Proceedings of the 10th International Conference on Music Perception and Cognition (ICMPC 10). Sapporo, Japan.
Ken'ichi Miyazaki, Yuzuru Hiraga, Mayumi Adachi, Yoshitaka Nakajima, and Minoru Tsuzaki (Editors)

Music in Everymind: Commonality of Involuntary Musical Imagery

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ABSTRACT

A new topic within the psychological discipline concerns involuntary semantic memories. Initial research has suggested that musical memories are the dominant type of memories that are remembered involuntarily. Interestingly, no reliable information exists on how common this phenomenon of 'earworms', mental replay of music, is among people living in a western culture. Present study intended to investigate this issue by examining the topic in retrospect. Study conducted among 12,420 Finnish Internet users showed that 91.7 % of people reported experiencing this phenomenon at least once a week. Several statistical procedures were used to relate the retrospectively reported frequency of the phenomenon to a set of background variables. This revealed a positive connection to increased music practice and listening, and sex (being a female). In contrast, with increasing aged, the frequency of the incidents decreased. The results are discussed in the paper revealing the most important factors underlying this non-volitional experience.

I. INTRODUCTION

The phenomenology of daytime consciousness includes many fascinating features. Synesthesia, despite its relative rarity, presents a case of continued research interest that has provided insight into main stream cognitive science (Kadosh & Henik, 2007). Much more common feature is involuntary musical imagery (Sacks, 2007) which refers to the conscious experience of music, familiar or novel that repeatedly goes over in one's mind during normal daytime awareness. I here suggest that involuntary musical imagery (abbreviated here as INMI; but see also Bennett, 2003, 2002) can be analyzed into two parts: activation and upkeep. The former occurs without attention (Koch & Tsuchiya, 2007) while the latter allows some conscious control over the imagery, being thus similar to deliberate musical imagery (Halpern, 1988, 2001; Godøy & Jørgensen, 2001). The main interest of this paper is activation.

Unlike synesthesia, INMI has remained relatively unexamined and only few studies with relatively small and constrained samples have been reported this far (Bennett, 2003; Kellaris, 2001, 2003). This appears odd, as almost two decades have passed since the research on musical imagery made a breakthrough into the psychological literature. This break occurred when the behavioral paradigms of visual imagery research were adapted into the domain of music cognition (Halpern, 1988). The application of neuroscientific methodology soon followed and has since greatly enhanced our understanding of the processing of musical memories in the neocortex and cerebellum (Halpern, 2001; Halpern & Zatorre, 1999; Kraemer, Macrae, Green, & Kelley, 2005; Zatorre & Halpern, 2005; Zatorre, Halpern, Perry, Meyer, & Evans, 1996). However, the phenomenon of involuntarily activated musical imagery has received only anecdotal remarks in the mainstream literature. The likely problem with INMI is its seemingly private and unstable nature, rendering it an unfavorable topic for rigorous research. But the dimensions of consciousness and imagery can nowadays be studied with more informative methods and trustworthy theoretical assumptions than some time ago (Baddeley & Andrade, 2000). This promises a new start for the study of subjects such as INMI.

Although mental images and conscious experiences propose a considerable challenge, the use of new behavioral methods has already shown progress. The studies of involuntary autobiographical memories have introduced, for instance, the diary method which can be used to record involuntary memory episodes soon after they have occurred, enabling more accurate and reliable data collection (Berntsen, 1996; Berntsen & Hall, 2004). The application of these methods has extended into semantic memories (Kvavilashvili & Mandler, 2004) – involving also music. In this framework, INMI is equaled with involuntary semantic memories, in particular musical ones, even though they might even be multimodal. Indeed this approach seems potential for studying this musical memory feature as well. This was recently demonstrated in a study utilizing the experience sampling method (ESM; Bailes, 2006, 2007) successfully to study different the forms of musical imagery in the daily lives of musicology students. However this method has the drawback of being demanding towards both parties of the research. The ESM studies are usually longitudinal, involving days or weeks of intensive commitment to data collection. This gears the research towards smaller, specified samples on the expense of generality.

