Interactive devices and time perception: triggering awareness of the passage of time

Yunfan Guo
Creative Computing Institute, University of the Arts London
Student ID:22039409

Video Demo Link: https://youtu.be/uY33vVXsSnc

ABSTRACT

This study aimed to design a multisensory time-guided device inspired by the traditional hourglass and to guide participants to pay more attention to the passage of time by combining visual, sound, and tactile stimuli. Participants of different ages were interviewed about their feelings and reactions when interacting with the device. In our experiments, we verified the positive impact of the multisensory time-guided device in improving the perception of time. Good feedback was given to participants of different ages. By discussing the results of the experiment, we highlight the potential impact of multisensory device design in the field of temporal psychology and human-computer interaction. This design points to future directions for designing smarter, more individually tailored devices. Directions for future work include expanding the group of participants, adding personalized settings, and incorporating physiological feedback for design optimization. This will help to deepen the human experience of time perception, and this research provides a useful empirical basis for further exploration in the field of interaction design and psychology.

1 BACKGROUND WORK

In the philosophy of time literature, our experience of the passage of time is often described as an ever-changing process of what we are experiencing now or what we will experience when we move into a future time (Fazekas, 2019). This statement is similar to a section of theorists, presentists, and a variety of others who claim that time passes. They believe that time passes because it undergoes objective changes with events, from the non-existence of the future to the existence of the present, and finally to the non-existence of the past once again (McTaggart, 1908). They both believe that we are always experiencing time in the present moment and because the present moment is constantly changing, a person experiences the passage of time. Another group of theorists believes that this is not the case. Their view is that there is a temporal order to the development of the world that can be expressed in terms of an earlier and later relationship and that all time exists equally (Oaklander and Smith, 1994). I think what they say and analyze makes sense. However, I am more concerned about whether people can be aware of the experience of the passage of time and whether the perception of the passage of time can be enhanced by the device.

In modern society, although the rapid development of technology has provided us with more convenience, however, people's perception of time in their daily lives is facing new challenges. Social media, digital entertainment, and fast-paced work life make people tend to get lost in the passage of time. This ambiguous perception of time may lead to individual distress in time management, affecting life efficiency and satisfaction (Muhammet TORTUMLU and Uzun, 2023). In a busy life, the stress caused by the passage of time is high and it can lead to harmful effects in making decisions (Zakay, 1993). Fatigue, confusion, and a sense of loss of control usually lead to a decrease in the productivity and quality of one's work. Stress and anxiety take up valuable time and energy. Anxiety drains our energy and time. By enhancing people's perception of time, people can manage it better rather than letting it manage them (Jackson, 2009). Therefore with the increasing importance of time in people's lives, research on how to better perceive and utilise time has become an important topic. People have different understandings and evaluations of time in different social backgrounds and cultures, which makes time perception complex and diverse (Brislin and Kim, 2003). Therefore, it is important to design a device that can trigger people's perception of the passage of time.

2 RESEARCH QUESTION

The goal of this study is to stimulate a deeper understanding of time in individuals by designing an interactive device that triggers a more sensitive perception of time. It is hoped that this design can arouse people's active attention to the passage of time, thus helping them to plan their lives more purposefully and improve their time management.

This study has important practical significance. Firstly, it helps to help people value time in modern society. By stimulating individuals' sensitivity to time, it is expected to help them perceive time better and increase their appreciation of time. Secondly, the results of the study will also be instructive for designing more intelligent and humanized interactive devices, providing practical experience to better meet people's needs for time perception. On a broader level, this study has a catalytic effect on the field of time psychology and human-computer interaction. Through an in-depth study of the mechanism of time perception, we can provide more empirical data on human time perception for the field of psychology and enrich the related theories. Meanwhile, by exploring the design and application of interactive devices, we also provide new ideas and examples for the development of the field of human-computer interaction.

Therefore, this study aims to awaken people's attention to time through the design of interactive devices and to provide new references for solving the problem of time perception in contemporary society. This has a positive impact on promoting the improvement of an individual's quality of life and the overall efficiency of society.

