

Effects of audio feedback types on waiting time while rebooting a system.

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ABSTRACT

Waiting time plays an important role in the user experience of a system. Researches have shown that right amount of wait time has a massive impact in the overall success of a product. Providing users with the right feedback during wait time is hence important. This study examines the effects of audio feedback types on users perception of waiting time while rebooting a personal computer. Three types of audio feedback - Slow Beep sound, Fast Beep sound and Running water sound were used with 2s, 7s, 15s and 20s to evaluate the impact of users perception of waiting time, degree of worth wait and the degree of pleasure. Results showed that the users' time perceptions and wait evaluations were affected by the feedback types and were consistent with the attention-gate model theory proposed by Zakay and Block. The perceived error time also varied with feedback type and wait time. Design recommendations were made from the study in regards to designing audio feedback types while designing for wait times.

KEY WORDS

Waiting time, Audio feedback, Time perception, System rebooting, Wait evaluations, Beep sound.

1. INTRODUCTION

Wait states are unavoidable in any computer and mobile application [1]. Actions like downloading, rebooting, installing, etc are very common in any sort of application and requires a significant amount of

waiting time. It is easy for a user to get bored of wait times and may even end up using the application just because of this [1]. Hence, wait states require appropriate, intelligent, innovative and interesting feedback to remove the negative experience. The wait indicator is an indispensable feedback design for the wait interface.

Wait time, if not understood and managed properly can cause serious damage to the whole experience which in turn can cause huge loss. There is an interesting study which investigates the slow loading page of Walmart Labs on its websites [2]. The study showed that every 100 ms improvement on page loading time of its website leads to a 1% increase in incremental revenue and every 1 second improvement leads to a 2% boost in conversion rates. This study also found that about 43% of online travel and lodging shoppers abandoned the site after 3 seconds of wait.

There are many ways by which this time can be managed so that it is perceived less. As the the attentional gate theory [3] of prospective timing states; attention-demanding activity caused the wait to seem less reasonable. Making the user aware of what is happening is one way to effectively tackle this. Giving appropriate and insightful feedback has become an integral part of any interactive tool. Right feedback at the right context make the tools more user friendly [1]. Feedback in the present day computer world broadly exploit visual, auditory and motional (eg., vibration). Visual feedback for waiting time in the form of graphs and animations are proving effective in many computer and mobile applications. There are also many other cues to increase the load on non temporal activities to which can shift

attentions. One of them is audio feedback, but the effect of audio feedback in this field is less addressed. In studies that dealt with restaurant waiting time, it is found that slow-paced music increases latency customers and fast-paced music will reduce customer waiting time [4]. These hypothesis need to be understood in the context of computer and mobile applications. The constant increase in the usage of computer and mobile phones [16] proves the need.

Audio feedback are used in different forms to know what is happening in the system. This study examines the effects of audio feedback types on users perception of waiting time while rebooting a personal computer.

2. LITERATURE REVIEW AND THEORETICAL BACKGROUND

There are some exciting theories that very well explains the psychological aspects while a person is waiting. The resource allocation model [5] and the attention gate model [3] are some of them. These models along with some important concepts associated with the study are explained below in detail.

2.1. THE RESOURCE ALLOCATION MODEL

The perceived waiting time is very much important during a wait stage. The resource allocation model [5] says that, the use of different cues like attractive visuals or sounds can distract people from thinking about the wait. This different cues shifts the focus of their attraction to the visuals or the sounds during the wait and this can be a way to increase the enjoyment and reduce the perceived waiting time. The rationale behind this viewpoint is that if more and more attention is directed towards those cues during a wait time, there are fewer resources available for time estimation. This results in a shorter perceived waiting time [6].

2.2 THE ATTENTIONAL GATE MODEL

Proposed by Zakay and Block, the attentional gate model [3] suggests that a person may divide his or her attentional resources into external

events or attending time. When a person starts to focus on time, the gate becomes active, allows more pulses to pass and the counter starts to count. The gate is closed when the attention is shifted to other cues and fewer pulses are counted. A person's judgement of time can be clearly explained with this model. Many non-temporal activities can be included to shift the attention and this shortens the attention devoted to the temporal or the main task. In short, more the attention shift to non temporal activities, narrower the gate and fewer pulses to count which in turn reduces the users' judgement in waiting time.

