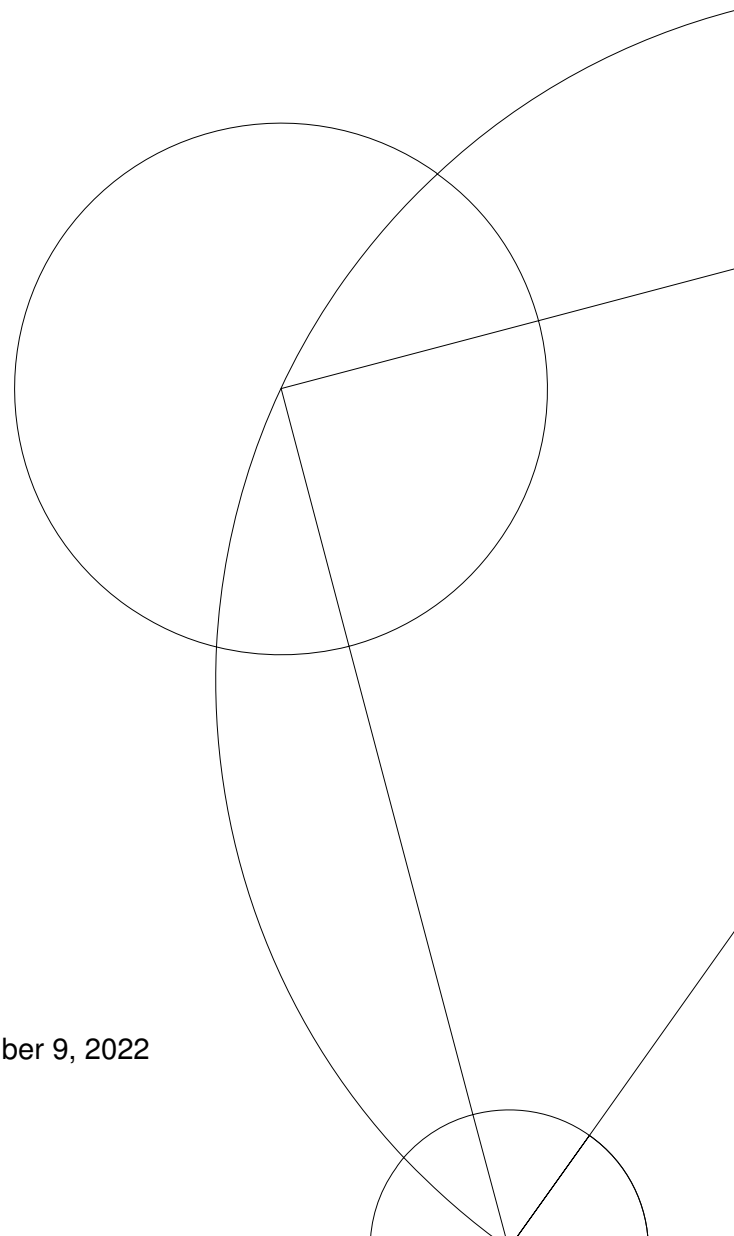
KØBENHAVNS UNIVERSITET

Cognitive Science III

Exam Paper

The Effects of Arousing Music on Normal Reading

An Eye-tracking Perspective



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Abstract

This paper presents an eye tracking study, examining what effects music with different arousal levels (low, medium and high) have on the reading process. The experiment was conducted on 16 participants, who were asked to read curated news article excerpts while listening to music with different arousal levels. Upon finishing each text excerpt, the participants were then asked to fill out an accompanying comprehension test. The participants' eye movement on particular areas of interest were then recorded and utilised in the succeeding analysis, as well as their results in the comprehension test. In the study, we tested three different variables: (1) *Mean Fixation Duration*, (2) *Fixation Count*, and (3) *Refixation Probability*. The data underwent an ANOVA test and multiple T-tests to test for differences. The study did not detect significant differences for variable 1 & 2. Variable 3, *Refixation Probability* did show a difference in the high arousal music scenario - suggesting a difference in the probability of refixations occurring when exposed to high arousal music. Based on the teachings gathered from this experiment, the paper will propose suggestions for future studies which investigate the correlation between music and reading.

Program Implementation & Analysis Resources

To properly carry out the ANOVA & T-test analyses for this study, we have composed multiple Jupyter Notebooks to accommodate these requirements. The notebooks are free and publicly available to anyone interested. They contain everything needed to reproduce our results, or they can serve as a basis for further analysis.

The source code for the notebooks along with the raw gaze and participant data generated can be obtained through this link to the designated Dropbox Repository. All potentially sensitive data is properly anonymised in accordance with good academic praxis.

1 Introduction

The act of reading is a task that most people will engage in on a daily basis. This act can occur in diverse contexts and places and is thus constantly prone to a profusion of potentially distracting elements coming from the surrounding environment. Background noise and music might come to mind as an often-cited distraction to the reading process, as it has often been shown in academic literature that music generally impairs performance when multiple tasks compete for attention. (Furnham & Stephenson, 2007; Husain, Thompson, & Schellenberg, 2002; Kuan, Morris, & Terry, 2017; Mather & Sutherland, 2011; Rayner & Raney, 1996; Zhang, Miller, Cleveland, & Cortina, 2018)

Somewhat paradoxically, some people might even deliberately choose to listen to music in an attempt to shield off even more distracting sounds coming from the surrounding environment (Cauchard, Cane, & Weger, 2012; Jones, Miles, & Page, 1990). Departing from the notion that reading is a cognitively demanding task, it seems puzzling why some people would then willingly choose to introduce more stimuli - given their initial motive is to maximize reading efficiency (Calderwood, Ackerman, & Conklin, 2014). An explanation for choosing this strategy might be to conceal oneself with music from an even more disturbing background sound coming from the surrounding environment. In this way, sound can have a beneficial effect on reading.

The above-described scenarios seek to elaborate on the plethora of ways and situations in which reading can occur. However, this study delimits only to consider reading what we deem an optimal reading situation, *i.e.* one where all other competing sensory inputs are kept to a minimum.

1.1 Motivation

By gaining a deeper understanding of the cognitive effects that listening to auditory stimuli while engaging in reading tasks have on the mind is an important subject within the field of cognitive science. This is true, as the answer to this question carries practical implications for how people might approach listening to music while reading. Given the goal is to maximize reading performance. Alternatively, it can affect how we design shared working spaces if it turns out that background noise (or sound) has a substantial negative impact.

In an attempt to contribute to the growing knowledge on the effects of listening to music while reading, we strive to provide insight into how humans deal with or are affected by different musical input by measuring its effects on eye movement during reading (Calderwood et al., 2014; Kennedy & Pynte, 2005; Reichle, Warren, & McConnell, 2009; Zhang et al., 2018). ()

1.2 Research Questions

We exposed the participants to three types of music with differing auditory arousal levels, while they engaged in reading as the primary task. We prepared news paper excerpts, which sought to mimic the 'normal' reading situation as much as possible. We then utilised the recorded eye movement as a measure of the effects the music has on the participants' reading efficiency.

Without inferring *a priori* assumptions in regards to what we might expect to see from the data, we deemed it more useful for this study to have it be driven by research questions, rather than hypotheses. As music's effect on reading is a relatively new field of study, we found a predominantly exploratory research design to be the most fitting mode of inquiry. For this first academic endeavour into this field, we strive to answer basic, descriptive questions about our data (Cauchard et al., 2012; Holmqvist & Andersson, 2017; Privitera, 2017). The stated research questions are then partly based on findings in the existing literature as well as fitted to our specific research case:

1. How do readers cope with auditory stimuli interruptions in normal digitally mediated reading situations?
2. Will any novel attention demanding task introduced while reading show negative effects on reading efficiency?
   (a) Is there a correlation between arousal level and disturbance in reading?

