

## Short Papers

# The Relation Between Technology Acceptance and Music Listening: An Experience Sampling Study

Der Zusammenhang zwischen Technologieakzeptanzfaktoren und dem Musikhörerlebnis: Eine Experience-Sampling-Studie

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## Abstract

In the intersection of technology and music listening, understanding user experiences is paramount. This research employed the Experience Sampling Method via the smartphone app MuPsych to continuously capture real-time data on individuals' music listening behaviors and related emotional responses. Over a span of two weeks, participants from Germany were prompted to report on various factors as they engaged in music listening, resulting in a rich dataset. Results indicate that Spotify Premium was the most frequently used music application, with personal playlists being the preferred listening format. To unravel the intricacies of these responses and their determinants, linear mixed-effects model analysis was utilized. Among the critical findings, the Perceived Usefulness and Perceived Ease of Use, two of the central constructs of the Technology Acceptance Model, emerged as significant predictors for the valence and enjoyment of the music experienced by users during the onset of music listening sessions. This highlights the imperative role of user-friendly interfaces in enhancing positive emotional states even before fully engaging with the music, underscoring the need for designers and developers of music-related apps to prioritise usability and useful functions.

*Keywords:* music listening, experience sampling method, Technology Acceptance Model, user experience, emotional valence, digital music platforms

## Zusammenfassung

Am Schnittpunkt von Technologie und Musikhören ist es von größter Bedeutung, Erfahrungen von Benutzer\*innen nachvollziehen zu können. In der vorliegenden Studie wird die Experience Sampling-Methode über die Smartphone-App MuPsych eingesetzt, um kontinuierlich Echtzeitdaten über das Musik-Hörverhalten und die damit verbundenen Reaktionen der Studienteilnehmenden zu erfassen. Über einen Zeitraum von zwei Wochen wurden Teilnehmer\*innen aus Deutschland aufgefordert, über ihre täglichen Musikhörerfahrungen zu berichten. Die Ergebnisse deuten darauf hin, dass Spotify Premium die am häufigsten genutzte Musikapplikation war, wobei persönliche Playlists das bevorzugte Hörformat darstellten. Um die Reaktionen während der Hörerfahrungen und ihre Determinanten zu analysieren, wurden Gemischte Lineare Modelle verwendet. Zu den zentralen Erkenntnissen gehörte, dass die wahrgenommene Nützlichkeit und Benutzerfreundlichkeit, beides zentrale Konstrukte des Technologieakzeptanzmodells, als signifikante Prädiktoren für die Valenz und die Freude an der Musik, die von den Benutzer\*innen beim Beginn von Musikhörsitzungen erlebt wurde, hervortreten. Dies unterstreicht die Rolle von benutzerfreundlichen Schnittstellen bei der Steigerung positiver emotionaler Reaktionen, noch bevor man sich vollständig mit der Musik beschäftigt, und betont die Notwendigkeit für Designer\*innen und Entwickler\*innen von Musik-Apps, die Benutzerfreundlichkeit und Nützlichkeit zu priorisieren.

*Schlüsselwörter:* Musikhören, Experience Sampling-Methode, Technologieakzeptanzmodell, Benutzererfahrung, emotionale Valenz, digitale Musikplattformen

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The digital age has revolutionized music consumption, with digital music platforms becoming ubiquitous. As users navigate these platforms, their experience—defined by usability, design, and features—becomes crucial. Moreover, a seamless user experience can potentially elevate the overall music-listening experience.

The Technology Acceptance Model (TAM; [Davis, 1985](#)) is a foundational framework that helps in understanding user interactions with technology, suggesting that factors such as Perceived Ease of Use, Perceived Usefulness ([Davis, 1989](#)), and Perceived Enjoyment ([van der Heijden, 2004](#)) can predict Technology Acceptance and user behavior ([Agarwal & Karahanna, 2000](#)). The model has been previously used to examine how software attributes ([Hampton-Sosa, 2017](#)) and musicians' communication regarding the technology ([Henning & Ruth, 2020](#)) impact the acceptance of music streaming services. This report specifically focuses on the core Technology Acceptance Model (TAM) factors and key personal variables such as age and gender, recognized for their significant impact on technology use. Age and gender are essential for identifying demographic patterns in technology interaction (e.g., [Tarhini et al., 2014](#)). Due to the concise nature of this paper, we did not explore additional variables like app familiarity, education of the users, social influences, or personal innovativeness, which could also affect technology acceptance and usage. The exclusion of these factors is a reflection of the short report's limited scope, aiming for a focused analysis rather than a comprehensive exploration.

