

# USER STUDIES IN THE MUSIC INFORMATION RETRIEVAL LITERATURE

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## ABSTRACT

This paper presents an overview of user studies in the Music Information Retrieval (MIR) literature. A focus on the user has repeatedly been identified as a key requirement for future MIR research; yet empirical user studies have been relatively sparse in the literature, the overwhelming research attention in MIR remaining systems-focused. We present research topics, methodologies, and design implications covered in the user studies conducted thus far.

## 1. INTRODUCTION

Despite recurring calls for a greater focus on user-centric research, work in the field of Music Information Retrieval (MIR) has been largely systems-focused. This paper reports on the limited but growing body of user studies in the field. A broad definition of ‘user study’ is employed in the article selection: qualifying documents report on empirical investigations of user requirements or interactions with systems primarily aimed at providing access to musical information, including musical recordings, scores, lyrics, photography and artwork, and other associated metadata.

The goals of this review are threefold: to survey the distinct topics that have been investigated by user studies in the field; to provide an overview of the research methodologies employed in these studies; and to report on implications for MIR systems design offered by the works covered.

## 2. SYSTEMS-CENTRIC FOCUS IN MIR

Research activity in MIR has been motivated to some extent by textual Information Retrieval (IR)—a field of research dating back to the 1950’s. Plans for an evaluation platform inspired by TREC (Text REtrieval Conference) [37] were

under discussion from ISMIR’s early days [13], and eventually led to the creation of MIREX, the Music Information Retrieval Evaluation eXchange [14]. Given this emulation of early developments in the field of textual IR, it is perhaps unsurprising that the primary emphasis of research in MIR has been placed on systems development. Formal consideration of user information needs and information behaviour has been sparse in comparison. This imbalance is problematic: a lack of grounding in user requirements makes the real-world applicability of developed MIR systems a matter of speculation [2]. The situation reflects the early state of research in the field of textual IR, where similar early emphasis on information systems gradually gave way to a more user-centric paradigm [10, 38].

Articles reflecting on the state of MIR have repeatedly called for a greater focus on the potential users of MIR systems [13]. In his wide-ranging summary of the early state of the field, Downie identifies the ‘multiexperiential challenge’ to MIR [11]: subjective musical experience varies not only between, but also within individuals, depending on affective and cultural context, associations between the music and events from episodic memory, and a host of other factors.

Users’ information needs vary accordingly; an ethnomusicologist’s analytical requirements are likely served by queries of a different nature to those used by a party host compiling a playlist. Core IR concepts such as ‘similarity’ and ‘relevance’ may also be variably defined: ‘similarity’ might, for instance, refer to song structure, or to mood conveyed; ‘relevance’ to a tune’s bibliographical fit to a keyword query, or to its applicability to a given use case (e.g., ‘driving,’ ‘housework,’ or ‘exercise’).

Design decisions have typically been based on “intuitive feelings for user information seeking behaviour,” [8] “anecdotal evidence and a priori assumptions of typical usage scenarios” [25] when facing such issues. User studies, conducted with the same empirical rigour and research excellence we have come to expect from systems-based research, can provide valuable insights for MIR researchers and developers, resulting in more useful systems for MIR users and greater ecological validity in research findings.

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### 3. REVIEW OF USER STUDIES IN THE MIR LITERATURE

#### 3.1 Selection Strategy

The criteria employed in article selection for this review employ a broad definition of the term ‘user study’, as described above. Articles primarily reporting the results of such user studies were targeted for inclusion. The ISMIR Cloud Browser [16] served as a starting point for article discovery; this textual information retrieval tool is capable of generating visualisations and ranked result lists based on a user query, using a TF-IDF-based metric [40] to match the query to a set of 719 articles representing the output of the first decade of ISMIR-related activity. Results from the following query strings were used: “human responses”; “information behaviour”; “information use”; “information need”; “participants”; “perceptual evaluation”; “respondents”; “usability”; “user study”; and “user testing”.

