The Effects of Music-listening on Human Concentration and Heart Rate?

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ABSTRACT:

There is a growing investigation into the effects of music listening on people's memory abilities and emotional regulation. However, the effects of music-listening on people's concentration remain confusing. This study investigates the impacts of music listening on people's attention. Ten participants were recruited for the research. The subjects' heart rates and reaction times were recorded using pre-existing apps when listening to different types of music (i.e., rap and soft music). No significant correlations between music's effect on concentration and heart rate were found due to the limited sample size. Future work would examine more variables influencing the relationship between music listening and concentration. This experiment is designed to provide suggestions about music listening management and assist as a reference for people who prefer listening to music at work.

Keywords: music-listening, concentration, reaction time.

1. INTRODUCTION

Music is diverse due to its differences in dynamics, melody, rhythm, tones, and tunes. People often use music to express their feelings or evoke memories with friends and loved ones. People's feelings from listening to music can become more relaxed and pleasurable since music affects mood and emotions. Music is everywhere in people's lives. It has been shown that music listening has many effects on human behaviors, mood, work performance, genetics, and even sleep [1, 2, 3].

Lesiuk's study [1] has demonstrated that listening to music makes people work efficiently while maintaining a pleasant mood under conditions with music. Participants were assigned questions. Researchers then gathered Trait Positive Affectivity. The higher the score, the more favorable it affects the participants. The data suggest that during the first three weeks, the mean of positive state affect increased steadily, which means there was less positive affect change in the beginning. However, that positive effect significantly increased at the end of three weeks. During week four, the condition was set to have no music; this change immediately caused the positive effect to decrease. In week five, the music was resumed, and the positive effect began to increase again. The results indicate how the participants were happy while listening to the music, but once the music was removed, the participants' joy was no longer maintained.

In addition, Lesuik [1] combined the work quality with data tables. The people who often listen to music while working might better understand their current mood than those who do not listen to music. This study suggests a positive correlation between music listening and positive mood effects. However, they did not have a control group, such as what type of music to listen to or how long they should listen.

Additionally, human microRNA expression is regulated by music listening [2], and it has been found that music listening can control the expression of miRNA amount and trigger different cell signaling pathways, including dopamine metabolism and apoptosis-related neurodegeneration. Dopamine has been demonstrated to play an essential role in the body since it can decrease pain perception and stress, control mood, enhance sleep, and even concentrate. This study links genetics to cognition about how music listening affects brain functions and emotional regulation [2].

Music can also affect health [3]. Research has examined the effects of music on heart rate. For example, slow music might decrease the heart rate, and fast rhythm music can increase the heart rate. Researchers experimented on 36 participants. At the beginning of the experiment, participants were asked to complete a questionnaire about whether they had smoked, used caffeine, or drunk alcohol. The participants' index fingers were then attached to a pulse sensor to measure their heart rate when listening to quiet music and decrease or increase temp music. The results demonstrated that "passive music listening can induce arousal on account of focused attention," which means passive listening to music, the heart rate is often reduced and low, and it is less likely to decrease. However, the heart rate might also be related to the respiration rate because every part of the body involves cellular respiration to react and function. The study

remains explorations, such as how the periods of music will affect heart rate and how people's heart rates change when listening to music because different ages may have various autonomic cardiovascular, which means their heart rate may also alter uniquely [4].

Based on the research about the effects of background music on attention performance, created by Yi-Muo Shih [5], their findings illustrate that if music without lyrics is played in workplaces, workers will have high concentration and attention. Workers' concentration will reduce if music with lyrics is played in the work environment. They used Chu's Attention Test to measure the work concentration level while listening to background music. Background music has the same volume and tone, except for the presence and absence of the lyrics. The results showed that the work concentration level with background music without lyrics was a little higher than the work concentration level with lyrics, which means that music with lyrics will harm attention during work performance because lyrics may distract listeners. The study didn't measure the quality and quantity of the task's performance [5].

In agreement, music can affect work efficiency and people's sleep quality if they choose the music they prefer. Ami [6] investigated how prescribed and preferred music influences sleep quality [7]. Their results showed no significant difference between the prescribed and preferred music groups. However, there was a significant reduction in PSQI (Pittsburgh Sleep Quality Index) scores of subjective sleep quality, sleep latency, and daytime dysfunction [6].