Within the realm of digital music, how might these factors, Perceived Ease of Use, Perceived Usefulness, Perceived Enjoyment, age, and gender, predict the affective state of listeners during their music listening experience? The design of a user interface (UI) for technologies like music streaming services is probably tailored to provide users with an enjoyable experience without negatively influencing their emotional state. Thus, the higher an individual's appreciation for the app, as suggested by the TAM factors, the greater the likelihood they will derive pleasure from their music and experience a positive state during their listening experience.

Traditional methods of studying such interactions—such as retrospective surveys—have been unable to capture the nuances and real-time fluctuations of user experiences. This is where the Experience Sampling Method (ESM) stands out, offering insights by collecting data in real-time and providing a snapshot of users' in-the-moment interactions and emotions ([Randall & Rickard, 2017](#)).

Against this backdrop, our study seeks to bridge a gap in the literature. We investigate how the principles of the TAM, particularly its determinants, predict music listening behavior as captured via ESM and which music apps and formats are most frequently used by mobile music listeners, using the MuPsych app ([Randall & Rickard, 2013](#)) as our primary tool.

## Method

### Participants

A total of 122 participants from Germany were recruited for the study through a combination of methods: social media advertisements, academic student pools, and personal communications. The participants predominantly comprised university students and general public members. Apple iPhone users could not be recruited as the MuPsych app is only available on Android smartphones.

For their participation, university students were remunerated with course credits, serving both as an academic incentive and a token of appreciation. In contrast, members from the general public were awarded music streaming vouchers upon completion of the two-week engagement and subsequent submission of all requisite surveys. This strategy ensured sustained participation and timely feedback.

The age of the participants ranged from 18 to 51 years, with a mean age of 26.36 years ( $SD = 7.62$ ). In terms of gender distribution, 54 identified as male (48.65%), 54 as female (48.65%), 2 as diverse (1.8%), and 1 chose not to disclose their gender (0.9%). Not all participants answered all surveys or received all experience sampling reports (ESRs) in the same frequency. Therefore, we have reduced datasets of 77 participants regarding Enjoyment of the Music as a dependent variable, resulting in 983 music experience sampling reports (mESRs) and 88 participants for valence as the dependent variable, resulting in 2012 mESRs.

### Procedure

The study spanned from August 2020 to October 2021, during which individuals could opt to participate. Upon enrollment, participants were directed to install the MuPsych application on their devices. The functioning and intricacies of the German version of the MuPsych app have been delineated by [Randall and Ruth \(2023\)](#). Upon installation, participants selected the “MeineMusik” study, for which they were presented with a full information statement and data protection plan, before providing their informed consent within the app. Following the consent and set-up process, the MuPsych app was able to detect whenever participants started playing music through any other music player app on their device, be it Spotify, Deezer, any other music streaming service, or a local mp3 collection. At the moment participants initiated music playback via their preferred music app, the MuPsych app sent them a notification to complete an ESR. The ESR questions were designed to capture their emotional state in the exact moment and to assess their listening context. Upon completion, participants listened to their music for a five-minute period, after which they were presented with the second set of ESR questions. This set collected data on their changed emotional states, music variables, and reasons for listening. In addition to the real-time ESRs, all surveys—including the TAM—were presented within the app.

Participants had a two-week window to engage in their regular music listening routines and respond to the associated in-app surveys. At the end of these two weeks, participants were shown a gratitude message and rewarded with either course credits (for university students) or music streaming vouchers (for the general public), acknowledging their invaluable contribution to the research.