2.3. PERCEIVED ENJOYMENT

Previously most of the systems and its interface were designed giving too much focus on the fictional and the performance aspects [7]. Now the importance is shifting towards the emotional aspect of it, such as pleasure, fun and excitement. In this regards balancing both the aspects can lead to a better overall experience. Venkatesh[8] suggested that perceived enjoyment represents the experience of using a system being perceived to be enjoyable regardless of resulting performance from such use. It is been found that the users value more of the emotional aspect of the system [8]. Through this research we are also planning to find out the how well are the different types perceived for different wait times.

2.4. AUDITORY INFORMATION AND FEEDBACK

We live in a world of "Okay Google" and "Hello Siri" which makes the lives easier, interesting and pleasurable.

Different feedback forms like visual, auditory and haptic have been used extensively in mobile phones now a days to enhance the user experience. Focusing on audio feedback, it said that Auditory information is processed by the brain faster than visual information [9] and auditory information is proved beneficial when the visual burden is overpowering. In certain instances like conveying directional information and exercise information [10], auditory information is effective than visual and haptic.

There are certain set of rules that is widely followed while providing auditory feedback and is very much effective in action. It is

important to follow some of those while designing the experiment. It is said that while processing an auditory information a pause of three seconds or more can give the listener an impression of error or termination [11]. Also, there should be change in sound when there is change in action [11]. For example the user should be aware that an action has started and it is ended. Important contents should be presented in a slow and louder volume and/or should be repeated two or three times [11].

2.5. TYPES OF AUDIO FEEDBACK

There are a huge variety of audio feedback type used in various instances. Having an onomatopoeic origin from the word “beep-beep”, a beep is a short, single toned and high pitched sound. It is first recorded in a car horn in 1929 and is currently associated with machines especially computers [12]. Beep sound is extensively used in computers, transport and in telecommunication as an effective and familiar audio feedback. Beep sounds of varied intensity is used for the study.

Foleys are reproductions of everyday sound effects [15]. It is primarily used in movies in enhance the quality of the audio. Foleys add meaning and enhance the experience. Foley are usually recorded from real life or created artificially. Many such sounds are used as audio feedback. In reference to tis stiudy, sound of a running water from a container is used in the study. Edited to different times, the audio clearly distinguishes the beginning and end. Hence, it could be called as a ‘meaningful audio feedback’.

2.6. USER WAIT EVALUATIONS

In this study, the users’ time perceptions is detected according to the prospective time estimations of the attentional-gate model. The contrast between the beep sound and soft music along with the speed/intensity with which it played is used to evaluate the users perceived time and wait evaluations(i.e., the degree of worth waiting and pleasure). The concept of ‘worth wait’ is a users’ thought on whether the needed time for rebooting was “worth it or not”. Pleasure is the emotional side of the wait time. “Pleasure” can be defined from various

perspectives (e.g., emotion, fun, feeling relaxed or calm, or enjoyment) [13]. During a pleasurable experience time moves at a faster rate. Therefore it is important to enhance the users’ pleasure to reduce the perceived time and to have a positive experience. Hence, the degree of worth waiting and the degree of pleasure were chosen as the constructs of users’ wait evaluations.

3. OBJECTIVE

The primary objective of the research is to understand users perception and wait evaluations for audio feedback for waiting time while a rebooting a system. In the study, we are addressing the following questions:

- How do different audio feedback types affect the users’ time perception and wait evaluations?
- How do changing the audio parameters like the intensity/speed affect the perceived waiting time?
- How is the degree of worth wait and degree of pleasure is affecting users with feedback type and waiting time.

