

AI-Driven Personalized Music Intervention for Adolescent Mental Well-Being: A Study and Design Proposal

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Abstract. Mental health of adolescent has become an important issue worldwide. The stress and anxiety faced by adolescents are increasing, which emphasizes the need for tools that can help with emotional regulation. Music is regarded as an effective non-pharmacological intervention. It can help reduce stress and regulate emotions. The rapid development of artificial intelligence (AI) makes it possible to generate personalized music according to users' emotions. This paper reviews research on music psychology, emotion regulation, AI-based emotion recognition, and generative music technology. Based on the reviewed literature, this paper proposes a design for an application called FlowTunes, which uses AI to generate music. This system combines emotion recognition, personalized AI-generated music, and supportive features such as guided breathing exercises and Pomodoro sessions to help individuals better regulate their emotions and facilitate the state of flow. This paper shows how interdisciplinary approaches can contribute to the development of accessible digital mental health tool and provide directions for future research on personalized music interventions.

Keywords: Adolescent Mental Health, Artificial Intelligence, Music-based Intervention, Personalized Music Generation, Flow State

1. Introduction

Mental health has become one of the most significant public health issues among adolescents. According to reports published by the World Health Organization (WHO), mental health disorders account for a significant proportion of the disease burden among adolescents worldwide [1]. This highlights the importance of providing effective and accessible interventions. Many adolescents encounter obstacles in accessing professional psychological services, such as limited access, high costs, social stigma. Therefore, using complementary intervention method is particularly important.

Music has received considerable attention among various non-pharmacological interventions due to its accessibility. Based on the previous research results, music can help reduce stress and regulate emotions to some extent, thus improving mental health [2-5]. Music can be integrated into daily life at a low cost, so it is more suitable for adolescents than traditional clinical interventions. Csikszentmihalyi proposed the idea of "flow" in his work and believes that when individuals are fully immersed in an activity, they can achieve their optimal performance and well-being [6].

Appropriate musical stimuli can help create this state by reducing distractions and assisting in maintaining continuous attention.

At present, most music-streaming services recommend songs according to the users' listening history and song popularity. Such systems generally do not consider users' real-time emotional states. Some meditation applications have added music playlists for relaxation and concentration, but the music is pre-recorded and cannot be adjusted according to one's own emotions. The current applications lack personalisation and are thus less effective in promoting emotional regulation.

The development of artificial intelligence (AI) is creating opportunities for personalized music applications. AI-powered recommendation algorithms and emotion recognition models can create music in response to a person's emotional states. These developments indicate that combining music, psychology, and AI to help people regulate their emotions in daily life is possible and promising.

Research on music psychology, emotion regulation, AI-based music recommendations and AI music generation for adolescent mental health is reviewed in this paper. This paper also proposes the design of an application called FlowTunes to show how the interdisciplinary findings can be integrated into an AI-assisted music application that offers personalized emotional support.

2. Music and psychological well-being

Studies found that appropriate musical stimulation can reduce stress levels, improve emotional state, and promote cognitive performance [2-5]. Compared to medication or therapy, music is accessible and inexpensive, which makes it especially suitable as a tool for supporting adolescent mental health.

Evidence of the effects of music on emotion is mostly manifested in terms of changes in the autonomic nervous system and cognitive processing. Slow rhythms, soft timbres and steady beats are known to reduce heart rate and cortisol levels, leading to a sense of calmness [2, 4]. The listener's emotion is influenced by various musical elements such as tempo, mode, rhythm and instrumentation [5]. In particular, slower tempos and major keys tend to evoke a sense of relaxation and positive emotions.

Music can also be used to create the state of flow. Csikszentmihalyi's Flow Theory [6] suggests that when an individual can maintain sustained focus and fully immerse themselves in the current activity, they enter a highly immersive psychological state. Studies have found that the right background music decreases the level of distractions, which helps get to the state of flow. Using music helps individuals find a balance between relaxation and focus. This gives a theoretical basis for the personalized psychological support.

3. Artificial intelligence in personalized music systems

The traditional music recommendation systems are primarily based on recommending similar music based on the user's history. This merely reflects long-term preference of the users and does not identify the real time psychological state of the user.

The development of emotion recognition models has provided new possibilities for personalized music interventions. According to Russell's Circumplex Model, emotion can be characterized by the dimensions of Valence and Arousal, rather than just by categories, such as happiness and sadness [7]. This emotion representation method is able to accurately represent the user's current states. It is also more suitable as the input for music generation model.

The development of generative AI has promoted the progress of AI music creation. Models such as MusicLM and MusicGen can generate music with different genres and emotional characteristics

based on natural language prompts [8-10]. Generative models can control music parameters like tempo, mode, and instruments, but traditional recommendation systems cannot. Therefore, personalised music that meets the different psychological needs of people can be created. AI music generation technology provides a new direction for the development of digital mental health applications [11].

