Modes of music listening to modulate stress and prevent burnout

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Abstract

Pathological stress sequelae and burnout syndromes are a global threat. Preventative and therapeutic approaches contain stress management, relaxation techniques, and cognitive-behavioural therapy. Although music has a long, cross-cultural tradition of psychosomatic calming and rebalancing, sound is usually not part of standard interventions for the reduction of stress and burnout symptoms.

Given that music listening is used in both clinical settings and self-administered application, a pre-study highlighted the crucial influence of different sensory approaches on psychological outcomes, and identified sensory focalisation, relaxation, imagery, trance, movement, and aesthetic experiences as most efficient co-modes of listening. The following main study suggests the feasibility of music-based stress- and burnout-modulation and highlights group dynamics, external guidance, self-efficacy and self-regulation techniques, real sound (in contrast to CDs), artistic quality of interpretation, and altered states of mind as determining factors.

Although further evidence based studies are needed to explore the results of this pilot study, music might be suggested as a viable means to complement clinical burnout-programmes and public health strategies to control stress-associated medical conditions.

Keywords: music therapy, stress reduction, burnout prevention, self-regulation, music listening

Modalitäten des Hörens von Musik zur Stressmodulation und Burnoutprävention

Zusammenfassung

Pathologische Stressfolgen und Burnout-Syndrome sind eine globale Bedrohung. Die bisherigen präventativen und therapeutischen Ansätze umfassen Stressmanagement, Entspannungstechniken und Kognitive Verhaltenstherapie. Obwohl Musik seit langer Zeit und kulturübergreifend dafür bekannt ist, eine beruhigende und ausgleichende Wirkung zu haben, gehört sie nicht zu den Standardmaßnahmen in der Behandlung von Stress und Burnout.

Das Hören von Musik wird dennoch sowohl in klinischen Settings als auch in der Selbsthilfe eingesetzt. Eine Vorstudie hat bereits den wesentlichen Einfluss unterschiedlicher Sinneseindrücke auf die psychologische Gesundheit untersucht – dabei stellten sich die sensorische Fokussierung, Entspannung, Bildsprache, Trance, Bewegung und ästhetische Erfahrungen als effizienteste Kooperationsmodi des Zuhörens heraus. Die folgende Hauptstudie thematisiert die Durchführung einer musikbasierten Stress- und Burnoutregulation und legt dabei ein besonderes Augenmerk auf die Gruppendynamik, die externe Anleitung, Selbstwirksamkeits- und Selbstregulationstechniken, den „echten“ Klang (im Gegensatz zu CDs), die künstlerische Qualität der Interpretation sowie verschiedene Gemütsverfassungen als bestimmende Faktoren.

Obwohl weitere evidenzbasierte Forschung benötigt wird, um die Ergebnisse dieser Pilotstudie zu untermauern, könnte Musik durchaus als sinnvolle Ergänzung dienen: für therapeutische Burnout-Programme und weitere Maßnahmen des Gesundheitswesens gegen stressinduzierte Krankheiten.

Schlüsselwörter: Musiktherapie, Stressreduktion, Burnoutprävention, Selbstregulation, Musikhören

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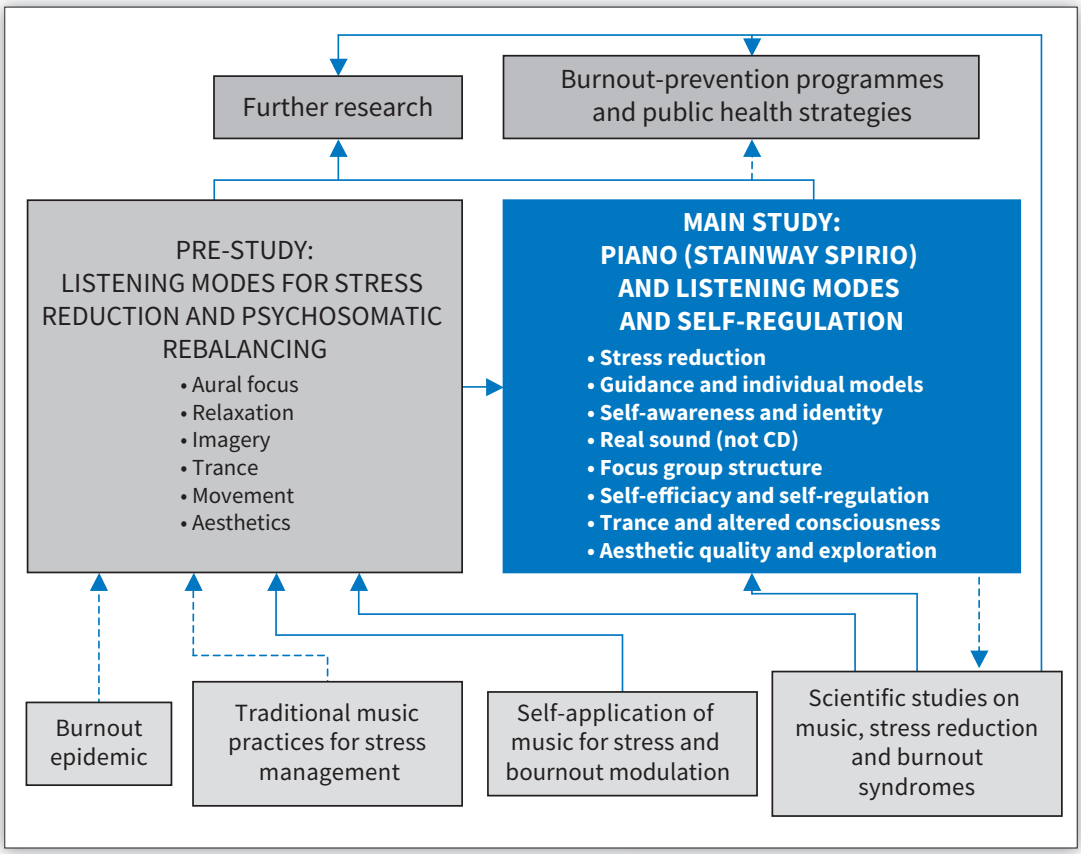
Graphical Abstract



