

# In the Zone: An Analysis of the Music Practices of Remote Software Developers

Makayla Moster  
Clemson University,  
Clemson, SC, USA  
mmoster@clemson.edu

Aarav Chandra  
Clemson University,  
Clemson, SC, USA  
aaravc@clemson.edu

Christal Chu  
Clemson University,  
Clemson, SC, USA  
hchu@clemson.edu

Weiyi Liu  
Clemson University,  
Clemson, SC, USA  
weiyil@clemson.edu

Paige Rodeghero  
Clemson University,  
Clemson, SC, USA  
prodegh@clemson.edu

## ABSTRACT

**Background:** Listening to music is a common practice among software developers. Music listening after work can help release work-related stress; while listening to music at work can improve work efficiency and make tedious work more enjoyable. The working environment of developers in the past few years has changed dramatically due to the vast adoption of remote and hybrid work policies. **Aims:** We aim to understand how listening to music at work affects remote developers' perceived productivity and creativity. **Method:** We investigated 130 software developers and collected their music listening habits during remote work in a questionnaire. We studied the impact of listening to music on developers' creativity and productivity while working remotely during the COVID-19 pandemic. **Results:** Our survey data suggests that developers generally feel more productive and creative when listening to music during remote working conditions. **Conclusion:** We found that developers who listen to music feel more productive and creative while working remotely due to reducing environment distractions.

## CCS CONCEPTS

• **Software and its engineering** → **Software creation and management**.

## KEYWORDS

remote work, music listening, programming habits

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## 1 INTRODUCTION

Software developers' productivity has been studied extensively due to the industry's competitiveness. With the onset of the COVID-19 pandemic, software developers had an unexpected transition to working from home (WFH) and, with current ongoing effects, may be returning to the office or switching to a hybrid work style. Before the switch to remote/hybrid work, developers had strategies for maintaining productivity, such as listening to music. Music has several benefits to human life and is used to help ease stress and anxiety through music therapy [11]. While WFH brings convenience, like time-saving on commuting as well as flexible scheduling, it also leads to isolation and anxiety [17]. Various research in sociology suggests that humans are social beings that crave social interaction [8, 12]. A shift to remote and hybrid work affects one's ability to interact with others naturally and thus causes various issues that eventually hinder an individual's productivity. This shift can also cause an imbalance in software developers' work-life balance, which is essential for recharging after work.

Pre-pandemic, developers could go out and enjoy social activities with friends and family for relaxation. This allowed them to decompress from a long day of work, and traveling from their work environment to their home created a clear boundary. With a clear boundary between work and home, developers could focus on the job before them while at the office and go home to relax, spend time on hobbies, or socialize with friends and family. The lack of a well-defined boundary between work and home life creates an environment where individuals' lives revolve around their work without proper partitioning. It causes an individual to quickly burn out as work and private life merge [19]. Unfortunately, during the pandemic, many companies closed their office spaces, forcing developers to complete their job duties from home [4, 9]. However, the future of software development work is turning towards hybrid, allowing developers to work at home part of the time and in the office during the other part [21].

This unexpected change caused a significant shift in working environments and employee productivity. Software developers had to adjust to remote and hybrid workflows by incorporating coping mechanisms like listening to music into their daily routine. The problem we aim to address with this research is identifying how developers' productivity and creativity are impacted when they listen to music while working. According to past research, working from home leads to better creativity and productivity for software

developers due to reduced commute time and more flexible working hours [1, 24]. However, there has been very little research on how listening to music affects developers' working performance, including creativity and productivity.

Overall, listening to music has been shown to reduce stress and increase the quality of work performance [1]. Barton *et al.* found in their pre-pandemic studies that between 63% and 88.2% of software developers listened to music at work [1]. 44.6% of the respondents to Barton's surveys listed that they listened to music to improve their productivity, while 18.8% stated that it increases the quality of their work [1]. Those who did not listen to music at work listed that it was not allowed (12%), decreased productivity (39.8%), and that it lowered their mood (65.8%) [1]. Fortunately, due to the ability of software developers to create their work environments, music listening is now more available during work. In this paper, we aim to determine how listening to music at work affects remote developers' perceived productivity and creativity.