Many people prefer listening to music while working since they believe music can motivate them and increase work efficiency [5]. However, there needs to be more agreement with this idea. Some people prefer not to listen to music because it distracts and interferes. Most studies demonstrate how music positively affects motivation and improves brain stimulation [8].

Based on the study about Heart Rate Variability During Attention Phases in Young Infants, researchers have examined how heart rate decelerates while maintaining great attention and returning to peristimulus level [1, 4, 5, 9].

Investigations of music have also shown that focus of attention affects the performance of motor skills in music, such as learning how to play instruments in the results of producing different movements and structures [4]. Both studies demonstrate how music can alter human behavior, mood, and work performance, but they didn't mention how music might affect people's concentration and focus. Since music alters human genes, it might also affect human focus and body changes such as heart rate, facial expression, and physical changes. This study aims to demonstrate how listening to different types of music will fluctuate people's attention and concentration while working on specific tasks.

Inspired by the two studies from Yi-Muo Shih about how music with and without lyrics will have effects on work performance and heart rate variability from Jone E. Richards and Betty Jo Cassey, this study aims to demonstrate how music listening will fluctuate people's attention and concentration while working on specific tasks such as attention-related games and will help people of different ages with different jobs to enhance their concentration. This research hypothesizes that relaxing music can lower heart rate and increase people's attention. This study is also an advisor because it provides valuable advice to human resources management and counselors on the proper use of music in specific situations and when it should be avoided [5]. The other studies used a survey to test, so there might be some bias and errors because self-reporting is not always accurate.

2. METHODOLOGY

2.1 PARTICIPANTS

Because relaxing music, such as music without lyrics, can help people work at their best performance [5], research hypothesizes that it will cause high focus and lower heart rates [4, 5, 9]. The total number of participants is 10, including 16-30 and 30-50 years old; all were Asians and live in California.

Before using the test tool, the participants were required to listen to a playlist with relaxing music. They can choose their playlist or the one the study provided since each person defines relaxing and exciting music differently [6]. After listening to music, the participants had to play the attention game five times, and each time, they had to record their heart rate by using InPulse, an app to measure the heart rate. To address the variation of the test, the experiment designed is five replicates per group.

2.2 MATERIALS

This experiment chose an attention game, Opatus CPTA, a mobile app to test motor activity levels designed by a Swedish medtech company to enhance people's attention and provide diagnostic assistance, such as treatment for patients with ADHD. Chu's Attention Test enlightened this app; although it is not completely the same, it is considered a tool to measure focus and concentration [5]. Optus works by tapping on the screen while presenting triangles. The triangles have two colors, one purple and one yellow, each with a different orientation. Once a triangle with a different orientation and color is shown on

the screen, the user must remember the presenting symbol to tap the screen with the same symbol as the previous one shown. Although the next triangle might show up with the same color and orientation, there is a chance that the next triangle will show up in a different color and orientation, which means the user must avoid tapping on the screen and concentrate more on the following symbol. The difficulty in this game is that the same color and orientation of the triangle might be presented multiple times, causing the user to associate the following symbols as all the same and accidentally tap the wrong symbol. Another reason that makes this game challenging is that the user must remember the previous symbol. Still, the user might forget the previous symbol and blindly tap the random symbol, so this game requires extensive attention. As a result, the Opatus attention games provide data such as the reaction time (ms), commission error (%), omission error (%), error rate (%), and multi-taps.

Participants are all ages 16-30 and 30-60 years old. Optus has games that indicate each age, such as toddler, child, adolescent, adult, and senior. The game also has time limits. In this study, the experiment chose 1 minute per each again five times (5 minutes).

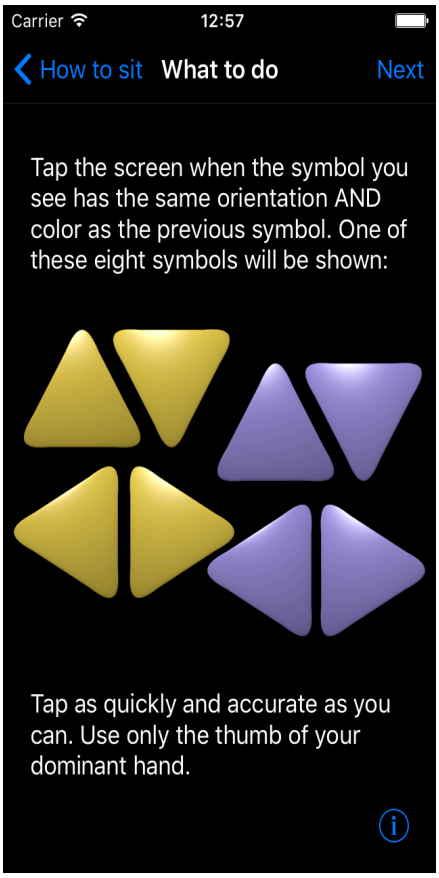

Figure 1: The eight triangles with different orientations and colors represent the symbol.