3 METHOD

The experience of time passing is a unique and complex subjective perception that encompasses perceptions of transition, change, and flow of time. The experience of the passage of time is specifically described as the feeling that time is carrying people along with it, and that the emergence of slowly later times changes time and people's experiences with it (Prosser, 2007). Many experiences of the flow of time are dynamic or vivid to varying degrees and are observations of constant change in oneself and in what surrounds one (Fazekas, 2019). For example, in the case of a stomach ache, when one experiences a succession of later pain sensations, one also compares it to the most recent pain sensation retained in the previous short-term memory, which may be lighter or heavier now than the pain sensation in the time just before, and one becomes aware of the flow of time when one compares what one is experiencing now with what has happened. Based on the above description and analogy of the experience of the passage of time, we can enhance this process by designing devices to enhance people's perception of time and achieve the goal of making people value time.

3.1 DEVICE DESIGN

The design of this interactive device is shown in Figure 1.

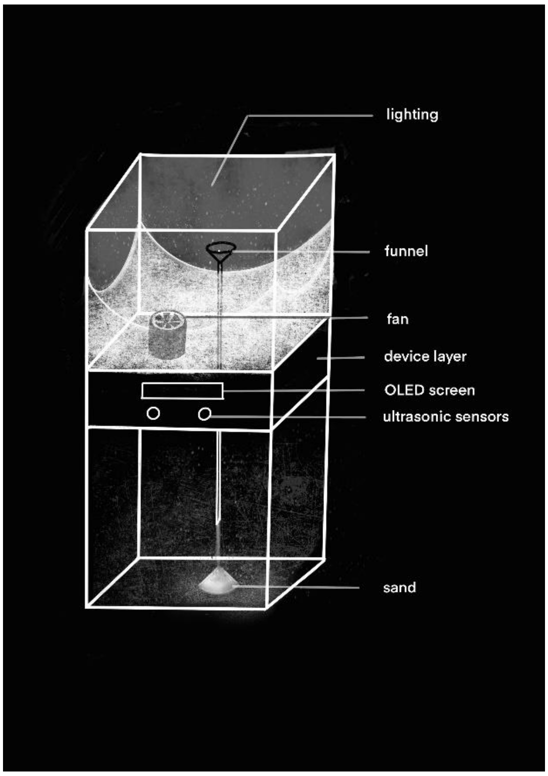

Figure 1: Multi-sensory device design drawings.

This device is inspired by the hourglass. However, it is different from an hourglass because it is not unilateral like an hourglass where only the visual part exists and directly performs a single action of lowering the hourglass. The device is designed to guide participants to be more aware of the passage of time through multi-sensory stimuli such as sight, sound, and touch. The installation is divided into three layers and three parts. The top layer (henceforth referred to as the first layer) holds the fine grains of sand, the fan output, and the upper part of the funnel. The middle layer (henceforth referred to as the second layer) was used to arrange the electrical circuits and controls of the device. The bottom layer (henceforth referred to as the third layer) holds the bottom half of the funnel and a tray to receive the sand particles. The device starts to operate when it detects that someone is looking around the device. Firstly, the ambient lighting and background music of the device will be switched on, then the fan inside the device will start to rotate, and due to the relative airtightness of the first layer, the fine sand particles will follow the wind and start to fly around the space of the first layer in an irregular manner. Some of the fluttering sand particles will fall onto the funnel, through which they will fall into the tray on the third level. In addition, because one side of the third layer is open, participants can use their hands to catch the sand that comes down from the funnel on the third layer of the installation, thus experiencing the passage of time through the sense of touch. As the participant interacts with the installation, the OLED display on the second level of the installation displays the amount of time the participant has spent from the beginning to the end of the experience and tells the participant how many seconds of his life he has spent watching the installation.

3.2 DEVICE IMPLEMENTATION

Device construction I through modular, divided into the upper, middle, and lower three layers were designed and constructed assembly. In the first layer and the third layer I use transparent acrylic board for the appearance of the building, transparent acrylic with high light transmission, so that the viewer can clearly see the changes inside, thus strengthening the immersion of watching. Fan wind needs to go through a series of debugs, the wind speed is not suitable for too large, too large will lead to the device inside the sand particles flying too fast, so that the viewer can not see the details of the process. Too slow wind speed will lead to sand particles not flying in the first layer of the device. The sand particles need to be of a size and weight that is not too large or too small, as they will also affect the viewing experience of the viewer. Through continuous testing, I found the most suitable sand size and wind speed. In the second layer, I controlled the operation of the device by programming the functional logic using Arduino. The basic logic and connections of the device are shown in the figure 2.