## 2 BACKGROUND AND RELATED WORK

In this section, we discuss essential background information on software developers' productivity, remote work, music's impact at work, and how music impacts software development.

### 2.1 Software Development & Productivity

Productivity and its measurement have been a topic of discussion within the software development community for quite some time. Due to the competitive nature of the software development industry, factors affecting performance have been studied extensively, including the developer productivity factor.

Canedo and Santos identified 37 factors that affect the productivity of software development teams either positively or negatively [5]. Additionally, Murphy-Hill *et al.* identified a list of productivity factors and identified a ranking system for use in determining which productivity factors companies should invest in for a quicker return [20]. Ramírez-Mora *et al.* found in their study that team maturity has a positive influence on team efficiency and effectiveness [23]. Furthermore, Qamar and Malik found in their study of team homogeneity that software development teams with a higher team homogeneity index (THI) score are more productive and produce higher quality work than teams with a low THI [22].

The work environment is also a factor in software development productivity and has recently started to be studied. Johnson and Zimmermann identified six themes related to physical working environments. They found that developers preferred to have windows and decorations in their space and the ability to communicate with their team or work privately without interruptions [16]. Additionally, Sochat recommends software developers start having a daily routine and creating clear divisions between work and home during remote working conditions [25]. For remote developers, factors that influence their productivity the most include external interruptions, adapting to a remote workstyle, and emotions [2].

### 2.2 Remote Work

There is a considerable amount of literature related to how remote work affects employees. Charalampous *et al.* identify some benefits of WFH for employees, stating that remote employees are more

satisfied with their job, more committed to their company, and experience less stress linked to office politics and commute traffic [6, 17]. Kłopotek *et al.* identify that remote workers also have more control over their remote work environment, allowing workers to adjust the temperature or play music while working [17]. There are also many disadvantages such as work and home boundaries are blurred, longer working hours, and less relaxation time [6, 17]. Other disadvantages include more perceived threats to professional advancement and limited social engagement [17].

### 2.3 Music & Productivity

Music's effect on productivity has been studied for decades. In the 1940s, the United Kingdom allowed workers to listen to music while manufacturing wartime munitions, and this increased factory productivity by 12 to 15% overall [14]. In the 1970s, Fox found that music helps influence productivity in industrial settings, which led to later experiments to test this theory [10]. Later, Fox *et al.* conducted another study and found that lively music was more effective in increasing workers' efficiency. Blood *et al.* explored how music affects anxiety, communication, and productivity, coming to inconclusive results for anxiety and productivity but finding that communication was more productive with music [3].

Other workplace studies have found that music affects both introverts and extroverts differently, showing that introverts performed poorly with the added music than the extroverts in the study [13]. Haake built upon this research, finding in their study that music created a relaxing effect in workers by distracting them from their thoughts, but also found that productivity while listening to music was context-dependent in all situations [15]. Respondents in Haake's study also mentioned that they listened to music in the workplace to become more creative [15].

### 2.4 Music's Impact on Software Development

There is little recent literature on how music impacts software developers and their work. Lesiuk found that music listening is beneficial to maintaining a high quality of work and time-on-task [18]. Another study found that music may have a positive impact on software developers within the workplace [27]. A different study found that developers were less stressed when solving programming tasks while listening to music [26]. These papers indicate that developers who listen to music while programming may positively impact their productivity; however, more research into this area is needed to further understand music's impact on software development.

## 3 STUDY DESIGN

In this section, we describe our research questions and our methodology for studying the effects of music listening in the workplace.

### 3.1 Research Questions

The overall goal of our study is to discover if remote software developers listen to music while working, how productive developers feel when listening to music, what genres of music are for specific tasks, and how creative developers feel when listening to music. With this, we developed the following Research Questions (RQs):

*RQ<sub>1</sub>* Are software developers listening to music while working from home?

*RQ<sub>2</sub>* For what tasks, if any, do developers choose to listen to music?

*RQ<sub>3</sub>* How does listening to music affect developers' productivity and creativity?

The rationale behind *RQ<sub>1</sub>* is to determine if software developers are listening to music while working from home. We investigate developers' company policies to determine if there are rules against listening to music in the workplace and examine developers' remote working conditions to help us establish a baseline to answer *RQ<sub>3</sub>*.

