

Recalled Music: Earworm Components and Implications

AP Research

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## Introduction

Earworms are the pieces of music that get stuck in your head. They occur without trying and are generally repeated. Earworms have been reported to be anything from a single line of a song to an entire symphony. They are different than general recalled music as they are brought to mind without meaning to and they cannot be stopped on one's own accord. Different scholars have many names for these specific pieces of recalled music, such as cognitively infectious musical agents, sticky music, catchy tunes, as well as the names used in other languages, such as the original Greek word *ohrwurm*.

Some research has been done on how to classify and categorize earworms among other types of recalled music, and some researchers have collected earworms, but there is little to no research published on the specific characteristics of an earworm with the goal of being able to fabricate one. With knowledge of this sort, anyone would be able to produce a piece of music that would be easily memorized. Therefore, any information in that piece of music could be easily memorized. This would be a powerful tool because it would provide people with the ability to have information stuck in their heads without putting in the effort of actually memorizing it. This is the overarching goal of researching what makes up an earworm. Thus, the purpose of this study is to identify specific characteristics that make an earworm different than a regular piece of music.

Interest in this topic was sparked after lengthy reading on a similar, more general topic, the psychology of advertising. Originally this research was going to be focused on how advertising groups could target the type of consumer they wanted buying their product. Eventually, this was narrowed specifically to music, and then further limited to how music in

advertising had an effect on the consumer. While doing research on this topic, the concept of earworms appeared. They were going to be included as a part of the research and the project would continue on the path of the psychology of music in advertising, but it was soon clear that earworms were a broad enough topic to stand on their own. Almost every person can say that they have had personal experience with earworms. The idea that a person could discover why this is and potentially find out exactly what made these songs get stuck in people's' heads time and time again was amazing. The relative lack of existing research done on the topic was intriguing, as any discoveries made would most likely have never been made before. This would be unexplored territory. So, research was narrowed to the topic of earworms specifically. As previously mentioned, there is very little research in the topic as a whole and even less information on what makes up an earworm. In order to better prepare to study this topic, it was necessary to begin doing research on the fields of psychology, advertising, and music theory as well as contacting professors in related fields. Although it would not be possible to go into these studies with much information on earworms themselves, it was important to start with knowledge of topics surrounding earworms in order to better understand what should be looked at in order to better comprehend the results.

### *Literature Review*

The conversation of earworms currently is rather small. Although, there is information on similar topics that begin to help explain earworms and how they may work. The topic of earworms revolves around music, psychology, and recalled music including earworms themselves.

In the field of music, there is information on what makes up a song and a melody, such as

the documents “The Parts of a Song” by Espie Estrella (2016), in which the components and aspects of a song are explained, such as the beat pattern, arrangement of choruses, verses, and bridges, and the chord patterns. Another similar article is “How to Write a Hit Song” by Mahmoud Ibrahim (2016), which explains song structure, melody, lyrics, titles, rhyme, and the process of songwriting. There is also existing literature on how music and memory have been used together in advertising, such as “Jingle All the Way” by Kamau High (2008) and “Single or Jingle? Turning Songs Into TV Commercials” by Lynn M. Burshtein (2006) which both detail how many popular songs are being reworded and used as tv commercial jingles.

The conversation about earworms also includes research about how music has been used previously in education. One document on this topic is “Employing Music in the History Classroom: Four Models” by Anthony M. Pellegrino (2013), which describes ways that music can be used to help students remember history lessons, including involving multiple sources, such as a song and a document together, and including emotional ties, including using a song that evokes some sort of emotion that the students can relate or connect to. Another document of this sort is “Let’s Bring Back the Magic of Song for Teaching Reading” by Becky Iwasaki, Timothy Rasinski, Kasim Yildirim, and Belinda S. Zimmerman (2013) which discusses how teachers have found certain melodies and rhythms to be more memorable, and details a method in which children learn a song by listening to it, and then later are shown the words so that they can learn to read them.