2 Related Work

Much of the current research on music and reading generally agree that any sound interference introduced to a reading task has shown to largely have a negative effect on the primary task; namely reading efficiency (Cauchard et al., 2012; Zhang et al., 2018). Earlier proposals to why this result has consistently come up in studies are explained through the lens of Kahneman's *Capacity Theory*, implying that attention is a limited resource, and all subsequent cognitively demanding tasks or sensory inputs will take away from the primary task (Kahnernan, 1973; Rayner & Raney, 1996).

However, to contest this claim a series of studies have looked at music (especially classical music) to detect differences in cognitive performance (Furnham & Stephenson, 2007; Gupta, Bhushan, & Behera, 2018). From these studies arose the 'Mozart Effect', which prompted many parents to play classical music to their infants in the hopes of improving their cognitive abilities (Rauscher & Shaw, 1993). It should be noted, however, that these studies did not specifically measure for reading efficiency. Rather, these experiments focused on spatial task performance, which is often associated with solving mathematical problems.

Another study measured the ability to solve arithmetic tasks, while being introduced to agitating, happy or touching music. In addition, the participants were equally distributed between introverts and extroverts. The study concluded that extroverts were significantly more affected by sound interference than introverts (Proverbio, De Benedetto, Ferrari, & Ferrarini, 2018).

While reading efficiency and comprehension cannot be meaningfully separated, we limited the scope of this study to only measure reading efficiency as the product of numeric values for different measures distilled from eye movement data. Optimal efficiency is achieved with fewer fixations, shorter fixation durations and fewer refixations in eye movement averaged per line across the reading task.

Considering the existing literature, reading while being exposed to external audio stimuli should render different effects on eye movement than what can solely be accredited from a particular reading strategy (Catrysse et al., 2018; Rayner, 1998).

The key difference between the two scenarios - reading strategy versus effect of audio stimuli - is that sound will cause distraction based on perceptual input, rather than internal thought patterns. Hence, our inference is that the correlation between auditory stimuli and reading efficiency is closely connected and will resultingly display the reciprocal interchange between the primary task; reading, and the introduced audio stimuli (Zhang et al., 2018). Concretely, we should then detect and identify critical places where the auditory stimuli are more inclined to exhibit some effect on the reading process.

2.1 Music & Arousal

In order to create a framework for understanding how music affects humans while engaging in reading tasks, we looked at arousal levels (low, medium and high) in music as a means of measure. For the purpose of providing a clear understanding of the term arousal, we shall consider it through the lens of arousal-biased competition theory (Mather & Sutherland, 2011). According to ABC theory '[...] *listening to music affects the arousal and mood, which then influence performance on various cognitive skills*', where '[...] *physiological responses to music differ depending on the type of music heard.*' (Husain et al., 2002).

The particular study of the effects of arousing music on competing goal-depending stimuli such as reading is not well understood. To the best of our knowledge, no study exists which attempts to combine ABC theory with reading tasks and music listening, while utilising eye-tracking as its main methodology (Holmqvist & Andersson, 2017).

3 Method & Experimental Setup

3.1 Participants

A total of 16 participants (8 female, 8 male) partook in the experiment. The majority reported perfect or corrected to perfect vision (75%), and perfect hearing (100%). 50% of the participants held a graduate degree, 6 participants an undergraduate and 2 had graduated from high school. The average age of the participants was 25.1 years. Only 3 participants (19%) reported English as their

first language (L1). All participants agreed to the experiment by signing a written consent form presented prior to the experiment.

3.2 Eye Tracking Apparatus

We employed a Tobii X120 eye-tracker with a sample rate of 120 Hz to record the participants' eye movements. The recording system included one monitor of type ASUS PB279 connected to an NVIDIA GeForce GTX 1070 graphic card mounted in a standard desktop computer. The monitor was equipped with a screen resolution of 2560 × 1440 pixels. The refresh rate was set to 30 Hz. The external eye-tracking device was positioned centred in front of the monitor. The eye tracker and monitor were installed on a height-adjustable office desk at which the participants conducted the experiments. We adhered to the manufacturer's recommendation after which the eye tracker is intended to be used by a subject at a distance of approx. 60 centimeters from the recording device. The recordings were carried out by a licensed version of the Tobii Studio software (v3.4.8) installed on a Windows 10 OS (64-bit).

3.3 Material

3.3.1 Reading Material

The English reading corpus consisted of 30 text excerpts extracted from 13 online articles published in *The Independent* newspaper (see Appendix). All articles were written in English (UK) and spanned various topics prominent at the time the articles were retrieved. We picked coherent passages that ranged from a character length of 445 to 1054 ($mean = 733.1$, $STD = 163.2$).

As the focus of this study is to explore the impact of music on reading efficiency, we removed factors that are known to influence reading efficiency. Previous eye-tracking literature suggests that readability affects the reading process (Sinha, Chaki, De Kumar, & Saha, 2019). The fact that low readability results in impaired reading then posed as a potential major source of error for our study, if not properly accounted for.

To analyse the readability of the given texts, we computed two long-established scores for each text: the Flesch Reading-Ease (FRE) (Kincaid, Fishburne Jr, Rogers, & Chissom, 1975) and the SMOG grade (McLaughlin, 1969). The Flesch Reading-Ease computes a numeric score, ranging from 0 to 100 and will translate to a certain educational level. Similarly, the SMOG grade directly returns the approximate number of years of education required to be able to read the given content (McLaughlin, 1969).

The observed FRE score ($mean = 50.1$, $STD = 13.7$) suggests an education level equal to 10th to 12th grade, whereas the SMOG grade ($mean = 13.2$, $STD = 2.5$) approx. equates to 13 years of education on average. We selected the aforementioned 30 text excerpts in a way so that the variation of readability scores was kept as low as possible while ensuring that the passages stay coherent and intelligible for themselves. We went with this approach to ensure that people attending formal education at university level would be able to read the texts with ease. Further, we presumed the majority of our participants would not have English as their first language, which in turn too advocates for keeping the readability scores low.

Each passage was plotted on a PNG image (1920 x 1080 pixels) which was displayed in full resolution on the screen. Paragraphs were centered horizontally and vertically on the image canvas, as well as formatted as justified text. To minimise horizontal head movements the content width was set to 992 pixels.

For improved text legibility, we investigated in picking one optimal subset of typographical parameters to design the reading material displayed to the participants. Previous eye-tracking research (Josephson, 2008) has shown that on-screen text legibility was optimal for *Verdana* among others that are specifically designed for on-screen textual content. As a result, we utilised the *Verdana* sans-serif typeface for all texts, incl. reading material and instruction screens. A previous eye-tracking study on reading performance (Rello & Marcos, 2012) revealed a user preference for large font sizes (22 and 26 pt) over smaller alternatives for on-screen content. Hence, text was displayed in 24 pt which translated to a visual angle of approx. 0.6° for each character given the viewing distance of 60 centimeters. Previous work (Rello, Pielot, & Marcos, 2016) suggests that a deviation of line spacing within the tested range of 0.8 to 1.8 line heights does not reveal a significant effect on legibility for on-screen content. To create sufficient padding for the sensor camera to capture eye movements within the configured areas of interests (AOI), we set the line height consistently to 2.0. Paragraph

spacing was set to 2.5. To prevent eye strain and at the same time strengthen reading stamina, the text was displayed in dark gray (HEX #333333) on pure white background (HEX #ffffff). According to a research study (Aleman, Wang, & Schaeffel, 2018), this technique prevents the retina from overstimulating and enable participants to read for longer periods.

3.3.2 Auditory Stimuli

To find good candidate songs for the introduced arousal levels (low, medium and high), we followed the procedure introduced by Patra, Das, and Bandyopadhyay (2016). First, the three male annotators (the authors) each added 6 songs to a pool of potential candidate stimuli. All annotators were enrolled in a graduate degree program and are between 25 and 27 years old at the time of writing. The annotators anonymously voted each song into one arousal group. Next, we picked a total of 9 candidates (3 songs for each group) that all annotators agreed on in terms of arousal levels, shown in table 1. Cohen's kappa score (Cohen, 1960) for the classification of the initial pool of 18 songs was computed to 0.70 which translated to 'substantial' agreement. In each experiment, songs within each arousal group were played in random order.

