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Quality of Experience Tests of an Object-based Radio Reproduction App on a Mobile Device

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Object-based audio provides many new features for the end-user. The quality of end user experience covers several different dimensions. Here, the relevant dimensions are identified and specific questions to cover these dimensions are developed. The first test of the radio app took place at JOSEPHS, a venue designed for testing new products and services located in Nuremberg, Germany. The second test took place in b<>com's facilities in Rennes, France. Interestingly, although the methodologies were different, relatively similar conclusions can be drawn from these two quality of end-user experience tests.

For the first test, two different user or application scenarios are provided: 'on-the go' and 'at home'. As result, the general acceptance of the new features and functions that come along with object-based audio is very high. The usability is rated high, but can still be improved. A very positive surprise is that the very good sound quality with surround sound or binaural reproduction impressed the listeners most, beside all other features. In the second test at the b<>com lab, the most appreciated feature was to set fore-/background balance. This feature was number two in the first test. The importance of speech intelligibility for Radio (and TV) is a long known and discussed issue. Now, with object-based audio and the Next Generation Audio (NGA) codec MPEG-H, solutions are at hand to address it.

1 INTRODUCTION

“Object-based media is the ultimate approach for creating and deploying interactive, personalized, scalable and immersive content. It allows media objects to be assembled in novel ways to create new and enhanced user experiences, being responsive to user needs as well as environmental and platform-specific factors. Examples are the adaptation of the dialogue level, the flexible playback on any end device or the variable length of a program. This technology is also an essential component for Radio/TV/Online cross-media demands. Moreover, it enables the transition from linear to non-linear and both on-air and on-demand listening, using broadcast and IP technologies.”¹ ORPHEUS is a recently completed European Commission HORIZON 2020 research project that pioneered the development of an end-to-end object-based media chain for audio content, for more details see [1, 2]. Two Quality of Experience (QoE) tests evaluate the object-based radio reproduction app on a mobile device, developed during the project.

The first two sections cover related work and motivation. The fourth section introduces a working model for quality of experience assessment in an object-based media eco-system. Section five and six explain the two evaluations done with the ORPHEUS app. And a comparison between the two evaluations finishes up the paper.

2 RELATED WORK

Object-based audio (OBA) allows for:

- a) Multi-dimensional and multi-lingual features;
- b) Novel interactive user experiences and personalized audio content, and;
- c) The delivery of acoustic environments in a format agnostic manner, e.g. the same audio content can be delivered to mono, stereo, binaural, 5.1 surround sound, as well as advanced multi-channel and immersive audio systems.

A general introduction to this concept is given in [3]. A Next Generation Audio codec (NGA) is necessary to transport all the required metadata. In the decoder of such an NGA codec the necessary features have to be implemented to provide all these properties. How this is

¹ <https://orpheus-audio.eu/>

done with the new MPEG-H standard is described in [4]. MPEG-H has been implemented throughout the ORPHEUS project and in the here investigated iOS app. The “Opportunities for Improved Listening Experience in Increased Listener Involvement” with MPEG-H are explained here [5]. A further article about “Curation, responsiveness and user experience” [6] explains further features of OBA and discusses on the possible relation between some of the features of OBA and the expected user experience.

One traditionally extensively evaluated issue of audio codecs is the so-called Basic Audio Quality, often perceptually measured in comparison to the non-coded audio, e.g. by the MUSHRA method [7, 8]. Beyond this a comparison of hedonic scales for perceptual evaluation (with and without reference) is presented in [9]. The Basic Audio Quality is extended and compared to the Overall Listening Experience or more general to the Quality of Experience in [10]. A further step forward in introducing the testee more actively in the test design is described and tested in “Adjustment/Satisfaction Test for the Evaluation of Personalization in Broadcast Services and Its Application to Dialog Enhancement” [11].

The here chosen method for the first evaluation uses an even more dialog orientated and interactive end-user evaluation for different dimensions of experience.

3 MOTIVATION

A continuously and stringent object-based broadcasting approach offers advanced possibilities to create and implement novel ways of encompassing experience and usability features. With audio becoming ‘interactive’ – within pre-defined producer authorized limitations – new challenges are opening up to make object-based media features accessible, understandable and operable. This applies throughout all stages of the media chain, during production, distribution and reception.

In addition, it’s not just the audio itself that matters, but also the additional services and features (e.g. transcripts, additional text-based information or still pictures) becoming integrative components in the assessment of the media experience.

This challenges the development of appropriate user interfaces, in order to make human interaction to control and adjust complex technical metadata and parameters delivered alongside the audio on the different devices appropriate and convenient. Only if this can be achieved, the user will consider object-based media technology able to provide an exciting and satisfying experience. As a consequence, domains for examining and evaluating ‘quality of end user experience’ that were previously evaluated separately will now have to be considered convergent and inclusive.