4. RESEARCH PLAN

A 3 X 4 mixed factorial approach was adopted for the study. Here the ‘feedback type’ is chosen as a within-subject variable and the ‘waiting time’ as the between-subject variable. Beep Sound (slow), Beep Sound (fast) and the Running Water sound forms the levels of feedback type and 2s, 7s, 15s and 20s are the levels of waiting time. Time estimation, worth wait and the degree of pleasure are the dependent variables.

4.1 APPARATUS AND PROTOTYPE

A click through prototype was made which mimics the rebooting of the system. The prototype was made for desktop size (1920 X 1080 pixels) Fig. 1. The screen starts with a welcome screen followed by an instruction page which asks the user for rebooting the system. Upon pressing the enter button the simulated rebooting starts with the loading animation. A bar type loading was chosen as the loading indicator with a plain screen. This was to ensure there is very limited

visual disturbance or influence in the perceived time. Twelve different prototype versions were created for the three feedback types against the four waiting times. No clue of the progress indicator in the form of time or percentage were shown.

4.2 PARTICIPANTS

More than 90% of the internet users in India is aged below 50 years [16]. This could be used as a direct indication of the usage of personal computer or mobile phones with age. Hence, people below the age of 50 years was invited for the study. A total of 9 participants (6 male and 3 female) were recruited for the experiment aged between 18-50 years Fig 3. All of them had prior experience of using a personal computer. All participants were unpaid volunteers, and included students, working professionals and home makers.

4.3 EXPERIMENTAL PROCEDURE

The experiment was conducted in a closed room environment. Each participant was given a randomly assigned waiting time group and made them experience the three feedback types. All the participants were instructed well in advance about the experiment and were asked to estimate the waiting time. They were also provided with the description of operating the prototype and when to evaluate. Evaluation for different feedback type for one feedback time was carried out in a session with experiment for each participant lasting over two days with multiple sessions. This was to avoid the immediate influence of one feedback time with the other. Each participant is given a headphone to avoid any sort of external noises or disturbances.

After completing the experiment, the participants were asked to fill a questionnaire which included the following questions -

1. The perceived time estimation (0-120s) in seconds.
2. Degree of worth wait on a 5 point Likert scale (from 1 “less worthwhile” to 5 “very worthwhile”)
3. The degree of pleasure on a 5 point Likert scale (from 1 “less pleasurable” to 5 “very pleasurable”)

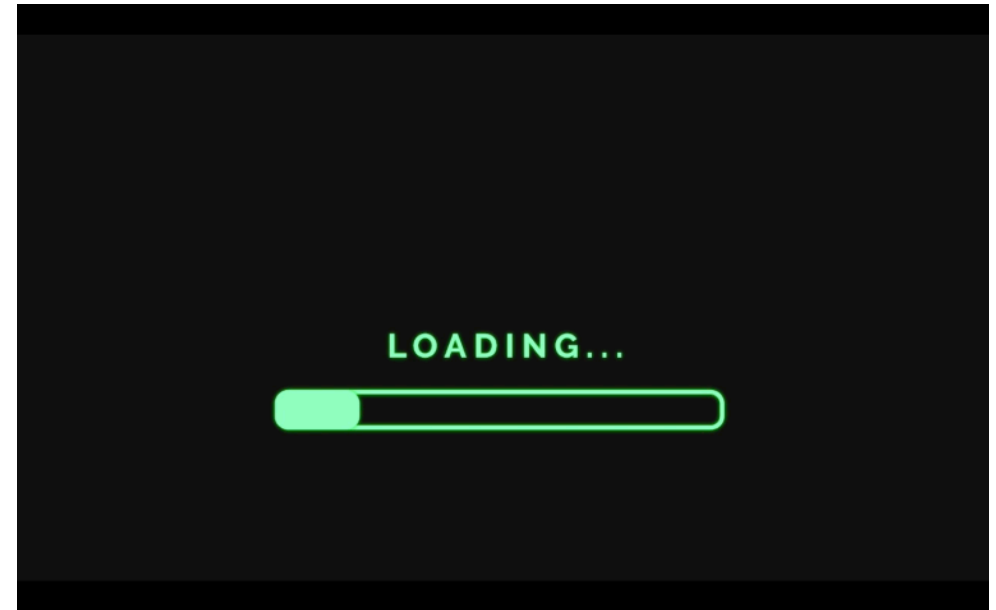


Fig. 1. The Loading screen used in the prototype.