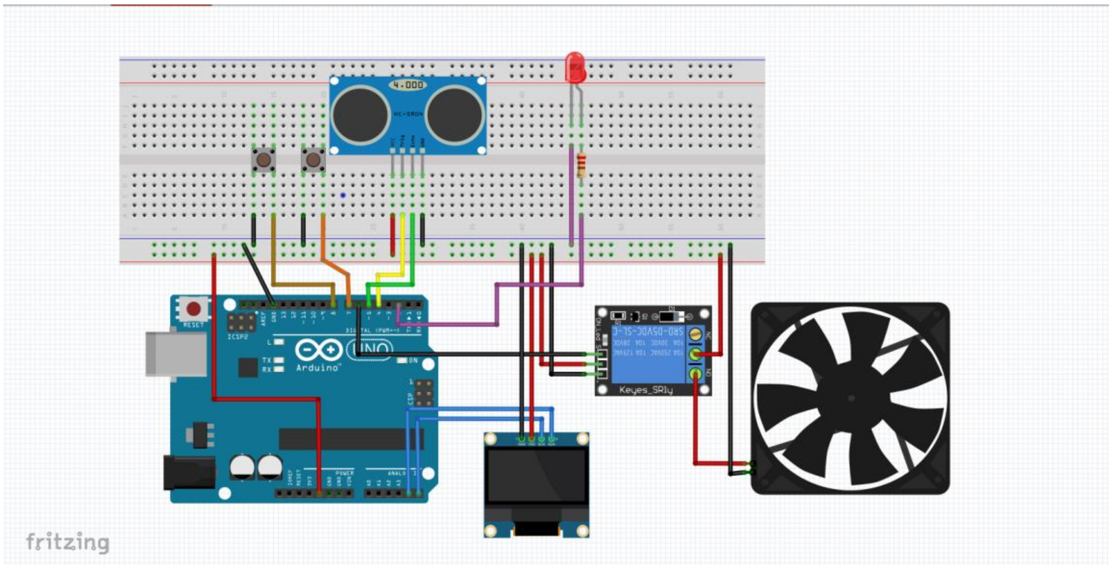

Figure 2: Basic logic and connections of the device. (audio via buzzer instead).

For the sensing device, I used an ultrasonic distance sensor to receive signals from the participants. The sensor was tested and a distance of 1.5m was chosen as this is where the participant could hear the sound of sand grains hitting the side wall of the device, and also for a clearer and more immersive viewing experience. The OLED screen was mounted underneath the ultrasonic sensor so that the participant could easily observe it. Lighting I used LED strips, which were installed in both the first and third levels of the unit respectively, and the brightness of the lights could be adjusted with a switch to suit the ambience created in different placement environments. For the music player, I chose separate stereo speakers for playback, with more thrust and clearer sound to create a better atmosphere. The background music was chosen after much deliberation to be Hans Zimmer's 'Cornfield Chase' and 'Time'. Because "Cornfield Chase" was used in the film "Star Trek", this song can bring people a feeling of time traveling in the universe. The other track "Time" was used as the ending song in the film "Inception", which brings a very strong sense of time immersion. The circuitry of the second layer of the device is on the same layer as the main body of the fan, because the fan needs to extract air, in order to facilitate the work of the fan, I sealed the main body of the circuitry in a separate compartment only connecting the connecting wires to the fan. During the soldering process of all the devices, the difference between the high-level relay and the low-level relay caused a logic error to occur when I didn't pay attention to its model number, which was later modified. By designing and completing this device, the participant will have multi-sensory stimulation during the engagement process, which will enhance the perception of time.

3.3 STUDY METHODOLOGY

For the sake of subsequent discussion and research, this project will also be tested experimentally after the device is completed. The experiment does not have any requirements for the age gender etc. of the participants. The research experiment will take place indoors and will be conducted by randomly selecting people who are willing to participate in the interviews during the course of the exhibition. The exhibition process will require participants to go through the experience one by one, with a time limit of two minutes for each participant. However, participants will not be informed of any information, such as the duration of their participation or the subject matter, before their participation. During the two-minute period, participants were allowed to interact with the installation without any guidance. After two minutes, participants were asked if they would like to be interviewed, and the content of the interview was recorded.