*RQ<sub>2</sub>* aims to determine if developers listen to music for specific tasks while working. This question looks into different tasks that developers listen to music for to see if there are correlations or everyday tasks that listening to music may benefit from. These correlations may allow us to recommend to developers which tasks benefit from music listening and which tasks are a detriment.

*RQ<sub>3</sub>* aims to identify if listening to music impacts developers' productivity and creativity while WFH. This question explores how productive developers feel while listening to music and how creative they feel when listening to music. We also explore different music genre types and if they impact creativity or productivity during specific development tasks. These answers will help us analyze how music listening affects developers' work performance.

### 3.2 Methodology

This section describes the methodology we used to answer our *RQs*.

**Survey Design.** We designed our survey using Qualtrics and included a mix of short answers, Likert scale, and multiple-choice questions<sup>1</sup>. Overall, we had a total of 27 questions. We piloted the survey online before distribution during summer 2021, which allowed the research team to clarify and incorporate additional questions based on the received feedback. We began by asking for demographic information such as age, gender, and programming experience. We included a short coding question to ensure that our participants had some coding knowledge and excluded those who had no programming knowledge from posting our survey openly on the internet. All responses who incorrectly answered the coding question were removed from our data. We then asked questions related to music listening at work, such as "Do you listen to music while you work?" and "Does your company allow you to listen to music while working in the office?" Other questions included short answers about what genres of music correspond to which tasks and why developers listen to music while they work.

**Data Collection.** We distributed our survey online to social networking platforms such as Reddit, Twitter, Facebook, and LinkedIn to gather participants working as software developers currently. Software engineering-specific subreddits worldwide were chosen, such as r/DevelEire, r/developersIndia, r/developers, r/SoftwareEngineering, and more. We left our survey open for 30 days to collect responses and reposted multiple times to all platforms. All survey responses were recorded anonymously using Qualtrics.

**Participants.** Our participant demographic comprises professional software developers with experience working remotely in industry. We had 130 participants in total, with 37 responses removed for

being incomplete, leaving 93 responses to analyze. Fifteen of our participants identify as female, 78 identify as male, two identify as non-binary, and one prefers not to disclose their gender. The majority of our participants (44%) are between the ages of 25 and 34, 31% are between 35 and 44, 18% are between 18 and 24, and 7% are between 45 and 64. No participants were older than 65 years of age. Our participants have about nine years of professional software development experience. Our participants' amount of professional experience ranged from 2.5 months to 33 years. Lastly, we asked about overall programming experience; responses ranged from 1 year to 38 years of programming experience, with the majority (11.5%) of participants having ten years of experience.

**Data Analysis** After collecting responses for 30 days, we ran standard statistical tests on our responses, such as response frequency, using the Qualtrics software. We used Tableau to generate visuals of our data and run our analysis of the demographic and multiple-choice data. We then hand-coded the free-response data to determine themes across productivity and creativity [7]. The first two authors on our team coded the free response questions using a set of predetermined codes. The third author then compiled the codes and resolved any discrepancies when the coding was complete.

## 4 SURVEY RESULTS

In this section, we explore our results as they relate to our *RQs*.

### 4.1 Remote Working Conditions

As a preliminary question, we asked developers if their employers required them to WFH due to the pandemic. This survey question was provided to help answer *RQ<sub>1</sub>*. We found 93% of developers agreed that they WFH due to the pandemic, with 6.5% stating that they did not WFH due to the pandemic.

When asked what type of work environment developers preferred, the majority answered that they would prefer WFH. We found that 7% preferred working at the office, and 36% preferred a hybrid model. We asked those who preferred working in a hybrid modality to elaborate what they wanted out of a hybrid model:

☛ "I'm fine working most days in an office with the allowance of 1 or 2 days from home." - P34

☛ "I prefer working wherever I feel most productive that day. Sometimes it's at the office where there's people to talk to face to face to bounce ideas off of. Sometimes it's at home where I can play music as loud as I'd like. Sometimes it's at a coffee shop with a unique atmosphere which breaks the redundancy of the typical work week. To me freedom is the best model... as long as the work gets done." - P6

☛ "Somewhere between 2 days at office, 3 days at home OR 3 days at office, 2 days at home" - P22

☛ "Work from home, but the option to occasionally go to the office for more focused sessions without interruptions or disturbance." - P75

Most developers who want a hybrid work model value the flexibility to WFH or at the office when needed. Most response answers were split between having two days at the office and three days working at home or spending three days at the office and two days working from home. A few responses wanted working at the office and weekly office meetings to be optional, instead wanting the meetings to allow for virtual call-ins. Only one response stated that they like either working from home or at the office, with no indication of wanting a hybrid work week.