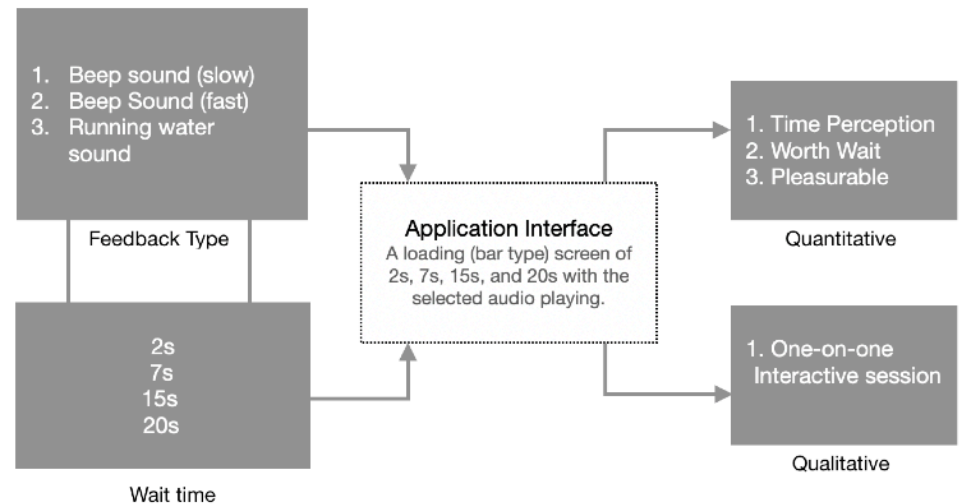


Fig. 2. The research model of the study.

After completing this a one-on-one discussion was done with the participant to get some qualitative insights about the feedback type and perceived waiting time. The experimental procedure is illustrated in Fig. 2.

5. EXPERIMENTAL RESULTS

5.1 TIME ESTIMATION

The goal here was to find the difference between the actual wait time used in the experiment and the perceived wait time by the participants. In all the cases for 2s and 7s, time was overestimated for all three feedback types. In case of 7s, beep sound (fast) was estimated more by about 2s compared to the other two. The perceived time was almost close to the actual time in the case of 15s, but with the beep sound (fast) it was overestimated by about 3.5s. In the case of 20s the case was different. The wait time with beep sound (slow) and running water

sound were underestimated by about 1s and 2s respectively when beep sound (fast) was still overestimated by about 3s. The findings are illustrated in Fig. 4.

5.2 PERCEIVED ERROR TIME

Perceived error time was calculated in order to find the value of the difference between the perceived waiting time and the actual time wait time used in the experiment (Perceived error time = Perceived wait time - Actual time). The value of perceived error time was positive in all cases for 2s, 7s and 15s while negative for 20s for beep sound (slow) and running water sound. However it remained positive for beep sound (fast) in the case of 20s. The magnitude of the difference decreased with the increase in wait time. The value of perceived error time remained high for beep sound (fast) in all cases. The data visualisation for Perceived error time vs actual wait time is shown in Fig. 5.



Fig 3. Participants taking part in the study.

5.3 DEGREE OF WORTH WAIT

The average of the Likert scale out of 10 showed that, when beep sound (fast) was considered worth wait for 2s for many of the participants, it lost significantly to running water when the wait time was 7s. However beep sound (fast) still proved was worth waiting for in higher waiting times. Beep sound (slow) was considered the least worth wait by majority of the participants in all cases. The collected data is illustrated in Fig. 6.

5.4 DEGREE OF PLEASURE

The experiment shows that the running water sound was more pleasurable to listen to in most cases. It was beep sound (slow) which was considered most pleasurable when the wait time was 2s. It is interesting to observe that even though beep sound (fast) was considered as worth waiting in most cases, remained less pleasurable in all wait times. The score decreased with increasing in wait time. The data visualisation can be seen on Fig. 7.