4 EXPERIMENTAL METHODOLOGY AND DISCUSSION OF RESULTS

4.1 EXPERIMENTAL DESIGN

I do not provide any hints about the theme of the installation until the visitors have experienced it. After their visit, I will interview them and ask them how they feel about it. I make a textual record of their feelings. Regardless of whether their feelings are relevant to my theme or not, I will tell them the theme I want to express in the installation after they share their feelings. If there are feelings that do not fit the theme, I will explain the theme of the installation after the participants have finished speaking, and then I will ask the visitors again if their feelings have changed, and if they have, I will record the new feelings again. After obtaining the feelings of different participants, I will analyze each person's feelings and draw conclusions about each participant's feelings. I will also summarise the ideas that emerge from the feelings. I also asked each participant to count the length of their experience without looking at the screen before starting the tour and finally compare it to the actual length of the experience on the screen (The test experience lasts for two minutes and an enquiry will be recorded when the time is up.).

4.2 EXPERIMENTAL RESULTS AND DISCUSSION

Through the interviews with the participants, it became clear that 70% of the participants were clearly able to feel the passage of time through the device. After being asked if they felt the passage of time, essentially all of the participants were certain that they did. More than half of the interviewees claimed to be able to sense time by touching the flowing sand with their hands before they were explicitly asked if they felt the passage of time. One-half of the participants also expressed that they felt the passage of time through visual descriptions. One-third of the participants reported that the feeling of time passing was enhanced by the ambiance of the music and the sense of hearing. Some research suggests that using different senses in combination (e.g., visual and auditory) may be more effective than using one of the senses alone because they can simultaneously promote relaxation and concentration. Developing and integrating these two aspects at the same time can be effective in bringing a person to a meditative state (Hussien Ahmed et al., 2017). When analyzed in conjunction with the results, the participants were able to quickly relax their nerves and enhance their concentration through the combination of multiple senses. The passage of time can be felt more easily as the participants enter into a meditative state, allowing the participants to feel more thoughts, and the resulting feelings and fragments of imagination are richer.

The feedback from this device varied for people of different ages. From the experimental interviews, we learned that people younger than thirty years old who estimated their participation in the project indicated that the difference between their estimated time and the time on the display was around 5 seconds. Participants in their upper thirties reported a difference of about 10 seconds between their estimated time and the actual time. Based on previous research, 233 healthy subjects (129 female) were divided into three age groups: G1, 15-29 years old; G2, 30-49 years old; and G3, 50-89 years old. Subjects were asked to close their eyes and mentally count out 120 seconds. In each group, the time spent in the mental counting process followed a normal (Gaussian) distribution. The mean elapsed times were G1, 114.9 ± 35 s; G2, 96.0 ± 34.3 s; and G3, 86.6 ± 34.9 s (Ferreira et al., 2016). This is shown in the figure 3 below:

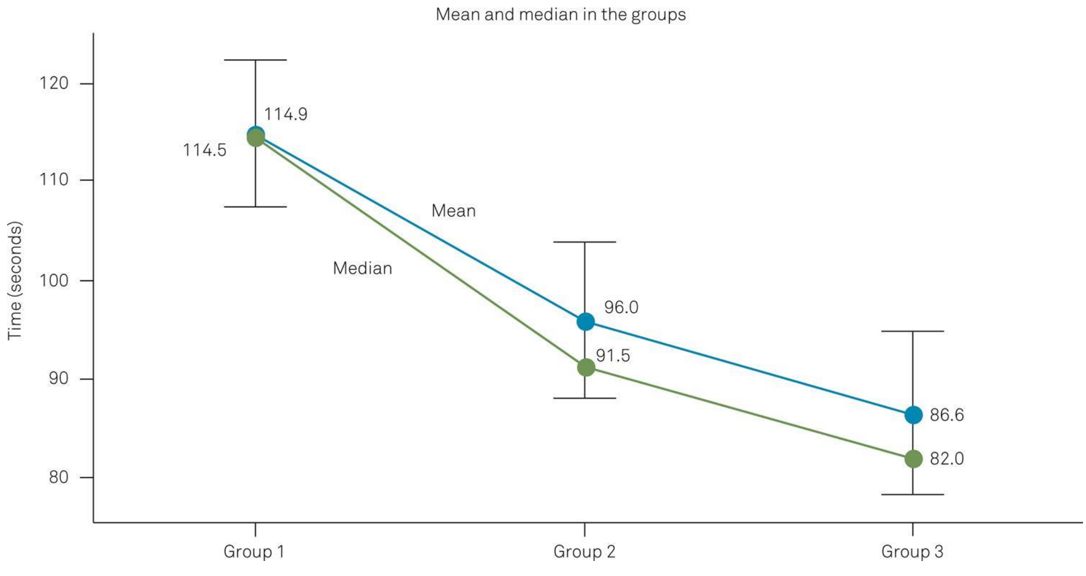

Figure 3: Mental perceptions of the passage of 120 s in different age groups. Values indicate the mean (upper line) and median (lower line) of each group; error bars indicate standard deviations. (Ferreira et al., 2016).