Introduction

Since Hans Selye's landmark brief 'letter' to the editor of Nature (Szabo et al., 2012) and the introduction of the term 'burnout' to the realm of medicine by Herbert Freudenberger (1974), both concepts have much impacted on clinical research and greatly influenced public health. In spite of different academic approaches to stress and burnout, in Germany, afflicted individuals often assume a casual nexus between both. In a nutshell, they tend to take burnout as a sequela of chronic stress, hence also our joint preventative approach.

In contrast to robust consensus that stress is a global threat, burnout has only slowly gained ground in medical fields. And while burnout is seen as a 'fashionable diagnosis' (Kaschka et al., 2011) and a good excuse for sick leave, it is 'time to consider the "Burnout Syndrome" a distinct illness' (Bianchi et al., 2015) that is considered a serious psychiatric condition in Germany (Kissling et al., 2014).

Today, burnout prevention comprises manifold approaches such as coping with work-related stress and body-oriented relaxation techniques for self-care. Therapy of burnout syndromes is often based on cognitive behavioural psychotherapy (Korczak et al., 2012), and unsolved problems give rise to interdisciplinary research such as the 'Dresdner Burnout-Studie' in Germany. Music does not rank among the standardised means to control the development of stress-related syndromes and to prevent burnout though.

Nonetheless, music and music therapy are also used to modulate stress and stress-related issues such as anxiety and insomnia, and are applied to reduce burnout syndromes (Bittman et al., 2004; Brandes et al., 2009). Two recent studies highlighted music listening as a means of stress reduction. On the basis of analyses of salivary cortisol and salivary alpha-amylase they pointed out that music is a viable means to reduce stress in daily life (Linnemann et al., 2015) and effects depend on social contexts such as the presence of others (Linnemann et al., 2016). Moreover, they provided insights into underlying mechanisms of these benefits.

Nevertheless, there is the crucial issue that different ways of listening to music and various music preferences might considerably influence cognitive, affective, and aesthetic states. From a musicological, music psychological, and music educational perspective, individual listening skills, biographical experiences with music, and music-based identities strongly determine psychosomatic responses to music (Theorell, 2014; Tan et al., 2010). In Germany, for instance, a whole academic bachelor- and master-programme – 'Gehörbildung' [i.e., aural training] – relates to these topics.

Considering these perspectives, this article intends to complement previous findings and to provide a preliminary theoretical frame-

work for listening-based prevention of burnout and self-regulated modulation of stress.

Pre-study

Given the heuristic evidence that skills and modes of listening have a strong influence on psychosomatic responses to music, a pre-study with healthy students was conducted to explore conditions of stress-reducing and psychosomatically re-balancing music. That study was not intended to yield robust outcomes but should help to design the interactive work with participants of the main pilot study.

Based on both introspection and qualitative research techniques with focus groups, students of the University of Music and Performing Arts in Munich were asked to explore how different modes of listening impact their psychological and psychosomatic responses to music. Particularly with regard to experienced stress and stress-related phenomena, regrouping verbal data allowed to identify six core modes of listening. These served as a tool to help participants of the main study develop optimised listening modes for psychosomatic self-regulation of stress and burnout-syndromes.