Music playlist:

Table 1: Relaxing music (without lyrics)

Music name	Time
Je te veux (By Erik Satie Satie—Pasacal Roge)	5:10
3 Gymnopedies: No. 1 (By Erik Satie Satie—Pasacal Roge)	3:08
Piano Sonata No. 15 in C, K. 545 “Facile”: I. Allegro (By Wolfgang Amadeus Mozart —Maria Joao Pires)	4:13
Fish In The Pool (By Frozen Silence)	0:59
Garden (Mobile Meldoy Series)	3:43
Pure Imagination (feat. Rook1e & j’san)	1:45
The city of Water (Bay Habor)	1:59
Total time	20

In Table 1, a list of 7 relaxing music was provided for the participants. The link is provided for each music so participants can easily access them. They are all background music without any lyrics or heavy metal. Table 2 shows a list of 5 exciting with lyrics. Most of the songs are J-pop music.

Table 2: Exciting Music (with lyrics)

Music name	Time
Mayday (feat. Laura Brehm)	4:07
Gunjou (By YOASOBI)	4:08
KICK BACK (By Kenshi Yonezu)	3:13
Kakumei o Narase (The Floor)	4:00
Mood (feat. iann dior)	2:21
Total time	17:49

2.3 PROCEDURE

The procedure was designed in three sections: no music, relaxing music, and exciting music. Each section contains a table to record heart rate. The participant was required to use the Opatus CPTA app to play the game for less than one minute and then record their first trial: reaction time, commission error, omission error, error rate, multi-tap, and calculate the averages. After recording the first trial on the concentration tables (no music, relaxing music, and exciting music), they needed to use the InPulse app to test their heart rate and record it on trial 1. Processes are repeated until finished.

2.4 INSTRUCTION

Participants were provided with instructions that included

the steps for the experiment, such as downloading the apps, beginning the demo, and collecting data. The instructions survey is a preparation before the experiment. Music lists are also provided above as an option for participants to listen.

Preparation before the test:

1. Make a copy of this doc.
2. Download Opatus CPTA and InPluse
3. Open Opatus CPTA and click "Next."
4. Select "Skip"
5. Select your country
6. Select "Test instructions and demo."
7. Select your age
8. Begin practice
9. Choose sex and date of birth
10. Begin practice with less than 1 minute.
11. Record your results into the no music table for trial 1(reaction time, commission error, omission error, error rate, and multi-taps).
12. Test the heart rate and record the pulse, HRV, stress, and energy in trial 1 for the heart rate table.
13. Play the game again and then test your heart rate (repeat the process five times).

Table 3: No music-listening

CPTA TEST	Reaction Time (ms)	Commission Err %(#/12)	Omission Err %(#/8)	Error rate% (#/20)	Multi taps
Trial 1					
Trial 2					
Trial 3					
Trial 4					
Trial 5					
Average					

Table 3 shows five trials of CPTA testing without listening to any music. Reaction time, commission error, omission error, and multi-taps must be recorded to better understand the participant's concentration and focus. The average is required to be calculated at the end of trials.

Table 4: Heart Rate

Heart rate	Pulse (BPM)	HRV (MS)	Stress (%)	Energy (%)
Trial 1				
Trial 2				
Trial 3				
Trial 4				
Trial 5				
Average				

In Table 4, the heart rate table has five trials to record how the participants have changed physically, including pulse, HRV, stress, and energy. The average is also required to be calculated at the end.

Relaxing Music (without lyrics)

Choose 5-7 relaxing music without lyrics (or use the music provided).

Listen to the music for about 20 minutes (you only need to listen for ONE time).

Open Opatus CPTA and click "Next."

Click "Test instructions and demo" and select your age

Play demo

Repeat steps 11-13.

