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The persistence of musical memories: A descriptive study of earworms

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We describe some characteristics of persistent musical and verbal retrieval episodes, commonly known as "earworms." In Study 1, participants first filled out a survey summarizing their earworm experiences retrospectively. This was followed by a diary study to document each experience as it happened. Study 2 was an extension of the diary study with a larger sample and a focus on triggering events. Consistent with popular belief, these persistent musical memories were common across people and occurred frequently for most respondents, and were often linked to recent exposure to preferred music. Contrary to popular belief, the large majority of such experiences were not unpleasant. Verbal earworms were uncommon. These memory experiences provide an interesting example of extended memory retrieval for music in a naturalistic situation.

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Those of us who study music cognition are frequently asked about tunes that seem to get stuck in memory. This involuntary mental imagery is generally held to be annoying and/or distracting, as expressed by the name for this phenomenon in many languages, such as French (*musique entêtante*, or stubborn music), Italian (*canzone tormentone*, or tormenting songs, Rumpler, 2009) and the common English term "earworm." A cartoon that one of us uses during talks on auditory imagery depicts a brain continually playing "Raindrops Keep Falling on My Head" while the hapless owner of the brain is looking distressed and saying "Umm. . . . brain?" The audience frequently responds with knowing nods and comments.

This type of memory is different from most daily memory retrievals, and even unlike auditory imagery (Hubbard, 2010). The episodes are extended and repeated, unlike most discrete semantic and episodic memories. They also have a serial, looping nature, in that the end of a phrase triggers the opening for many cycles. And they are held to be involuntary in onset, possibly involuntary in offset as well (Levitin, 2006), as the cartoon and the name for the phenomenon implies.

However, despite reports in popular media about earworms, little systematic investigation has been carried out. Brown (2006) provided an extensive self-study of his near-constant musical imagery. These were often images of recently heard music, which looped in the way described above. They were involuntary and distracting to him.

Bailes (2007) queried 11 music students at random intervals over several days. Immediately after each call, participants reported on whether they were imaging music at the time, and if so, the circumstances. Of the 417 reports, 32% comprised reports of imagining music at the time of the probe, and these were often tied to having heard or performed the particular music recently. Respondents actually rated the experience positively. Bailes (2007) did not ask her respondents to distinguish between voluntary auditory imagery and persistent earworms, and only 4 of 102 reports referred to the imaged tune being "automatic" or "sticky." Music students might also have motivations or propensities to engage in mental practice, making the experience more enjoyable than might be typical for other people.

Beaman and Willliams (2010) described a survey and a diary study (in different samples) about earworm experiences. All of their respondents were familiar with earworms, with the majority claiming that the experience "can last" hours or longer (although average duration was not queried and thus we do not know how long they did last). Only small minorities reported that earworms were typically problematic, and the music was usually different on each occasion and differed widely over respondents. The earworms were usually not bothersome, and on more than half the occasions, disappeared on their own. Finally, Wammes and Barušs (2009)

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devised a musical imagery questionnaire with the intent of investigating a variety of factors that may comprise the experience, and possible relationships with personality variables.

As far as we know, these are the only reports in the peer-reviewed literature that formally describe earworm experiences. Our study was similar in some respects to that of Beaman and Williams (2010)[1] in that we used both a survey and a diary instrument. However, they focused mostly on how interfering the earworms were and possible group differences, whereas we focused more on characteristics of the earworm experiences themselves. Furthermore, our diary and survey in Study 1 were carried out on the same participants, allowing us to examine congruency of concurrent and retrospective reports. In Study 2 we recruited a large sample for a diary study, allowing us to see general rather than possibly idiosyncratic patterns in the diary results. We also asked our respondents about nonmusical (verbal) earworms, although these proved to be rarer experiences.

Study 1

Method

PARTICIPANTS

The survey sample comprised 21 undergraduate students at the University of Texas at Dallas. Of these, 18 also completed the diary study. Half were males; ages ranged from 18 – 21 (median = 18.5). Only one participant reported having an extensive musical background, and six had no musical background at all; the remainder (N = 11) reported having a moderate musical background.