6. DISCUSSION

Results showed that the users' time perceptions and wait evaluations were affected by the feedback types and were consistent with the attention-gate model theory proposed by Zakay and Block. When participants overestimated shorter waiting time, and underestimation in the actual time was observed when it came to 20s. The observation was also in line with the Vierordt's [14] theory which states that the relatively "short" waiting time was overestimated, while the "long" waiting time tended to be underestimated. The perceived error value indicated that the magnitude of error increased unto 7s and then decreased and even went negative when it came to 20s. The qualitative feedback also suggested that some participants estimated time on the basis of the number of beep even though it was not synced with a second.

When beep sound (fast) was considered worth wait in many instances it failed to pleasure the users in all wait times. Running water sound was rated worthy of waiting for 7s and eventually got reduced

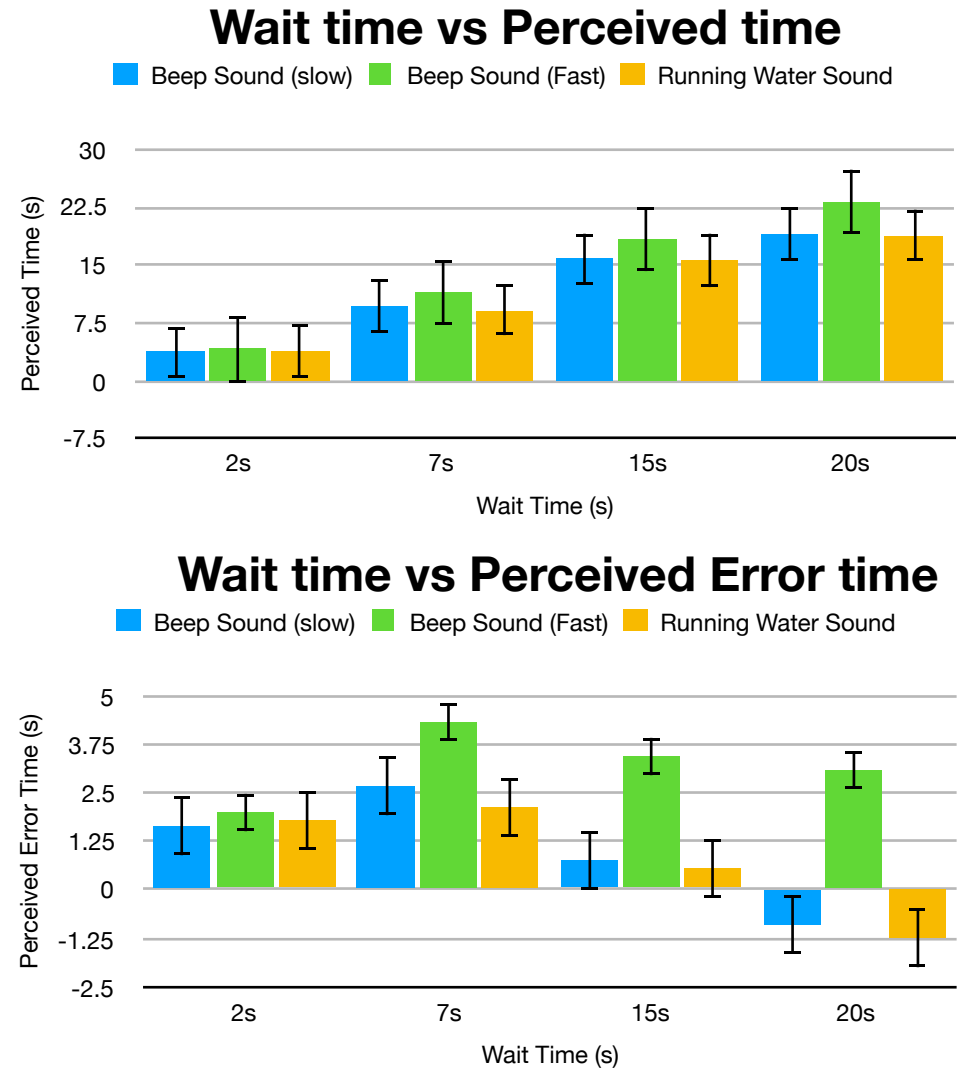


Fig. 4. (above) The comparison between the actual wait time and the perceived wait time for different feedback types (scale on y axis: 1 unit = 6s). Fig. 5. (below) The comparison between the actual wait time and the perceived error time for different feedback types (scale on y axis: 1 unit = 1.25s). (Perceived error time = Perceived wait time - Actual time)

when the waiting time was increased. The results show that different feedback type is suitable or best for different waiting times. Running water sound was pleasurable to hear for many as it induced a meaning and was less monotonous compared to the other two types.

7. CONCLUSION

The study explored how different audio feedback types affects users perception of waiting time. There were some conclusions that can be made which can be incorporated while designing an audio feedback while rebooting a system. Following are some design recommendations contributed by the quantitative and qualitative analysis in the study -

1. Users perceptions of wait time is affected by the type of feedback used. This varies with duration of waiting time. Different feedback type is useful for different wait times.
2. Beep sound when altered with its intensity affects the perception of time. Faster the sound means there is urgency and is an indirect indication of thing happening faster. This makes the sound worth waiting for even though it might not be a pleasurable experience. A right balance according to the need is necessary while choosing the correct feedback type.
3. Meaningful audio feedback like the sound of running water made the experience pleasurable also indicated the beginning and end of the process with its variations in sound. This could be used while designing for blind people.
4. There is a positive impact in degree of worth wait and degree of pleasure on the participants preferences when the waiting time is shorter.
5. Monotonous feedback tend to make the users feel bored. Hence it is better to have diversity while choosing the sound. This might affect the users positive emotions.

Waiting times are unavoidable and forms a significant part in the user flow of any systems. The study can be extended to find out the right feedback type while designing for blind by understanding more about how the feedback progresses in each interval. Choosing the right wait time and right feedback type is very much essential for a seamless experience.