1) *Focal listening and sound identity.* A quasi-selective attentiveness to perceived sound phenomena generates an experienced identity with the music listened to. This requires a certain ability of auditory concentration and might cause the temporary self-awareness of 'being rhythm and sound' that virtually blinds out the consciousness of other dimensions of the self.
2) *Listening and deep relaxation.* This listening mode is associated with the impression of music penetrating the body in a way that alleviates tensions. Feelings of body-mind-resonance might also involve altered forms of breathing and cause states that remind us of progressive muscle relaxation, for instance.
3) *Auditory stimulation of imagery.* Intense and yet not compulsive/overdoing listening to music might elicit visual sensations. Similarly to various approaches in analytic music therapy are models such as Guided Imagery and Music, these images might disclose repressed inner-psychic contents and touch upon psychotherapeutically relevant topics.
4) *Listening-induced trance.* Ethnology highlights a wealth of music-associated trance processes in many cultures and arts-related hypnotherapy exploits the potential of music to enhance neuro-psychological reorganisation and regeneration. Music-induced altered states of consciousness seem to also encompass stress-reducing potential.
5) *Music and movement.* Listening to music brings about motor responses and phenomena of body-expression that match musical rhythms and the dynamics of the melodic gestalt. Experienced somatosensory identity between music and the self was described as likely to reduce inner tensions and obsessive-compulsive patterns.
6) *Aesthetic sound-experience.* Enjoying the beauty of music beyond any analytic modes of listening accords with the anthropological phenomenon of aesthetics. Experiencing the beauty of music was described as incompatible with stress and conditions of burnout.

Evaluating the relevance of listening-experiences to burnout-prevention, the pre-study referred to the criteria proposed by Maslach and Jackson (1981) and Shirom and Ezrachi (2003), i.e., emotional, physical, and cognitive fatigue, cynicism and/or depersonalisation, and decreased productive capacity.

Material and methods

Admission to the study required subclinical burnout states, readiness to participate in focus group-oriented processes, and to actively work on listening-based means to modulate stress and burnout-factors. Over two months, sessions were held once a week in the evening at the Steinway & Sons house in Munich in a room with rather chamber musical atmosphere and no clinical ambience.

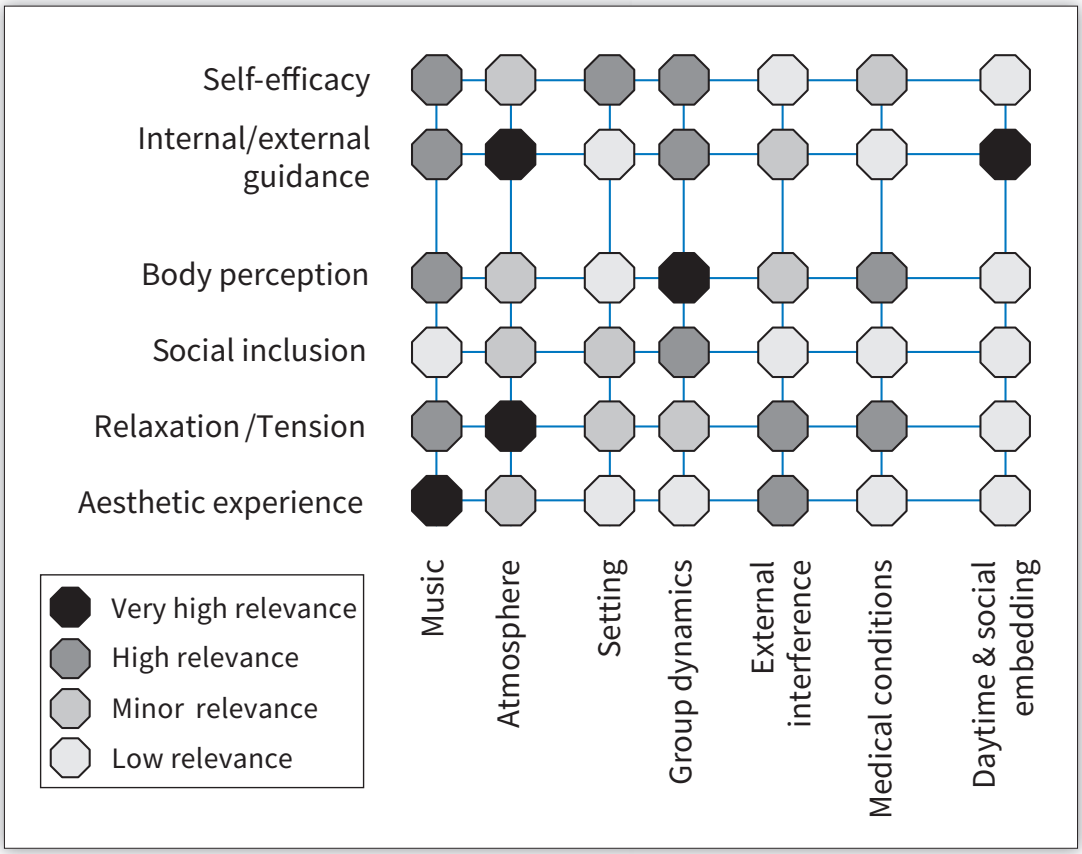
As music source a Steinway & Sons Spirio B-grand piano was used. The Spirio is a high resolution player piano that allows to reproduce music with such nuance that it is physically seen nearly indistinguishable from a life performance. In this context, participants greatly admired recordings of famous interpretations such as by Vladimir Horowitz and Art Tatum.