MATERIALS AND PROCEDURE

Surveys were distributed as part of a voluntary class activity, which was unrelated to the grade in the course. Participants were asked about the frequency of "music playing over and over in your mind," the extent to which the style or actual piece of music remains the same over different occurrences of an earworm, the typical tone (positive, negative, mixed/neutral) and valence of the experience, and how the experience ends. A similar set of questions asked about phrases or sentences playing in one's mind. No mention was made of the later diary study. Four weeks later, the class members were asked to keep track of all persistent auditory experiences for seven days, and for each, to record the type of experience (words or music), the duration, time of day, type of word phrases or music and its emotional tone, whether the words/music was liked or not, how the experiences went away, and whether the experience was pleasant, unpleasant, or mixed/neutral. Each earworm was recorded on a separate sheet and all earworm diary entries were handed in at the end of the period. The diary period encompassed a week between Thanksgiving and Christmas, which is relevant to the frequency of holiday-related songs reported. Surveys and the diary entry form are shown in Appendices A and B.

Results

MUSIC EARWORM SURVEYS

We report data from the 18 people who completed the survey as well as the diary. Persistent musical memories were quite common, with 13/18 reporting the experience as happening either a few times per week, or almost daily. No one was unfamiliar with the experience. The type of music experienced was variable for most of the respondents (12/18); only two people reported that the same piece of music tended to repeat frequently. Of the nine people reporting on the familiarity and presence of lyrics, everyone said their earworms were of familiar pieces with lyrics, and were either positive or mixed/neutral in tone. The experience was typically pleasant or mixed/neutral for 16/18 people, and 12/18 people reported that earworms eventually go away on their own. In summary, the retrospective reports indicated that earworms are common, but do not typically constitute an obsessive repetition of the same piece, and are not considered an unpleasant experience.

MUSIC EARWORM DIARIES

Over the seven days of the diary, a total of 102 earworms was reported. The frequency per person ranged from 1 to 15; median = 5 entries. For those reporting at least three earworms, they occurred on multiple days, rather than being clustered on one day. Morning was the most common time to experience earworms, comprising 34% of the reports, followed by afternoon and evening with 20% each, and 10% occurred at night. Almost all the reported tunes were familiar (96%) and had lyrics (83%). The tone of the music was almost always positive (83%), with 14% reported as mixed/neutral and 5% being negative in tone (this latter proportion significantly differed from chance of 33% by a binomial test, $p < .001$).

The duration of the earworms varied considerably, ranging from 2 min to 240 min (plus one report of a tune persisting all day, on several days). The mean of the

[1]Our study was conducted independently and without knowledge of Beaman and Williams's (2010) study, which appeared just as preparation of this manuscript was completed.

median duration for each person was 36 min. Only four people reported that a song ever repeated as an earworm experience in different episodes. The experience was mostly pleasant (64% of reports) or mixed/neutral (23%); 13% of the reports were classified as unpleasant (again, different from chance by a binomial test, $p < .001$) and percentage of pleasant earworms did not correlate with median of reported duration for each person, $r(16) = .12$; in other words, longer periods of persistence were not more unpleasant, on average.

The type of song varied widely within and between respondents. Most reports were of popular music, but several Christmas-related tunes appeared in the diaries, as well as a few reports of country and gospel selections, film scores, and several Beatles songs. "Yellow Submarine" was a particularly persistent earworm (4 out of 13 diary entries) for one respondent. This report was a good example of the tolerance shown by most of our respondents for earworms. The person wrote: "I like the song but I don't know the lyrics and it keeps appearing in my head" and rated the experience as positive on the third repetition and mixed/neutral (but not negative) on the fourth repetition.

The large majority of reports on triggering events mentioned recent exposure or liking for the tune and sometimes both. Some other triggers included thinking about the upcoming Christmas holiday, or another semantic association ("I had a discussion with a friend earlier in the day about love. This could have somehow triggered the earworm.")

In most reports, (73%), the earworm "retreated" on its own. When the reporter desired to stop the earworm, the most common strategy was to listen to other music, followed by engaging in some other activity such as studying.

