

CHARACTERISTICS/RELATED CONDITIONS

MITEMPFFINDUNG IN SYNAESTHETES: CO-INCIDENCE OR MEANINGFUL ASSOCIATION?

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ABSTRACT

Mitempfindung is the referral of a tactile sensation to a location far away from the stimulation site. This brief note reports a 40% incidence of *Mitempfindung* in a sample of 20 digit-color synaesthetes which contrasts with a 10% incidence in two control groups of non-synaesthetes. Phenomenological similarities between *Mitempfindung* and synaesthesia are discussed, and we propose that an erratic neural connectivity underlies both phenomena. To better characterize the nature of the purported neurophysiological peculiarities, prospective studies are needed that characterize *Mitempfindung* in synaesthetes and nonsynaesthetes.

Key words: tactile stimulation, cutaneous senses, referred sensations, plasticity, digit-color synaesthesia

INTRODUCTION

Synaesthesia manifests itself in a vast variety of crossmodal associations. Despite this heterogeneity at the phenomenological level, there is general agreement about a common cause, at the neuronal and perhaps the genetic level, of the sensory referral from one modality to another. In support of the notion of a “synaesthetic constitution” is the observation that most synaesthetes report more than one type of synaesthesia. While one of the most common forms is the association between two visual submodalities, i.e., grapheme-color synaesthesia, the cutaneous senses are among the least frequently involved modalities. However, an early study described the merging of thermal and tactile impressions, the latter simultaneously being felt at a location far away from the stimulation point (Dallenbach, 1926). Specifically, this author described that coldness applied to a young woman’s forearm made her aware of pressure sensations in the teeth, cheeks and other parts of her head. Dallenbach (1926) emphasized that the young woman’s mother reported more traditional types of synaesthesia (involving the visual, auditory, olfactory and gustatory, but not the somatosensory modality) and proposed an inherited “peculiarity of nervous structure” (Dallenbach, 1926, p. 575) common to both his two subjects. Apparently unbeknownst to the author, the phenomenon of cutaneous double sensations had been described almost 200 years earlier (Hales, 1733) and was later labeled *Mitempfindung* (Müller, 1844; after the German ‘sensing together’), a term subsequently used also in the English language literature (e.g., Evans, 1976; Hammond and Ebers, 1992; Martin, 1991; Schott, 1988 for review). Given the above mentioned co-

occurrence of different types of synaesthesia in one individual, we investigated whether the incidence of *Mitempfindung* would be higher in people with digit-color synaesthesia compared to non-synaesthetic control subjects.

METHOD

Twenty digit-color synaesthetes (17 woman) and 20 non-synaesthetes (matched for age, gender and education) were recruited for an ongoing project in synaesthesia. History of psychiatric and neurological disease was checked with an abbreviated neuropsychiatric inventory (Campbell, 2000); one of the synaesthetes reported epileptic seizures, another one reported a history of unexplained fainting-attacks. All synaesthetes became aware of their synaesthesia in early childhood. Automaticity of individual digit-color associations was established with a random generation paradigm (Knoch et al., 2005). Synaesthetes had to name (eyes closed) the colors they associated to the digits 1 to 6 in a sequence as random as possible (66 responses generated at a rate of approx. 1 Hz). Control subjects learned the 6 digit-color associations of their pair-matched synaesthete and performed the same random color generation task. Synaesthetes, but not controls, “counted in colors”, i.e. consecutive color responses represented digits adjacent to each other on the number line.

