 pupils age nine to twelfe years, a ratio of 0.9 percent.

3) Who carried out the first longitudinal study with a child to test whether synaesthesia is consistent over years? When was this and how was the question answered, if synaesthesia is congenital or learned?

The American Edward S. Holden studied his daughter Mildred, who saw days of the week, the alphabet and numbers in colour, and he repeated his testing several times over a period of 24 years. He knew about synaesthesia from the writings of Galton and altogether he published five short articles about Mildred's synaesthesia in the established journals *Science and Nature* (Holden, 1885; 1888; 1891; 1895, 1906). His observations began in 1882, when his daughter was seven years old, and ended in 1906, when she was 31. During this period, Holden discovered only small shiftings of colours and small changes in brightness within his daughter's synaesthesia; e.g., the colour for the number nine changed from greenish (1885) to blue (1887) to bluish-green (1889) to dark blue (1891).

The question of consistency of synaesthesia was also discussed by other authors. At the end of the 19th century, the psychologist James Sully published a popular book, *Studies of Childhood* (1896), which was translated into German one year later, with several editions and reprints in both languages. In this textbook *For Teachers and Educated Parents* (as the German subtitle explained), Sully described a six-year-old girl with coloured numerals whom he questioned again three years later. Some colours had changed, and Sully suggested, also

in context with coloured hearing, that new experiences and associations may modify the tint and shade of sounds as given in the youth (Sully, 1896, p. 34). He regarded the origin of synaesthesia as 'survivals of early fanciful brain-work' (Sully, 1896, p. 35). The psychologist Géza Révész examined 25 children age eleven, and ten children age 17, and concluded that there may be a regression of synaesthesia around age eleven. However, since the small number of analysed children did not give clear results, Révész called for a statistical examination with a larger number of children (Révész, 1923, p. 316).

During the 19th century, it was not clear if synaesthesia was congenital or learned during childhood. Some preferred the latter interpretation (Chabalier, 1864; Kaiser, 1882); some, like Galton, did not. The first to give the origin of synaesthesia back to birth was Cornaz: 'It's likely that this state dates back to birth: this is the case for this student of Wartmann […]; it was also undoubtedly true for Sachs, who was too conscientious an observer to have omitted information about any period when he noticed such a remarkable physiological change. It's possible that with age, reason little by little diminishes the vivacity of these coloured perceptions […]' (Cornaz, 1851, p. 8). Eugen Bleuler and Karl Lehmann (1881) found many relatives within a group of 76 synaesthetes and concluded that synaesthesia is congenital and in this way present still in childhood.

4) How old were the youngest children with synaesthesia documented in the 19th and early 20th century?

As we have seen, Ellen Tucker Emerson was eight years and eleven months old, when she described her synaesthesia; Mildred Holden was seven years old, when her father discovered her synaesthesia. Were there younger children with synaesthesia during the 19th and early 20th century? We know of only a few (some are listed in Riggs & Karwoski, 1934). Perhaps there are some within the empirical studies by Galton, but he did not give exact ages but only wrote about 'schoolboys'. Thus the next cases after Ellen Tucker Emerson are the Nussbaumer brothers.

As noted above, Fidelis Alois Nussbaumer (1848-1919)[3] published an article in 1873 about his own synaesthesia and that of his brother Johann, who was two years older. Within this article, he reported that he and his brother, when they were five and seven years old, would play a game with spoons and forks attached to a long band. Each of these objects had a different sound when hit, which the boys named with the corresponding colour, which was a little different for each of them. This is first time in history of synaesthesia that we know in detail from an adult that his synaesthesia went back to early childhood (Jewanski et al., 2013). Prior to this was the unknown student of Wartmann, who only said that he was affected with it in childhood but gave no details.

In 1883, Granville Stanley Hall published a study on children entering primary school in Boston, Massachusetts. The study aimed to examine various facets of developmental psychology, of which synaesthesia was only one small part (Hall, 1883). In 1896, James Sully subsequently reported on a six-year-old girl with coloured numerals (Sully, 1896). This study in particular closely mirrors a contemporary investigation (Simner et al., 2009) which shows synaesthesia emerging in primary school children as young as six years old, and indeed becoming more robust over time until the ages of ten to eleven years, when the study ended.