In the field of psychology, the earworm conversation includes some research about memory and how it can be targeted. One study in this field is “Making Information Memorable: Enhanced Knowledge Retention and Recall Through the Elaboration Process” by Donn Ritchie

and Belinda Dunnick Karge (1996). It explains how connections can be made to target information stored in long term memory, and how one can attempt to get a piece of information filed away in the long term memory category. It explains how creating something yourself makes it easier to remember, such as creating one's own song or acronym. It also details specific types of elaboration that help aid memory. These are macro-level elaborations, which focus on specific, individual pieces of information using devices such as word association and visual stimuli, and micro-level elaborations, which focus on the comprehension of entire lessons and can be targeted using analogies, real-life examples, and framework type outlines of a subject. Another article about memory that can be applied to earworms is "Capturing Conceptual Implicit Memory: The Time it Takes to Produce an Association" by Kathleen L. Hourihan and Colin M. MacLeod (2007), which explains how details are not just remembered when asked to recall them, but how these memorized details affect the decisions a person makes and how it affects their life.

Additionally, the psychology of advertising goes into the topic of earworms. One study on this is "How the Science of memory Can Affect your Marketing Campaigns" from Skywire (2014), which explains sensory memory, which is targeted by showing the consumer a picture or video of something associated with a certain sense, such as a hamburger, fire, or a crying baby, short term memory, which is targeted using repetition, and long term memory, which is targeted using emotional attachment. Another study on this topic is "How to Get Ahead in the Psychology of Advertising" by Ian Florance (2011), which explains how advertisers use a combination of placement and timing of their ads to best influence consumers. Another is "The Influence of Advertising Frequency on Attitude-Behavior Consistency: A Memory Based Analysis" by Ida E. Berger (1999), which explains how increasing exposure to something until it reaches a

maximum, and then slowly easing off is the most effective way to get something to stay in long term memory. One final document on this topic is “Conceptual Implicit Memory in Advertising Research” by Temple Northup and Neil Mulligan (2013). It explains the difference between two more types of memory, explicit and implicit memory, and how implicit memory can be used in advertising research. Explicit memory is the memory used when a person is directly asked to recall information from memory, while implicit memory is used when this memory affects how a person acts or what decisions they make. The latter would be most applicable to earworms, as they are a behavior of sorts that is affected by a memory.

On the topic of earworms themselves, we know a little bit about what earworms are and how to categorize them, as well as some basic characteristics that have been noted. Documents that detail the existing research on earworms include “Earworms: Why That Song Gets Stuck in Your Head” from NPR (2012) and “The Classification of Involuntary Musical Imagery: The Case for Earworms” by Tim I. Williams (2015). The latter focuses on involuntary musical imagery as a whole and defines many specific types, and explains how earworms are different than other types. It fails to explain how earworms, or any type of involuntary musical imagery, is structurally different than any other piece of music.

In order to expand this small pool of information about earworms, this study will be collecting the names of songs people have stuck in their heads, some characteristics of songs they get stuck in their heads, and the situation they are in when it gets stuck, such as their mood and their opinion of the song itself. This research will examine commonalities between the songs provided by participants and similarities between the characteristics of the people who had the earworms, such as their musical background and how long they spend listening to music daily.

Some commonalities that could be tested for in the songs include complexity or simplicity, beat pattern, timing and speed, genre, the instruments in the song, repetition, chord progressions, and key, as well as the “millennial whoop” which is a series of notes that alternate between the third and fifth notes on a scale and is present in many popular current songs. Hopefully these studies will produce concrete characteristics that can be replicated in order to recreate unique earworms.