The current study presents the first large-scale study into INMI among people living in a western culture, an environment where the use of music has become ubiquitous due to numerous technical innovations. Intention is to replicate the results from the pioneering experiments (Bennett, 2002, 2003; Kellaris, 2001, 2003) using generalizable sample size, and also to shed light on the possible causes of INMI. In particular, the relation of INMI to musical and linguistic competence, musical exposure, age, and characteristics of personality will be examined. Regarding individual characteristics, previous research suggests that the people scoring high on trait neuroticism report experiencing INMI more often than the others (Kellaris, 2003). In the current study I sought to relate this prevalence to the general factors of stimulus screening and arousability (Mehrabian, 1995). They are both qualities that reflect a generic trait of 'sensitivity', which seemed a candidate feature for predicting the predisposition for INMI as well.

ISBN: 978-4-9904208-0-2

II. METHODS

An electronic questionnaire called 'Music in Mind 2007' was created to gather data among Finnish Internet users. The digital medium enables to address wide audiences quickly and cost effectively. It can reach audiences outside the department borders, involving not only university students and staff regularly employed in psychological research. It also extends the means of survey methodology by allowing dynamic changes. This can happen in a data-driven manner, so that adjustments to the instrument are made in response to real data. Web was also considered appropriate for the current study because it permits people to respond easily in their everyday settings, increasing the ecological validity of the study, although at the expense of making it selective towards the users comfortable with interactive Internet services. Another drawback is that online participation poses additional demands for controlling the quality of the data, because it is easier for people to cheat and misbehave in this kind of environment where the presence of researchers is missing. (Nosek, Banaji, & Greenwald, 2002; Skitka & Sargis, 2006)

The experiment was freely accessible on a web server of the University of Helsinki for a period of three months starting from April 2007. No particular criteria for participation were established, but all materials were provided only in the national language, effectively screening out people not speaking Finnish. In the data-analysis repeated entries from the same subject, entries with unrealistically fast and slow completion times, and cases showing no variation between the answers were additionally discarded. Few compulsory open-ended questions were used to ensure that respondents were human and had comprehended the task in question.

The survey was delivered on eight questionnaire web pages as follows: After a briefing and consent page, the subjects were asked to answer questions about the role of music in their everyday life. On the third page, five musical pieces representing widely known pop and tango pieces were presented as a part of a simplified musical image scanning task (Halpern, 1988) requiring subjects to complete lyrics for these songs. This effectively forced them to use their mind's ear to access the information prompted for. This was done to remind them about the nature and existence of musical imagery. Two following questionnaire pages concerned the types of involuntary memory encountered and the conditions in which INMI commonly occurs in life. A custom, short instrument for measuring generic stimulus sensitivity, conceptually similar to the stimulus screening and arousability questionnaire of Mehrabian was also embedded on the sixth page. In the following page, subjects' auditory consciousness was probed by asking them if they had encountered INMI (previously introduced to them) while participating in the experiment. On the final page, the participants provided information about their background, including for instance sex, age, and handedness. The survey yielded a considerable amount of data and only some parts of the data can be reported in this paper. The main dependent variable analyzed here is the retrospectively evaluated frequency of INMI episodes during the last two months.

During the duration of the study, few questions were also removed or added between the experiments. This resulted in a change of *N* between some items, that is visible in the results reported below. All the descriptive statistics and statistical tests have been done using SPSS 15.0 for Windows.

III. RESULTS

During the data collection period, more than 12,500 completed surveys were stored in the database. After disqualifying a part of the entries, a total of 11,904 cases entered into further analyses. The respondents were mainly female (68.4 %), in average 27.8 years of age (SD = 8.4). The participants were dominantly city dwellers (88.0 %), right-handed (89.5 %) and reported no hearing disabilities, neurological dysfunction or use of medication affecting central-nervous system. The subjects were generally musically oriented, having some musical education. 49.4 % of them had had a period of at least one year training during their lives. Almost everyone (98.1 %) listened to music at least weekly and nearly half of the subjects (49.9 %) sung, trained, or composed music at the same interval. These figures are somewhat higher than those reported by Finnish National Statistics Centre (91 % and 19 %; see STAT, 2008) suggesting that musically active people are over represented in the sample. The people who reported over a fifteen year period of continuous musical education (27.7 % of eligible subjects) were considered as musicians in the following analyses.