Table 5: Relaxing Music

CPTA TEST	Reaction Time (ms)	Commission Err % (#/12)	Omission Err % (#/8)	Error rate% (#/20)	Multi taps
Trial 1					
Trial 2					
Trial 3					
Trial 4					
Trial 5					
Average					

Table 5 shows five trials for the CPTA after listening to relaxing music.

Table 6: Heart Rate

Heart rate	Pulse (BPM)	HRV (MS)	Stress (%)	Energy (%)
Trial 1				
Trial 2				
Trial 3				
Trial 4				
Trial 5				
Average				

Table 6 shows five trials for heart rate after completing Table 5.
Exciting Music (with lyrics)
Choose 5-7 exciting pieces of music (with lyrics)
Listen to music for about 20 minutes
Open Opatus CPTA
Click “Test instructions and demo.”
Play demo
Repeat steps 11-13.

Table 7: Exciting Music (with lyrics)

CPTA TEST	Reaction Time (ms)	Commission Err % (#/12)	Omission Err % (#/8)	Error rate% (#/20)	Multi taps
Trial 1					
Trial 2					
Trial 3					
Trial 4					
Trial 5					
Average					

Table 7 shows five trials in total for the CPTA test after listening to exciting music.

Table 8: Heart Rate

Heart rate	Pulse (BPM)	HRV (MS)	Stress (%)	Energy (%)
Trial 1				
Trial 2				
Trial 3				
Trial 4				
Trial 5				
Average				

Table 8 shows the Heart rate table after completing Table 7.

2.5 STATISTIC ANALYSIS

SPSS 27.0 was used to perform all statistical analyses. Bivariate correlation (Pearson, 2-tailed) was conducted between different types of music-listening (including no music, relaxing music, and exciting music), the reaction time, and the participant's heart rate to detect their relationship. One-way ANOVA was then conducted to examine the impact of music listening (three types) on the subjects' concentration and heart rate.

In Figure 2, the blue dots show variation between each participant. In the control group (no music), three people had the closest reaction time, and two had a very slow reaction time.