SURVEY/DIARY CORRESPONDENCE

The surveys and diaries matched quite well on several metrics. The retrospective and concurrent frequencies were approximately the same (several earworms per week). The two instruments also agreed on the variability of the music imagined. The proportion of earworms that disappeared on their own were quite similar retrospectively (67%) and in the diaries (73%), as was the low frequency of negative assessment of the experience (11% of respondents in the survey and 13% of diary reports). The retrospective frequency of occurrence, scored on a "1" ("a few times per year") to "4" ("almost daily") scale correlated positively, but not significantly, with number of diary entries, $r(16) = .39$, $p = .054$ (one-tailed). We note that as no one used a response of "1," the range was quite restricted.

WORD EARWORMS

Because of the relative rarity of these events, we report results from the full survey sample of 21. Nine people said that they had had at least one experience of a persistent phrase or sentence. The modal reported frequency was a few times per month, and the modal response (6/9) for type of words was "variable in type and actual words." Three people answered about the most typical kind of word earworm, and said the words were familiar sayings, and were liked or mixed/neutral. The tone was happy ($N = 3$) or mixed/neutral ($N = 4$), but never sad. The experience was pleasant ($N = 2$) or mixed/neutral ($N = 5$) but never unpleasant. The seven people who reported how the experience ends all said it went away by itself. In the diary study, only 3 of 105 reports were of words. One was a quote from a movie (duration = 5 min), one a cheer (15 min), and one an advertisement slogan (20 min). None of these was an unpleasant experience.

Study 2

The purpose of this study was to increase the number of diary reports by increasing the sample and the reporting period. Less information per report was gathered, although we added a question on proportion of earworms that were triggered by an event.[2]

Method

PARTICIPANTS

Respondents were 41 undergraduates (8 male) at the University of Texas at Dallas, drawn from the Introductory Psychology subject pool. Ages ranged from 18 to 38 (median = 23). Musical background was not assessed.

MATERIALS AND PROCEDURE

Diaries of earworms were kept for two weeks. We collected information on: duration, time of day, whether the earworm was triggered, how the event ended, the pleasantness of the event, and whether the music repeated. Each earworm was recorded on a separate line of a form. See Appendix C for the form.

Results

The 41 respondents reported a total of 780 earworms. The frequency per person ranged from 2 to 57, with median of 14 (i.e., 7 per week, approximately the same

[2]We intended to collect information on word-only events, but a typographical error made this instruction unclear. Given the low rate of word-only earworms in Study 2, we assumed that all of the diary reports were of music.

as the median of 5 for a one-week period in Study 1). The median occurrences of earworms per day was 1.7. The events occurred approximately equally throughout the day, with the exception of fewer reports during the evening than at other times (19% of reports). One person reported several instances of all-day memories. Otherwise, durations were reported from 30 s to 195 min; mean of the median duration was 8.22 min (this computation excluded five people whose estimates suggested they were using a unit of time different than the requested report in minutes). In this study, median duration correlated positively with percentage of pleasant earworms, $r(39) = .53$, $p < .01$, so that more persistent experiences were on average more pleasant.

A slight majority of earworms were reported as having been triggered by a particular event (56%). About the same proportion (57%) disappeared on their own. In the remainder of cases, the earworms disappeared when another event interfered (23%) or when the respondent took action to erase it (20%). Only 22% of earworms repeated in separate entries during the response period, and only 15% were considered unpleasant experiences (55% pleasant and 31% neutral/mixed; once again, unpleasant reports differed from chance by a binomial test, $p < .001$).

Discussion

We gathered information on persistent musical memories in three ways: a retrospective survey followed by a one-week diary period in one sample, and a two-week diary study in a larger sample. Earworms were reported by all respondents, with the large majority reporting approximately one event per day, although there was considerable variability as well. Contrary to popular depictions, but similar to some recent reports, the experience was reported as unpleasant in only about 15% of cases across three measures, and most often was considered pleasant. This proportion is congruent with reports in the two-week diary that taking steps to stop the experience was done relatively rarely. People seem to replay mentally the music that they like (which may also be the music they expose themselves to), even if it is unconsciously done.