The data clearly confirms that older adults (> 50 years) have a significantly lower mental perception of 120 seconds compared to younger adults (< 30 years) (Ferreira et al., 2016). These data and experimental results suggest that the perception of the passage of time accelerates with age. The phenomenon that leads to this may be related to a lack of new experiences (Friedman, 2013) and a decrease in dopamine neurotransmission (Meck, 1996).

In the interviews, we can see that some people in their twenties and thirties will always describe how time has been changing very slowly lately in the process of work or study, which causes people to be very anxious. In the process of learning and working, there are a lot of things that are just starting and first contact. And the time spent on learning new things is always subjectively prolonged (Hammond, 2012). In general, we can clearly remember the beginning of every new experience that occurred between the ages of 15 and 25. This may partly explain why random days seem to be longer for younger people than for older people (Robert Adler, 1999). Whereas those thirty and upwards in the interviews were more reminiscent, their new attempts may have been relatively few. So young people in their twenties and thirties among the participants interviewed were more accurate in their estimation of time and had a stronger sense of time perception.

With respect to dopamine neurotransmission, the ability of people's internal clocks to estimate the passage of time depends on attention and memory. For example, estimating the time required to perform a given task requires concentration and memorization of a range of information. The concentration depends on the function of dopamine neurotransmission in the basal ganglia. Memory depends on acetylcholine neurotransmission in memory-related brain regions in the hippocampus-prefrontal cortex axis (Coull, Cheng, and Meck, 2010). When we become accustomed to a certain period of time (e.g., a 30-minute class), that time depends on memory (and the neurotransmitter acetylcholine). And increasing dopamine production has the effect of accelerating time perception (Meck, 1996). In the results of the experiment, time perception was relatively weaker in older individuals because of the reduced dopamine secretion. However, in the experiment, participants over 30 years old still described a lot of feelings of time passing, so the multi-sensory stimulation through the device can accelerate people's dopamine secretion so that the participants can concentrate more and strengthen the memory, which strengthens people's ability to perceive time.

It was evident from the participants' feelings that many of them were describing things from the past. They felt sorry for the things they had not accomplished. Others felt sad about losing someone important to them in the past. Others recalled important things they had not accomplished in the present. There were also people who were thinking about their future lives and wanted to make better use of their time. Through the above feelings of the participants, it can be concluded that older people seem to be more conscious of valuing time and they are more likely to recall things that happened in the past. As for young people, it is more about thinking about the future and yearning for the unknown that triggers their dreams.

One phenomenon that is very interesting can be found in the records after the visit. The intention of the installation was to let people feel the passage of time, but the common feedback from most people was that they felt that time stopped for a moment during the interaction with the installation. That is to say that people lost their sense of time or time trajectory during the experience. This phenomenon has been confirmed in past research, where people experience forgetting time and space during immersive experiences (Reichenbach, 2016). It is only when they are asked about the length of their engagement afterwards that they come back to their senses. Research on immersion and time perception in digital games indicated that there is a disconnect between immersion and time perception, and that time perception may be reduced during the immersion experience, with an inability to accurately estimate time (Nordin et al., 2013). So in the experiment, the factors that people are immersed in during the experience of the device also affect the participants' inability to accurately estimate time. Whereas, through self or external arousal, one can be pulled into reality again and one can continue to experience the flow of time.