Arousal group	Title	Artist
Low	A Better Place	Joel Lyssarides
	El Suelo Mio	Jorge Roeder
	Recollections	jrd.
Medium	Sundown	Arbour
	A Waltz for My Best Friend	Kupla
	Salt Lamp	Jobii
High	Rattlesnake	King Gizzard & The Lizard Wizard
	You Mess Me Up	The New Mastersounds
	Burnin	Calvin Harris

Table 1: Selected auditory stimuli per arousal group.

3.4 Experiment Procedure

Experiments were conducted individually and took 20 to 40 minutes to complete depending on the participant's individual reading speed. Participants were instructed to focus their attention on the primary task of the study: to read and comprehend the presented article excerpts. As the study did not test reading speed, participants were advised to read in their individual pace. In addition, participants were asked to answer a multiple-choice comprehension question (1 correct out of 4) after each trial.

Subsequently, participants were introduced with the eye-tracking apparatus and the recording system. Before each experiment, the eye-tracking camera was calibrated using a 5-point calibration grid. The researcher adjusted the chair position, desk height and camera angle to obtain the optimal distance to the system.

Furthermore, participants were instructed to wear the provided headphones (Bose QuietComfort 35 around-ear) during the entire experiment. Noise-cancelling was disabled. The volume was set to medium-low and kept constant during the entire experiment. Sound was controlled by the researcher.

The experiment started with general background questions (multiple-choice). A general instruction screen was shown afterwards to familiarise the participant with the process. The main part of the experiment consisted of 3 subsequent groups representing the introduced arousal levels (low, medium and high). Each group included 8 trials. Each trial was constructed of one fixation screen, one main screen and one reading comprehension question screen. As seen in figure 1, the fixation screen displayed a black cross (56×56 pixels) approx. 5 characters left of the first character of the text passage on the main reading screen. It was replaced by the main screen after 2 seconds. The main screen constituted the primary reading task of the experiment as it presented the reading materials, as characterised in section 3.3.1. For each participant 24 trials out of 30 were picked at random. Moreover, the trials occurred in random order in each participant sequence and were counter-balanced among all participants.

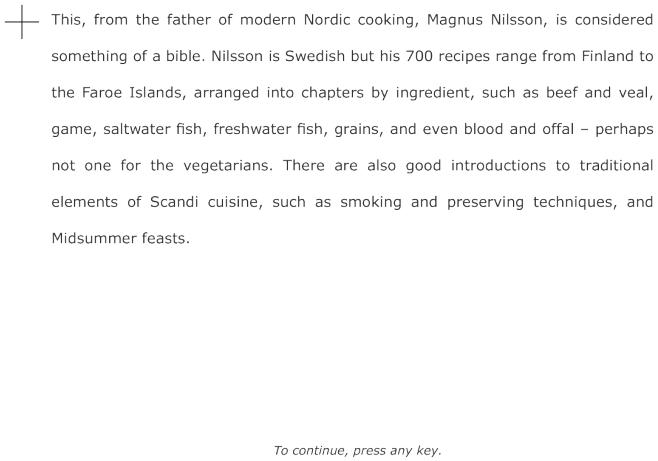

Figure 1: Fixation screen and main reading screen for Text 3 rendered on top of each other. The two screens were shown after each other in each trial.

The arousal levels were randomised per sequence which resulted in 6 variants (e.g. M-L-H). The variants were counter-balanced among all participants to ensure independence of the sequence of arousal levels and the sequence of trials. After each group, a short video (30 seconds) was shown to the participant. Participants were instructed to focus on the video for them to relax between reading tasks.

3.5 Data Collection and Analysis

Single word reading patterns can be affected by several factors such as semantics, morphology and syntactic role (Boyle, 1996). We based our analysis on the hypothesis that the arousal level of auditory stimuli affects eye movement measures sufficiently enough to perceive change not only on single word reading patterns, but also on entire sequences of texts at the same time. Thus, we defined an AOI as the area around the words contained in one line of text, as illustrated by figure 2. The last incomplete line of each text was discarded from the analysis. The average line length was 79.12 characters with a standard deviation of 1.03.

To analyse the subjects' reading process, we carefully selected three eye movement measures which we deemed important: (1) *Mean Fixation Duration* which is defined as the average fixation duration of all fixations contained in one AOI; (2) *Fixation Count* which represents the total number of fixations in each AOI; (3) *Refixation Probability* which is inspired by the word-level quantity proposed by Kennedy and Pynte (2005). A fixation was considered a refixation when the preceding fixation did not hit the current AOI nor an adjacent one.

To identify the relationship between the aforementioned variables and arousal groups (low, medium and high) we joined the participants' eye movement data with the selected screen and audio sequence of the corresponding recording. This enabled us to test for statistical significance between the arousal levels using ANOVA. Afterwards, we employed student T-tests between each pair of arousal levels to also test for pairwise significance.

Figure 2: Text 15 represents a robust example of how the areas of interest (AOI) were designed per reading screen. Each colored rectangle covered one line of text and represented one AOI.

4 Results

4.1 Comprehension Tests

Reading comprehension scores varied greatly among participants. We observed a mean of 20 correct answers out of 24 (82.29%) with a standard deviation of 2 (8.53%). For further analysis, we only included eye movement data of subjects that exhibited an accuracy of at least 85%. This rendered participant P01, P04, P10, P11, P12, P13, and P16 as suitable candidates for the next steps in the analysis.

4.2 Mean Fixation Duration

To compare the fixation duration of all participants without taking personal reading patterns into account, we encoded the zero-mean and 0 to 1 normalisation of the fixation duration for each participant. We examined the relationship between the *Mean Fixation Duration* and arousal level. With a type 2 ANOVA, we observed a P-value of 0.22, which discarded any possible relation between the *Mean Fixation Duration* and the arousal level.

Next, we repeated the analysis with the cleaned subset of participants, as illustrated in section 4.1. The resulting P-value of this ANOVA test was 0.36. Since this endeavour failed in rejecting the null hypothesis, we discontinued any further analysis of this variable.

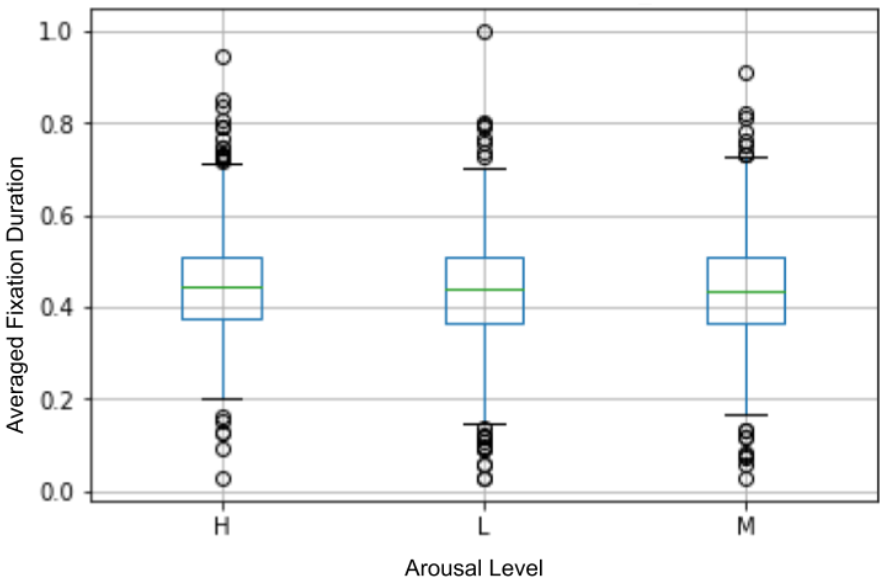

Figure 3: The distribution of *Mean Fixation Duration* in relation to arousal level. *H* is associated with high, *L* with low and *M* with medium arousal. This analysis only took participants with at least 85% accuracy into account.