Of course, retrospective reports such as on surveys are prone to various memory errors and distortions. Thus, it is of some comfort that in several respects, data from our three measures were congruent. The three measures were consistent in reports that earworms are often triggered by recent exposure, which was also reported by musicians in Bailes's (2007) study. Another consistency over measures was the fact that earworms eventually disappeared on their own. It is possible that a mechanism can be invoked to stop the retrieval, but it may not be consciously accessible to our reporters. Finally, all reports suggested that once a particular earworm disappears, for most people it tends not to recur on different days, a result also shown by the diarists in Beaman and Williams's (2010) study.

One difference in the studies was that the mean of the median reported earworm duration was more than four times longer in the diaries from Study 1 compared to diaries from Study 2. In Study 1, participants had to give longer descriptions of each earworm, compared to Study 2, in which each earworm was entered on a single line of a spreadsheet. Reporting requirements in Study 1 may have caused respondents to omit more fleeting experiences in favor of only reporting richer or longer events, or to have made more reporting errors. This may also account for the much higher frequency reported in our diary studies than in the study by Beaman and Williams (2010), who asked for a lengthier report than we required.

Although our focus was on musical earworms, Study 1 did elicit evidence that nonmusical auditory memories might also at times persist. It is unclear whether the dominance of musical earworms is due to the multiple retrieval cues for musical extracts (the words as well as pitch, harmony, timbre, etc., of the music), or whether we are simply picking up more common exposure to music afforded by live and electronic media, compared to listening to speeches or reading poetry, which might be the verbal equivalent of exposure to catchy tunes.

In summary, the data presented here document the ubiquity of a memory experience unlike the discrete retrievals examined in most laboratory and naturalistic memory studies. We also document that, by and large, people have reasonably accurate retrospective reports of persistent musical memories. Although length of the reported earworm was variable, multiple reports occurred of quite long-lasting earworms, and certainly much longer than typical memory experiences. Topics for future investigation include individual differences in frequency of reported experiences (Wammes & Barušs, 2009), persistence of nonmusical auditory memories, and the relationship of musical earworms to voluntary auditory imagery and involuntary hallucinations.

Author Note

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Appendix A

Survey from Study 1

Survey on Auditory Imagery Experiences

This survey asks you to think about times when auditory information, such as songs or words, persists in your mind. For each item, please only select one alternative.

1. Have you ever had the experience of music playing over and over in your mind? Y N
   If Y, how often does this happen? (If N, skip to #6)
   A few times/year ___ A few times/month __ A few times/week __ Almost daily __
2. What choice best describes the music you hear in your head (pick one)
   a. The style (e.g., rock or country) and actual piece are variable ____
   b. The style is the same each time but the piece changes ____
   c. The same piece repeats frequently ____
   d. The same piece repeats nearly all the time _____
3. If you checked 2b, 2c, or 2d, think of the style or actual piece of music that you most frequently hear inside your head. Check one attribute in each group that best describe that music
   a. Familiar _____ Unfamiliar (made-up) _____
   b. With lyrics _____ Without lyrics _____
   c. Music you like _____ Dislike _____ Mixed/Neutral _____
   d. Type: Classical ____ Pop _____ Rock ____ Jazz _____ Country _____
   Kid or holiday _____ TV or movie theme _____ Religious _____
   Other (describe) _____
   e. Positive tone _____ Negative tone _____ Mixed/Neutral _____
   f. If applicable, write the name of the piece you most often hear in your head
4. When a tune persists in your head, do you find the experience
   Pleasant _____ Unpleasant _____ Neutral/Mixed _____
5. How does the experience end, typically?
   Goes away by itself _____
   I do the following to stop it _____
6. Have you ever had the experience of a phrase or sentence (without music) playing over and over in your mind? Y N (If N, skip to #11)
   If Y, how often does this happen:
   A few times/year ___ A few times/month __ A few times/week __ Almost daily __
7. What choice best describes the words you hear in your head (pick one)
   a. The kind of speech (e.g., poetry, quote) and actual words are variable ____
   b. The kind of speech is the same each time but the words change ____
   c. The same words repeat frequently ____
   d. The same words repeat nearly all the time _____
8. If you checked 7b, 7c, or 7d, think of the kind of words or actual words that you most frequently hear inside your head. Check one attribute in each group that best describes the words in your head:
   a. Familiar _____ Unfamiliar _____
   b. Words you like _____ Dislike _____ Mixed/Neutral _____
   c. Poetry ____ Part of a famous speech _____ Saying or quote ____ Advertising _____
   Part of a conversation you had _____ Other (describe) _____
   d. Happy tone _____ Sad tone _____ Mixed/Neutral _____
   e. If applicable, write the words you most often hear in your head
9. When a sentence or phrase persists in your head, do you find the experience
   Pleasant _____ Unpleasant _____ Neutral/Mixed _____
10. How does the experience end, typically?
    Goes away by itself _____
    I do the following to stop it _____