## Measures

A diverse set of measures was employed during this study. Both comprehensive surveys and brief, in-the-moment ESRs were utilized to capture a wide range of participant responses and behaviors.

For the purposes of this report, the primary focus has been narrowed down to selected measures. Specifically, we focused on three key factors derived from the TAM as applied in a study by Hampton-Sosa (2017), namely: Perceived Ease of Use (4 items, 5-point Likert scales,  $\alpha = .78$ ), Perceived Usefulness (8 items, 5-point Likert scales,  $\alpha = .81$ ), and Perceived Enjoyment (6 items, 5-point Likert scales,  $\alpha = .81$ ), in reference to their preferred music app. ESR variables used were: reported levels of Enjoyment of the Music (single item, 7-point Likert scale), and the listener's felt Valence and Arousal at the onset of their music listening experiences (single items, 7-point Likert scale).

Basic demographic information was collected from all participants, including age, gender, and other relevant personal details. These data served as control variables and provided contextual insights into the broader patterns observed in the study.

To gain a deeper understanding of participants' digital behavior, information regarding their use of the music apps was gathered.

It is worth noting that the study was expansive in its data collection, incorporating a variety of other surveys and ESR items. While these have not been central to the current report's analysis, they provide a rich dataset for potential future investigations and analyses.

## Results

Our analysis sheds light on the music platforms predominantly used by the participants during all music experience reports (see Table 1). A clear differentiation was observed between users who accessed paid subscriptions, those who relied on free versions, and a segment who did not disclose specifics about their subscription details. Users indicated this when they first used the tracked app.

**Table 1**

*Frequency of Used Apps and Subscription Plans During Music Experiences Captured Through Music Experience Sampling Reports (mESR)*

Music application	Frequency	Number of users
Spotify (Premium)	4113 (89%)	90
Spotify (Free)	299 (6.5%)	17
Spotify (undisclosed)	113 (2.4%)	7
Deezer	62 (1.3%)	2
Local files	25 (0.5%)	3
Google Play	1 (0.002%)	1
Pandora	1 (0.002%)	1
SoundCloud	1 (0.002%)	1

*Note.*  $N_{mESR} = 4615$ ,  $N_{participants} = 122$ , percentages refer to the frequency in relation to the total number of music experience samples. Participants initially selected their primary music player app, with the option to change this selection subsequently. The right column refers to the number of participants who selected the respective player and subscription. No changes in the primary player were found. This method may not reflect instances of multiple app usage by individuals.

Further investigation provided insights into the participants' most frequently selected audio formats within their apps (see Table 2). This exploration elucidates the diversity in music and audio consumption behavior and choices among the participant cohort.

**Table 2**

*The Ten Most Frequent Formats That Were Used During Music Experiences*

Used format	Frequency	Number of users
A personal playlist	441 (9.6%)	18
An album	137 (3%)	5
Songs by a certain group / person	121 (2.6%)	6
A playlist created by a company or provider	104 (2.3%)	6
An algorithmic playlist that is based on my listening history	98 (2.1%)	8
My collection of liked songs	62 (1.3%)	4
One particular song	53 (1.1%)	5
A playlist a person unknown to me created	42 (0.9%)	2
A podcast	25 (0.5%)	1
A playlist a friend created	17 (0.4%)	1

*Note.*  $N_{\text{mESR}} = 4615$ ,  $N_{\text{participants}} = 122$ , eleven more options had 16 or fewer cases or were free answers to the option 'other', percentages refer to the frequency in relation to the total number of music experience samples. The right column refers to the number of individuals who selected the respective format at least once.

To examine how technology acceptance and socio-demographics as stable factors are related to the overall Enjoyment of the Music at the onset of music listening, a linear mixed-effects model was utilized, setting the enjoyment of a music listening session as the dependent time-varying variable. All variables in this model were standardized using z-scoring. The random effects structure, a random intercept for participants, highlighted variability in the intercept among individual participants. Specifically, the variance of the random intercepts for individual participants was measured at  $\sigma^2 = 0.27$  ( $SD = 0.52$ ), denoting the presence of individual differences in baseline enjoyment levels, even after considering the fixed effects. The residual variance, signifying the variation in enjoyment not captured by the model, was found to be  $\sigma^2 = 0.73$  ( $SD = 0.85$ ). Notably, the analysis identified Perceived Usefulness as the sole predictor (see Figure 1) which is almost at a significant level. The variance explained by only fixed effects or the marginal  $R^2$  is .066 and the variance explained by both fixed and random effects or conditional  $R^2$  is .319. Detailed estimates for all predictors are provided in Table 3.