4 DEFINITION OF A WORKING MODEL FOR A QUALITY OF EXPERIENCE ASSESSMENT IN AN OBJECT-BASED MEDIA ECO-SYSTEM

In the course of the ORPHEUS project user requests for object-based audio broadcasting were collected. For

this purpose, several in-house workshops with creative and technical staff were conducted, to find out what kind of features and requirements are to be considered as necessary or desirable for next generation audio (NGA) production and distribution. The implications of these basic requests were first enriched in brainstorming sessions, finding applications and more detailed descriptions for practical scenarios. In a second step, their relation and relevance to existing typical broadcast genres and formats was discussed. At this stage, also the implications for production and distribution workflows under the predictable change of broadcast infrastructure were considered, for details see [12]. These user requests are visualized in Figure 1. Through this approach, the colloquially uttered basic requests could more clearly be related and assigned to the **key-features of object-based broadcasting**:

- Interactivity
- Immersion
- Personalization
- Accessibility

A basic approach for practical examination and evaluation of user experience within an object-based media eco-system as a holistic model, based upon the user requests and use cases. This model defines three main **experience dimensions**:

- Audio experience, referring to the key features ‘immersion’ and ‘intelligibility’ (personalization)
- Usability experience, referring to the key features of human ‘interaction’ with the devices and user interfaces
- Information experience, referring to ‘contextual metadata of content’ (accessibility)

In order to test the real-world applicability of our approach, we had to find a suitable test setting, offering low barrier access to general users in the public.

5 JOSEPHS EVALUATION

5.1 The Test Concept and Setting at JOSEPHS

JOSEPHS² is a public ‘open innovation lab’ in the city center of Nuremberg (Germany). It’s based upon the concepts of ‘design-thinking’ and ‘co-creation’, in order to develop user-centric products and services. At JOSEPHS new ideas are created from casual conversations, without time limits, between visitor and JOSEPHS-GUIDE, stimulated by your research exhibit.

In a preparatory conceptualization workshop with the experts at JOSEPHS we have shaped the setting for our installation to be based upon ‘user stories’. We decided to focus on two usage scenarios and aimed to get basic responses on our three defined experience dimensions – audio, information and usability experience, see Figure 1.

² www.josephs-service-manufaktur.de/en/

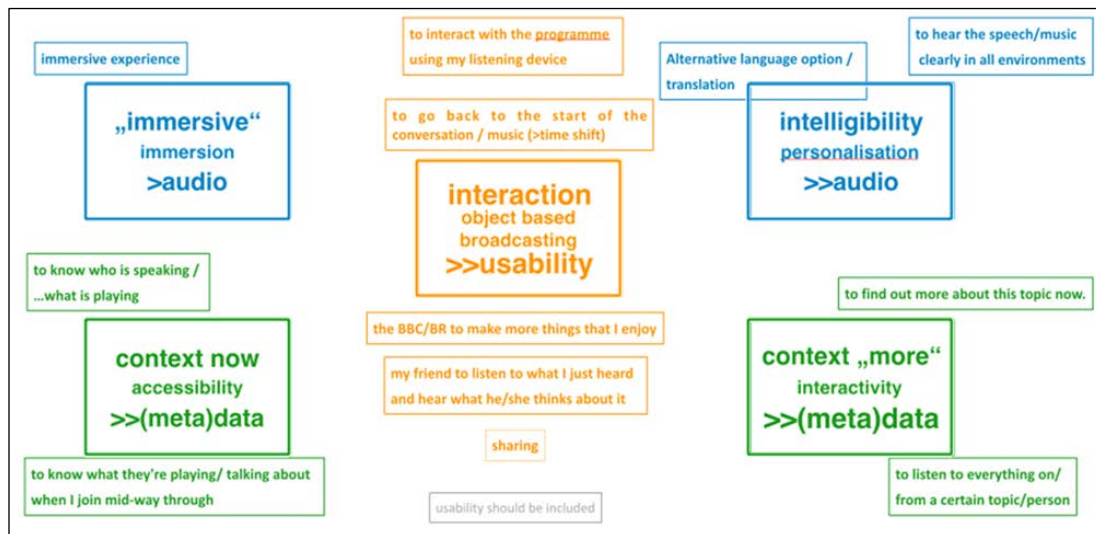


Figure 1: Identifies user requests for object-based audio, [12]. The audio experience dimension is presented in blue, the information experience in orange, and the usability experience in green.



Figure 2: ORPHEUS test installation at open innovation lab JOSEPHS; left side: loudspeaker reproduction 'at home'; right side: headphone reproduction in a noise environment (produced by loudspeakers in sonic chair) 'on-the go'.

- **On-the go:** ORPHEUS iOS app with headphones connected, offering as optimum binaural reproduction (compared to standard stereo and mono) and the fore-/background balance feature. Simulation of being on an airplane by playing typical cabin flight noise from outside via a Sonic Chair, right side of Figure 2.
- **At Home:** iOS App with a connected AV-Receiver and a 5.1 loudspeaker setup, offering as optimum 5.1 surround sound (compared to standard stereo and monaural), left side of Figure 2.

As playback device for both situations, the iOS app was installed in a 'presentation mode' on 12-inch iPad Pro devices, with a German language user interface and additional instructions displayed alongside the app interface.