Additional articles were identified through a search on the ISI Web of Knowledge database using the query string “‘music information retrieval’ AND user”; by following citations in the resultant documents; and by searching for articles citing the original documents using Google Scholar.

#### 3.2 Research Topics

A number of different aspects of music information behaviour have been investigated. The topics have been formulated here by reference to explicit research questions, where provided, or by the implied aims of the research:

- User requirements and information needs [1, 30];
- The information needs of specific groups [9, 17–19] and in specific contexts [7];
- Insights into specific aspects of music perception and preference, such as the factors that cause listeners to dislike certain songs [5], the impact of social relations on music acquisition and taste [23], and the effects of demographic factors and musical background on the semantic descriptions of music [26, 27];
- Analyses of textual MIR queries—symbolic representation of the melody sought [34], and natural language expressions of music information needs [1, 25];
- Employment of user studies to generate ground-truth data for use in training and evaluation corpora [31–33].
- The organisation of digital music information [6, 17];
- Search strategies and relevance criteria used when actively seeking new music [22, 24];
- Information behaviour in passive or serendipitous encounters with new music [4];

#### 3.3 Methodologies

The research methodologies employed in the user studies are predominantly qualitative in nature. Approaches range from situated-researcher methodologies, such as ethnographic observation of information behaviour, face-to-face user interviews, and participatory design panels, to more remote methodologies such as diary studies, online surveys, and query log analyses.

The emphasis on qualitative methodology reflects the largely exploratory nature of existing research; only a few studies take quantitative or mixed approaches, by quantitative analysis of natural language user queries [25], by applying measures from usability engineering [34], by use of behavioural studies [21, 36], and by systematic analyses of demographic factors and musical background [26]. A further group of studies employs quantitative approaches towards the systems-centric goal of corpus generation, crowdsourcing annotations from large quantities of users competing in music-related online games [31–33].

The relatively small number of user studies is reflected in the equally small number of researchers involved. Consequently, many studies have used somewhat uniform participant pools, consisting predominantly of male subjects from similar backgrounds. Several studies do take precautions to ensure more representative sampling: for instance, Taheri-Panah and MacFarlane [30] recruit participants from 3 distinct age-bands, balancing gender; and Lesaffre et al. [26] make the effect of demographic context on the perception and description of music a research priority in a large scale, cross-sectional study.

The limited number of researchers has also resulted in a somewhat homogeneous use of research methodologies; the majority of the user studies in the field have been qualitative in nature, usually making use of Grounded Theory (GT) in the analysis phase [15]. GT is an approach in which observations are coded with no prior assumptions, allowing theory to emerge from the data. GT is relied upon exclusively in the data analysis phases of many of the articles covered [1, 4–8, 22, 24].

GT is an appropriate tool in exploratory research, where no conceptual models have been established to aid data analysis. As such, these studies represent valuable work; however, there is a clear opportunity for further research to build a conceptual framework informed by the existing results, by conducting further qualitative research to pin down the required concepts, or by pursuing quantitative work to identify whether existing results can be generalized.

A notable exception is presented by Inskip, Butterworth, & MacFarlane’s study into the information needs of users of a folk music library (2008) [17]; here, qualitative, face-to-face interviews are analysed in line with Nicholas’ framework for evaluating information need (2000) [29]. The researchers are thus able to base their results on an established

analytical tool, while at the same time validating the applicability of the tool in a new context.

### 3.4 Recommendations for MIR System Design

While the studies presented in this review are concerned with user requirements and information behaviour, a primary goal of such research is to inform the development of information systems to better meet such requirements and support such behaviours. Over the last decade, researchers have built an arsenal of algorithms and components to tackle various aspects of MIR; however, the field has yet to produce an integrated, full-featured system, tying together these various capabilities. Accomplishing this has been described as the “Grand Challenge” of ISMIR’s second decade [13] (p. 18). By conducting user-centric research and applying findings to the design of such a system and its components, we can “improve the quality of the community’s research output” and help create “truly useful music-IR systems” (p. 17).