During the early 20th century, we know of some child synaesthetes up to the age of eight. David Starr Jordan (1917), who himself was a synaesthete, reported on his son, who at the age of eight years in 1912 wrote a list of colours for the letters of the alphabet. Géza Révész (1923), who himself did research on synaesthesia, reported on his seven-year-old daughter, who saw numbers as coloured. Anna Kellman Whitchurch (1922) reported on Edgar Curtis, a boy of three and a half years, who had different colours for different kinds of noises; for him, the sound of a frog was bluish (and this case appears in the title of Jamie Ward's book *The frog who croaked blue,* London, 2008: Routledge). In addition, the keys of the piano had different colours, going from *E* (and all tones below) black over grey, orange, red, blue, green, yellow to *a'''* (and all tones above) white. The same tone on different instruments had different colours (*e'* on a guitar was white, but on a piano was blue). Horace B. English (1923) reported on Fulton P., a boy of three years and eleven months, for whom soft music is yellow, loud music black, 'blue music is loud, but not so loud as black music'.

Summary and discussion

We have raised four questions and now can summarize our answers. The presented studies show a general interest in childhood synaesthesia even in the 19th century. This led to basic questions, which are still of interest for us today. Already in the 19th and early 20th century, initial answers were given to these questions.

[3] We want to thank Matthias Svojtka, University of Vienna, for providing the death date of Nussbaumer.

The first documented case of a child with synaesthesia was eight-year-old Ellen Tucker Emerson (coloured words: lexical-colour-synaesthesia) in 1848, reported by a friend of her father in a private letter, which was published in 1892. There is no reason why children before 1848 should not be synaesthetes, but till today we have no source for any before Emerson.

The first empirical study of synaesthesia in children was carried out by Sir Francis Galton in 1880. This inspected the variant known as number forms (also now called 'sequence-space synaesthesia'). The study concluded that the condition was more prevalent in children, although this conclusion would now be questioned by modern science given that it rested on self-reporting to diagnose synaesthetes. Today we now know that self-report is a poor method of detecting synaesthetes because it does not also faithfully reject non-synaesthetes (e.g., Simner et al., 2006). Similar objections can be raised in the question of sex differences. Galton found a ratio of five percent for synaesthesia in boys and concluded that it was higher in girls. New studies show that the ratio is in fact around 1:1, and the prognosticated majority of female synaesthetes in earlier studies might perhaps be traced back to the higher reluctance of men in talking about their synaesthesia in comparison to women (Ward & Simner, 2005).

The first and still most comprehensive longitudinal study of a child synaesthete was carried out by Edward S. Holden, who examined his daughter Mildred between 1882 and 1906, when she was seven to 31 years old. Holden discovered only a small shifting of colours and small changes in brightness within her synaesthesia. Furthermore, this long-term study is one of the longest ever done on this variant of synaesthesia. There is only one other study, covering a period of 27 years, three years more than Holden's, but it dealt with an adult from late teens to his late 40s and was not published until 2008 (Simner & Logie, 2008): This is more than 100 years later than the articles on Holden's daughter.

During the 19th century, it was not clear if synaesthesia was somehow 'learned' during early childhood. Since synaesthesia's new attention in scientific circles starting in the 1980s (e.g., Cytowic, 1989), it has become clear that the phenomenon that it is in most cases congenital, although it can still be affected by learning. Some authors have shown that grapheme-colour-synaesthesia is in some cases learned from childhood toys or alphabet books (Witthoft & Winawer, 2006; Witthoft, Winawer & Eagleman, 2015), although this happens rather rarely (Rich, Bradshaw & Mattingley, 2005). A new study shows that the prevalence of synaesthesia depends also on early language learning (Watson et al., 2017).

Following our recent state of knowledge, Ellen Tucker Emerson is the earliest documented child with synaesthesia; the youngest during the 19th century was the five years old Fidelis Alois Nussbaumer, and the youngest ever until the 1920s was the three and a half year old Edgar Curtis. Aside from these single case studies during the 19th century, no examinations of younger children took place.

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Up to 1923

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Dr. Jörg Jewanski
Department Musikhochschule
Universität Münster
Ludgeriplatz 1
D-48151 Münster
jewanski@gmx.de

Prof. Dr. Julia Simner
School of Psychology
University of Sussex
Sussex House, Falmer
UK-Brighton, BN1 9RH
j.simner@sussex.ac.uk

Dr. Sean A. Day
Department of English
and Journalism
Trident Technical College
PO Box 118067
USA-Charleston, SC 29423

Prof. Dr. Jamie Ward
School of Psychology
University of Sussex
Sussex House, Falmer
UK-Brighton, BN1 9RH
jamiew@sussex.ac.uk