Synaesthetes were recruited by flyers and ads in a local newspaper. Matched non-synaesthetic subjects were recruited among acquaintances and people attending a local recreational area. Thirty-four non-synaesthetes (20 woman), participating in an unrelated study, were also interviewed regarding

TABLE I
 Characteristics of *Mitempfindung* in the 13 subjects reporting the phenomenon

Subject	Gender	Age of first awareness of <i>Mitempfindung</i>	Reference zone(s) rostral to trigger zone	Trigger zone on (side of body)	Reference zone on (side of body)
1 (S)	f	not specified	not necessarily	midline	midline
2 (S)	f	17	yes	right	midline
3 (S)	f	32-37	yes	left	left
4 (S)	m	18	yes	left	left
5 (S)	f	always been aware	yes	left	left
6 (S)	f	13	yes	midline	midline
7 (S)	f	always been aware	trigger zone: anywhere reference zone: head, shoulders, toes	not specified	not specified
8 (S)	f	4	yes	left and right	midline
9 (M-C)	f	early twenties	no	left and right	left and right (ipsilateral)
10 (M-C)	f	puberty	no	midline	midline
11 (NM-C)	f	always been aware	no	left and right	left and right (contralateral)
12 (NM-C)	m	14	yes	right	midline
13 (NM-C)	f	14	yes	left	left

S = synaesthete; M-C = matched control subject; NM-C = non-matched control subject; f = female; m = male.

their experience with *Mitempfindung*. All participants gave written informed consent according to the Declaration of Helsinki.

Subjects were asked whether tactile stimulation of one part of the body simultaneously produced a sensation also at a different location. If the response was affirmative, the subject was asked to indicate the trigger- and reference zones on a full body figure, seen from 4 different views (Richter, 1977). Moreover, subjects were required to fill in a brief questionnaire about various quantitative and qualitative aspects of their *Mitempfindung*.

RESULTS

Mitempfindung was reported by 8 of the 20 synaesthetes (7 of whom were women) and 2 of the 20 matched control subjects (both women) ($\chi^2 = 4.8$, $p < .03$). Three of the 34 non-matched control subjects (two women) reported *Mitempfindung* ($\chi^2 = 7.5$, $p < .01$). Most subjects indicated that they first noted the occurrence of *Mitempfindung* during early childhood or puberty. A majority of subjects reported a strictly ipsilateral referral of sensation, but no laterality differences were evident in the distribution of trigger or reference areas. The reference zones were usually located rostral to the trigger zones. For further information on the 13 subjects with *Mitempfindung* see Table I.

DISCUSSION

The incidence of *Mitempfindung* was 40% in synaesthetes, 10% in the matched control group, and 9% in the non-matched control group. This renders a meaningful association between digit-color synaesthesia and *Mitempfindung* plausible

and supports the notion of a conceptual similarity between the two phenomena (Dallenbach, 1926; de Fromental, 1888). Previous reports diverge with respect to the prevalence of the phenomenon in the general population. Some are vague, mentioning that it is "observed in many people" (Bean, 1979, p. 155) or "commoner than might be supposed" (Schott, 1988, p. 1188). Among those authors who provide exact figures, these vary between 8 out of 9 subjects (Mittelmann, 1920) and 8 out of 41 (Evans, 1976). This high variability is possibly a consequence of many factors, such as preselection of participants, individual differences in subjects' introspective abilities and different assessment methods.

Not only the relatively high incidence of *Mitempfindung* in synaesthetes, here empirically determined for the first time, would seem to justify a conceptualization of the phenomenon as a type of synaesthesia. There are a number of striking similarities between these two unusual forms of simultaneous double perceptions. For instance, both originate in early childhood, are highly variable *between* individuals, but very specific and stable *within* an individual. The unidirectionality principle in synaesthesia (e.g., an auditory stimulus elicits a color, but looking at the color does rarely ever evoke an auditory experience) is also encountered in *Mitempfindung*. Typically, stimulation at one point of the body ('trigger zone') elicits a simultaneous perception at a second point ('reference zone'), but referral does not occur in the opposite direction. For further attributes of *Mitempfindung*, also characteristic of non-cutaneous synaesthetic associations, see Table II. The features of *Mitempfindung* assessed in our subjects (e.g., onset and unidirectionality) were consistent with the findings listed in Table II.