4. FlowTunes: system design

This paper presents the design of the FlowTunes application. Music psychology and AI are used to help adolescents' manage their emotions. First, the user enters an emotion expression, and it is received by the AI virtual character named Flowy. Flowy will next analyze how the user feels and choose suitable music according to tempo, mode, harmony, instrumentation, and dynamic range. These attributes are provided to the AI music generation model as structured conditioning parameters. Then, the model generates lyric-free instrumental music based on the parameters. Finally, the generated music is shown to the user.

FlowTunes has other functions that help achieve the state of flow. Flowy can communicate with users and help them express their emotions. The Box Breathing module synchronizes breathing rhythms with music, which guides users to relax. The Pomodoro mode adds background music to help people focus for a certain amount of time and rest periodically.

The prototype of this application uses Amazon Nova for multimodal emotional understanding. It also incorporates ACE-Step, an open-source AI foundation model for personalized music creation. The core system adopts a serverless architecture that is highly scalable and low-cost to run.

5. Discussion

The integration of music psychology and AI provides new possibilities for accessible and personalized mental health support. Compared to traditional music recommendation systems, AI-generated music has greater flexibility by adapting musical characteristics to users' real-time emotional states.

FlowTunes illustrates how research in psychology, music cognition, and generative AI can be brought together as an application application. The app has features of emotion recognition, personalized music generation, Box Breathing and the Pomodoro technique to foster emotional well-being in daily life.

There are several obstacles to be overcome. Due to different preferences in music and various cultural backgrounds among the users, a universal recommendation system cannot be established. Also, the accuracy of AI-based emotion recognition may affect the quality of generated music [12]. The extended impacts of AI-assisted music intervention have not been explored. Future research should examine the extent that personalized AI music can enhance emotional regulation and the state of flow by experimental validation and user evaluation.

6. Conclusion

This paper reviews research on music psychology, emotion regulation, AI, and personalized music systems for adolescent mental health. Existing studies suggest that music can effectively support emotional regulation and concentration, and developments in AI make it possible to generate music that adapts to users' psychological needs in real time.

FlowTunes shows how music psychology and AI can be integrated to an accessible digital tool for adolescent mental health support. Although further validation is required, the design provides insights for exploring how personalized music interventions can develop.

References

- [1] World Health Organization. (2021). Adolescent mental health. <https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health>
- [2] de Witte, M., Spruit, A., van Hooren, S., Moonen, X., & Stams, G. J. (2020). Effects of music interventions on stress-related outcomes: A systematic review and two meta-analyses. *Health Psychology Review*, 14(2), 294–324. <https://doi.org/10.1080/17437199.2019.1627897>
- [3] Labbé, E., Schmidt, N., Babin, J., & Pharr, M. (2007). Coping with stress: The effectiveness of different types of music. *Applied Psychophysiology and Biofeedback*, 32(3–4), 163–168. <https://doi.org/10.1007/s10484-007-9043-9>
- [4] Thoma, M. V., La Marca, R., Brönnimann, R., Finkel, L., Ehlert, U., & Nater, U. M. (2013). The effect of music on the human stress response. *PLoS ONE*, 8(8), e70156. <https://doi.org/10.1371/journal.pone.0070156>
- [5] Juslin, P. N., & Västfjäll, D. (2008). Emotional responses to music: The need to consider underlying mechanisms. *Behavioral and Brain Sciences*, 31(5), 559–621. <https://doi.org/10.1017/S0140525X08005293>
- [6] Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. Harper & Row.
- [7] Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, 39(6), 1161–1178. <https://doi.org/10.1037/h0077714>
- [8] Agostinelli, A., Denk, T. I., Borsos, Z., et al. (2023). MusicLM: Generating music from text. arXiv preprint arXiv:2301.11325. <https://doi.org/10.48550/arXiv.2301.11325>
- [9] Copet, J., Kreuk, F., Gat, I., et al. (2024). Simple and controllable music generation. *Advances in Neural Information Processing Systems (NeurIPS)*, 36. (MusicGen)
- [10] Huang, C. A., Vaswani, A., Uszkoreit, J., et al. (2019). Music Transformer: Generating music with long-term structure. *International Conference on Learning Representations (ICLR)*.
- [11] Schedl, M., Zamani, H., Chen, C. W., Deldjoo, Y., & Elahi, M. (2018). Current challenges and visions in music recommender systems research. *International Journal of Multimedia Information Retrieval*, 7(2), 95–116. <https://doi.org/10.1007/s13735-018-0154-2>
- [12] Dzedzickis, A., Kaklauskas, A., & Bucinskas, V. (2020). Human emotion recognition: Review of sensors and methods. *Sensors*, 20(3), 592. <https://doi.org/10.3390/s20030592>