For technical reasons, it was not possible to install a complete 3D loudspeaker system (including elevated loudspeakers) for reproduction of immersive sound in the living room setup, but only a 5.1 configuration as shown in Figure 2. Studio loudspeakers were used in this

scenario. The tube radio seen in the picture was for decoration only. These test items were installed in the app. The producing partner is given in square brackets:

1. Heute im Stadion: a typical (live) radio report from a football match, [BR]
2. Die Kunst des Geräuschemachens (The art of Foley): radio documentary, [BR]
3. Passo Avanti – Mozart Gigue: short jazz adaption of a classical music piece, [BR]
4. Erlebe objekt-basiertes Audio (Experience object-based audio): informative feature, [BR]
5. Herbst (Autumn): Poem with 3D soundscape, [Fraunhofer IIS]
6. The Turning Forest: cinematic radio drama, [BBC]

The items offered the following OBA features:

- Audio experience³
 - Audio reproduction: mono/stereo/binaural/5.1 surround (1,2,3,4,5,6)
 - Fore-/background level adjustment (1,2,4,5,6)
 - Clarity/dynamic range control (1,2,3,4,5,6)
 - Multi-language (2: DE/EN/FR, 4: DE/EN, 5: DE/EN, 6: DE/EN)
 - Audio interaction (3: positioning of the instruments, 5: interactive 3D audio object)
- Information experience
 - Text transcript (1,2,4,5)
 - Additional program info (1,2,3,4,5,6)
- Usability experience
 - Dial to navigate within the currently playing content (1,2,3,4,5,6)
 - Points of interest /chapter markers (1,2,3,4,5,6)
 - Additional pictures (6)

Entering the ORPHEUS area at JOSEPHS, visitors received a short introduction to our specific subject (“audio experience of the future”) and, if they were interested in participating, they were asked some basic questions about their listening habits and preferences. After that, the participants were offered to go into one of the usage scenarios – “on-the-go” or “at home” – and explore the app and the features of object-based audio in greater detail.

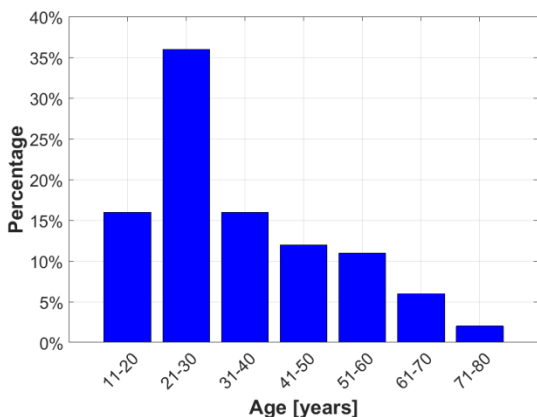


Figure 3: Age distribution of the 361 participants

5.2 The Findings from JOSEPHS

In the three months that the experiment ran (Dec. 1 2017 - Feb 28th 2018) a total of 361 participants visited the ORPHEUS ‘island’.

The participants were assigned to one of two groups: one below 40 years old and one above. A control group was defined by the ones doing both scenarios, without age differentiation, see Table 1.

The age distribution can be seen in Figure 3. The average age of the participants is 35 years. 40% of them were female and 60% male.

Most of them listen radio “on the go” (70% of n=243) and “as background listener” (72% of n=271).

Table 1: Number of participants per scenario and age classification

	Participant	Age < 40a	Percentage
Airplane scenario	82	67	82%
Living room scenario	115	61	53%
Both scenarios	158	-	-

First, the participants were asked select memory cards with the logos of radio programs and streaming apps. This introductory task served to find out more about the subjects’ familiarity with present day smartphone applications of broadcasters and other audio services providers, in order to categorize them more clearly to different target groups of users in the subsequent evaluation process. The answers are visualized in Figure 5. 38% use apps from public service broadcasters, 54% use streaming services, 43% of them use Spotify.

5.3 Audio Experience in the Airplane Scenario ‘On-the Go’

In noisy environments, such as inside an airplane, spoken word is sometimes difficult to understand and quiet parts in music become less audible. The Sonic Chair (Figure 2 right side) was used to emit a switchable airplane noise to simulate a realistic listening scenario. The audio reproduction was done over open headphones (Beyerdynamic DT990) to get full impact of the reproduced airplane noise.

5.3.1 Binaural Reproduction

Participants were asked which reproduction format they liked best. A vast majority preferred binaural reproduction (83%) compared to stereo (13%) and mono (4%). The age dependency of the answers is shown Figure 4.

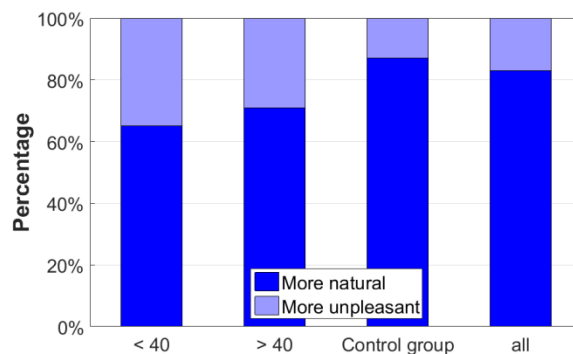


Figure 4: Is the binaural reproduction more natural than mono or stereo? In airplane scenario

³ the numbers in brackets refer to the numeration of the items above.