<sup>1</sup><https://doi.org/10.5281/zenodo.6833342>

This information helps answer  $RQ_1$  by showing that most developers have had to undergo WFH due to extreme circumstances such as the COVID-19 pandemic. The responses also show that most developers prefer WFH or flexible hybrid conditions.

## 4.2 Music Practice at Work

To help answer  $RQ_1$  and  $RQ_2$ , we asked developers about their music-listening practices while working from home. We found that most developers listen to music while they work remotely. According to our data, 86% of developers listen to music while they do work-related tasks, which answers  $RQ_1$  affirmatively. We found 43.5% of our participants listened to music about the same amount working from home as in the office, 26% of developers responded that they listen to music more when working remotely than in the office, 15% stated that they listened to music slightly less at home, and 15% noted that they do not have an increase in music listening due to the transition from office space to home. Responses from developers about why they listen to music more while WFH:

☛ “I find it easier to listen to music and concentrate on my work in my home office. Personally the office is distracting enough, I find that there are too many things going on if I try to work, listen to music, and have office buzz in my environment.” - P8

☛ “I am able to concentrate more without interruptions from peers or stakeholders, and it helps me to concentrate.” - P27

We also asked the developers who had a decrease in music listening while WFH why they listen to music less, they said:

☛ “I don’t need to drown out distracting sounds from an open office space. Music was less to help me focus and more because it is less distracting than the alternative of having headphones off.” - P7

☛ “I have more freedom at home to take a lap, sit in weird positions, etc. There’s also more pleasant noise at home, like birds chirping. Music acts as an escape in the office.” - P34

☛ “I don’t need to wear headphones as a means to implicitly communicate ‘do not disturb’.” - P11

Most of our participants (60%) are extremely likely to listen to music when completing repetitive tasks. At the same time, 25% are somewhat likely, 25% are neutral, and 10% are unlikely to listen to music to complete repetitive tasks. To answer  $RQ_2$ , we asked our participants to elaborate on the work activities they listen to music for, with most developers stating that they listen to music when doing mindless tasks or programming. Some responses are:

☛ “Refactoring, debugging, implementing APIs/components that I have already specified/planned out.” - P81

☛ “Pretty much anything that involves me getting into a flow state. I typically do my morning routine (reading emails, planning daily tasks) with no music...” - P44

☛ “I listen to music while in the zone. I don’t listen to music if I have lots of meetings lined up.” - P61

We found that 61% of developers use headphones during remote working tasks, while only 17% of developers sometimes use headphones, and 22% do not use headphones while working remotely. Most developers responded that they use headphones not to disturb others in the environment and to have a more focused, immersive working environment. We asked our participants to elaborate on why they use headphones while working remotely, as shown below:

☛ “I have much better headphones than speakers, I also just enjoy headphones more. I prefer the experience of having the music to myself, and don’t want to impose on my housemate.” - P34

☛ “My partner is also working from home and I want to be respectful of her work environment.” - P26

☛ “My kids are in virtual school, and I don’t want the other second graders learning Cardi B lyrics.” - P1

These responses indicate that developers listen to music while working remotely, corroborating our  $RQ_1$ . Developers who listen to music while working usually have activities that they typically listen to music for, such as programming tasks or debugging code, which helps answer  $RQ_2$ . Software developers also use headphones while working remotely to create a focused space within their home environment. Headphones are also used to create continuity between video conferences and not disturb housemates who may also be working or schooling remotely.

## 4.3 Productivity Impacts

$RQ_3$  focuses on how listening to music impacts the productivity of software developers. We found that most developers felt that listening to music positively impacts their productivity, with most participants answering that music slightly or moderately impacted (6-9 on our Likert scale) their productivity, as shown in Figure 1. Many of our participants commented that listening to music helped them focus on the task at hand and enter the ‘zone,’ a state where participants have an extreme focus on their current tasks or work.