**Table 3**

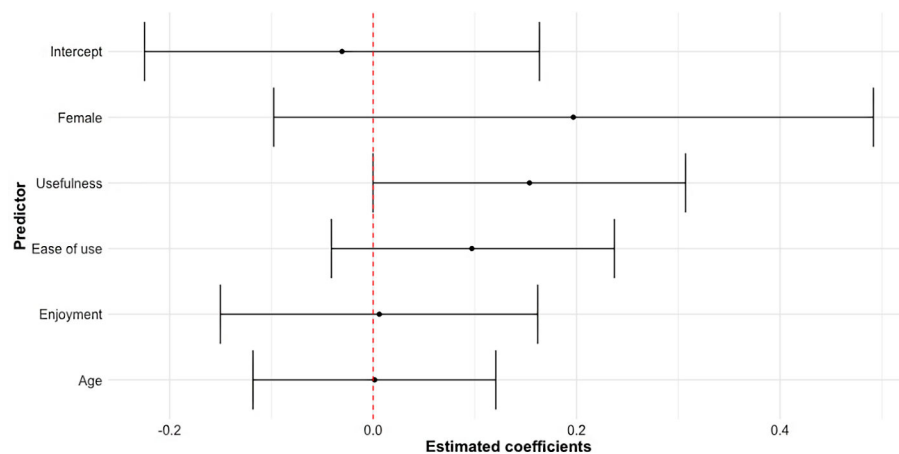
*Fixed Effects of Predicting Enjoyment of the Music at the Onset of Music Listening Sessions With a Mixed Effects Model, Marginal  $R^2 = .066$ , Conditional  $R^2 = .319$*

Predictor	Estimated coefficient	SE	Lower CI	Upper CI
(Intercept)	-0.16683	0.11042	-0.37584	0.04205
Gender: female	0.19677	0.15562	-0.09771	0.49173
Usefulness	0.1537	0.08115	-0.0001	0.3071
Ease of use	0.09702	0.07329	-0.04112	0.23717
Enjoyment	0.00607	0.08242	-0.15016	0.16172
Age	0.00148	0.06305	-0.11816	0.12057

*Note.*  $n_{\text{participants}} = 75$ ,  $n_{\text{mESRs}} = 929$ . Not all participants answered all mESRs.

**Figure 1**

*Estimated Coefficients (Standardized) of the Predictors for Enjoyment of the Music at the Onset of Music Listening Sessions*