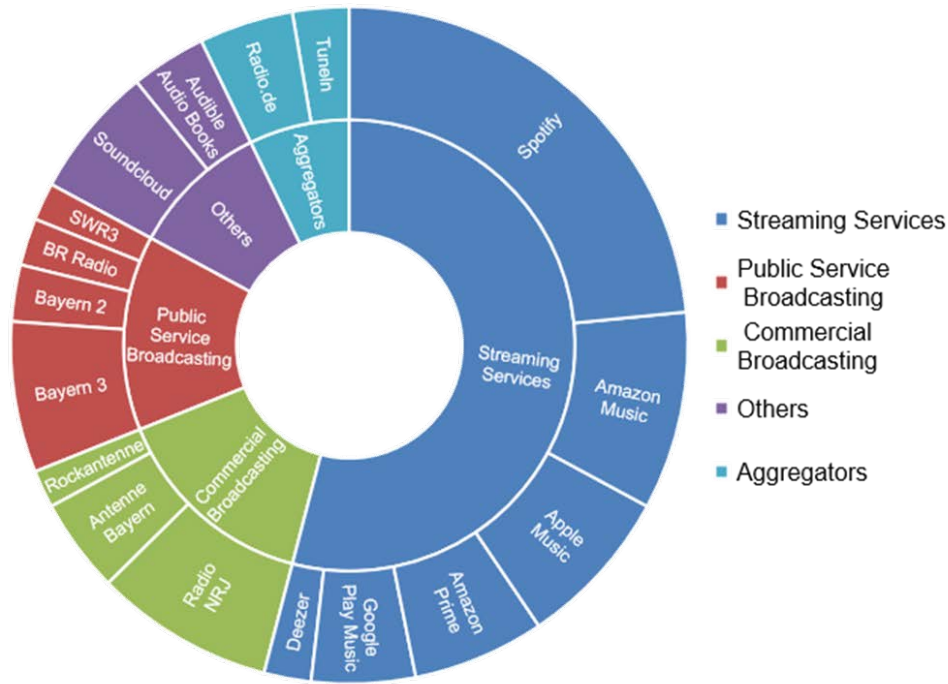


Figure 5: “Which radio or streaming apps are you using?”, n=242 (multiple answers are allowed)

All questions and answers were induced in conversations between the participants and the JOSEPHS guide. Some of the retrieved comments are presented below (more can be found in [13]).

Some of the positive comments:

- “I’m blown away by the binaural sound, really knocked out.” (f, 23)
- “The sound is especially impressive for football broadcasts.” (m, 48)
- “Once you’ve heard binaural, you don’t want to hear anything else.” (m, 37)

Some of the negative comments:

- “Instead of binaural, I would prefer to hear louder ambient sounds.” (f, 26)
- “The binaural sound gives me a headache.” (m, 54)
- “The sound is unpleasant. I feel like I’m in a helmet.” (m, 38)

Summary and interpretation: The binaural reproduction was vastly preferred. This result is more positive than from many other formal binaural listening tests, e.g. [14]. Still, a small percentage of users have different sound reproduction expectations. This is not a problem, because these listeners can just select stereo or mono reproduction instead of binaural reproduction. This is the advantage of object-based production, it is not a fix mix.

5.3.2 Fore-/Background Balance

With a slider in the app the level balance between the fore- and the background (f/b) part of the content could be adjusted. The results are presented in Figure 6.

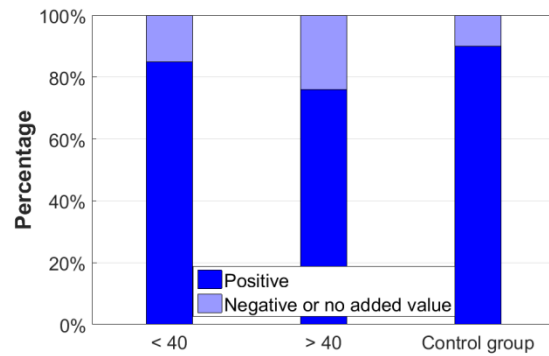


Figure 6: How is the fore-/background balance feature? In airplane scenario

Some of the positive comments:

- “The individual sound experience is most important to me.” (f, 20)
- “Finally you can hear the football supporter songs without commentary.” (m, 48)
- “Background noise no longer impairs listening pleasure.” (m, 38)

Some of the negative comments:

- “In everyday life I would not use the settings.” (f, 23)
- “The settings are not yet perfectly worked out.” (m, 53)
- “I can hardly notice any differences to other sound experiences.” (m, 66)

To make this fore-/background balance even easier to adjust a simple switch was offered in the user interface. It was labelled “Clarity, make quiet parts louder”. Results are shown in Figure 7.

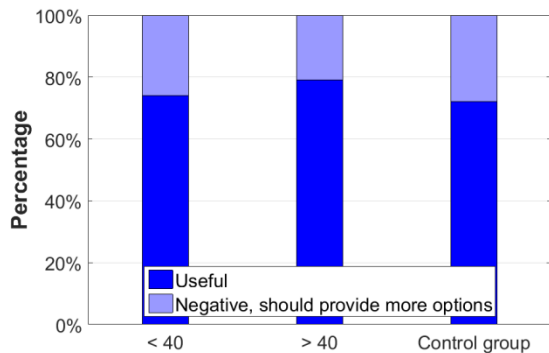


Figure 7: How useful is the clarity button? In airplane scenario

Some of the positive comments:

“With this setting I can understand what I usually would barely hear.” (m, 28)

“This setting helps you to understand the speaker better. I think that’s great.” (m, 48)

“I think this setting is very good because you can get more of the atmosphere.” (m, 54)

Some of the negative comments:

“I’d rather have just one setting that is perfect for the purpose.” (m, 23)

“I don’t want to hear every slight noise.” (m, 45)

“I want to hear everything as it should be. I don’t need this setting.” (m, 28)

Summary and interpretation: The new foreground/background feature was really appreciated. The adjustable slider was preferred to a simple switch. As an additional feature, the original intended balance setting defined by the sound engineer, tonmeister or producer should be used as default and/or marked on the scale.

5.4 Living Room Scenario

5.4.1 Audio Experience in the Living Room Scenario ‘at home’

For this scenario the first question was: How do you like the 5.1 surround reproduction and why. Results are presented in Figure 8.