5 CONCLUSIONS

The results of the experiment showed that people were guided through the multisensory device, which had a significant positive effect on people's perception of time. This is consistent with the original design intent and confirms the effectiveness of the device. The multisensory time-guided device effectively enhanced participants' perception of the passage of time by combining visual, auditory, and tactile sensory stimuli. This provides new ideas for the design of future interactive devices and highlights the importance of multisensory design in influencing user psychology and behavior. However, it is also known from the participants' interviews that multisensory applications are not acceptable to everyone. For example, auditory input may have an effect on visual choices (Bernstein and Edelstein, 1971), and binaural hearing can also facilitate responses to visual stimuli (Campbell and Taylor, 1974). So some senses affect the experience of others. One of the participants suggested that the brightness of the visuals was unacceptable to him, resulting in not having the best experience of the device. So some individuals may be more sensitive to multi-sensory stimuli, while others may require a longer adaptation time. Therefore, in future designs, consideration could be given to introducing personalized settings to accommodate the perceptual differences of different individuals.

Age can similarly have an impact on the time-perception experience. Interviews with participants of different ages showed some differences in their responses to experiencing the device. Younger people had a stronger perception of time than older people. This is also related to organ aging, which leads to a decrease in perception in older people due to the aging of the sensory organs involved (Schieber, 1992). Multi-sensory devices, on the other hand, can enhance the perception of time in older people by combining multiple senses. Therefore, multisensory devices need to emphasize the consideration of the psychological and physiological characteristics of viewers of different ages in their design and to make the interactivity better, which can be done better in the customized design of multisensory.

In the experiments, it could be noticed that many unanticipated disturbances were found during the simple study of the time perception problem. Some participants did not know how the device worked without prompts. So there are still a lot of issues to consider in terms of interaction. And in the experiment, the interviews were open-ended. This can lead to divergent thinking of the participants and an inability to control the variables better for a single question, which can lead to unstable experimental data. So in terms of the experiment, more could have been done to collate what was to be interviewed. Collecting them anonymously in the form of a form or a questionnaire would have protected the participants' information and minimised subjective influence.

6 RECOMMENDATIONS

Despite some positive results from the experiment, there are still some areas that need further research and improvement:

1. A more comprehensive group of participants: Future work could expand the group of participants to include people of different age groups, cultural backgrounds, and psychological characteristics. Cross-cultural studies may reveal differences in the perception of time across cultures, with people from different cultural backgrounds understanding time differently (Brislin and Kim, 2003). People who speak different languages may also reason about time differently (Fuhrman and Boroditsky, 2010). This helps to deepen the understanding of the impact of multisensory time-guided devices in different groups and increases the universality of the design. This in turn guides the design of more inclusive devices.

2. Design optimization incorporating physiological feedback: Introducing more detailed physiological feedback systems, such as brainwave monitoring, biofeedback, and other technologies, can more accurately capture the physiological changes of individuals under multisensory stimulation. A combination of implicit photoplethysmography (PPG) sensing and facial expression analysis (FEA) can be employed to predict the audience's attention, engagement, and mood while experiencing the device (Pham and Wang, 2017). Using these techniques can help explore more objective results, help design more accurate and personalized interaction devices, and enhance the precision of people's time experience.

7 Reference

1. Robert Adler (1999). *Look how time flies . . .* [online] New Scientist. Available at: https://www.newscientist.com/article/mg16422180-900-look-how-time-flies/ [Accessed 18 Nov. 2023].

2. Bernstein, I.H. and Edelstein, B.A. (1971). *APA PsycNet*. [online] psycnet.apa.org. Available at: https://psycnet.apa.org/record/1971-20217-001.

3. Brislin, R.W. and Kim, E.S. (2003). Cultural Diversity in People's Understanding and Uses of Time. *Applied Psychology*, 52(3), pp.363–382. doi:https://doi.org/10.1111/1464-0597.00140.

4. Campbell, G.T. and Taylor, R. (1974). Facilitation of seeing by hearing: Binaural summation. *Bulletin of the psychonomic society*, 3(1), pp.61–62. doi:https://doi.org/10.3758/bf03333395.

5. Coull, J.T., Cheng, R.-K. and Meck, W.H. (2010). Neuroanatomical and Neurochemical Substrates of Timing. *Neuropsychopharmacology*, 36(1), pp.3–25. doi:https://doi.org/10.1038/npp.2010.113.

6. Fazekas, K. (2019). The Experience of the Passage of Time. *The Philosophical Forum*, 50(2), pp.163–189. doi:https://doi.org/10.1111/phil.12216.

7. Ferreira, V.F.M., Paiva, G.P., Prando, N., Graça, C.R. and Kouyoumdjian, J.A. (2016). Time perception and age. *Arquivos de Neuro-Psiquiatria*, 74(4), pp.299–302. doi:https://doi.org/10.1590/0004-282x20160025.