WFH Developers’ Perceived Productivity Levels using Music

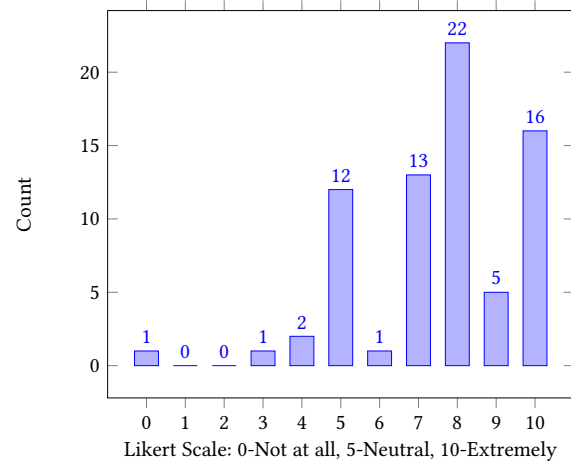


Figure 1: Participant answers to “How productive do you feel when listening to music while working from home?”

When asked if their productivity while listening to music differed in WFH and office settings, participants answered:

☛ “Yes. When I was working in an office I interacted with other people a lot more, including my boss. This would break me out of the ‘zone’.” - P3

☛ “Music or twitch stream helps me relax, which in turn helps me better focus. It’s also more difficult for people to interrupt me working remote compared to the office where they literally just come up to you and bug you until you help them.” - P12

“Less distractions at home (I live alone) compared to the office, when people can tap your shoulder at random times and interrupt your flow.” - P57

Other themes we found in the free response mention that there is no difference or about the same productivity level between WFH and the office, office distractions create an environment where music is welcomed, and a few responses held negative feelings toward their physical office. One respondent called going to the office a ‘huge waste of time’ and that it ‘drains my will to do anything.’

Our findings show that most developers feel at least slightly more productive while working from home if they are listening to music. Within free response answers to elaborate on how their productivity changes at home versus at the office, a theme within the answers is that working at the office includes being distracted by noises or interrupted by coworkers when trying to focus on a task, which are both perceived as unwanted distractions.

#### 4.4 Creativity Impacts

RQ<sub>3</sub> also focuses on how listening to music impacts the creativity of software developers. Our findings in Figure 2 show that most developers answered that they felt more creative (6-10 on the Likert scale), with a tie between the number of participants feeling neutral (5) and feeling moderately more creative (8). When asked if they feel more creative when working from home and listening to music:

“At work I found myself unable to put in my headphones and concentrate on music for any length of time in the office. Home allows me more focused development time.” - P63

“Being at home has me more at ease and I have a lot more time to sit back and think without looking unproductive. ... At the office this is frowned upon especially in my work environment...” - P55

“I feel more creative when working from home, but I am also more distracted than when I am at the office.” - P7

We found that most free response answers stated no difference in creativity at the office and home. Others answered that music helps them be creative no matter their location. Others mentioned that the office space is not conducive to creative thinking due to the number of distractions it brings.

From our findings, developers feel at least slightly more creative when WFH than at the office with music. The office brings distractions from creative focus, including noise and intrusive coworkers. Working at home is a customizable environment for developers, allowing them to build an environment specific to them.

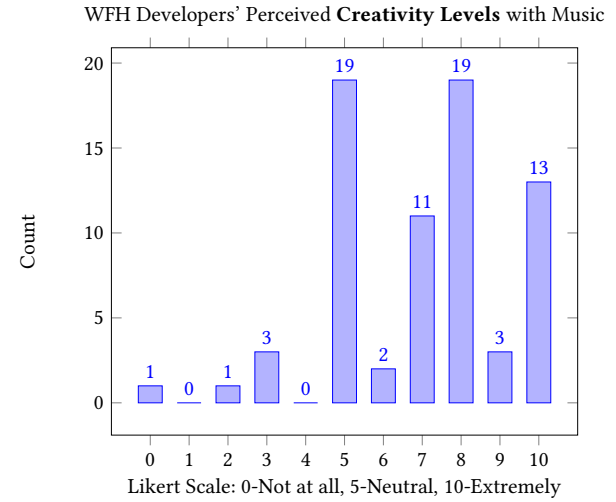
## 5 DISCUSSION

Our paper begins to answer three important research questions related to remote software developers and their music listening.