The contemporary literature conceives of *Mitempfindung* as a "neuroanatomical and

TABLE II
Attributes of *Mitempfundung* as described in the literature

Attribute	Reference(s)
Onset early in life or possibly congenital	Schott, 1988; Hammond and Ebers, 1992
Often runs in families	Bean, 1979; Dallenbach, 1926
Unidirectionality: Stimulation of a referral point never generates sensation in the trigger zone	Evans, 1976; Schott, 1988; Monro, 1898
Association between trigger and reference zone variable across individuals, but very stable within an individual	de Fromental, 1888; Kowalewsky, 1884 (cited in Nawrocki, 1886); Sterling, 1973; Bean, 1979; 1981; Sinclair, 1949
Possibly underreported (until questioned, subjects with <i>Mitempfundung</i> are often not aware that they experience something special)	Dallenbach, 1926; Sinclair, 1949
Cases of acquired <i>Mitempfundung</i> are described	Schott, 1988; Bors, 1979; Aglioti et al., 1999; Nathan, 1956; Hammond and Ebers, 1992; Turton and Butler, 2001 (for cases of acquired synaesthesia see Armel and Ramachandran, 1999; Harrison, 2001; Steven and Blakemore, 2004)

physiological puzzle” (Hammond and Ebers, 1992, p. 724). Neither peripheral factors (e.g., extensive axon branching) nor mechanisms at the spinal, subcortical or cortical level alone can fully account for the pattern of observations. Rather, studies of acquired *Mitempfundung*, i.e., the referral of sensation after peripheral or central nervous system damage (Table II for references), suggest that referred double sensations are a general sign of neural plasticity, irrespective of the level at which irritations or deafferentations occurred. As in the literature on the non-cutaneous synaesthetics (e.g., Baron-Cohen and Harrison, 1996; Grossenbacher and Lovelace, 2001), both an aberrant neural connectivity (e.g., Aglioti et al., 1999; Sterling, 1973) and the functional release of normally inhibited pathways (Hammond and Ebers, 1992) are discussed as a potential neural correlate of *Mitempfundung*. The features of apparently spontaneous and those of acquired *Mitempfundung* are very similar in that both appear at highly variable sites interindividually, but that individual mappings of the trigger and reference zones are highly stable. Unlike spontaneous *Mitempfundung*, however, acquired *Mitempfundung* tends to be rather transient (Schott, 1988). In fact, transient *Mitempfundung* can be elicited by experimental application of acute pain to a healthy subject’s hand followed by non-noxious tactile stimulation of the ipsilateral lip (Knecht et al., 1998). These authors found that a considerable number of volunteers subjected to this procedure reported a touch sensation not only on the lip, but simultaneously also in the hand. This experimentally induced *Mitempfundung* is reminiscent of “referred

sensations” in amputees that involve the referral of touch applied to normesthetic body sites to the phantom limb (Ramachandran et al., 1992). Thus, the phenomenon of *Mitempfundung* appears highly significant with respect to the understanding of processes of reorganization and plasticity. A similar conceptual background is assumed for synaesthesia, both in its “natural” (Grossenbacher and Lovelace, 2001) and acquired forms (Armel and Ramachandran, 1999; Steven and Blakemore, 2004).

While Table II lists the phenomenological (and possibly conceptual) similarities between synaesthesia and *Mitempfundung*, we also wish to point out one discrepancy: while the incidence of synaesthesia is clearly much higher in women compared to men (e.g., Harrison, 2001), to our knowledge no comparable gender bias has ever been reported for the cutaneous referral of sensation. The present study cannot contribute to the issue of gender differences in the prevalence of *Mitempfundung* since the majority of our subjects were women.

We hope that our brief note will raise the awareness of scientists working in the field of synaesthesia for the phenomenon of *Mitempfundung*. A deeper understanding of one of the phenomena may lead to a better understanding of the other.

Acknowledgements. This research was in part supported by the Swiss National Science Foundation (grant # 3100-67168.01) and by the Theodor and Ida Herzog-Egli Stiftung (grant # 208).

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