A. Commonality of INMI

The prevalence of INMI within the sample was high. The typical report of the retrospective frequency was 'everyday' (33.2 %). More than 90 % of all respondents indicated that they had these experiences at least every week. The detailed distribution of the responses is provided in Figure 1.

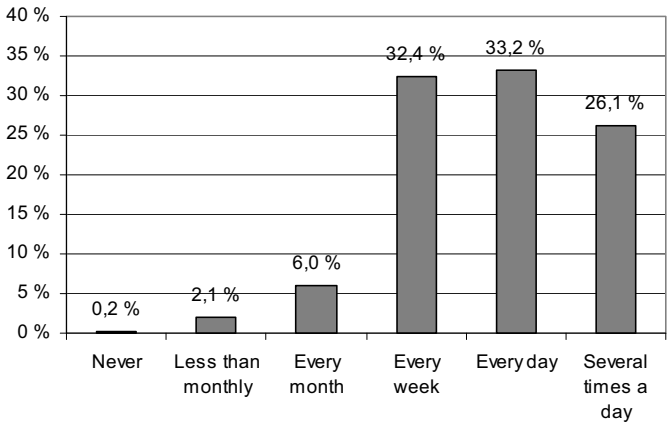

Figure 1. How often people experience INMI. The proportions of different retrospectively reported INMI frequencies among the respondents (N=11910).

The subjects retrospectively had reported about a variety of involuntary semantic memories in addition to music. This allowed comparing INMI to involuntary experiences in other domains. As expected, music came out as the most commonly occurring form of involuntary recollection. The results come close to those reported earlier (Bennet, 2002; Kvavilashvili & Mandler, 2004), showing the privileged status of music, visual images and words over cutaneous or chemical senses. The detailed results are shown in Table 1 (next page).

Table 1. Proportions of the different forms of involuntary semantic imagery in descending order of typicality. The rightmost column indicates the how often each type was selected as the most disturbing type of imagery.

	Often	Now and then	Seldom	Never	Considered disturbing
Music	59,3 %	32,4 %	8,1 %	0,2 %	15,1 %
Visual images	50,3 %	41,1 %	8,1 %	0,5 %	7,4 %
Words, sentences	37,3 %	44,5 %	16,6 %	1,6 %	5,1 %
Odours or smells	21,8 %	45,8 %	26,0 %	6,3 %	2,5 %
Kinetic patterns	8,2 %	28,3 %	48,4 %	15,1 %	0,0 %
Tactile sensations or pain	8,1 %	30,2 %	50,1 %	11,6 %	2,4 %
Tastes	8,0 %	43,3 %	39,8 %	9,0 %	0,9 %

An exploratory factor analysis (using Maximum likelihood estimation method with Varimax rotation) showed that the data could be reduced into two factors, which explained 33.7 % of total variance. The factors indicate an interesting underlying structure for involuntary memories. The first factor loaded most heavily tastes and smells. The items loading on the second factor included images, words, but also sensations, pains, and kinetic patterns. Interestingly, music did not load considerable (> .10) into any of these factors. An exploration with a third factor (computationally unfeasible) showed that musical memories tended to load on a single factor of their own.

Participants also described the kinds of music they usually experienced with INMI ('what kind of music do you hear'). Familiar lyrical music dominated over instrumental or new music (76 % vs. 26 %). If musical competence was considered, a statistically significant an increase in the proportion of instrumental and new music (p >.001) was witnessed among the musicians, as illustrated in Figure 2.

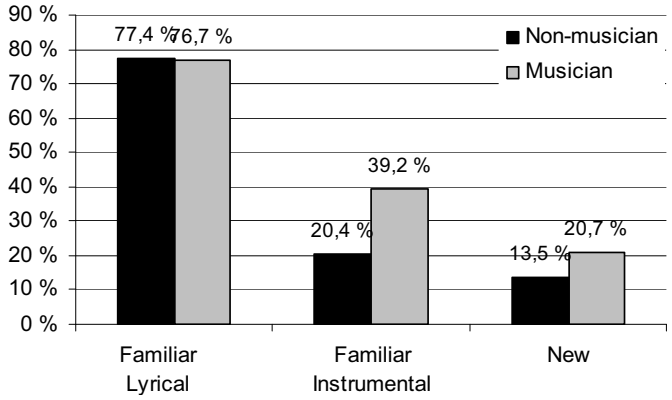

Figure 2. The type of music regularly involved in an INMI experience depending on person's musical training. The categories of experience contents are complementary. For familiar music items, N=8566, and for new N=2136.