8. Friedman, R.A. (2013). Opinion | Fast Time and the Aging Mind (Published 2013). *The New York Times*. [online] 20 Jul. Available at: https://www.nytimes.com/2013/07/21/opinion/sunday/fast-time-and-the-aging-mind.html.

9. Fuhrman, O. and Boroditsky, L. (2010). Cross-Cultural Differences in Mental Representations of Time: Evidence From an Implicit Nonlinguistic Task. *Cognitive Science*, 34(8), pp.1430–1451. doi:https://doi.org/10.1111/j.1551-6709.2010.01105.x.

10. Hammond, C. (2012). *Time Warped: Unlocking the Mysteries of Time Perception*. [online] *Google Books*. Canongate Books. Available at: https://books.google.co.uk/books?hl=zh-CN&lr=&id=N3YWRNw72sIC&oi=fnd&pg=PT8&ots=5SiG7uJhHP&sig=V6KNS038Kx2zSa0XH0tHM2w8ixw&redir_esc=y#v=onepage&q&f=false [Accessed 18 Nov. 2023].

11. Hussien Ahmed, M.M., Silpasuwanchai, C., Salehzadeh Niksirat, K. and Ren, X. (2017). Understanding the Role of Human Senses in Interactive Meditation. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. doi:https://doi.org/10.1145/3025453.3026000.

12. Jackson, V.P. (2009). Time Management: A Realistic Approach. *Journal of the American College of Radiology*, [online] 6(6), pp.434–436. doi:https://doi.org/10.1016/j.jacr.2008.11.018.

13. McTaggart, J.E. (1908). The Unreality of Time. *Mind*, [online] 17(68), pp.457–474. Available at: https://www.jstor.org/stable/2248314.

14. Meck, W.H. (1996). Neuropharmacology of timing and time perception. *Cognitive Brain Research*, 3(3-4), pp.227–242. doi:https://doi.org/10.1016/0926-6410(96)00009-2.

15. Muhammet TORTUMLU and Uzun, K. (2023). A Scale Development Study for the 21st Century Time Traps: The Scale for Time Traps of the Modern Age. *Afyon Kocatepe Üniversitesi sosyal bilimler dergisi*, 25(2), pp.552–569. doi:https://doi.org/10.32709/akusosbil.1037465.

16. Oaklander, P.L.N. and Smith, U.D.F.S. and P. of P.Q. (1994). *The New Theory of Time*. [online] *Google Books*. Yale University Press. Available at: https://books.google.co.uk/books?hl=en&lr=&id=-Wv59xyNDjsC&oi=fnd&pg=PR11&ots=Q99t9KDvDE&sig=oqSI8kqO0QJTBCKg6YduEt-ExSw&redir_esc=y#v=onepage&q&f=false [Accessed 17 Nov. 2023].

17. Pham, P. and Wang, J. (2017). Understanding Emotional Responses to Mobile Video Advertisements via Physiological Signal Sensing and Facial Expression Analysis. *Proceedings of the 22nd International Conference on Intelligent User Interfaces*. doi:https://doi.org/10.1145/3025171.3025186.

18. Prosser, S. (2007). COULD WE EXPERIENCE THE PASSAGE OF TIME? *Ratio*, 20(1), pp.75–90. doi:https://doi.org/10.1111/j.1467-9329.2007.00348.x.

19. Schieber, F. (1992). *10 - Aging and the Senses*. [online] ScienceDirect. Available at: https://www.sciencedirect.com/science/article/abs/pii/B9780121012779500140 [Accessed 19 Nov. 2023].

20. Zakay, D. (1993). The Impact of Time Perception Processes on Decision Making under Time Stress. *Time Pressure and Stress in Human Judgment and Decision Making*, pp.59–72. doi:https://doi.org/10.1007/978-1-4757-6846-6_4.

21. Nordin, A.I., Ali, J., Animashaun, A., Asch, J., Adams, J. and Cairns, P. (2013). Attention, time perception and immersion in games. CHI ’13 Extended Abstracts on Human Factors in Computing Systems on - CHI EA ’13. doi:https://doi.org/10.1145/2468356.2468551.

22. Reichenbach, D.J. (2016). Losing Time and Space: Experiencing Immersion. The frontiers collection, pp.503–512. doi:https://doi.org/10.1007/978-3-319-44418-5_39.