The recommendations and implications for MIR systems concluded by the studies covered in the review originate from a number of different contexts, e.g., digital libraries versus personal collections. Thus, not all of the recommendations are necessarily applicable to the same system; rather, provided here is an overview of the recommendations available, in order to guide future development efforts.

#### 3.4.1 Undirected Browsing

Users spend much of their time seeking new music updating and expanding their musical knowledge, without a specific goal in mind; they are often more motivated by the pleasure of this activity in itself, than by an actual information need [24]. Emphasis should be placed on such serendipitous ‘discovery’ processes in the context of MIR systems development by supporting various different browsing approaches.

One such approach is the provision of “entry points” to the catalogue, to aid users navigating through collections of potentially unfamiliar music [17]; this allows users to situate themselves, encouraging subsequent browsing and discovery. Audio previewing can be a useful tool in the browsing process, allowing users to quickly sample a piece of music to determine whether further attention is warranted; here, MIR systems could usefully identify representative portions of the music to sample, for instance by offering a skip-to-chorus feature [7].

Other approaches might make use of visual elements; one study proposes a shifting collage of CD covers accompanied by snippets of songs from each album as it is given prominence in the collage [8]. Musical content could also be visualized symbolically, by generating map displays that translate sound or rhythm similarity into visual proximity to

better support genre browsing [8], or by generating graphics that translate audio similarity into visual similarity more explicitly [21].

#### 3.4.2 Goal-Directed Search

As when browsing, individuals employ different approaches to the goal-directed search for new music. Inskip et al. (2008) give examples of different strategies employed by users of a folk music library, noting that strategies significantly vary with research experience of the individual; thus, variable search techniques should be supported [17]. Searching by similarity (to a particular song or artist) is a popular feature among MIR system users [36]; Isikhan et al. (2010) [20] evaluate a melody similarity metric in a perceptual study, aiming to improve result rankings of MIR systems. Another user study evaluates the suitability of supporting textual queries for melodic content by symbolic encoding of the sought melodic contour; results indicate that such queries are too difficult to be used successfully by ordinary users, and require considerable musical training to construct [34]. A different approach to textual queries retrieves musical recommendations based on semantic qualities of music through affective, structural, and kinaesthetic descriptors [27].

Certain search strategies may be of value for use in specific contexts; for instance, a search function matching video features to music features would have potential applications in film making, advertising, and other domains requiring synchronisation [18]. Casey et al. (2008) provide a far-ranging overview of other available content-based search approaches, outlining different use cases and query types [3].

#### 3.4.3 Recommendations on Metadata

Descriptive elements, stored as metadata, are used to search, filter, and organize music collections. If the metadata in a user’s collection is to remain cohesive and up-to-date as new items are added, simplicity of use is paramount; adding valid metadata to a track should be a task requiring no more than a few clicks [6]. Beyond bibliographic information such as artist, album, and song name, user studies frequently identify the potential value of including lyrics in metadata [1, 6, 7, 18]. Relational information between catalogue items, such as inter-artist links, should be provided to aid the user in his or her selection [22]. While metadata should be accurate, ‘fuzzy’ querying should be supported; e.g., date queries should be treated flexibly, allowing retrieval by decade or more blurry categories such as ‘recent’ and ‘old’, instead of requiring a year to be specified [1].

Beyond describing musical content, metadata may describe context; “use tagging” can prove valuable to users by encoding information on different scenarios in which a given piece of music might be relevant [6, 17]. Allowing

users to provide arbitrary metadata would allow for flexibility in this regard, and cater to a number of use cases; for instance, attendees might seek to justify the inclusion of a song in a party playlist at a social gathering, to the party's host [7]. Related to "use tagging" is the provision of user profiles, or "music personalities"; these allow a recommender system to cater to different user contexts and moods [22]. Demographics and musical background, and familiarity with a particular piece, have been shown to impact on users' semantic descriptions of music [26], further suggesting the usefulness of distinguishing between different categories of users. Chai and Vercoe (2000) propose an XML-like mark-up language which would encode such contextual tagging for efficient sharing and re-use between different MIR systems [35].