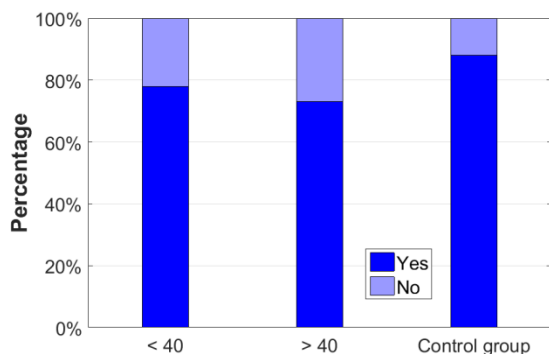


Figure 8: Do you like surround sound? In living room scenario

Some of the positive comments:

“Very cool. You can really feel it.” (f, 22)

“I could imagine that in a car.” (f, 54)

“I find the feeling of the music around myself very pleasing.” (f, 61)

Some of the negative comments:

“I miss the bass.” (m, 23)

“The good old stereo sound is sufficient for me.” (m, 45)

“I don’t like the sound because I prefer listening to music through headphones.” (m, 24)

Summary and interpretation: A large majority of listeners preferred 5.1 surround sound. From the comments given it seems that many people had never really experienced surround sound reproduction in this context, even though it has been on the market for more than 20 years. Other tests have shown even the advantage of 3D reproduction over 2D reproduction [15], which is possible with the MPEG-H codec.

5.4.2 Information Experience

The “live text” transcript presents the spoken language as readable text. Backward and forward navigation can be facilitated by scrolling up and down the text feed, (or with transport wheel), as shown in Figure 9.

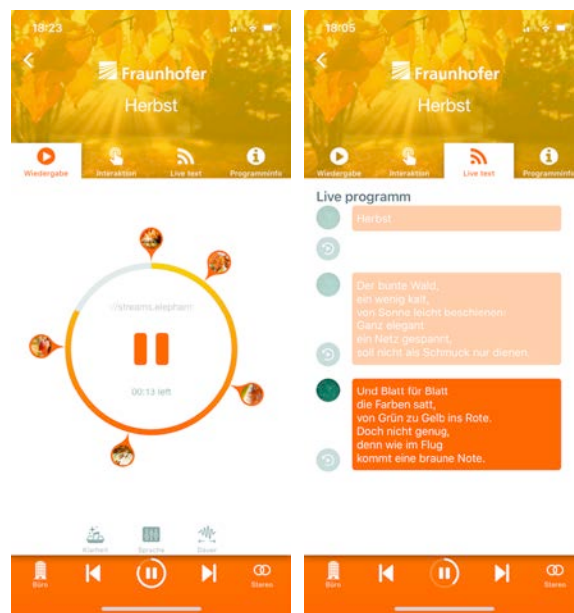


Figure 9: Two pages of the user interface of the ORPHEUS app. Left side: transport wheel with chapter markers. Right side: transcript of the spoken word.

Some of the positive comments

“Useful when I can’t turn on my smartphone’s sound.” (m, 11)

“I can’t hear so well anymore. The transcript would make listening to the radio easier for me.” (m, 60)

“When my boyfriend interrupts, I can just read it all.” (f, 31)

Some of the negative comments:

“I listen to podcasts on the go and don’t want to read along.” (f, 20)

“If I want to read, I’m reading a book, not a transcript.” (f, 58)

“When I read, I read. When I listen, I listen.” (m, 24)

The participants were asked how useful text transcript is and why. Results are shown in Figure 10.

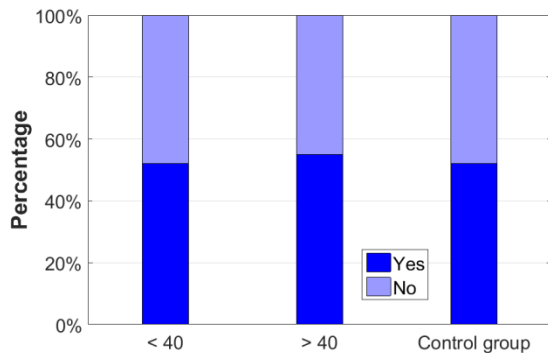


Figure 10: How useful is the transcript? For information experience

Summary and interpretation: About half of the participants found the text transcript feature useful. Several special cases were mentioned, where this feature is useful: repeating it again, people with hearing difficulties, learning a language, translation. Others did not see the benefit of the feature.

5.4.3 Usability experience

Concerning the usability, one of the questions was: “How do you find the dial for navigating within the piece?”. Answers are reported in Figure 11.

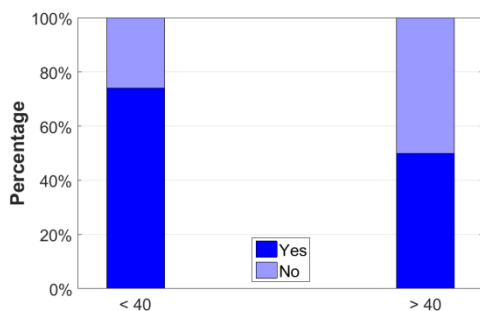


Figure 11: “Is the usability of transport wheel good?”