4.3 Fixation Count

Similarly, as for the *Mean Fixation Duration*, we initially performed an ANOVA in which we tested the relationship between *Fixation Count* per AOI and arousal level. For the analysis of all participants we calculated a *P*-value of 0.38, which discarded any possible relation between *Fixation Count* and arousal level. Figure 4 shows the distribution of *Fixation Count* per arousal level for a second analysis utilising only the participant subset. Even though high arousal has a higher *Fixation Count* at first glance, the analysis resulted in *P*-value of 0.24 which similarly did not suffice to satisfy the null hypothesis.

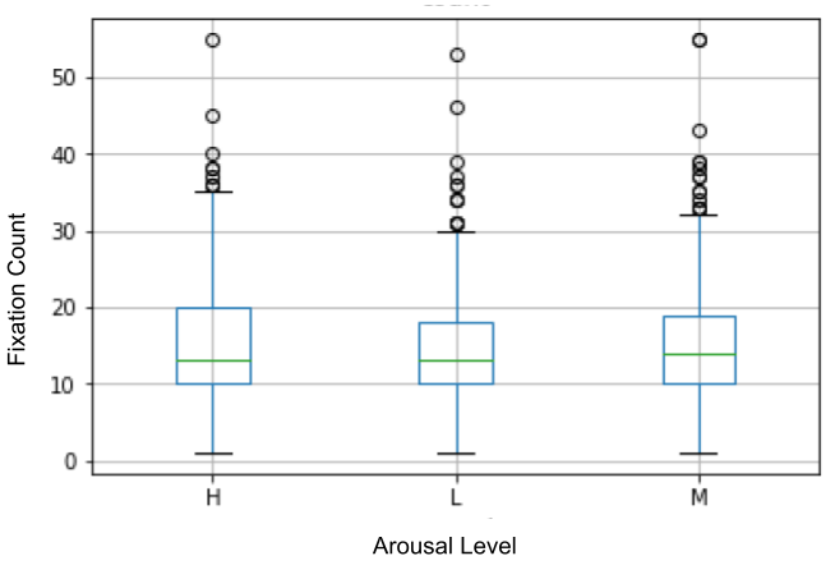

Figure 4: The distribution of *Fixation Count* in relation to arousal level. *H* is associated with high, *L* with low and *M* with medium arousal. This analysis only took participants with at least 85% accuracy into account.

4.4 Refixation Probability

After realising that we would not be able to prove any relation between arousal level and *Mean Fixation Duration* or *Fixation Count*, we continued our investigations with a measure presented in more recent reading studies Kennedy and Pynte (2005), the *Refixation Probability*. In similar fashion to the previous analyses, we carried out two ANOVA tests. The first test included all participants and resulted in a P-value of 0.003 while the second test resulted in a P-value of 0.015. Both results enabled us to reject the null hypothesis. Figure 5 shows the distribution of *Refixation Probability* per arousal level for the second analysis utilising only the participant subset. In order to explain which arousal levels were different between each other, we performed student T-tests. Table 2 illustrates the P-value of the two-sided T-test for each pair of arousal levels.

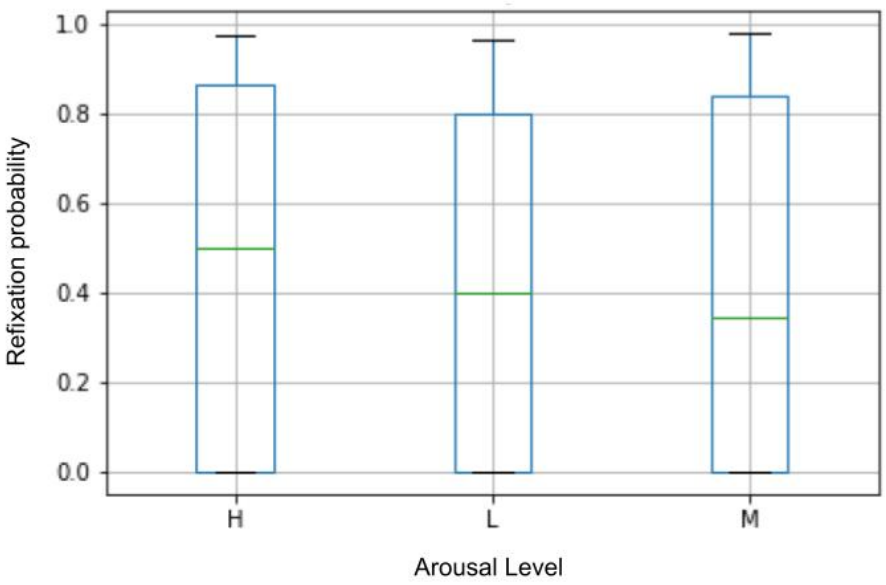

Figure 5: The distribution of *Refixation Probability* in relation to arousal level. H is associated with high, L with low and M with medium arousal. This analysis only took participants with at least 85% accuracy into account.

Arousal level pair	Participants included	P-value
High-Low	Accuracy > 85%	**0.041**
	All	0.158
High-Medium	Accuracy > 85%	**0.012**
	All	**0.005**
Low-Medium	Accuracy > 85%	0.590
	All	0.15

Table 2: Results from pairwise T-tests.

5 Discussion

5.1 Refixation Probability & Music

We tested three variables in order to establish whether there is a significant difference in reading efficiency when exposed to music while reading. The three variables are (1) *Mean Fixation Duration*, (2) *Fixation Count*, and (3) *Refixation Probability*. The analysis was unable to detect a significant difference between the three reading scenarios for the first and second variable we tested.

However, we did observe a difference in the probability that a participant would go back and re-read previously read text more often when exposed to music with a high arousal level than the other scenarios. This finding partially addresses our research question, since it proves that particular

arousal levels does in fact affect the reading pattern of the participants. One explanation as to why we did not obtain more concrete result could quite possibly be due to the fact that the difference between the low and medium stimuli was simply too subtle to be detectable for the participants. Alternatively, one might speculate that if an introduced audio stimuli is sufficiently low it does not create a noticeable effect. But if it exceeds some set arousal limit, the stimuli might start to show detrimental effects on reading efficiency. Based on the conducted research so far we cannot say for sure. However, these considerations do pose as competent hypotheses for a related future study.

We propose that future experiments should take note of this insight and include a more fine-grained analysis in order to better detect the effects of arousal music in normal reading to further investigate the notion of a higher re-fixation probability. An example of this could be to add single word AOI variables such that re-fixation probability per word, initial gaze duration and mean fixation count could be analysed in same fashion as in (Kennedy & Pynte, 2005).

Even though our primary focus for this study was not to test for reading comprehension, we still chose to incorporate a reading comprehension test to make sure the participants properly focused and absorbed the text information and not just lightly skimming over the words. Although the comprehension test scores should only cautiously be considered due to its implied uncertainty and the risk of running into a *Ceiling Effect* problem, an overall accuracy score of 82,29% is still a valid indicator that the participants did in fact have a pretty good understanding of text contents (Cauchard et al., 2012; Zhang et al., 2018).

In contrast to other eye tracking studies, we chose to have no time limit on reading and we sought to normalize the text parts as much as possible in order to more closely simulate a normal reading session. In Rayner and Raney (1996), they utilised a screen reading design comprising of only single sentence text screens, as well as fixed time restraints for every screen. This setup comes with the obvious benefit of more congruently being able to compare the individual text screens against one another. However, one should factor in the plethora of components that might play into a person's individual reading speed, while not affecting comprehension. For instance a non-native English reader might read slower, while still pertaining the same amount of information. We too speculated that putting people under time pressure might stress them, and thus render incorrect results.