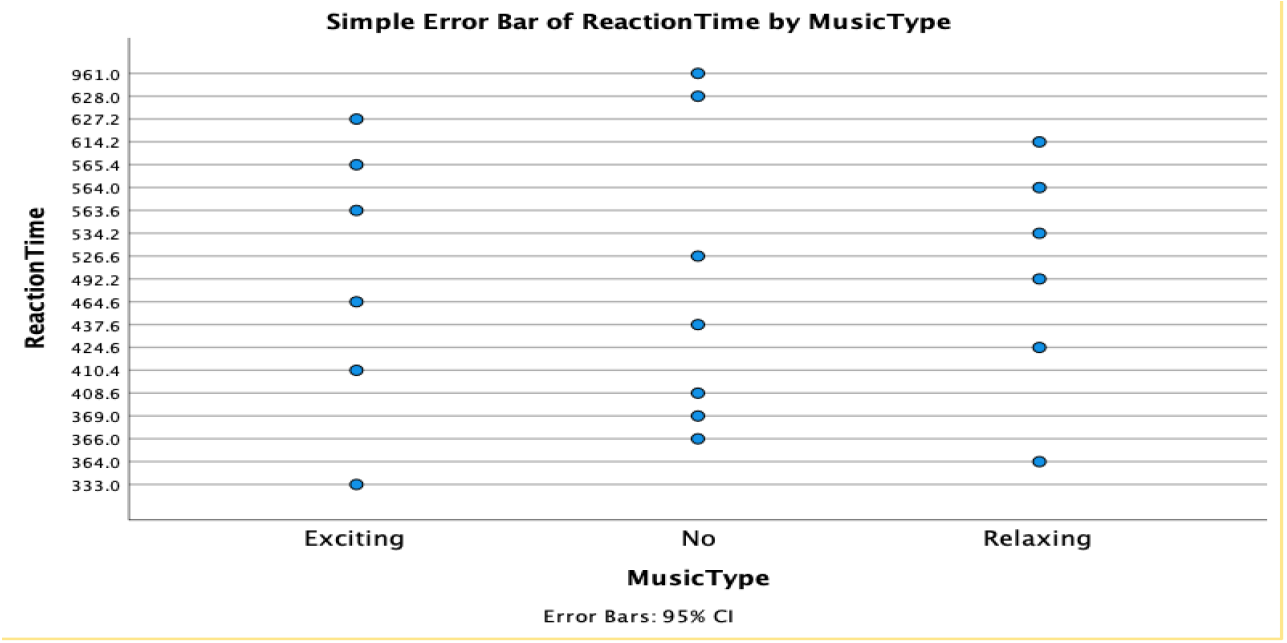

Figure 2: Simple Erro Bar of Reaction Time by Musci Type

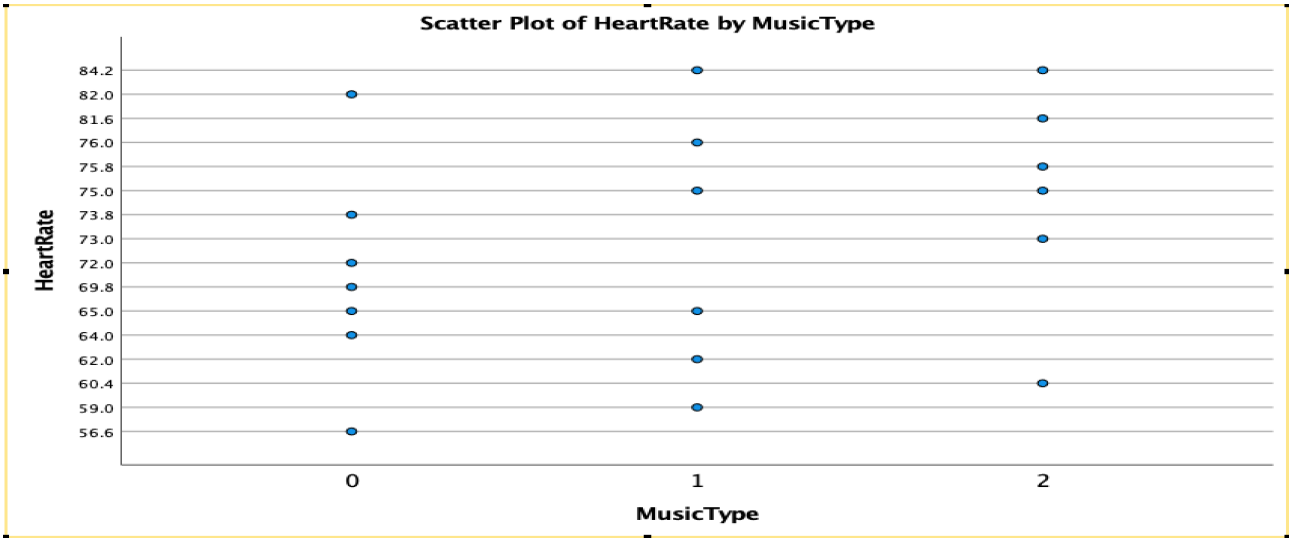

Figure 3: Scatter Plot of HeartRate by Music Type

Figure 3 shows how music types affect heart rate. Number 0 is the control group (no music); 1 represents relaxing music, and 2 represents exciting music.

Table 9: The correlation between reaction time and heart rate is affected by music types.

	df1	df2	F	p
Reaction time	2	16	.096	.909
Heart Rate	2	16	.827	.455

Table 9 illustrates the correlation between reaction time and heart rate affected by music types.

3. RESULTS

After statistical analysis, this experiment didn't show any significance between reaction time ($p<0.05$, $0.9>0.05$) and heart rate ($0.455>0.05$). The F value between and within groups for reaction time and heart rate is .096 and .827, indicating no significant variation within the samples. The sum of the individual degrees of freedom for each sample is 2. Based on the one-way ANOVA table, the values of df1 and 2 for both reaction time and heart rate are 2 and 16. According to the scatter plot graph for the reaction time by music type, dots are unevenly distributed. The distribution indicates that some participants had a faster reaction time when they listened to exciting music, and others had a higher reaction time when they listened to relaxing music. Based on the graph of heart rate by music, "2" on the x-axis represents exciting music, and a few dots had higher values on the heart rate, which could potentially conclude that exciting music does increase participants' heart rate.

4. DISCUSSION

The research's hypothesis did not match the result since no music types were correlated with concentration and heart rate. However, Figure 2 shows that the exciting music did increase the heart rate compared to the no music and relaxing music. According to the previous study [5,9], attention and concentration positively correlated with music without lyrics. Although the experiment's test did not show a strong correlation, it is repeatable and may exploit more factors and variables, such as changes in heart rate. Tables 3-8 are good examples of recording other factors since they are practical. They can be used to record heart rate and concentration and other factors such as respiration level.