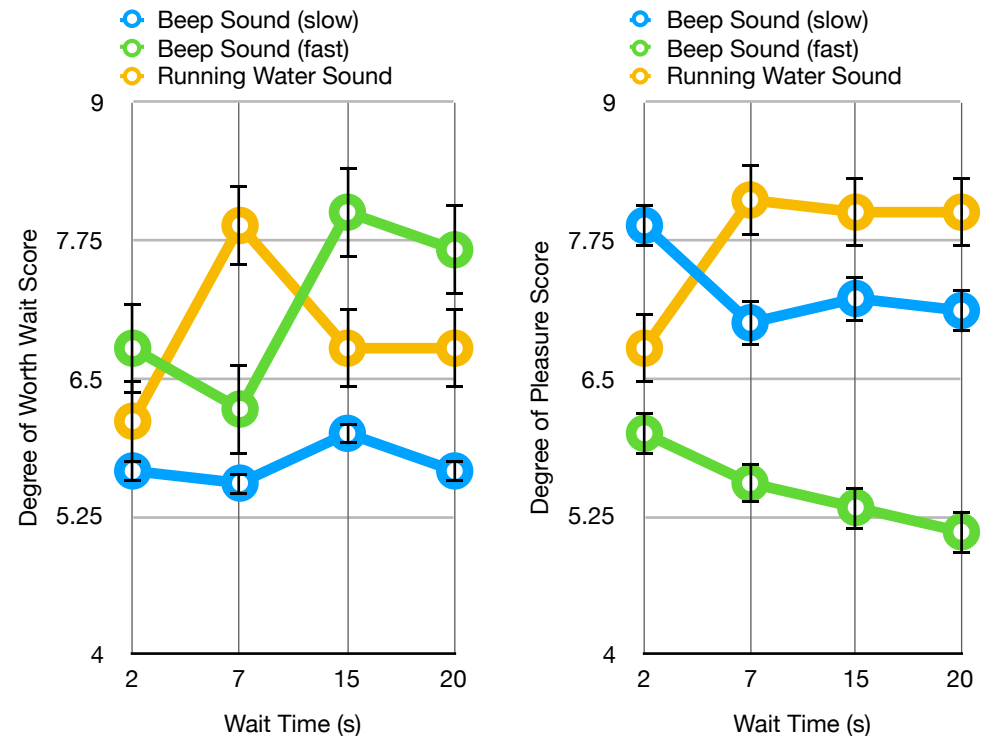


Fig. 6. (left) The graph comparing the degree of worth wait and wait time for different feedback types (scale on y axis: 1 unit = 1.25 points) . Fig. 7. (right) The graph comparing the degree of pleasure and wait time for different feedback types (scale on y axis: 1 unit = 1.25 points).

REFERENCES

1. Chien-Hsiung Chen, Shasha Li, The effect of visual feedback types on the wait indicator interface of a mobile application *Displays*,(2020), 61 101928
2. Cliff Crocker, Aaron Kulick, and Balaji Ram of Walmart Labs, The study of Walmart Labs was presented at the SF Web Performance Meetup, (February 16, 2012), ([http:// www.meetup.com/SF-Web-Performance-Group/events/50485972/](http://www.meetup.com/SF-Web-Performance-Group/events/50485972/)).
3. D.Zakay, Experiencing time in daily life, *Brit. Psychol. Soc.*25 (8)(2012)578–581.
4. Zhou Fang, The Study on the Effect of Background Music on Customer Waiting Time in Restaurant, *The Open Cybernetics & Systemics Journal*, (2015), 9, 2163-2167
5. D. Zakay, Subjective time and attentional resource allocation: an integrated model of time estimation, in: D. Zakay (Ed.), *Time and Human Cognition*, North-Holland, Amsterdam, (1989), pp. 365–397.
6. D.H. Maister, The psychology of waiting lines, in: J. Czepiel, M.R. Solomon, C.F. Surprenan (Eds.), *In The Service Encounter*, Lexington Books, Lexington, MA, (1985), pp. 113–123.
7. Y. Lee, A. Chen, V. Ilie, Can online wait be managed? The effect of filler interfaces and presentation modes on perceived waiting time online, *MIS Quarterly* 36 (2) (2012) 365–394.
8. V. Venkatesh, Determinants of perceived ease of use: integrating perceived behavioral control, computer anxiety and enjoyment into the technology acceptance model, *Inf. Sys. Res.* 11 (2000) 342–365.
9. Rosati, G., Roda, A., Avanzini, F., Masiero, S., On the role of auditory feedback in robot-assisted movement training after stroke: review of the literature. (2013) *Comput. Intell. Neurosci.* 11.
10. Bronkhorst, A.W., Veltman, J.A., Van Breda, L., Application of a three- dimensional auditory display in a flight task, (1996), *Hum. Factors* 38, 23e33. [http:// dx.doi.org/10.1518/001872096778940859](http://dx.doi.org/10.1518/001872096778940859).
11. Tae-Hyun Kim, Sung-Hee Jin, Development of auditory design guidelines for improving learning on mobile phones, (2015), *Computers & Education*, 91 60e72.
12. Lawrence Cawley, "The ubiquity of the modern beep", (12 May 2014)BBC. Retrieved 12 May 2014.
13. B. Shneiderman, Designing for pleasure: how can we design user interfaces to be more fun?, (2004), *Interactions* 11 (5), 48–50.
14. K. Vierordt, *Der Zeitsinn nach Versuchen*, Laupp, Tübingen, (1868).
15. Almo, Laura, "Why Is It Called 'Foley' Anyway?", (1 February 2016), *Cinemontage*. Archived from the original on 13 June 2018. Retrieved 13 June 2018.
16. Tapashi Dasgupta, A Study on Aspects of India"s Digital Divide, *International Journal of Multidisciplinary*, (2018), ISSN: 2455-3085 (Online).