### **Methods**

The data for this study was gathered using two methods, each providing different characteristics of earworms to test for commonalities. The first was an online survey sent out through social media, email, and text messages. It received 140 responses. The surveys were sent out to no particular sample population, as the purpose of the study was to find commonalities among all earworms. This means that there would be no difference in the conclusions whether multiple genres of music were tested, or if just one was tested. The main purpose of the survey was to gather data about people's' general ideas of their earworms. The questions on the survey were:

- How much formal musical experience/training do you have? (band, choir, playing an instrument, etc.)
- How long do you spend listening to music daily?
- What genres of music do you generally listen to?
- How frequently do you notice songs stuck in your head?
- Songs get stuck in my head after I listen to them: always, frequently, sometimes, rarely, never (select one)
- Do songs stay stuck in your head: consistently for a period of time or they play in my

head on and off for a period of time (select one)

- I notice songs getting stuck in my head when I feel: stressed, calm, happy, sad, angry, tired, energized, I do not notice a connection to my mood.
- How long do you notice songs stay stuck in your head?
- The songs that get stuck in my head have a specific memory or emotional connection attached to them: strongly agree, agree, neutral, disagree, strongly disagree
- Are there any songs you notice getting stuck in your head frequently?

Only some of the questions were used to look for trends. The most relevant data gathered from the survey was the song titles, which were used with the results from the other part of the study. Information regarding the amount of time spent listening to music daily, the frequency of earworm occurrences, the presence of memory triggers as causes of earworms, mood during earworm occurrences, and the length of time earworms stay stuck in a person's head was also helpful.

This other part of the study was a two week earworm diary. Thirty volunteers wrote down some details about their music experience and training and how much time they spend listening to music daily, and each time a song got stuck in their head for two weeks, they wrote it down along with some other notes. Participants were selected on a volunteer basis to ensure participation. If the participants had been selected and asked to participate, they may not have any interest in providing detailed responses. Once again, no particular sample population was used as the earworms should be universal no matter who they came from. Each time an earworm occurred the participants filled out the following details:

- Date:



- Song:
- Approximate time stuck in head:
- Current mood:
- Stress level (1-10, 10 being most stressed):
- Opinion of song (like it, find it annoying, etc):
- Specific part of song:
- Any notable characteristics (repetition, certain instrument, etc.):
- Have you listened to this song recently? (approx. how long ago?):
- Memory triggers? (someone said something that reminded you of it, you have an experience related to it, etc):
- Other notes:

This is where a majority of the data came from, as it was more detailed and precise.

Although, when combined with the responses from the surveys, there was no noticeable difference in the data results, so each source of data was equally effective.

Once the data had been gathered, the name, artist, key, beats per minute, specific part of the song if applicable, amount of time the person who sent the earworm spends listening to music daily, the person's music history, the participant's opinion of the song, their stress level and mood during the occurrence of the earworm, and if they had experienced a memory trigger were analyzed. All the details except key and beats per minute were provided by the participants. A memory trigger is categorized as recently listening to the song, usually within two days, or experiencing something that reminds one of the song, such as reading a line of it somewhere or being reminded of a memory associated with the song.

Key of each song was found by plugging the chords of each song into an online program on [musictheorysite.com](http://musictheorysite.com). Beats per minute were found manually using a program on [all8.com](http://all8.com). While playing the song, a key on the keyboard was pushed on each beat, and the program calculates the beats per minute. The longer you push a key on the beat, the more precise the outcome is, and it usually stabilized and stopped changing around 25 presses, so that is approximately how many times it was done for each earworm.