This experiment includes a lot of variables and factors such as reaction time, music types, and heart rate. Since the participants weren't experimenting with strict conditions and supervision, other confounding variables, such as environment, time, and place, might affect the result. In the beginning, the research was going to investigate the relationship between music and people of different ages. Also, the participants were mostly friends, so there might be bias. However, the research included many variables, requiring massive numbers of participants and tools to measure. The main problem in this experiment is that the instruction needed to be clearer and more precise. There was a lack of communication between participants and the researcher because there was no training on using the Optaus CPTA app. Participants did this experiment by themselves without researchers supervising. From the data, it is clear that some participants were unfamiliar with the concentration game because they didn't get enough training before they started the experiment, causing a big difference in the reaction time as shown in recorded Tables 3, 5, and 8 by each participant. For example, one of the participants started with a reaction time of 900 but ended up with 300. One reason could be that he didn't know how to play the game, so they started blindly, but in the end, they got familiar with the game, and their reaction time became faster. The experiment didn't have enough sample sizes since the experiment was designed only in a few weeks. In addition, the experiment was designed in many processes, so participants may feel fatigued, which could cause them to pay a lack of attention to the concentration game. Furthermore, everyone defines relaxing and exciting music differently, which means the music the experiment provided or the music they chose may include distinct things such as dynamics, tone, and speed. These are all limitations that could cause no relationship in this experiment.

Recommendations for further research: more variables and factors can be considered in this experiment, such as age, gender, sex, and culture, since music differs in all these variables—the duration of the experiment and the sample sizes. Because more time and participants in an investigation indicate more data and accuracy, another recommendation is that this experiment could be investigated by using a questionnaire such as a survey with a scale method to measure people's feelings and thoughts about how different types affect them. In addition, the experiment could correlate if the participants listened to the music while playing the concentration game. In this case, music might arouse and affect concentration more obviously.

5. CONCLUSION

The research question focuses on the reaction time affected by various music in addition to heart rate. This experiment was designed to help counselors and efficient human management. In the end, even though there was no obvious effect seen between these variables, it is clear that the experiment needs intensive improvements: increase the sample sizes, extend times for music listening, and perform the experiment while listening to the music since the previous study has shown mixed results on the performance while listening to music. The Optaus CTPA is designed for patients who have ADHD and other types of disorders. The game is not complex or associated with academic problems, so this can be the confounding variable that makes it easy for the patient to adapt. According to the music department at the University of Amsterdam, people become less critical when the task is easier, and there is a negative correlation between the frequency of BGM and age, indicating that younger generations tend to use more BGM than older adults [10].

REFERENCE

[1] Lesiuk, Teresa. “The effect of music listening on work performance.” Psychology of Music 33.2 (2005): 173-191.

[2] Nair, Preethy Sasidharan, et al. “Music-listening regulates human microRNA expression.” Epigenetics 16.5 (2021): 554-566.

[3] Harvard Medical School. (2021, September 11). Music and health.

[4] Van Dyck, Edith, et al. “Adopting a music-to-heart rate alignment strategy to measure the impact of music and its tempo on human heart rate.” Musicae Scientiae 21.4 (2017): 390-404.

[5] Shih, Yi-Nuo, Rong-Hwa Huang, and Hsin-Yu Chiang. “Background music: Effects on attention performance.” Work 42.4 (2012): 573-578.

[6] Yamasato, Ami, et al. “How prescribed music and preferred music influence sleep quality in university students.” Tokai J Exp Clin Med 45.4 (2020): 207-13.

[7] Lee, Taekyu, et al. “Music for sleep and wake-up: an empirical study.” IEEE Access 7 (2019): 145816-145828.

[8] Ralph Meyers, author of “OPATUS CPTa: New ways in precise diagnostics and therapy support for optimized treatment results in ADHD and other neuropsychiatric disorders.” October 13, 2022

[9] Richards, John E., and Betty Jo Casey. “Heart rate variability during attention phases in young infants.” Psychophysiology 28.1 (1991): 43-53.

[10] Goltz, Franziska, and Makiko Sadakata. “Do you listen to music while studying? A portrait of how people use music to optimize their cognitive performance.” Acta Psychologica 220 (2021): 103417.