

A neural basis for the distinction between involuntary musical imagery (INMI), hallucinosis and hallucination

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Since the late 1990s, scientific interest in the phenomenon of musical imagery has grown, reaching from musical hallucinations [1,2] to the everyday phenomenon of involuntary musical imagery, aka 'earworms' [3,4].

Interestingly, the phenomenon can reach different levels of occurrence and disturbance, shown by previous research on single and multiple case studies, resulting in a proposed brain basis of "musical hallucinosis" [5] and a theoretical framework on "INMI" [6]. So far, the terminology used to describe the different stages of musical imagery is rather diverse (e.g. mixing scientific and clinical terms), and

clear cut definitions to differentiate between the stages and terms are missing.

In a qualitative interview study, seven participants, exhibiting a form of involuntary musical imagery (five cases are reported in [3]), revealed a conspicuous issue: they were all worried about the music potentially being a symptom of a developing mental disorder which could not be treated. After being in contact with most of the participants for a few years, it can be said that the conditions and symptoms were stable with no effect from medical treatment, if even employed.

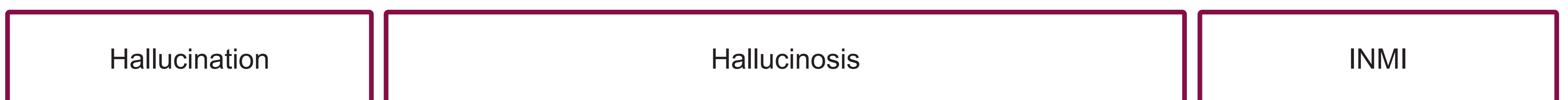
Aims:

- proposing a terminology and definitions for the different forms of involuntary musical imagery based on these reports and studies
- considering clinical and scientific terms
- characterizing the different forms with behavioral and neural substrates (hypotheses)
- providing a framework for further scientific research as well as a differentiated medical diagnosis and treatment of pathological occurrences

1. Terms used in clinical context and scientific research

Hallucinations (ICD-10 R44.0) DSM-IV-TR: <i>a sensory perception that has the compelling sense of reality of a true perception, but that occurs without external stimulation of the relevant sensory organ</i> [8; p.823]		involuntary musical imagery <i>imagined musical experiences that originate without the subjects' intention and are not pathological</i> [9] <i>double involuntary occurrence: involuntary storing music in long-term memory and involuntary retrieval</i> [3]	
symptom of a mental disorder , e.g. obsessive-compulsive disorder (OCD), schizophrenia	symptom of an organic disorder , e.g. hearing loss, de-afferentiation, tinnitus, sensory deprivation Organic Hallucinosis (ICD-10 F06.0): <i>A disorder of persistent or recurrent hallucinations, usually visual or auditory, that occur in clear consciousness and may or may not be recognized by the subject as such.</i> [9]	permanent INMI caused by increased sensitivity to music (hypothesis)	'everyday' INMI ('earworm') common to everybody