#### 3.4.4 Social Aspects

Changes in musical taste are invariably influenced by social factors [23]; in one study, 96% of participants discussed music with their friends [30]. To incorporate social aspects, researchers have suggested support for collaborative playlist creation [7] among users in social settings; further studies discuss collaborative browsing and search [8], annotation [17], and collaborative filtering, taking into account both preferences and dislikes [5].

Beyond collaborative access of an external catalogue, users enjoy browsing through other users' music libraries. This allows them to target users with compatible tastes, and thus discover new music [30]. Cunningham et al. (2004) [6] discuss such sharing of personal collections, emphasising the requirement that a collection's public appearance must be customisable, e.g., to hide 'guilty pleasures' that might negatively affect the image the user wishes to convey of his or her musical tastes.

Social networking techniques could create trusted recommendations among users, mirroring the way that trust is built up in musical tastes among peers [24]. An online forum could fulfill a similar role, encouraging networking between users [17].

#### 3.4.5 Organization of Music Information

A study examining personal music collections reveals organization principles based on intended use: people organize music on the basis of the situation in which they intend to listen to a particular set of music (e.g. "work music", "driving music") [6]. The same study calls for functionality enabling links between songs or song collections and online resources; furthermore, an archival function is suggested, which both removes neglected tracks from the standard library, and provides a mechanism to rediscover old music. Another study [7] recommends that media interfaces support and seamlessly integrate different file formats and media (e.g., music downloaded to the hard drive, USB sticks,

CDs, etc) into a single collection without loss of metadata.

#### 3.4.6 User Interface Appearance

Music playback systems should feature simple, clean interface designs featuring large, clearly labeled controls. Interfaces should be attractive and playful, avoiding the clinical and "somewhat dark" appearance of most currently available media players [7]. Existing visual representations of musical content, such as "landscape" representations providing a geographic view of a musical collection, have certain disadvantages [21]; one solution is a procedural algorithm to generate icons to be applied to the music files of the content they represent; this allows visual data mining of music collections from within the file listings of a standard computer operating system.

Special considerations must be taken into account when developing interfaces aimed at young users. A comprehensive review of relevant guidelines has been established, making use of a participatory design panel in order to create a novel music organizer for children [9].

#### 3.4.7 User Support

Graduated access ("training wheels") can help inexperienced users to overcome the learning curve of an unfamiliar system. Online support should be available; in a digital library context, users should be able to contact librarians for help [17]. Certain metadata such as genre or record label are useless to people lacking the required knowledge to interpret them; thus, supporting descriptions should be provided [22]. User studies are useful in shedding light on the "information problem" of the users of MIR systems, but ultimately, a cognitive framework will be required to better understand the music seeking behaviour of MIR users [30].

#### 3.4.8 Hardware/Portable MIR Device

Cunningham et al. (2007) outline plans for a portable MIR platform. This device would be equipped with a microphone that constantly records surrounding sounds, identifying musical extracts and saving them for later analysis by audio-fingerprinting against a database. Such a device would be useful in tracking down information on music encountered serendipitously during everyday activities [4]. This direction of research seems especially relevant given the capabilities and increasingly widespread adoption of smartphone platforms [28].

## 4. CONCLUSIONS

User studies have been identified as key components of music information research. A number of studies have been conducted in this direction; however, the dominant paradigm in the field is firmly systems-oriented.

While the existing work has provided valuable findings and recommendations for future MIR development, expanded research attention will be required to provide a comprehensive, generalizable picture of music information use. Future research might include the more widespread adoption of quantitative methods; this would provide a route towards testing the generalisability of developer's assumptions and of the initial findings thus far. Crowd-sourcing methodologies, previously applied to corpus-generation [31–33], provide an intriguing direction for future quantitative work. Furthermore, a greater emphasis on demographic diversity and cross-sectional research will broaden the applicability of future research findings towards the listening public at large.

If the “Grand Challenge” of the field is to provide a fully-integrated system providing all manners of MIR access [13], a firm focus on user requirements is important; otherwise, convincing listeners to actually use such a system in the real world may prove to be a Grand Challenge Still.

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