The reason why we chose to steer away from the already performed practices in the aforementioned study is due to the fact that we felt these design choices were in fact limiting the degree of applicability of the results. For example, if the text screen did not in the slightest resemble a normal reading situation, then what good is the data then. Similarly, we did not focus on the speed at which the participants were able to complete the experiment. Rather, we deemed it more pertinent to give them adequate time to complete the tasks in proper fashion.

5.2 Limitations

Throughout the design of this experiment, we experienced various limitations with regards to the Tobii Studio software that ought to be overcome by future work. Most importantly, the editor did not allow audio input to be played in parallel with the presented visual input. This forced us to control the audio sequences manually during the experiment while the software carried out the visual stimuli.

This would have enabled us to control for changes in reading performance while having the musical pitch as a variable. Speculatively, a future study in the effects of sound on reading might seek to explore what correlation exists between for instance the effects of the beat of a high-pitched snare drum in a musical piece have on reading efficiency.

Furthermore, the relatively low number of passed comprehension tests (82.29%) as compared to the >95% reported by Kennedy and Pynte (2005) indicates difficulties with the introduced material or experimental setup. We believe, several factors led to this observation. First, the concept of short comprehension tests can be interpreted differently. In review, we found that some questions were in fact more difficult to pass than initially anticipated. Some asked for specific details that were not highly relevant for the overall comprehension of the text passage (e.g. dates), while others offered too similar answer options. We advise future studies to refine the comprehension tests to be more general with regards to the text content. Second, the low number of English first language speakers among the participants (19%) might have caused additional comprehension problems. Consequently, we suggest future studies to focus on native English speakers only.

Due to restrictions in regards to the ongoing COVID-19 pandemic we only managed to recruit 16 participants. We confirmed planned experiments with about 30 participants. However, due to the

complete lockdown of campus, we were forced to cancel the remaining experiments. To allow more detailed analyses, future studies would benefit from larger gaze data sets, either gathered through more participants or extra trials per subject.

6 Future Work

We believe that incorporating a no-sound control group into the experimental design is essential for future investigations. To test how our findings compare to 'silent' reading scenarios where the independent variable (arousal level) is omitted, we suggest adding an extra group per sequence in that no auditory stimuli are presented to the participant.

The relationship between musical patterns and the reading process embodies a promising path for future work. For instance, previous work (Beauchene, Abaid, Moran, Diana, & Leonessa, 2017; Garcia-Argibay, Santed, & Reales, 2019) have tested how musical pitch (especially high-pitch sounds) affects reading. Due to the software limitations discussed in section 5.2, analogue analyses were impossible for us. Therefore, we advocate for carrying out more fine-grained analyses on how individual musical features influence eye-movement in reading tasks.

As previous studies (Furnham & Allass, 1999; Proverbio et al., 2018) have demonstrated, personality traits such as extroversion/introversion affect cognitive-task performance. Moreover, Furnham and Allass posits that '*the responses of introverts and extroverts to background stimuli (such as music) should differ according to their specific preference of stimulation level*'. We were inspired to explore the relationship between personality traits and responses to arousal-varying music in a 'normal' reading session. By including a simple background question for each participant, we opened the door for such investigations. However, due to time and space constraints, we were forced to lease this exciting research direction to future studies.

7 Conclusion

In this study, we proposed descriptive questions about the relationship between arousal levels in music and reading. We were unable to identify any significant differences comparing *Mean Fixation Duration* and *Fixation Count* against the different arousal levels. However, *Refixation Probability* showed to be significantly different for the high arousal case.

Therefore, we cannot decisively conclude that music introduced to a reading task renders poorer reading efficiency. However, we can say that the probability of people re-reading previously read text is higher when they are exposed to high arousal music.

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A Appendix

Division of Labour

For this project, we deem that every group member have contributed equitably. Every member has taken active part in every step and in every part of the project - from programming, to literature research, to report writing. In order to comply with the requirements, we added our names to each section.

- Jonas: Abstract, Introduction, Related Work, Discussion, Conclusion, Comprehension Questions
- Héctor: Method, Results, Discussion, Conclusion, Gaze Data Analysis, Statistical Analysis, AOI design
- Lukas: Method, Discussion, Conclusion, Comprehension Test Analysis, Appendix, Supplementary Material

Precautions in Regards to COVID-19

To align with the recommendations of the Danish health authorities, we disinfected the recording system, desk and headphones before and after each experiment. During one session a maximum of two persons were present in the dedicated eye-tracking room. According to this, only one researcher was guiding the participant through the process. Moreover, the researcher and the participant wore a mask during the entire time of the experiment.

Participant Background Information

Table 3 demonstrates the results of the background questions. Each participant was asked to answer basic demographic questions in the beginning of the experiment.

Participant	Age	Education level	English L1	Gender	Perfect vision	Perfect hearing	Personality trait
P01	18-24	Master	Yes	Male	Yes	Yes	Extrovert
P02	18-24	Master	Yes	Female	Yes	Yes	Extrovert
P03	25-29	Master	No	Female	Yes	Yes	Extrovert
P04	25-29	Master	No	Male	No	Yes	Extrovert
P05	18-24	High school	No	Female	Yes	Yes	Extrovert
P06	18-24	Bachelor	No	Female	No	Yes	Introvert
P07	18-24	Bachelor	No	Male	Yes	Yes	Extrovert
P08	25-29	Master	Yes	Female	Yes	Yes	Introvert
P09	25-29	Bachelor	No	Male	Yes	Yes	Extrovert
P10	25-29	Master	No	Female	No	Yes	Introvert
P11	25-29	Bachelor	No	Male	Yes	Yes	Introvert
P12	25-29	Bachelor	No	Male	Yes	Yes	Extrovert
P13	30-34	Master	No	Female	Yes	Yes	Introvert
P14	25-29	Bachelor	No	Male	No	Yes	Extrovert
P15	25-29	Master	No	Female	Yes	Yes	Introvert
P16	18-24	Master	No	Male	Yes	Yes	Extrovert

Table 3: The background information gathered at the beginning of each participant sequence.

Reading Comprehension Tests

Table 4 demonstrates the results of the comprehension tests. Each participant took 24 tests in total as each trial was accompanied by one comprehension question.

Participant	Number of correct answers	Percentage of correct answers
P01	21	87.50%
P02	19	79.17%
P03	20	83.33%
P04	21	87.50%
P05	17	70.83%
P06	20	83.33%
P07	18	75.00%
P08	19	79.17%
P09	20	83.33%
P10	23	95.83%
P11	22	91.67%
P12	22	91.67%
P13	15	62.50%
P14	18	75.00%
P15	19	79.17%
P16	22	91.67%
Mean	20	82.29%
STD	2	8.53%

Table 4: The results of the reading comprehension tests incorporated in the research design after each reading trial.

Reading Material

The following reading material can also be found free and publicly available compacted in a TSV file in the Dropbox Repository designated for supplementary material.

Text 1

Title: 10 best Scandinavian cookbooks
Author: Pippa Bailey
URL: Link to article
Retrieved: 2020-11-30

Simon Bajada is a slightly curveball addition here because he's actually an Australian living in Sweden, but his book is a standout and brings a creative, slightly removed perspective. Being a photographer as well as a cook, each recipe is accompanied by a gorgeous image: we challenge you to find a more beautiful pudding than the nutmeg cream pots with rhubarb and puffed spelt. Our favourite recipes have the Scandic feel without sticking to the classics: kale and buckwheat waffles with eggs, and pear, sage and hazelnut bread.