2. Terminology and classification suggested for research context



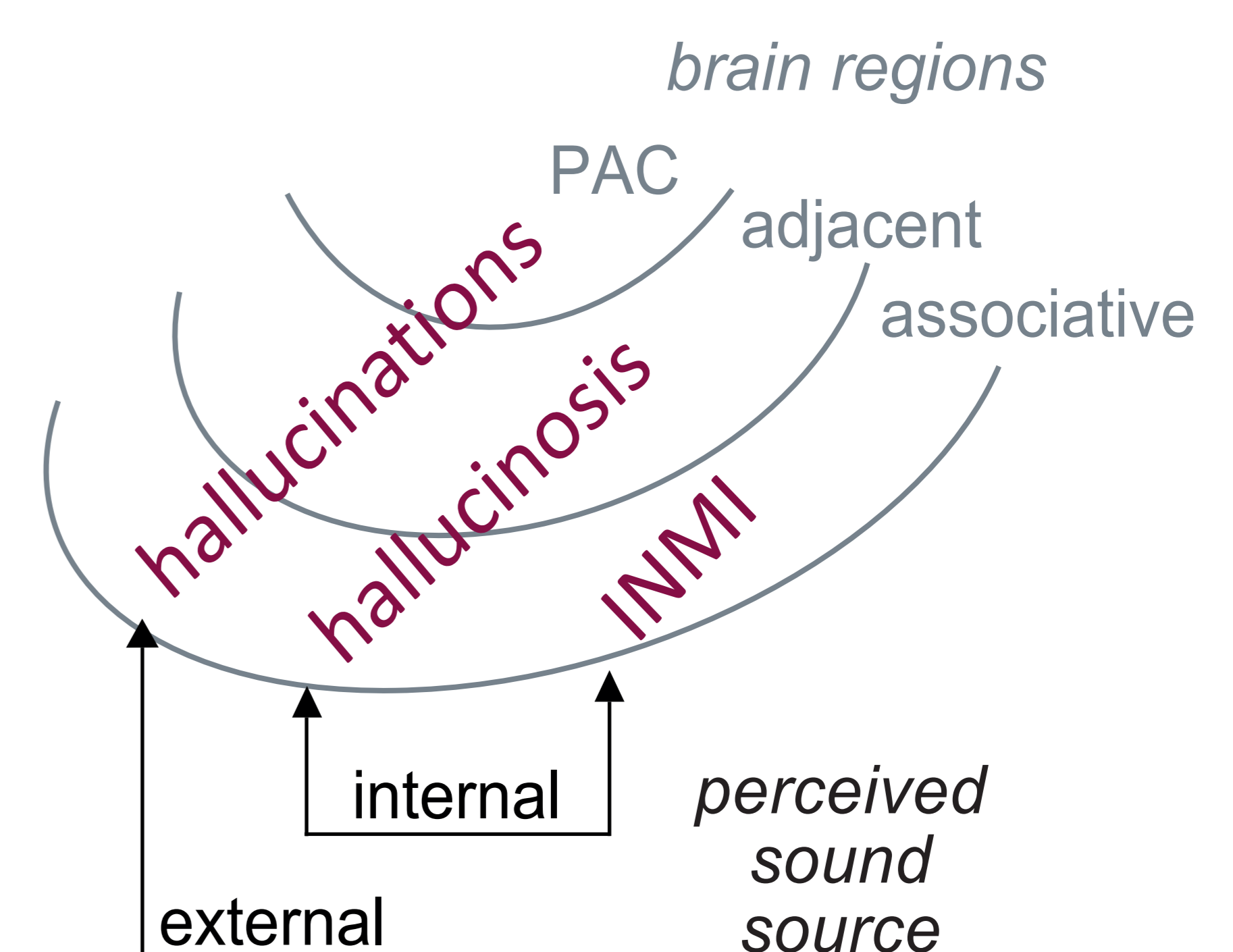
3. Proposed differences between Hallucinations, Hallucinosis and INMI

Behavioral substrates:

- The sound source is always in subjective space with different degrees of awareness for the absence of the sound source:
 - In hallucinations the sound source is perceived as external.
 - In hallucinosis and INMI the sound source is perceived as internal.
- The perceived disturbance ranges from very disturbing in hallucinations to less disturbing or even pleasant in INMI.
- The vividness ranges from high in hallucinations to low in INMI (hypothesis).

Neural basis:

- The parts of the auditory cortex are differently engaged.
 - In hallucinations the primary auditory cortex (PAC) and adjacent and associative areas can be active [10].
 - In hallucinosis only adjacent and associative areas were found to be active [1,2,5].
 - In INMI no evidence for brain activation is available yet, but inclusion of adjacent or even only associative areas is hypothesized.
 - In the case of voluntary musical imagery adjacent and associated areas were active [11].



References

- [1] Griffiths, T. D. (1997). *Neurocase*, 3, 167-172.
 [2] Griffiths, T. D. (2000). *Brain*, 123, 2065-76.
 [3] Hemming, J. (2009). In Auhagen, W. et al. (Eds.): *Musikpsychologie* [...]. 184-207. Göttingen.
 [4] Liikkanen, L. (2009). In Louhivuori, J. et al. (Eds.), *Proc 7th Triennial Conf ESCOM*. Jyväskylä.
 [5] Kumar, S. et al. (2014). *Cortex*, 52, 86-97.
 [6] Liikkanen, L. (2012). *ACNR*, 12(4), 12-14.
 [7] Hemming, J., & Altenmüller, E. (2012). In Cambouropoulos, E. et al. (Eds.): *Proc 12th Int Conf Music Perc Cogn* [...]. Thessaloniki, Greece.
 [8] *Diagnostic and Statistical Manual of Mental Disorders DSM-IV-TR* (2000). 4th Edition. Text Revision. Amer Psychiatric Pub Inc.
 [9] *International Classification of Diseases (ICD)* (2011). 10th Revision. World Health Organization.
 [10] Kompus et al. (2011). *Neuropsychologia*, 49, 3361-9.
 [11] Zatorre, R. & Halpern, A. (2005). *Neuron*, 47(1), 9-12.