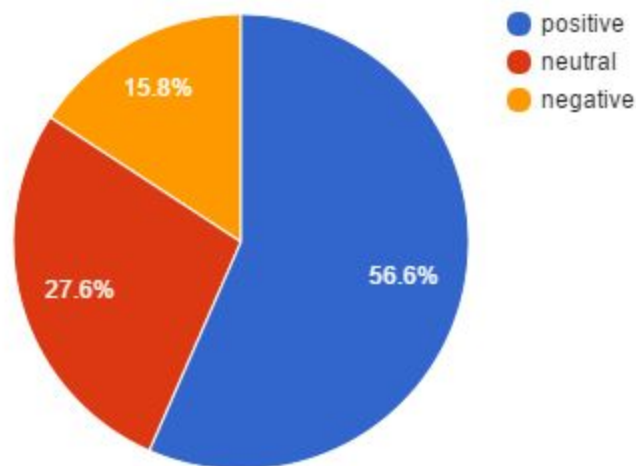
Many participants did not include the part of their song in their response so that data was ignored. Music experience and training were entered by adding together all years of training of any type. So, if a participant sang in a choir for 6 years and played in a school band for 4 years, it was entered as 10 years, even if some of the years overlapped.

Time spent listening to music was divided up into the following categories: none, five minutes to a half an hour, half an hour to an hour, one to two hours, two to three hours, and three or more hours. Opinion of the song was categorized as positive, neutral, or negative. The positive category included descriptions such as “I like the song”, “I love the song”, “this song is catchy”, etc. The neutral category included descriptions such as “the song is okay”, “I am impartial to the song”, “I have no opinion of the song”, etc. The negative category included descriptions such as “I hate this song”, “the song is annoying”, “I don’t like the song at all”, etc. Stress level was rated on a scale of one to ten by the participant, with one being minimal to no stress and ten being extreme stress. Mood was categorized as positive, neutral, or negative. Positive mood included happy, excited, etc. Neutral included tired, calm, neutral, etc. Negative included stressed, angry, sad, nervous, etc. Spreadsheets were made and analyzed for each category in order to look for trends in the data.

## Results

Once data from the studies had been placed in spreadsheets and analyzed, trends began appearing in the data. It was found that mood, participants' opinions of the song, beats per minute, key, and the presence of memory triggers had an effect on the earworms. Stress level and music training did not have common results among the earworm participants.

For mood, only 15.8% of participants reported being in a negative mood during the occurrence of an earworm. 27.6% reported a neutral mood, and 56.6% reported a positive mood. As shown below, this displays that earworms are most likely to occur when in a positive or neutral mood, and a negative mood seems more likely to prevent earworms.

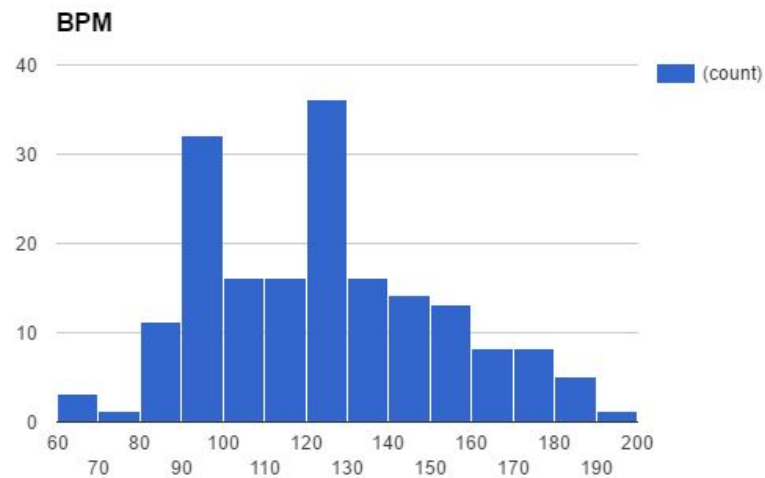


For opinion of the song, 90% of earworms were viewed positively by the participant that experienced it. 10% of earworms were disliked by the participant, and less than 1% were considered neutral.

Thus, earworms are most commonly songs that the person enjoys.

For beats per minute, the most common values that stood out were 90-100 and 120-130.