Some of the positive comments:

“I find the design and the operation of the dial attractive.” (f, 21)

“If you’ve missed something, you can rewind intuitively.” (m, 28)

One of the negative comments:

“The transport wheel is too small – especially for elderly”

Summary and interpretation: Regarding the usability questions, the participants, called co-creators in JOSEPHS, responded mainly on the navigation dial. This feature was more appreciated by the younger ones. Only half of the older ones were able to use it intuitively. Co-creators also spontaneously added some more features on a wish list: e.g. search function, a user interface for people with larger fingers, music or program adaptive presets, and user-defined presets.

On the questions “*Do you like the new user features?*” 88% answer with yes (n = 196).

On the question “*Would you use the app?*” 58% answer with yes (n = 116).

This suggests that most people like the new features of the app, provided by the object-based approach.

Some of the positive comments:

- Good binaural sound
- Access to interesting radio programs
- Appealing, innovative design
- Individuality, because you can create your own profile
- Intuitive and easy to use
- Use: yes, if free of charge and data protection is guaranteed

Some of the negative comments:

- Too many functions
- No added value because I am more a casual listener
- The app is not useful because it does not provide presets, you have to set everything yourself⁴
- Cumbersome handling
- Not much different from existing apps
- Use of the app: only if it is integrated in Spotify, otherwise not useful

5.5 Summary of the JOSEPHS Evaluation

The majority of the participants listen to music or spoken word programs casually or on the go. Streaming services, such as Spotify, are the most popular audio apps among the participants. Most of the participants rated binaural sound as better and more natural than mono or stereo. Participants rate the fore-/background balance predominantly positive.

75% of participants find the setting “turn up/down the volume of specific sounds, e.g. the announcer” useful. The majority of participants liked the surround sound over speakers as played in the living room setup. However, some participants find this sound too intense.

⁴ There were presets, but maybe too hidden.

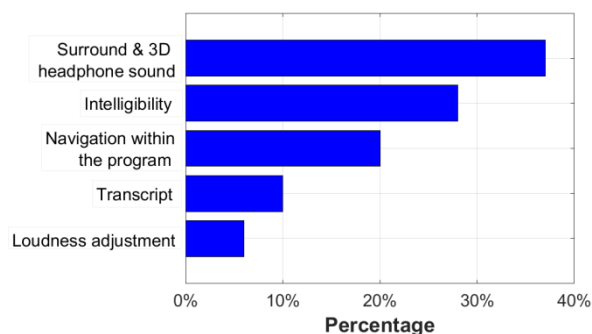


Figure 12: “Which feature or function do you like most?” (n = 194)

Only half of the participants would use the transcript. The transcript is deemed useful for people with hearing impairments, for language learning and translation. Participants up to the age of 40 found the transcript and dial more intuitive and easier to use than older users. Some participants would like an easier navigation and search function as well as more presets within the app. All in all, controls and font should be bigger.

The majority of participants liked the new app functions. Overall, audio experience of surround and 3D-headphone sound are the most popular feature, see Figure 12. Intelligibility, setting the fore-/background balance, is rated second.

Just over half of the participants would use the app. Others would like to see the features in the apps of the existing audio streaming providers.

The general acceptance of the new features and functions provided by OBA is very high. Much potential for OBA is recognized, but some user propose that usability should still be improved. A very positive surprise is that the audio experience with surround sound or binaural reproduction impressed the listeners most. Until now, this aspect of “reality-like listening” was apparently underestimated in audio production and commercial products.

6 B<>COM EVALUATION OF ACCEPTABILITY and ACCEPTANCE

In parallel to the study conducted at JOSEPHS, the authors conducted a separate evaluation with the same app that took place at the institute of research and technology b<>com, located in Rennes, France.

6.1 Motivation

The aim of this study was to understand how non-expert users judged the different aspects of the ORPHEUS iOS app and, more generally, object-based audio. One interesting aspect in that regard was to investigate whether the user’s perception changed after using the app. Therefore, an acceptability / acceptance approach was taken for this study. *Acceptability* refers to prospective judgments on technologies or products before use [16], whereas *acceptance* refers to judgments on and behavioral reactions to products after use [17].

6.2 Methodology

The study involved a total of 21 participants and took place from December 2017 to January 2018. It consisted of three main steps, which are described below.

6.2.1 Initial Questionnaire

First, the subjects were asked to fill a questionnaire. The aim of the questionnaire was to gather information about their appetite for new technology, their radio listening habits and their expectations regarding the features offered by the app and more generally, Object-Based Audio.

The questionnaire started with a series of questions focusing on the profile of the test participants. Specifically, the participants were asked:

- Their age and gender
- Whether they owned a smartphone and which kind
- About their music and radio listening habits using their smartphone.
- About their general view on new technologies.

The questionnaire then provided a quick description of the app. In particular, seven features offered by the app were described:

1. Navigating between the chapters of a program.
2. Displaying a text transcript of the program
3. Adjusting the “audio clarity” (fore-/background balance)
4. Interacting with the content (moving sound sources or changing the listening perspective)
5. Choosing the program language
6. Setting the rendering format (mono, stereo, or binaural)
7. Adapting the duration of the program.

For each feature, as well as for the iOS app as a whole, the participants were asked to rate on a 0-10 scale how much they agreed with the following statement:

- This app/feature seems easy to use
- This app/feature seems useful
- This app/feature seems innovative
- It is likely that I will use this app/feature in the future.

6.2.2 Test of the ORPHEUS iOS App

After they filled the first questionnaire, the participants were asked to test the ORPHEUS iOS app. This test occurred several days after the initial questionnaire in order to reduce the fatigue of the participants and so that their answers would be more consistent.