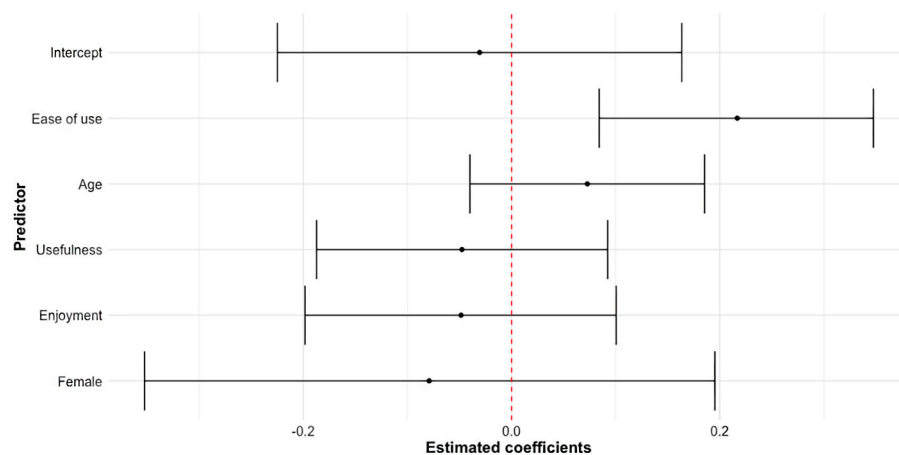


*Note.* Number of participants that completed the survey,  $n_{\text{participants}} = 75$ , Number of music experience samples of these individuals,  $n_{\text{mESR}} = 929$ , dots represent the coefficients, bars represent the 95% confidence intervals. To ensure comparable group sizes, two individuals who did not disclose their gender or identified as neither female nor male were excluded from the analysis.

To investigate how user experience predicted mood at the onset of music listening, another linear mixed-effects model was computed with valence at the beginning of a music listening session as the dependent time-varying variable. Again, all variables were standardized using  $z$ -scoring. The random effects structure pointed towards variability in the intercept across individual participants. Precisely, the variance of the random intercepts for individual participants was  $\sigma^2 = 0.29$  ( $SD = 0.54$ ). This indicates that there exists individual variation in baseline valence levels even after accounting for the fixed effects. The residual variance, representing the variability in valence unaccounted for by the model, was determined to be  $\sigma^2 = 0.72$  ( $SD = 0.85$ ). The analysis spotlighted Perceived Ease of Use as a significant predictor (see Figure 2). The marginal  $R^2$  is 0.047 and the conditional  $R^2$  is 0.325. The estimates of all predictors can be found in Table 4.

**Figure 2**

*Estimated Coefficients (Standardized) of the Predictors for Valence at the Onset of Music Listening Sessions*



*Note.*  $n_{\text{participants}} = 86$ ,  $n_{\text{mESR}} = 1921$ , dots represent the coefficients, bars represent the 95% confidence intervals. To ensure comparable group sizes, two individuals who did not disclose their gender or identified as neither female nor male were excluded from the analysis.

**Table 4**

*Fixed Effects of Predicting Valence at the Onset of Music Listening Sessions With a Mixed Effects Model, Marginal  $R^2 = 0.047$ , Conditional  $R^2 = 0.325$*

Predictor	Estimated coefficient	SE	Lower CI	Upper CI
(Intercept)	-0.03061	0.10183	-0.2248	0.16349
Ease of use	0.21681	0.06883	0.084212	0.347567
Age	0.07282	0.05908	-0.03991	0.185423
Usefulness	-0.04755	0.07327	-0.1872	0.09235
Enjoyment	-0.04848	0.07833	-0.19832	0.10053
Gender: female	-0.07907	0.14356	-0.35251	0.19532

*Note.*  $n_{\text{participants}} = 86$ ,  $n_{\text{mESRs}} = 1921$ . Not all participants answered all mESRs.

Another linear mixed-effects model analysis with the same predictors focused on arousal at the start of the music-listening experience. Contrary to our expectations and the findings from the prior model on valence, this analysis did not yield any significant predictors.

## Discussion

This study's findings reveal insights into individual differences in the emotional valence associated with the onset of music-listening experiences. The descriptive analysis offered a snapshot of the music platforms participants predominantly used, underscoring the widespread preference for Spotify, particularly its premium version. Such insights are valuable for understanding the digital ecosystem of music consumption.

The diverse audio formats most frequently used by participants underscore the varying modes of music consumption. Personal playlists predominate, pointing towards the personalized nature of modern music listening. However, users also showed tendencies to explore algorithmic suggestions, company-created playlists, and even content curated by strangers. This suggests that while personal choices dominate, there remains a curiosity and openness towards algorithmically curated and externally suggested content.

The analysis indicated the importance of Perceived Ease of Use as a significant predictor for felt emotional valence at the start of music listening sessions. This aligns with the Technology Acceptance Model (TAM; Davis, 1985), emphasizing that user experience, particularly the Perceived Ease of Use associated with technology, can play a pivotal role in influencing emotional states. Interestingly, while ease of use influenced valence, no predictors significantly affected arousal. This divergence indicates that while certain technological factors may influence the listener's felt valence, they might not necessarily impact arousal levels in the same manner.