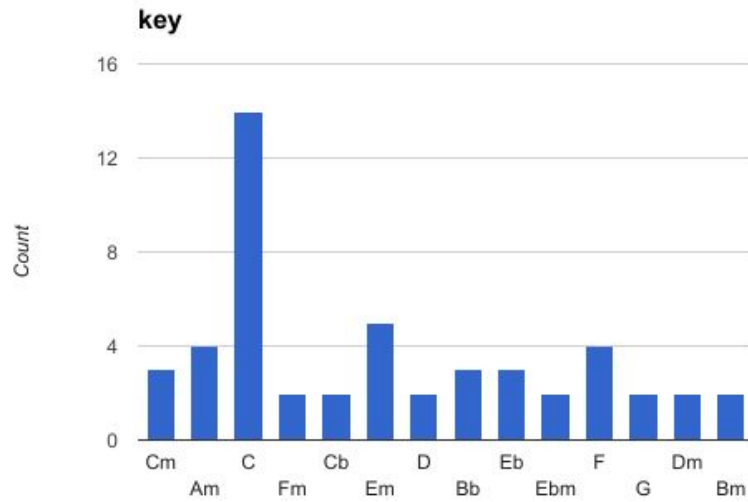
Together, these values account for nearly 40% of the collected earworms, as seen below:



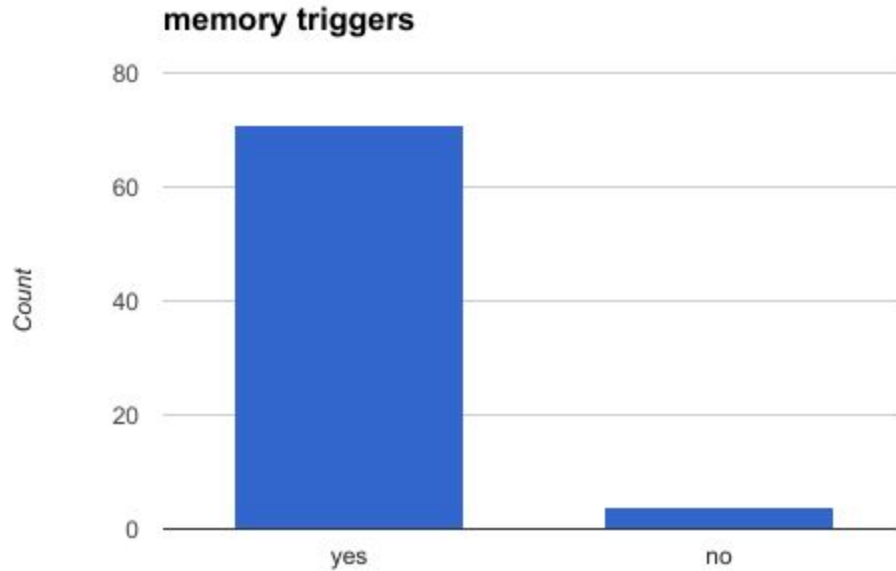
The next most common ranges each accounted for approximately 8% of the earworms.

This indicated that songs with a bpm between 90 and 100 or 120 and 130 are more likely to become earworms.

In testing data on the key of the earworms, most keys accounted for between 3% and 11% of the earworms, while the key of C accounted for nearly 22% of the songs. C major was the most common result. This means that a song is more likely to become an earworm if it is in the key of C. These results are displayed here:

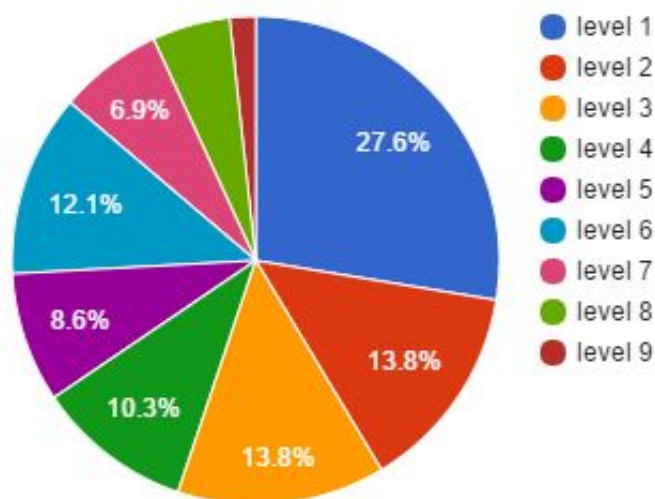


Memory triggers were extremely common in causing earworms. 96% of earworms were brought on by memory triggers, and only 4% were reported as occurring spontaneously with seemingly no cause. This can be seen in the chart below:



When looking at stress levels experienced during earworm occurrences, there was seemingly no trend. The participants rated their stress levels between one and ten, with one being

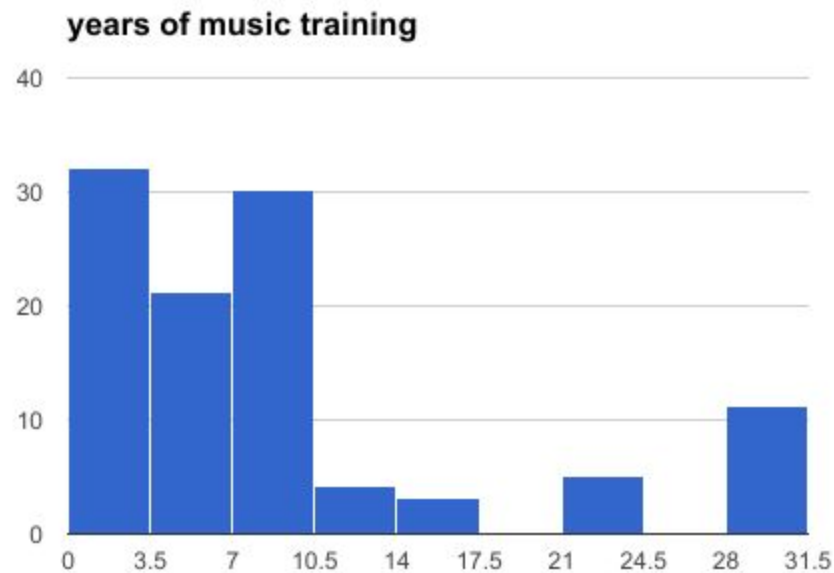
minimal or no stress and ten being extreme stress. The results were scattered, with 16/25 responses at 1, 8/25 responses at 2, 8/25 responses at 3, 6/25 responses at 4, 5/25 responses at 5, 4/25 responses at 6, 4/25 at 7, 1 at each 8 and 9, and 0 at ten. This data is displayed here:



While there seems to be a much higher number of level one responses, but this is unlikely to have anything to do with the earworms. Generally, people's baseline stress level is relatively low, and therefore it can be assumed that stress levels have no correlation with earworms.

The same can be said of music training history. Responses were varied, with no single number of years of music training standing out. For example, one participant of the two-week earworm diaries has six years of music training. This participant recorded 38 earworm occurrences over the two-week period. Another participant of the same study also had six years of music training, but only recorded three earworms over the course of the two-week study period. There is a greater number of earworm responses from people with between one and ten years of music training, but this is most likely due to the fact that a very small number of people

train formally in music for more than ten years. The results from the years of music training count are shown below:



With multiple examples similar to this one, as well as no clear trend in earworm occurrences versus years of music training, there seems to be no commonality among earworms regarding music training.

### **Limitations**

The first limitation that this project had to overcome was an extreme lack of published, scholarly research on the topic of earworms. With very little information to go off of, it became more difficult to formulate a method for testing earworms. This was overcome by one study explaining the concept of an earworm diary, even though it did not explain the results. This study allowed me to formulate my own earworm diary and look into how to create a survey that would provide even more information.

The second problem I faced through my research was a few of the earworm diary participants not having any earworms to send in. While at first this was concerning, I was able to use the data about what type of person got zero earworms over the course of one week to further my research.