B. Factors Predicting Retrospective Reports

The next series of analyses concerned how individual characteristics are related to and can predict the disposition for INMI. In the examination, the initial findings reported by Bennett (Bennett, 2003) were used a set of hypothesis. He demonstrated several factors that contribute to the frequency of retrospective INMI. Some of those observations were confirmed. Based on the background variables, INMI occurs more often among younger individuals (Table 2) and among females than males. The latter differences could be represented by a cross-tabulation, but here the variables of an ordinal scale were converted into absolute scale. This produced a significant difference for the sexes ($M = 4.66$ and $M = 4.78$, men and women respectively; $p < .001$).

Bennett had also found a tendency for left-handers to have more frequent INMI, but the current data does not support that association. Also, among our respondents there was no connection between INMI and whether the subjects found it irritating or not. The variables regarding ongoing musical interests reveal how both active music listening and active training increase the frequency of INMI.

Table 2. The relation of different variables to the frequency of retrospective INMI. Columns in the middle display the strength of association using a non-parametric Spearman rho statistic. The upper part of the table presents variables suggested important by Bennett (2003), the bottom shows novel associations discovered.

Variable	Spearman ρ	p	N
Practice	0,241	< .001	11877
Listening	0,190	< .001	11877
Musical education *	0,157	< .001	11877
Musical education	0,115	< .001	11877
Handedness	0,009	> .05	11877
Irratated by INMI	-0,005	> .05	11877
Age group	-0,114	< .001	11877
Musicality	0,235	< .001	2977
Pronunciation	0,152	< .001	2977
Portable music player	0,113	< .001	2977
Tinnitus	0,059	< .001	11877
Sensations sensitivity	0,003	> .05	7798

*excluding persons with over 15 years of musical training

The amount of musical education (in years) was also positively related to INMI frequency, but a single statistical oddity was observed. Among the respondents with over fifteen years of musical education (the musicians), the retrospectively reported frequency of INMI was lower than for any other musically cultured group, irrespective of age. For this reason, Table 2 includes a row indicating the correlation without this non-linear effect. Additionally, we sought to relate INMI to some additional variables including self-evaluated musical talent, linguistic proficiency, tinnitus, and the frequent use of a portable music player. This observation showed that self-evaluated musicality was positively related (Table 2, lower portion) to the retrospective frequency. The relative ease of learning to pronounce foreign languages was also related to the frequency of INMI experience, as was the frequent use of a portable music player. Finally, a weak positive connection between INMI and tinnitus was also observed. It should be noted that self-evaluated musicality correlates strongly with active musical practice ($\rho = .598$, $p < .001$) and the use of a portable player ($\rho = .331$, $p < .001$). The ad-hoc Stimulus screening and Sensation sensitivity instrument proved mediocre resolution (Cronbach's alfa = 0.491) and the scores were correlated neither with INMI history nor current INMI sensitivity.

The nonparametric correlations presented in Table 2 provide an estimate of the different associations, but ignore the

inter-dependencies between the variables. The relative contribution of each factor to INMI can be evaluated more precisely by several statistical methods. To investigate the relative contribution of each factor to the retrospective INMI frequency, a regular ANOVA procedure (acknowledging its limitations due to the ordinal nature of the variables) was used. The ANOVA test revealed several significant effects shown in Table 3. By including only significant factors and interactions into a custom model (adjusted $R^2 = .962$) and comparing the partial eta squared (η2) estimates of effect size, the greatest contributor was active training ($F(2, 12418) = 377.54$, $p < .0001$, partial $\eta^2 = .0573$). It was followed by active music listening ($F(2, 12418) = 208.34$, $p < .0001$, partial $\eta^2 = .0325$) and sex ($F(1, 12418) = 167.80$, $p < .0001$, partial $\eta^2 = .0133$). The interaction of training and listening was also significant, but had a relatively small effect ($F(4, 12418) = 4.1434$, $p = .0023$, partial $\eta^2 = .0013$). For the other significant main effects, the effect sizes were negligible.