Text 2

Title: 10 best Scandinavian cookbooks
Author: Pippa Bailey
URL: Link to article
Retrieved: 2020-11-30

This, from Swedish chef Niklas Ekstedt, focuses on a particular cooking method: cooking over flame. Its intro covers the practical elements for great results: wood, fire, iron, smoke and fat, before a chapter on basic ingredients, including making your own butter, rye bread and pickling liquid. There's plenty of herring and roe in the "small dishes" chapter (try the juniper-smoked turbot, roasted onion and brown butter mayonnaise), while venison meatballs with red cabbage salad and blackened apple is a standout elsewhere.

Text 3

Title: 10 best Scandinavian cookbooks
Author: Pippa Bailey
URL: Link to article
Retrieved: 2020-11-30

This, from the father of modern Nordic cooking, Magnus Nilsson, is considered something of a bible. Nilsson is Swedish but his 700 recipes range from Finland to the Faroe Islands, arranged into chapters by ingredient, such as beef and veal, game, saltwater fish, freshwater fish, grains, and even blood and offal – perhaps not one for the vegetarians. There are also good introductions to traditional elements of Scandi cuisine, such as smoking and preserving techniques, and Midsummer feasts.

Text 4

Title: Booker Prize 2020: A guide to the shortlisted authors, from Douglas Stuart to Avni Doshi
Author: Martin Chilton
URL: Link to article
Retrieved: 2020-11-30

The 2020 Booker Prize for Fiction contains the most diverse shortlist in the award's 51-year history, featuring four debut novels, and four books by writers of colour. One of these authors is Zimbabwean author Tsitsi Dangarembga, who was arrested this July in Harare for anti-government protests. The award has come a long way since it was dominated by male, privately-educated writers, something that prompted author Julian Barnes to dub the Booker Prize "posh bingo".

Text 5

Title: Booker Prize 2020: A guide to the shortlisted authors, from Douglas Stuart to Avni Doshi
Author: Martin Chilton
URL: Link to article
Retrieved: 2020-11-30

Avni Doshi's debut novel Burnt Sugar, set in India, is also a mother-daughter drama, but one about an intense, toxic relationship. The pregnant narrator Antara is preoccupied with her unpleasant mother's Alzheimer's, as Antara faces up to the truth about their fraught, conflict-filled past. As well as a searing social commentary, Doshi has written a defiantly unsentimental (and sometimes bleakly humorous) tale about the chaos of family life.

Text 6

Title: Booker Prize 2020: A guide to the shortlisted authors, from Douglas Stuart to Avni Doshi
Author: Martin Chilton
URL: Link to article
Retrieved: 2020-11-30

"Shuggie Bain, the debut novel by Glaswegian-born Douglas Stuart, is the bookmakers' favourite to win the Booker, and would get my vote. It's a brutal, tender and darkly funny account of Shuggie, a child who grows up as the gay son of Agnes, a self-destructive, wild alcoholic drowning in the Thatcher-ravaged Glasgow of the 1980s. Bain's haunting story is about poverty, inequality, toxic masculinity, homophobia and how even the worst situations can bring out the best in people.

The Booker Prize winner will be announced in a live ceremony broadcast by BBC Front Row and BBC iPlayer from 7.15pm on Thursday 19 November".

Text 7

Title: Sheffield United vs West Ham result: Rare Sebastien Haller goal condemns bottom Blades to another defeat
Author: Sean Taylor
URL: Link to article

Retrieved: 2020-11-30

"A rare top-flight goal from Sebastien Haller handed West Ham a win at Bramall Lane on Sunday, piling further misery on bottom Sheffield United.

United were the greatest surprise package last term on their return to the Premier League as they finished ninth, but Chris Wilder's men are enduring a difficult second season at the highest level.

The Blades have just one point from their opening nine games, with Haller's finish from the edge of the box on 56 minutes condemning the hosts to a fourth straight defeat and an eighth in the Premier League this campaign."

Text 8

Title: Cyber Monday tech deals 2020: Best offers from Sky, Samsung and Ring
Authors: Louise Whitbread, Eva Waite-Taylor
URL: Link to article
Retrieved: 2020-11-30

"Whether it's Apple AirPods, a fitness tracker, or a portable speaker, tech gadgets are the products you're likely to find on Christmas lists, but the prices aren't always so attractive.

Luckily, Black Friday is nearly here, and it's the best time of year to get a great deal on big-name brands such as Huawei, Beats and Samsung.

What began as a one-day sale after Thanksgiving, quickly went on to span the whole weekend until the following Monday, also known as Cyber Monday, while now many retailers also offering pre-sales the week before."

Text 9

Title: Cyber Monday tech deals 2020: Best offers from Sky, Samsung and Ring
Authors: Louise Whitbread, Eva Waite-Taylor
URL: Link to article
Retrieved: 2020-11-30

"As coronavirus continues, this year's sale will move online, so you'll only have virtual queues to contend with, rather than standing in the cold outside a physical store.

Whether you're on the hunt for new loungewear, a warm winter coat or chunky black boots that will last you years, fashion often sees some of the biggest discounts, with retailers including Asos, Missoma, and Oliver Bonas expected to participate again this year. Below we've listed the early-bird deals to shop now and beat the rush.

Throughout the long weekend of sales and during the weeks leading up to the event, we'll be bringing you the best deals to help you bag a bargain on everything from outerwear to underwear and everything in between, so ticking off your shopping list will be a breeze."

Text 10

Title: The future of Fox News is hanging in the balance
Author: James Moore
URL: Link to article
Retrieved: 2020-11-30

In a recent column I looked at the rise of rivals like One America News (OAN) and Newsmax that seek to outflank the network on the right, which would be tougher with the possible launch of Trump TV (or maybe the soon-to-be-former president will partner with one of them). I wonder how Fox responds. It's a fascinating question given the pushback it's facing from its audience and the central role it plays in Rupert Murdoch's empire. CNN's Brian Stelter has made the point that Fox's much smaller, but suddenly fast-growing rivals, are driven by their Donald Trump loyalist viewers' demand for a fictional universe in which their god-emperor won the election.

Text 11

Title: Gyms opening: What are the new rules and how can you stay safe?
Author: Sarah Young
URL: Link to article
Retrieved: 2020-11-30

"In the days before coronavirus, sweat-inducing classes were a vital part of many people's routines. But after prime minister Boris Johnson ordered all gyms to close as part of the nationwide lockdown on 23 March, people were forced to find other ways to get their fitness fix. Last month, the general consensus was that the date for the grand reopening of gyms would be 4 July, alongside other personal care establishments such as hairdressers.

In the government's "Our Plan to Rebuild" document, gyms and fitness studios were highlighted as part of step three, which it stated would come into action no earlier than 4 July, though the Mr Johnson made it clear this would be subject to the government's five objectives being met."

Text 12

Title: Gyms opening: What are the new rules and how can you stay safe?
Author: Sarah Young
URL: Link to article
Retrieved: 2020-11-30

"Then on Friday 3 July, Mr Johnson told LBC radio that gyms would be able to reopen in a "couple of weeks". He said: "We are going to reopen gyms as soon as we can do it in a Covid-secure way and I think that the date for reopening gyms at the moment, if we can do it, is in just a couple of weeks' time."

On Thursday 9 July Culture Secretary Oliver Dowden confirmed the date for reopening would be 25 July, saying that "normal life is slowly returning." But gyms will not look the same as pre-pandemic; there will be new rules and ways of operating to keep everyone safe. ""We will be giving gyms the certainty, clarity and time that they need to open safely,"" he said."

Text 13

Title: Gyms opening: What are the new rules and how can you stay safe?
Author: Sarah Young
URL: Link to article
Retrieved: 2020-11-30

"Why is it important for gyms to reopen?

The fitness industry reacted with frustration at Mr Johnson's decision to give the green light to many sectors of the economy, but not gyms.

PureGym, one of the UK's largest operators with more than one million members, said in a statement: "We understand that these decisions are not easy, but it is a strange 'war on obesity' that sees pubs and restaurants open before gyms.