Appendix B

Diary Format for Study 1

Fill out one for each "earworm" experience

Code _____ Date _____ Time event began _____

Words or music? (circle)

Content of "earworm"

If Music
Check one attribute in each section that best describes the music
a. Familiar _____ Unfamiliar (made-up) _____
b. With lyrics _____ Without lyrics _____
c. Music you like _____ Dislike _____ Mixed/Neutral _____
d. Style: Classical ____ Pop _____ Rock ____ Jazz _____ Country _____
Kid or holiday _____ TV or movie theme _____ Religious _____
Other (describe) _____
e. Positive tone _____ Negative tone _____ Mixed/Neutral_____

If Wording
Check one attribute in each section that best describes the words
a. Familiar _____ Unfamiliar _____
b. Wording you like _____ Dislike _____ Mixed/Neutral _____
c. Poetry ____ Part of a famous speech _____ Saying or quote ____ Advertising _____
Part of a conversation you had _____ Other (describe) _____
d. Positive tone _____ Negative tone _____ Mixed/Neutral _____

How long did the experience last (in minutes)?

How did the experience end?
Went away by itself ___
I did the following to stop it

Was the experience
Pleasant _____ Unpleasant _____ Neutral/Mixed _____

Other comments?

Appendix C

Diary Format for Study 2

"Earworms" are auditory images of music or other sounds that persist in your mind. Please record each instance of an earworm during the recording period.

Date: use one line for each earworm, even if you have more than one per day

Dur: Put the duration of the earworm, in minutes

Time of Day: Please code this as
1 = morning 2 = afternoon 3 = evening 4 = night

Trigger?: Put a √ in this column if something immediately preceded the onset of the earworm, which you think triggered it. *Otherwise leave blank*

End Event? This item asks how the earworm event ended. Please code this as
1 = went away by itself
2 = something happened that stopped the earworm
3 = I did something deliberately to stop the earworm

Pleasantness: Please code the pleasantness of the earworm event as
P = Pleasant NM = Neutral/Mixed U = Unpleasant

Repeated item?: We would like to know if the same music or words comes up more than once during the recording period. Please note on a piece of scratch paper the identity of the earworm for your own records. Leave the column blank if the event is a first-time occurrence. Put a
2 if this is the second appearance
3 if the third appearance. . . . etc

Record of Auditory Imagery "Earworms"

Date	**Dur(Min)**	**Time of Day 1–4**	**Trigger? √**	**End Event 1–3**	**Pleasantness: P/NM/U**	**Repeated item? 2, 3. . . .**

References

Bailes, F. (2007). The prevalence and nature of imagined music in the everyday lives of music students. *Psychology of Music, 35*, 555–570.

Beaman, C. P., & Williams, T. I. (2010). Earworms ('stuck song syndrome'): Towards a natural history of intrusive thoughts. *British Journal of Psychology, 6*, 37–61.

Brown, S. (2006). The perpetual music track: The phenomenon of constant musical imagery. *Journal of Consciousness Studies, 13,* 25–44.

Hubbard, T. L. (2010). Auditory imagery: Empirical findings. *Psychological Bulletin, 136,* 302–329.

Levitin, D. J. (2006). *This is your brain on music: The science of a human obsession*. New York: Dutton/Penguin.

Rumpler, V. (2009, November). Catchy songs. *Cafebabel Magazine.* Retrieved from http://www.cafebabel.co.uk/article/31946/catchy-song-expressions-idioms-european-languages.html

Wammes, M., & Barušs, I. (2009). Characteristics of spontaneous musical imagery. *Journal of Consciousness Studies, 16,* 37–61.