Weekly intervention sessions lasted 90 minutes and comprised sharing about psychosomatic responses to listening and music- and symptom-related experiences during the week, music-centred phases, exploration of listening modes, and interactive attempts to develop individual approaches to modulate and control burnout-features.

Gained and processed data comprised the participants' oral/written verbal information, audio and video recordings of the weekly sessions, and visual observations of the body language and facial expression at the moment (Figure 1).

These data were collected as a pool and processed according to qualitative methods of comparison, interpretation, and re-grouping.

Figure 1



Outcomes resulted in the identification of core factors of music listening for stress-management and a preliminary framework for further research. Within the data-pool, gridpoints indicating very high and high relevance are robust and consistent, those relating to minor or low relevance are much less reliable and instable.

Results

Regarding the following results we have to take into account that (i) they are derived from a small sample, (ii) are mainly based on the participants introspection and self-evaluation, and (iii) do not generate an explicit inner logic.

Listening to music can reduce stress and burnout-syndromes both at the moment and with a limited sustained effect.

Balanced interaction between guidance (coach/therapist) and self-determination (self-efficacy/self-regulation) is superior to both working completely alone and standardised programmes that do not allow for individual features.

Work in focus groups supports relaxation and coping processes and allows for individual dynamics of self-experience and listening-based self-regulation. Self-efficacy, allowance to determine music selection and time frames, and sharing of aesthetic experiences elicit mental states that enhance relaxation. Moreover, exchange of individual music preferences improves aesthetic tolerance.

Training on a weekly basis helps to enjoy time exclusively for oneself and to re-access one's inner life.

Music-induced trance increases the benefits of music on relaxation and the reduction of burnout-specific symptoms.

(Guided) imagery is not specifically helpful, occurs literally always unintentionally, but might enhance the joy of sensory experience. Moreover, expressing inner images helps to cope with inner tensions.

Body-expression and creating movements that respond to the music was considered as awkward and hence rejected. However, educational and social factors, acculturation, and unfamiliarity with the body-self have to be taken into account.

Combining listening to music with breathing techniques and body-oriented relaxation enhances the preventative/therapeutic effect.

Sound from an acoustic instrument is superior to Hi-Fi-reproduction/sound condensation and impacts considerably on relaxation-levels and recovery.

Aesthetic experiences greatly modulate relaxation and psychosomatic recovery and the artistic quality of the presented music is considered of crucial importance. Felt identity with music impacts on psychosomatic outcomes.

Discussion and conclusions

The results of this study supports previous findings about the stress-reducing and burnout-preventative effect of music listening and encourages the integration of these approaches into standardised programmes. In light of the assumingly high amount of self-application of music for burnout-prevention, these techniques should also be considered in self help groups and preventative occupational medical settings.

Programmes that are tailored to individual listening profiles and psychosomatic responses to music might optimise preventive and therapeutic outcomes. Qualitative data from this study emphatically advocate the integration of individual aural trainings and listening-oriented self-discovery and not to apply standardised and invariant intervention packages.

Additionally to specifically shaped aural trainings, music-listening-programmes should also encompass phases of silence and take the likelihood of music-induced altered states of mind and trance-processes into account. This can help to optimise outcomes and prevent risks of unexpected hypnotic states.

Although linking music and movement/body-expression might help to modulate symptoms of upcoming burnout, individual shyness, unfamiliarity with the body-self, and disinclination to share inner processes with others might obstruct preventative benefits. This needs individual support and a sufficient confidence base within the group.

Sound from real instruments seems to be superior to sound from loudspeakers and condensed sound information (CDs). This contrasts with the lion's share of research and clinical settings in this domain and requires rethinking means of intervention that match the human auditory system and associated neuropsychological functions such as sound-space-localisation.

Humans might be equipped with a subconscious evaluation system of artistic and aesthetic quality – these topics are extremely difficult to define and there is no consensus about robust criteria – that differs from their regular aesthetic estimation and judgements. We assume a certain psychosomatic response to a quasi 'embodied music interpretation", i.e., a way of playing that precisely accords with musical features that mirror psychosomatic dynamics and symbolise inner psychic realities. At this point of discussion, interdisciplinary approaches that involve neurophysiology, psychology, cultural anthropology, musicology, aesthetics, and the arts as well as arts-related reasoning are needed.

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

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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

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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