"Our facilities are, on average, the size of five or six doubles tennis courts and are exceptionally well ventilated, enabling people to work and exercise safely and securely.""

Text 14

Title: The Secret Behind Babbel: Our Language Learning Approach Is Built On 3 Pillars
Author: Thea Bohn
URL: Link to article
Retrieved: 2020-11-30

Berlin is an international city where you'll hear snippets of conversations in dozens of different languages on the daily. This is one reason why it's the perfect city for Babbel's headquarters — we are 600 language enthusiasts piling into one five-story building in the heart of Berlin. Babbel has employees from over 60 countries, speaking more languages than you can imagine, all working on one popular product in this space. Working here, I'm often asked how Babbel is so good at teaching

people new languages. To answer this question, I decided to sit down with our own multilingual Belen Caeiro. She leads our Product Marketing team here at Babbel and knows the app inside and out. Here's what she said about why learning a language with Babbel is so effective.

Text 15

Title: The Secret Behind Babbel: Our Language Learning Approach Is Built On 3 Pillars
Author: Thea Bohn
URL: Link to article
Retrieved: 2020-11-30

"We learn a new language in order to speak it with other people. To make that possible, our product has a few special features," explains Belen. She opened the Babbel app on her laptop and pointed to the overview of the available courses. "We categorize language learning content in Babbel into relevant topics." Depending on the language, you'll find cultural traits and the most common conversation topics right at the beginning. Using public transportation, ordering food and expressing what you want — these are all at the top of the list. Belen points out that the learning content builds on itself, so it's easy to stay oriented. But if you just want to refresh a few topics, you can also jump right in! Belen clicks "next" on a lesson and then on the microphone symbol: "We use our users' feedback to continually optimize our product. Thanks to our customer service team, but also the feedback we collect in meetups, we know that our users want to practice their pronunciation. Our speech recognition feature in the product supports them in that."

Text 16

Title: The Crown: The true events leading up to the wedding of princess Diana and prince Charles
Author: Charley Ross
URL: Link to article
Retrieved: 2020-11-30

"Prince Charles and Lady Diana Spencer announced their engagement at Buckingham Palace in February 1981, and were married only months later in July.

However, their marriage was not to be the royal fairytale that it was often publicly portrayed as – the royal couple divorced in 1996 after having two sons together, William and Harry.

There were, perhaps, some signs there could be trouble ahead – Diana herself said that she had only met Charles 12 times before they became engaged and Diana was only 19 years old when she accepted Charles proposal – the prince was 32.

Charles allegedly had reservations in the lead up to the marriage, not least because of his feelings for his (now wife) Camilla Parker Bowles, who he eventually married in 2005. "

Text 17

Title: The Crown: The true events leading up to the wedding of princess Diana and prince Charles
Author: Charley Ross
URL: Link to article
Retrieved: 2020-11-30

"Charles also reportedly had misgivings about the relationship before he proposed, particularly about the media frenzy that was forming around Diana.

According to royal biographer Robert Jobson's 2018 book Charles At Seventy: Thoughts, Hopes And Dreams, Charles was encouraged by his father the Duke of Edinburgh to either release Diana, or propose to her as a means of stabilising things for her.

Unfortunately, choosing to propose escalated the media frenzy and brought into sharp relief how little the couple had in common.

"I desperately wanted to get out of the wedding in 1981, when during the engagement I discovered just how awful the prospects were, having had no chance whatsoever to get to know Diana beforehand." he told Jobson."

Text 18

Title: 'It's always been counter cultural': Is witchcraft part of an anti-science renaissance?
Author: Naomi Curston
URL: Link to article
Retrieved: 2020-11-30

"witchcraft "is not based on dogma or a set of beliefs, nor on scriptures or a sacred book revealed by a great man. Witchcraft takes its teachings from nature, and reads inspiration in the movements of the sun, moon, and stars, the flight of birds, the slow growth of trees, and the cycles of the seasons."

This is how Starhawk, an author, activist and witch, defined witchcraft in her book The Spiral Dance in 1979. In other words, it's a broad and flexible nature-based practice, and those who practice witchcraft may both use and honour nature in their spiritual practice.

As you read this, many witches may be gearing up for the new moon (the new moon is a great time to set intentions, as they will grow alongside the waxing moon over the next two weeks), but the way each witch marks this moon phase will be very different. Likewise, different witches have different ways of interpreting the world."

Text 19

Title: Why are so many gym-going, young men suffering from 'muscle dysmorphia'?
Author: Ieuan Cranswick
URL: Link to article
Retrieved: 2020-11-30

"body image concerns among men are increasingly common and can have a serious impact on mental health. And for an estimated one in ten young men who go the gym in the UK, these body image concerns can result in a mental health condition known as muscle dysmorphia.

Though researchers are only just beginning to understand the complexities of the condition, it appears young men are currently being affected by it at a higher rate compared to other sectors of the population. It's believed there are many reasons driving this, but researchers have found that media and social media pressure, alongside changing ideas of masculinity may both be major causes.

Sometimes referred to as "bigorexia" or "reverse anorexia", people with muscle dysmorphia believe their body is too small, skinny, or insufficiently muscular – even though the opposite may be true."

Text 20

Title: Why are so many gym-going, young men suffering from 'muscle dysmorphia'?
Author: Ieuan Cranswick
URL: Link to article
Retrieved: 2020-11-30

"But currently diagnosing muscle dysmorphia is still difficult. Though several self-report surveys exist to help physicians diagnose patients, these surveys only assess related symptoms (such as a desire for bigger muscle, or body image issues) rather than offering a robust diagnosis.

Diagnosis also relies on patients meeting a specific set of criteria, such as having a preoccupation with being lean and muscular, lifting weights excessively, and dieting. But since so many different methods are used to diagnose muscle dysmorphia, this can make fully understanding the condition difficult.

However, in general, most experts agree people with muscle dysmorphia tend to engage in steroid use, have symptoms of eating disorders (such as compulsive exercise and eating habits) and higher body dissatisfaction, usually with their general appearance, weight and muscularity."

Text 21

Title: Facebook accused of 'risking staff lives' by forcing them back to offices during pandemic
Author: Kate Ng
URL: Link to article
Retrieved: 2020-11-30

”More than 200 Facebook employees have written an open letter accusing the social media giant of forcing them back into the office despite the ongoing pandemic.

The open letter, from Facebook content moderators based all over the world, said the firm was placing them at risk of contracting Covid-19 in order to “maintain Facebook’s profits during the pandemic”.

They called on Facebook to prioritise the health of employees and their families, to allow more remote work, and offer other benefits, including hazard pay and mental health care. According to the letter, content moderators who had a doctor’s note about “personal Covid risk” were exempt from going to the office, but moderators with relatives who are vulnerable to the virus were not.”

Text 22

Title: Facebook accused of ‘risking staff lives’ by forcing them back to offices during pandemic
Author: Kate Ng
URL: Link to article
Retrieved: 2020-11-30

”The firm added that all content moderators have access to “healthcare and confidential wellbeing resources” and that Facebook has “exceeded health guidance on keeping facilities safe”.

A spokesperson for CPL said in a statement that the nature of content moderators’ work means “it cannot be carried out from home”, adding that their “roles are deemed essential”.

“The health and safety of our employees is our top priority and we review each employee’s situation on a case by case basis,” they said. ””Our employees work in a state-of-the art office, which is operating at 25 per cent capacity to facilitate strict social distancing. We are providing private transport to and from the office, so employees do not need to take public transport.”

Text 23

Title: Facebook accused of ‘risking staff lives’ by forcing them back to offices during pandemic
Author: Kate Ng
URL: Link to article
Retrieved: 2020-11-30

”The summer visitors have gone, and the winter rains and wind have reclaimed County Kerry, a remote and beautiful region in the southwest of Ireland. But the residents of Dingle, accustomed to all that, have an even bigger worry: Fungie, the resident male, bottlenose dolphin that helped transform it from a small fishing and farming community into a global tourist destination, has vanished after 37 years.

