



# Environmental and mental conditions predicting the experience of involuntary musical imagery: An experience sampling method study



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## ABSTRACT

An experience sampling method (ESM) study on 40 volunteers was conducted to explore the environmental factors and psychological conditions related to involuntary musical imagery (INMI) in everyday life. Participants reported 6 times per day for one week on their INMI experiences, relevant contextual information and associated environmental conditions. The resulting data was modeled with Bayesian networks and led to insights into the interplay of factors related to INMI experiences. The activity that a person is engaged was found to play an important role in the experience of mind wandering, which in turn enables the experience of INMI. INMI occurrence is independent of the time of the day while the INMI trigger affects the subjective evaluation of the INMI experience. The results are compared to findings from earlier studies based on retrospective surveys and questionnaires and highlight the advantage of ESM techniques in research on spontaneous experiences like INMI.

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## 1. Introduction

Involuntary cognitions, in the form of memories, thoughts and future planning, constitute a significant fraction of mental activity in people's everyday lives (Killingsworth & Gilbert, 2010; Kvavilashvili & Mandler, 2004). One type of involuntary cognition that is fairly prevalent in Western populations (Liikkanen, 2012; Williamson et al., 2012) takes the form of music and is referred to as 'involuntary musical imagery' (INMI, or an "earworm" as it is commonly known). INMI is a short section of music that comes to the mind spontaneously without effort and then goes on repeating itself without conscious control.

Despite the fact that research on INMI only begun fairly recently (Brown, 2006; Kellaris, 2001), a considerable number of studies during the past few years have produced a range of significant results which now allow the construction of a theoretical framework as well as the refinement of research methods which help to further investigate this by definition very inaccessible phenomenon. Thus, research findings to date have provided information on a range of environmental factors and psychological conditions that contribute and affect the experience of INMI. We will summarize these findings first before laying out the rationale and motivation for the current study. In this brief summary of the literature, we focus on transient momentary conditions and states rather than on personal traits and stable individual differences that have been covered elsewhere (Beaman & Williams, 2013; Müllensiefen et al., 2014).

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## 1.1. Mental and environmental phenomena related to INMI

### 1.1.1. Triggers

Both INMI and non-musical involuntary memories (Berntsen, 1996, 2001; Rasmussen & Berntsen, 2009) are generally assumed to be triggered by external or internal cues, with the major difference that in the case of involuntary semantic memories (ISM) the majority of the people (63% according to Kvavilashvili & Mandler, 2004) are not able to report what preceded them, whereas in the case of INMI, triggers can be identified most of the time. A study by Williamson et al. (2012) investigated cues that precede and ultimately trigger INMI. The study identified several different such triggers, which can be categorized in 4 dominant themes, namely exposure to music, memory triggers, affective states and low attention states. The first two themes (recent exposure to music and memory triggers) have also been confirmed by Hyman et al. (2013) and are supported by ISM literature (Kvavilashvili & Mandler, 2004).

### 1.1.2. Mind wandering

Mind wandering is one of the low-attention states that Williamson et al. (2012) found to be associated with subsequent INMI experiences. Mind wandering is characterized by a shift of attention from a main task that the individual is engaged in toward internal information such as the processing of memories (Smallwood, Baracacia, Lowe, & Obonsawin, 2003; Christoff, Ream, & Gabrieli, 2004; Smallwood, O'Connor, Sudberry, & Ballantyre, 2004; Smallwood, Obonsawin, & Heim, 2003; Smallwood and Schooler, 2006; Smallwood et al., 2004). Different terms have been used to describe this phenomenon, including task-unrelated thought (Smallwood, Davies, et al., 2004), stimulus-independent thought (Antrobus, 1968; Teasdale, Lloyd, Proctor, & Baddeley, 1993), mind pops (Kvavilashvili & Mandler, 2004), and zone outs (Schooler, 2002; Schooler, Reichle, & Halpern, 2005). There are minor differences between the exact meaning of these terms but all of them generally characterize a process of self-generated thought. The association between mind wandering and INMI reported by Williamson et al. (2012) supports findings from early INMI research, such as those of Bennett (2002) who suggested that the appearance of INMI is always associated with a lack of focus and relaxed states in which the brain is in a condition of break or distraction. This is also in line with Kellaris (2001) assertion that «earworms eat idle brains».

### 1.1.3. Concurrent activities

In addition to mind wandering and low-attention states, mental or physical activities that are concurrent to the appearance of INMI are assumed to be a key feature for understanding the latter's etiology. From the data of a large survey of retrospective reports, Liikkanen (2012) concluded that INMI appear most frequently when individuals are working alone, traveling or exercising. He also found that they occur least during activities requiring auditory engagement (e.g. conversing, which was mentioned by only 10.9% of the participants of his survey). However, the same study also reported that watching TV and listening to music was the fifth most common situation (42.3%) to be associated with INMI, even though they also require auditory engagement. The apparent contradiction implied by these two findings is one of the topics addressed by the current study.

In a study on both, voluntary and involuntary musical imagery, Bailes (2006) reported that socializing was the most frequent activity in the context of which musical imagery tend to appear, a result which conflicts with Liikkanen's findings (2012) described above. Other activities associated with INMI occurrence, as reported by Bailes (2006), are working and traveling as well as waiting and getting up in the morning, while INMI was reported less commonly during audio/visual activities like watching TV and listening to music.

A more recent study by Hyman et al. (2013) showed that the activities which tend to be associated with INMI can be characterized by low but also by high cognitive load ("cognitive load continuum").

Taken together, findings to date suggest that INMI tend to occur more frequently when the activity that a person is engaged in is not demanding, is associated with low cognitive load and tends to be monotonous and automatic. These conditions are generally also associated with mind wandering (Schooler, 2002; Smallwood & Schooler, 2006).

### 1.1.4. Time of the day

Findings about the relationship between time of the day and likelihood of INMI occurrence are mixed. Halpern and Bartlett (2011) found that mornings (34%) favor INMI appearances, followed by the afternoon (20%), evening (20%) and night (10%). On the other hand, in Bailes' study (2007) the musical imagery (voluntary and involuntary) rate was found to be almost constant throughout the day, dropping to half during the night. Byron and Fowles (2013) found no significant difference between the frequencies of INMI occurrence at different times of the day. They argued that the contradiction between these findings with those of previous studies could be due to chance or – in the case of Bailes' study – the inclusion of voluntary imagery in the observations.

### 1.1.5. Factors affecting subjective evaluation

Although common belief has it that INMI is mostly evaluated as a negative experience, studies so far have shown that evaluations of INMI experiences can vary greatly between individuals. Several studies show that the experience of INMI is predominantly considered as pleasant (Beaman & Williams, 2010; Halpern & Bartlett, 2011; Hyman et al., 2013) while others report negative evaluations (Floridou, Williamson, Stewart & Müllensiefen, in press; Hemming, 2009; Williamson et al., 2014). Thus it is not yet clear which are the factors that modulate the evaluation of INMI experiences and, for this

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