Table 3. ANOVA table for effects of different background variables on the retrospectively reported frequency of INIMI

Variable	Sum of Squares	df	Mean Square	F	p	Partial n2
PRACTICE	668,289	2	334,145	377,543	0,000	0,057
LISTENING	368,785	2	184,393	208,341	0,000	0,032
SEX	148,514	1	148,514	167,803	0,000	0,013
LISTENING* PRACTICE	14,668	4	3,667	4,143	0,002	0,001
IRRITATION	11,922	1	11,922	13,471	0,000	0,001
HANDEDNESS	0,121	1	0,121	0,137	0,712	0,000
Error	10990,553	12418	0,885			
Total	292650	12430				

IV. DISCUSSION

The documented investigation showed that the involuntary music imagery, or INMI, is a prevalent phenomenon not only among young music students, but in a representative sample of Finnish people. For the first time, the phenomenon was now examined in a large scale providing valuable reference information for several parties. These data are potentially interesting for researchers of music and cognition, and even to remote disciplines such as biological psychiatry, in which topics such as musical hallucinations and obsessions are investigated (Hermesh et al., 2004; Zungu-Dirwayi, Hugo, van Heerden, & Stein, 1999). The present study corroborates evidence that INMI is a valid target of research in cognitive musicology and promises that in future we might have a cognitive theory for it. This could make the psychodynamic explanations of INMI (see Reik, 1953) obsolete.

The results regarding retrospective reports on involuntary memories are comparable with previous investigations (Bailes, 2007; Bennett, 2003; Kvavilashvili & Mandler, 2004). Music was found to be the dominant type of involuntary imagery and the clear majority of people in Finland experience it every week. However, the figures of prevalence must be considered critically due to known biases in retrospective, episodic memory reporting. The results from the factor analysis suggested that involuntary musical imagery was distinct from other forms of semantic memories, which might provide a hypothesis for future studies. The ANOVA modelling showed that the retrospective INMI frequency was most significantly and positively affected by the amount of active musical training, followed by listening and background characteristics. While I do not attempt to interpret these results here thoroughly, it is possible that people who actively rehearse music are likely to report more INMI experiences in retrospect because they are more interested in music generally pay more attention to it.

But there are also more positive explanations for the results. The dynamic factors that seem to predict INMI all involve active processing of music. Playing or performing certainly requires engagement at the most comprehensive level. The evidence presented here might support a conception of INMI as a memory-based phenomenon. This view would be compatible with the account of involuntary semantic memory that included the accumulation of activation in cross-domain semantic networks (Kvavilashi & Mandler, 2004; see Mandler, 1994). This means that the repeated processing of musical memories strengthens them and leads to prolonged high activation levels within the network. This makes it more likely that some memories exceed some mental threshold, and under certain circumstances internal music is perceived. The data analysis presented here is still in progress and more conclusions are to be made in the future. Already the tentative results have evoked ideas for further research and revealed untouched research questions.

The research on INMI has the potential to enlighten research on consciousness and cognition on several accounts. It is possibly related to a variety of issues, the nature of musical memory, the motor theory of speech perception, the acquisition of phonetic lexicon, and so forth. One area worth exploring in the future would be to do comparative studies of people living in different cultures. This would allow positioning INMI into a perspective with overt music behaviors, and examining whether it is a consequence of a modern western music culture, where overt expression is often inhibited, meanwhile the private and shared consumption of popular music tends to overload our musical mind, causing it to get stuck on songs we hear excessively.

In short, INMI appears to be real and common phenomenon. It has distinctive predictors in active involvement with music, but is also somewhat dependent upon fixed background factors such as gender and age. Some people (not all) find it annoying and those seeking asylum from daily mental replays may or may not find comfort in the result that giving up musical activities will decrease the expected frequency of these events. But considering the realities of a western world, this may not be feasible sot the better option is to enjoy a plenty of music you like and have a positive attitude towards inner music you can not block reliably even with medical substances (see Sacks, 2007).

ACKNOWLEDGMENT

I wish to thank all people who volunteered in the experiments. I am also grateful for the help and support of several people at the University of Helsinki, especially Sinikka Hiltunen. The presentation of this work was supported by a travel grant from the Chancellor of the University of Helsinki.

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