Two weeks after the last confirmed sighting of Fungie, on 13 October, boats were still going out every day – storms and ocean swell permitting – to search the rocky coast for signs of the missing dolphin. At the narrow mouth of the harbour, where he spent most of his time, people with binoculars scan the waves for a glimpse of his dorsal fin. Yet hope is diminishing.

Kevin Flannery, a marine biologist who built a popular aquarium on the back of the Fungie phenomenon, says the dolphin had gone missing before but only ever for a day or two.”

Text 24

Title: Facebook accused of ‘risking staff lives’ by forcing them back to offices during pandemic
Author: Kate Ng
URL: Link to article
Retrieved: 2020-11-30

”Mankind should develop the technology to spot and destroy large asteroids hurtling towards the Earth, the scientist Richard Dawkins has said.

The evolutionary biologist, best known for his writing on atheism, made the comment on social media in response to a story in The Independent about the extinction of the dinosaurs. The article had outlined a new study claiming that the dinosaurs would have continued to thrive on our planet for longer if a large asteroid had not struck 66 million years ago. This contradicts previous suggestions that the large reptiles were already in steep decline prior to this event.

Using statistical modelling, researchers at the University of Bath and the Natural History Museum in London concluded that the dinosaurs could have remained the "dominant group of land animals on the planet" if the asteroid collision had not been so severe."

Text 25

Title: 'The need for human contact is extremely profound': When we can hug, will we remember how?
Author: A C Shilton
URL: Link to article
Retrieved: 2020-11-30

"Alexis Block was worried that the robot she had built was malfunctioning. She was testing the optimal hug duration for her "HuggieBot 1.0", a purple-furred squeeze machine. Block had built pressure sensors into the machine's torso, so if the human tester tapped or squeezed the robot on the back, it let go. But this hug was going on and on. "I worried that the pressure sensors were malfunctioning," she says.

Her palms began to sweat (getting stuck in the clutches of a giant robot is no one's idea of a good time). But then, the hug ended, and the HuggieBot released its test subject. When Block, who is working toward her PhD at the Max Planck ETH Centre for Learning Systems in both Stuttgart, Germany, and Zurich, Switzerland, asked the subject if something had gone wrong, he surprised her by saying that he had wanted the hug to last a long time. "He said, 'I just needed it, and the robot wasn't going to judge me.'""

Text 26

Title: 'The need for human contact is extremely profound': When we can hug, will we remember how?
Author: A C Shilton
URL: Link to article
Retrieved: 2020-11-30

"Which brings us to the first rule of Hug Club: you don't have to hug anyone you don't want to, and it's best to ask before going in for a squeeze. While, of course, you can simply say, "Can I hug you?" Dr Wendy Ross, director of the Centre for Autism and Neurodiversity at Jefferson Health in Philadelphia, says a better way to ask is: "Some people like hugs; some don't. What do you prefer?" This framing makes the question about the other person's preferences.

In most of the cases, people first of all have this very soft hug, and whenever a certain time was passing, they started to pat on the back, and then they separated.

Ross notes that asking for consent for interpersonal touch is crucial. This extends to children, too – no matter how much you want a hug from your niece or nephew. "We're sending our kids really mixed messages when we say 'our bodies are our own,' but also, 'you need to hug your grandma,'" says Regine Galanti, a child psychologist who practices in Long Island, New York."

Text 27

Title: Can old dogs teach us new tricks about the ageing process?
Author: James Gorman
URL: Link to article
Retrieved: 2020-11-30

"Dogs go through stages in their life, just as people do, as is obvious to anyone who has watched their stiff-legged, white-muzzled companion rouse themselves to go for one more walk. Poets from Homer to Pablo Neruda have taken notice. As have folk singers and storytellers. Now science is taking a turn, in the hope that research on how dogs grow and age will help us understand how humans age. And, like the poets before them, scientists are finding parallels between the two species.

Their research so far shows that dogs are similar to us in important ways, like how they act during adolescence and old age, and what happens in their DNA as they get older."

Text 28

Title: Can old dogs teach us new tricks about the ageing process?
Author: James Gorman
URL: Link to article
Retrieved: 2020-11-30

"Most recently, researchers in Vienna have found that dogs' personalities change over time. They seem to mellow in the same way that most humans do. The most intriguing part of this study is that like people, some dogs are just born old, which is to say, relatively steady and mature, the kind of pup that just seems ready for a Mister Rogers cardigan. "That's professor Spot, to you, thank you, and could we be a little neater when we pour kibble into my dish?" Mind you, the Vienna study dogs were all border collies, so I'm a little surprised that any of them were mature. That would suggest a certain calm, a willingness to tilt the head and muse that doesn't seem to fit the breed, with its desperate desire to be constantly chasing sheep, geese, children or Frisbees. Another recent paper came to the disturbing conclusion that the calculus of seven dog years for every human year isn't accurate. "

Text 29

Title: Can old dogs teach us new tricks about the ageing process?
Author: James Gorman
URL: Link to article
Retrieved: 2020-11-30

"Merriam-Webster's dictionary defines a time warp as a "discontinuity, suspension or anomaly" in the otherwise normal passage of time; this year, all three terms could apply. It seems like March happened 10 years ago; every day may as well be Wednesday, and still, somehow, here come the holidays – fast, just like every year.

Some bard or novelist may yet come forth to help explain the paradoxes of pandemic time, both its Groundhog Days and the blurs of stress and fear for those on the front lines, or those who had infectious people in their household. But brain science also has something to say about the relationship between perceived time and the Greenwich Mean variety, and why the two can slip out of sync.

In a new study, a research team based in Dallas reported the first strong evidence to date of so-called "time cells" in the human brain."

Text 30

Title: Can old dogs teach us new tricks about the ageing process?
Author: James Gorman
URL: Link to article
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"The finding, posted by the Proceedings of the National Academy of Sciences journal, was not unexpected: in recent years, several research groups have isolated neurons in rodents that track time intervals. It's where the scientists look for these cells, and how they identified them, that provide some insight into the subjective experiences of time.

"The first thing to say is that, strictly speaking, there are no such things as 'time cells' in the brain," says Gyorgy Buzsaki, a neuroscientist at New York University who was not involved in the new research. "There is no neural clock. What happens in the brain is neurons change in response to other neurons."

He adds: "Having said that, it's a useful concept to talk about how this neural substrate represents the passage of what we call time.""

Text Characteristics

Text	Character Count	Word Count	Sentence Count	FRE	SMOG
1	530	88	3	50.2	11.9
2	527	81	3	44.07	12.5
3	493	78	3	45.09	13.6
4	468	74	3	46.4	12.5
5	445	68	3	39.97	14.1
6	620	103	4	53.75	12.6
7	563	97	3	64.07	8.8
8	541	92	3	57.23	11.9
9	771	132	4	54.90	13.4
10	659	111	4	51.72	13.0
11	729	123	4	48.67	14.2
12	668	130	2	30.88	12.9
13	593	101	3	45.73	16.7
14	767	130	7	69.52	10.3
15	1054	180	9	59.64	11.0
16	747	128	4	55.92	12.2
17	739	119	3	31.18	16.7
18	903	160	5	64.38	11.2
19	854	140	4	35.95	15.6
20	871	127	5	20.31	18.0
21	747	121	4	40.72	14.9
22	743	121	3	30.57	17.5
23	951	166	6	60.28	12.2
24	872	141	4	35.65	17.4
25	925	166	7	72.80	8.0
26	1001	183	6	65.9	10.9
27	659	117	6	77.06	10.5
28	902	160	5	55.92	13.0
29	853	149	5	58.15	12.7
30	798	133	3	34.97	16.3
Mean	733.1	124.0	4.2	50.1	13.2
STD	163.2	30.6	1.5	13.7	2.5

Table 5: Counts and readability measures for each text