The next issue was approached after all the data had been collected and trends had been found. I was concerned that trends in BPM and key were going to exist simply because most songs existed in those ranges. But with further research, it was found that the average BPM for music in general is 112, which does not fit into either of the ranges found. Also, there is no single key that is much more common than the others. This means that the trends found in this study are specific to earworm songs, not just music in general.

One more limitation of this study is that, since it was focused on responses from people, there is always going to be human error. There is a chance that when someone heard a song, it repeated in their head once, and they wrote it down as an earworm when it may not have been. It is also possible that, since there are many categories of recalled music, the songs in the person's head may not have fit specifically into the earworm category. Although, there are not many studies about how to differentiate between types of recalled music when it gets stuck in your head, so for the purpose of this study, all music stuck in a person's head was considered an earworm.

### **Conclusions**

In conclusion, there are a number of factors that affect earworms. While there were no data sets that determined one commonality that was completely universal among all the earworms collected. There were many categories of data that had clear trends. These include key,



beats per minute, mood during earworm occurrence, participants' opinion of the song, and the presence of a memory trigger.

Each of these components makes a song more likely to become an earworm. Although none were universal among all songs collected, the five categories had clear trends that show that the songs are much more likely to become earworms if they include these components. A song would, therefore, be most likely to become an earworm if it included the trends from each of the categories.

While testing key, it was found that the key of C was the most common for earworms. For beats per minute, there were two trend ranges. These were 90-100 beats per minute and 120-130 beats per minute. For mood, earworms are most likely to occur when the person is in a positive mood, and slightly less likely to occur during a neutral mood. They rarely occur during negative moods, times of extreme stress, etc. In the category of opinion of song, earworms are usually songs that the person experiencing it likes or enjoys. Although it is rare that songs that a person dislikes turn into earworms, it is not impossible. As for memory triggers, nearly all earworms were caused or preceded by a memory trigger.

Therefore, earworms are most likely to occur in a person who is in a good mood after they have experienced a memory trigger. The song that becomes an earworm is most likely to be in the key of C and have a bpm of either 90-100 or 120-130. Songs that fit these criteria are not the only ones that become earworms, but they are much more common than faster or slower songs or songs in a different key.

These findings are significant in that no results have previously been recorded of concrete similarities between earworms. In the past, researchers have studied what an earworm is and

categorized them along with other types of recalled music, as discussed earlier. This is the first time conclusions can be made about what physical characteristics make up an earworm, as well as what environment an earworm is most likely to occur in. These conclusions can be used to formulate earworms. This is another task that previously has not been possible, due to the lack of data on the topic.

Many fields would benefit from being able to produce earworms. At schools, this could be beneficial for teachers. According to the studies by Iwasaki, Rasinski, Yildirim, and Zimmerman, as well as Pellegrino, music has been used in schools for years as a method of memorization, but it could become even more productive if the songs became earworms for the students. If the songs got stuck in the students' heads easily, the information would become much more memorable.

One way to make it more likely that the songs would become earworms for the students, besides creating them using the correct key and bpm range, would be to match the environment to that in which earworms are more likely to occur. Teachers could introduce the songs on a relatively stress-free day, such as one without any tests or a lot of high-pressure assignments. This would ensure that stress would not prevent the earworms from occurring. The teachers could find out which type of music the students enjoyed most, to ensure that they would have a positive opinion of the song. Alternatively, in a study done by Ritchie and Karge, it was found that if a person produces something, such as a song or literary work, themselves, it is more likely to stick in their heads. So, teachers could provide a song without words that followed the correct key and BPM criteria and introduce it in the conditions mentioned before, and have the students write the lyrics themselves. This way, as well as containing all the components of an earworm,

there is an added memorization component of creating the song themselves. This would mean the songs would have the best chance to become earworms, and therefore be easier to remember.