In order to test the app, the participants were instructed to perform six tasks, with each task focusing on specific features:

- **Chapter navigation** – To test this feature the participants were asked to select the program named “Experience Object-Based Audio” and jump from chapter to chapter.

- **Text transcript** – The participants were instructed to select the “Art of Foley” program and activate the text transcript feature.
- **Audio clarity** – The participants were asked to select the “Live Football” program and listen to the effect of changing the fore-/background balance.
- **Interaction** – The participants were instructed to select the program named “Passo Avanti: Mozart Gigue in 360°” and try the different versions of this content.
- **Multi-language** – The participants were instructed to select the “Art of Foley” program and switch language to English.
- **Audio presets and rendering** – The participants were instructed to configure a profile that used binaural rendering.

6.2.3 Final Questionnaire

Immediately after testing the app, the participants were asked to fill a questionnaire. Similar to the initial questionnaire, the final questionnaire asked the participants to rate, for each feature as well as for the app as a whole, how much they agreed with the following statements:

- This app/feature is easy to use
- This app/feature is useful
- This app/feature is innovative
- I will use this app/feature in the future.

A total of 21 subjects participated to the evaluation, however only 16 of them tested the app and took the final questionnaire.

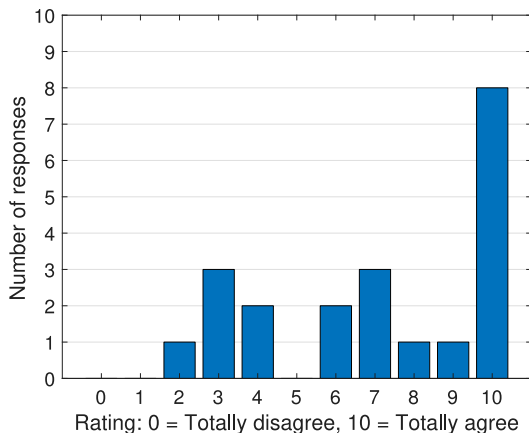


Figure 13: Responses to the statement “I often listen to music using my smartphone

6.3 Results

6.3.1 Participant Profile

Of the 16 participants that filled both questionnaires, 11 were men and 5 women. Their average age was 28.6 years (with a standard deviation of 5.9 years). All declared that they owned a smartphone, 6 running on iOS and 10 on Android.

Most users reported that they used their smartphone to listen to music, as illustrated in Figure 13.

On the contrary, most participants reported that they rarely listened to the radio using their smartphone, as shown in Figure 14.

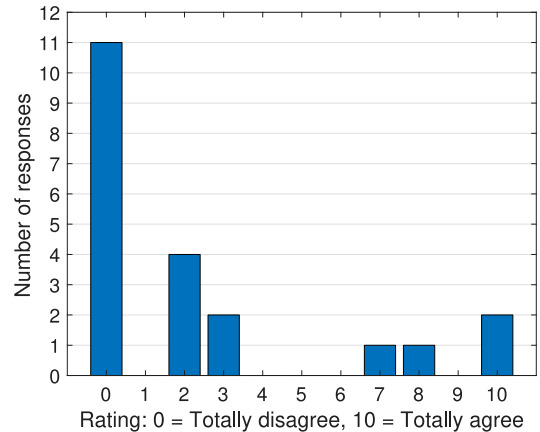


Figure 14: Responses to the statement “I often listen to the radio using my smartphone”

Lastly, a majority of participants were enthusiastic about technology and eager to try out new ones, as shown in Figure 15. This is not a surprise, as the test participants were all employees of a research center.

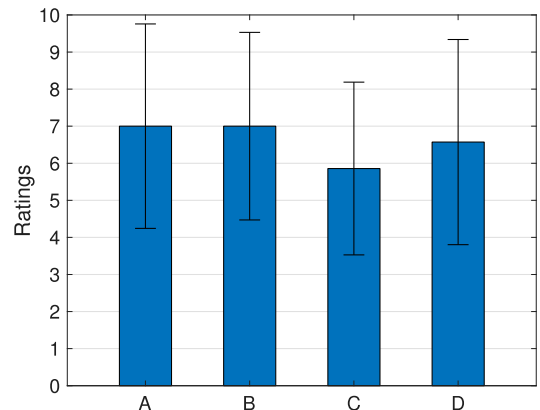


Figure 15: Responses to the statements: A) “I like to experiment with new technologies”; B) “In general, I am not hesitant to try out new technologies”; C) “When I hear about a new technology I look for ways to try it out”; D) “Among my peers, I am usually the first to try out new technologies”. The error bars represent the standard deviations.

To summarize these results, the test participants were relatively young, frequent smartphone users and in majority eager concerning new technologies. Relatively few of them had the habit of listening to the radio using their smartphone.

6.3.2 Overall Acceptance and Acceptability

We now present the results regarding the global appreciation of the app. Figure 16 presents the ratings before and after using the app for the four following criteria: innovation, ease of use, usefulness, intention to use.

The expectations of the participants were globally positive regarding the app. In particular, the app was seen

as innovative and expected to be easy to use. However, the participants were dubious about the usefulness of the app and only about half of them thought they would use it in the future.