### 5.1 Music Listening Impact on Developers

Our paper advances the understanding of music and its impact on remote developers’ workspaces. Since software engineers are more collaborative than other office workers, how they collaborate and communicate are essential factors in their work environment. The first contribution of our paper is the knowledge that **software developers are listening to music while working remotely.**

We found that most software developers were listening to music while working before the pandemic in regular office spaces and during the pandemic within their personal areas. However, some participants stated that music is more distracting to their working



**Figure 2: Participant answers to “How creative do you feel when listening to music while working from home?”**

flow. Barton *et al.* found in their paper that developers are listening to music while in provided office spaces to remove noise and regulate mood [1]. Our results support these findings, with many developers responding that they listen to music to remove noise and when they need to get ‘into the zone.’

Johnson *et al.* found that within office spaces, headphones were used as an indicator of developer availability, with headphones on being the signal for unavailable and headphones off as being available [16]. While working from home, developers utilize headphones for the same reasons and remove environmental noise, not disturb housemates, and focus on the current task.

Our results show that developers are listening to music to increase concentration and not disturb others in their working environments. Many responses mentioned that music keeps them focused and relaxed while working and blocking out environmental noises. Some responses said that their computer speakers are lower quality than their headphones, so they prefer to use their headphones at home. Others use noise-canceling features to focus.

Our results provide an insight into the minds of developers who WFH. These developers are using music at home the same way they would at the office – to provide a space for focus and block out any unnecessary environmental noises. For those with roommates, developers are continuing the trend of using headphones to signal availability. They are using headphones in the office as a way to indicate focus as well as noise removal, which is the same reason why they use them while WFH. It is important to note that most of our participants indicated to be in the 25-34 years of age range, which may be a limitation for the responses within this section.

### 5.2 Productivity Impacts

We also focus on the impact of music on developers’ productivity. Overall, we found that **remote developers feel more productive when listening to music, with over half of our participants stating that music positively affects their productivity.**

Developers feel productive when listening to music, which could be due to fewer interruptions from coworkers or housemates and more time spent focused on the task. It is also possible that music

can hinder productivity due to tasks like singing or humming, changing the song, having a task not suited for music, or changing the music genre based on mood. Most responses note that they listen to music when performing repetitive duties. The overall impact of music on remote developers' productivity levels is hard to determine but appears to positively impact how developers perceive their productivity based on our results.

### 5.3 Creativity Impacts

We investigated how creative developers felt when WFH and listening to music, and **the majority stated that they felt at least slightly more creative**. However, when asked if this creativity differs from their creativity in the office, most developers stated their creativity levels are about the same WFH as in the office.

These conflicting results could be caused by the context of their job, since being a software developer means that it might be more challenging to have the space to be creative when developing software or fixing bugs. It is also possible that the daily tasks of software developers are repetitive and tedious so they choose to listen to music to help overcome the monotony, but the real creative space is within their team meetings where they cannot listen to music and contribute ideas to the group discussion concurrently. However, those that feel more creative attribute their creativity to being in a comfortable, relaxed environment with pleasing music rather than at the office with music meant to drown out environmental noises.

### 5.4 Limitations

This study surveyed the software development community virtually to gain insight into their music practices while they WFH. Due to distributing our surveys via social media and communication forums, there may be more of a focus on software developers who utilize internet forums such as Reddit, Twitter, Facebook, and LinkedIn and does not gain any insights from developers who are not active on the internet. Another limitation may be that since we utilized surveys to obtain data, participants may leave out important information resulting in bias.

## 6 CONCLUSION

In this paper, we studied the music listening practices of remote developers. We studied the impact of music on developers' productivity and creativity, and we also studied specific tasks for which developers listen to music. Despite the outbreak of the COVID-19 pandemic and the shift in working environments, it did not significantly change the music listening practices of software developers. In terms of productivity, we found that the primary motivation for developers to listen to music was to remove background noise and regulate their mood due to the lack of social interaction. We found that developers feel productive when listening to music, which could be due to fewer interruptions from colleagues. Additionally, we found that developers feel slightly more creative when WFH with music. However, it is hard to determine remote workers' productivity and creativity levels, and most responses noted that they listen to music when tasks require less thinking.

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