A particularly compelling finding was the role of Perceived Usefulness in predicting the overall enjoyment of music at the onset of a listening session, even if only marginally significant. This raises the proposition that users who find a music streaming application or platform to be useful are more likely to be immersed and derive pleasure from the music. One possible rationale is that a sense of usefulness might be indicative of an effective UI design. A well-designed UI can streamline the user's journey, minimizing obstacles and ensuring that users can effortlessly access and engage with their desired content.

Moreover, the fact that Perceived Usefulness was more influential than other factors like Perceived Ease of Use and Perceived Enjoyment underscores its importance. This could be because usefulness transcends mere interface interac-

tion and taps into the holistic value and relevance the platform offers to the user. It might be that while ease of use pertains to the immediate interaction with the platform, perceived usefulness resonates with the user's broader music consumption goals, making it a more salient factor in determining the overall Enjoyment of the Music. In essence, when users perceive a platform as useful, it not only fulfills their immediate needs but also aligns with their long-term musical aspirations, leading to enhanced enjoyment.

## Limitations

While this study presents valuable insights into the relationship between technology acceptance factors and emotional states during music listening, a few limitations merit consideration. First, the participants were all from Germany and predominantly recruited through social media advertisements, student pools, and personal communication. While this method ensured a focused group of respondents, it might have introduced selection bias. However, this approach was intentional, aiming for a more homogeneous group for clear initial findings. Future studies could employ a broader sampling to ensure a more diverse and representative sample.

Second, data was primarily collected through participants' self-reports. While self-reports can sometimes introduce recall biases, they were employed to capture real-time responses, offering a more authentic snapshot of users' experiences. Third, the study specifically focused on three factors of the TAM and a few demographic variables. While this ensured a focused analysis, other potential predictors, e.g. context variables, personal factors, and emotional traits were not examined. Future studies may also benefit from incorporating physiological measures that can be assessed using smartphones and wearable smart devices. The narrowed scope was by design, allowing for a targeted investigation. Subsequent research using our data could broaden the set of predictors, delving deeper into other user experience aspects and their interplay with emotional responses.

Finally, the requirement for participants to select a single music app as their primary platform, despite potentially using a variety of apps in their daily listening routines, should be mentioned. Although the option to change their preferred app in the settings was available, it is probable that data concerning the usage of apps other than the initially chosen one were not fully captured. This could limit the breadth of insights into participants' true listening behaviors across different platforms.

## Conclusion

The intersection of technology and music consumption offers a compelling avenue for understanding how user experience with digital platforms influences emotional reactions to music. Our short report, leveraging the experience sampling method, has emphasized the significance of the usefulness and ease of use components of the Technology Acceptance Model in shaping the valence and enjoyment of the music at the outset of a music listening session.

The findings suggest that while the Perceived Usefulness of a platform critically affects the initial state when selecting music, it doesn't notably alter arousal levels. This delineation reinforces the complexity of factors that modulate our musical experiences in a digital context.

The data-driven insights into participants' music platform preferences and the diversity in their audio format choices further delineate the multifaceted nature of contemporary music consumption behaviors. These observations underscore the importance of intuitive design and user-centric features in digital music platforms for an enhanced music listening experience.



As technology continues to evolve and embeds itself deeper into our daily routines, understanding these intersections becomes crucial. It aids in the creation of more effective, user-friendly platforms, ensuring optimal user experience and emotional resonance. Future research endeavors in this domain will undoubtedly enrich our comprehension of the dynamic between digital technology and music consumption, offering pathways for more refined and impactful technological solutions.

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## Competing Interests

The authors have declared that no competing interests exist.

## Ethics Statement

The present study was conducted in accordance with ethical principles and standards according to the guidelines of the German Psychology Association. It was reviewed and approved by the Human-Computer-Media Ethics Committee at the University of Wuerzburg.

## Data Availability

Due to commitments with industrial partners, the data used in this study are not freely available to the public. In case of reasonable interest, a reduced dataset can be made available upon request. The industry partners were not involved in the planning and implementation of the study.

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