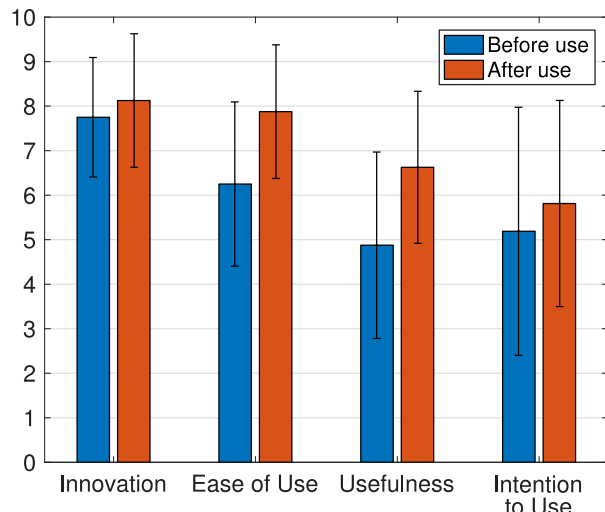


Figure 16: Overall appreciation of the ORPHEUS iOS app before use (acceptability) and after use (acceptance). The error bars represent the standard deviations.

On average, the ratings increased for every criterion after the participants tested the app, which indicates that most participants appreciated it. The increase in ratings is particularly large for the “Ease of Use” and “Usefulness” criteria, which indicates that the participants did not expect the app features to be as easy to use and useful as they found during the test. By contrast, the increase in “Intention to Use” is moderate, which is probably related to the fact that a majority of the participants do not use their smartphone to listen to radio programs, and do not see themselves doing so in the future. Note that the increase in the “Innovation” rating is also small but the initial rating was already very close to the maximum score.

6.3.3 Feature Acceptance and Acceptability

The results regarding the perceived usefulness of the different app features, before and after use, are shown in Figure 17. Most features were judged more useful after use than before by the participants. The increase in perceived usefulness was significant for the “Audio Clarity” (fore-/background balance) and “Audio Rendering” (switching from stereo to binaural) features. The two features that were found to be the most useful after use were the “Audio Clarity” and “Multilanguage” features.

On the other hand, the usefulness ratings for the “Interaction” feature (ability to change the perspective in the audio scene or move sound sources) decreased significantly after use. Participants reported that they could not hear the difference between the different versions of the program, which could have been caused by a technical problem in the app or in the content itself.

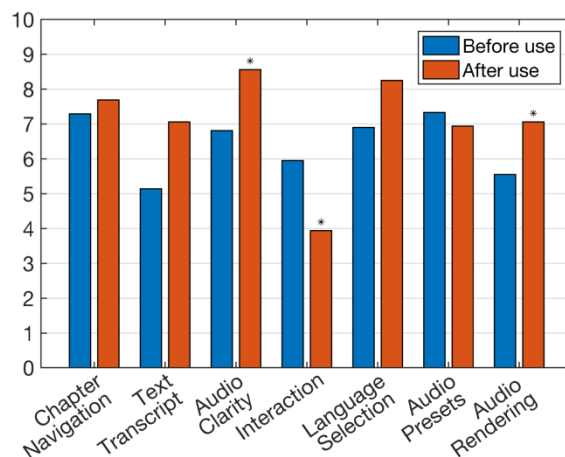


Figure 17: Perceived usefulness of the different features tested in the iOS app, before and after use. Note: stars located above the bars indicate that the change in rating was considered statistically significant.

6.4 Summary of the b$\langle\rangle\text{com}$ Evaluation

This study, aimed to compare the perception of users before and after use of the ORPHEUS iOS app. This comparison was done both on a global level (global user assessment of the app) and on a feature-specific level.

The overall acceptability of the application was relatively high, which shows that the application was perceived positively by the users. In addition, the users found the app easier to use and more useful after they had a chance to try it. This indicates that the app convinced the users of the advantages of object-based audio. However, the fact that ratings increased significantly after use indicate that it is important for users to experience these aspects themselves. Moreover, the participants’ intention to use the app did not increase very much after use, which could be related to the fact that most of them rarely listen to the radio using a smartphone.

In terms of features, the “Audio Clarity” (fore-/background balance) was the most popular among users, followed by the “Multilingual” and “Audio Rendering” (ability to listen to a binaural version of the programs) features. Conversely, the “Interaction” feature (spatial changes in the audio scene) was perceived as the least useful but this seems to have been caused by a technical problem.

7 COMPARISON OF THE TWO EVALUATIONS

The JOSEPHS evaluation in a public accessible venue and a run-time of three months resulted in a high number of participants ($n = 361$), covering all ages and types of users. The audio quality evaluation is less strict than in a standard listening test but may represent the judgment of a “normal” user more closely. The open-question investigation approach, with all the verbal comments, give much more information and insight how the participants think and judge about the app. On the other side, there is no easy statistical ‘summation’ possible.

The more ‘traditional’ lab evaluation from b$\langle\rangle\text{com}$ uses the advantage of well-defined conditions and questionnaires with clear quantified results. The effort for

such an evaluation is smaller as for the open-question investigation.

Both evaluations supplement each other and came to very similar results for the OBA evaluation:

- (1) The acceptance after use of the app is very high.
- (2) Listening to a radio program on a separate app is not so popular. The integration of the OBA features in the popular streaming provider apps is more promising.
- (3) The audio clarity feature or intelligibility gets the highest or second highest ranking of all features in both tests.

Speech intelligibility for Radio (and TV) is very important and a long known issue. Now, with object-based audio implemented in the NGA codec MPEG-H, tools are available to address it.

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