Another potential application of earworms would be in the advertisement field. Earworms could be used as jingles, as well as in the background of advertisements, movie trailers, commercials, etcetera. If a connection can be made between the earworm song and the advertisement, consumers would be more likely to recall the product or service being advertised through implicit memory, as noted by Northup and Mulligan. This means that, rather than attempting to recall as much from an advertisement as possible, which is categorized as explicit memory, the product would pop into the consumer's head and cause them to act on the memory. In order for earworms to be most effective in advertisement, the jingle or song would need to be in the correct key and BPM range- the key of C, and a BPM of 90-100 or 120-130. The advertisement would also be aired during a happy or fun program, such as a comedy movie, rather than during a horror movie or tragedy, to ensure that the viewer would be in a good mood. The song could also be one that already exists that gained wide popularity, such as a song currently at the top of the pop music charts, with rewritten lyrics. This would make it more likely that the viewers would like the song, rather than find it annoying, another component of the ideal earworm. With all these components combined, advertisers could create ads that would be much more likely to stick in a viewer's head and influence them towards purchasing their product.

Overall, the ability to formulate an earworm has the potential to have a major impact on professional industries, as well as people's' personal lives. This research opens up an entirely new realm of possibilities for human ability to recall information or cause it to get stuck in a person's head. Earworms have just entered the research field recently, but they will undoubtedly

remain and we will continue learning more and more about them.

## Sources

- Berger, I. E. (1999). The Influence of Advertising Frequency on Attitude Behaviour Consistency: A Memory Based Analysis. *Journal Of Social Behavior & Personality*, 14(4), 547568.
- Hourihan, K. L., & MacLeod, C. M. (2007, September). Capturing conceptual implicit memory: the time it takes to produce an association. Retrieved April 20, 2017, from <https://www.ncbi.nlm.nih.gov/pubmed/18035619>
- Earworms: Why That Song Gets Stuck In Your Head. (2012, March 12). Retrieved September 01, 2016
- Estrella, E. (2014). The Different Parts of a Song Everyone Should Know. Retrieved October 17, 2016
- Florance, I. (2011). How to get ahead in the psychology of advertising. *Psychologist*, 24(6), 462465.
- How The Science of Memory Can Affect Your Marketing Campaigns. (2014, August 18). Retrieved August 22, 2016
- How to Write a Hit Song. *Writing Fever*. N.p., n.d. Web. 20 Apr. 2017.
- High, K. (2008). Jingle All The Way. *Billboard*, 120(31), 10
- Iwasaki, B., Rasinski, T., Yildirim, K., & Zimmerman, B. S. (2013). Let's Bring Back the Magic of Song for Teaching Reading. *Reading Teacher*, 67(2), 137141. doi:10.1002/TRTR.1203
- Northup, T., & Mulligan, N. (2013). Conceptual Implicit Memory in Advertising Research. *Applied Cognitive Psychology*, 27(1), 127136. doi:10.1002/acp.2892

- Pellegrino, A. M. (2013). Employing Music in the History Classroom: Four Models. *Social Studies*, 104(5), 217226. doi:10.1080/00377996.2012.755458
- Ritchie, D., & Karge, B. D. (1996). Making information memorable: Enhanced knowledge retention and recall through the elaboration. *Preventing School Failure*, 41(1), 28.
- Single or Jingle? Turning Songs into TV Commercials. (n.d.). Retrieved April 20, 2017, from <https://www.highbeam.com/doc/1P3-976657141.html>
- Smith, C. W. (2007). The Anatomy of Melody: Exploring the Single Line of Song. *American Music Teacher*, 56(4), 8186.
- Williams, T. I. (2015). The Classification of Involuntary Musical Imagery: The Case for Earworms. *Psychomusicology: Music, Mind & Brain*, 25(1), 513.  
doi:10.1037/pmu0000082
- Writing Fever. (n.d.). Retrieved October 17, 2016, from