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HOW FAST IS TOO FAST: AN ANALYSIS OF THE RELATIONSHIP BETWEEN
AUDIO COMPREHENSION AND PLAYBACK SPEED

by

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ABSTRACT

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A lack of research regarding audio-only comprehension has created inconsistency in what would be considered average performance in terms of comprehension. Most research has focused on coupling this with video components leading to varying results due to cueing and a lack of standardizing testing methods. Given the advent of audio-only in an educational setting through means such as lectures and podcasts, understanding how those who engage with them using tools such as playback manipulation is becoming increasingly important. This study analyzes the effect of playback speed on comprehension and attempts to find the range where comprehension decreases. Participants underwent five different assessments ranging from 1 to 2 times original playback speed in increasing increments of .25, testing their comprehension between trials. Findings suggest that prior to the speed of 1.75 times, individuals should not expect a drop off in terms of performance. This suggests advising individuals to utilize playback

manipulation tools across modalities, leading to a 40% decrease in time required to listen to the material.

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CHAPTER I:
INTRODUCTION

The State of the Current Related Literature

Technology is increasing the level of autonomy that the population has for how they consume information. One such modality of information is audio processing. Having the ability to listen to information outside of a scheduled timeframe allows individuals to process information at their own rate. Given that reality, technologies have been developed and are being refined to optimize information processing through this specific modality (Kao et al., 2014). One notable tool is manipulating the playback speed of an artifact. These are typically presented in a video or audio form. Using playback manipulation, or speed increases, an individual can decrease the amount of time that it takes to “go through” the content by increasing the speed at which the content is played.

Additionally, many systems of education are using online lectures as supplemental material. Students are beginning to use the tools available to them to speed up the lecture content with seemingly positive results (Lang et al. 2020). It should be noted that there does seem to be a difference between the type of audio heard. Specifically, if it is from a person or artificially similar to text to speech, with similar speed speaking speech patterns, Gordon-Salant et al. (2014) found that very fast human speech is more difficult to process than artificially enhanced normal speed to similar speed speaking speeds. This was hypothesized to be because of the differences in cadences and irregular speech patterns that artificial software may use. Within these materials, users have the opportunity to manipulate the audio allowing them to get through the information substantially faster (Song et al., 2018).

Currently there is no uniform means of consuming this modality of information and so individuals are left to use their own discretion on what would be ideal for their

listening habits. Furthermore, the lack of uniformity as it relates to speaking speed and cadences may add additional confusion for those who are looking to optimize both their time and comprehension of the subject matter (Gordon-Salant et al. 2015).

Mixed Outcomes

The current literature is mixed regarding the ideal playback speed ranging from 1.4 (Vemuri et al., 2004) to 1.8 (Ritzhaupt et al., 2008). Some studies claim that the effects of speeding up are overstated and have actually been shown to have negative effects on educational outcomes (Ness et al., 2021; Song et al., 2008). Other studies have stated that speeds up to 2.5 times the standard 150 words per minute do not have a significant effect on comprehension (Hausfeld, 1981). The level before unintelligibility is difficult to establish. Unfortunately, much of the literature combines both audio and visual cues in terms of comprehension so decoupling the two becomes difficult. Work by Davidesco et al. (2018), attempt to capture these moments via fMRI readings. There is a demonstrable change in brain function before and after a participant claims to reach their limit (Davidesco et al, 2018). Such research reflects the maximum cognitive load that an individual is able to undergo before they begin to tune out the information and it becomes completely unintelligible.

However, in pursuit of concentrating on providing information that is universally accessible via slowing down speeds, an inverse effect on comprehension presents itself. This is due to an inability to maintain attention out of boredom (Rodero, 2016). This area of boredom is typically found in narratives of less than 170 words per minute (Rodero, 2016).

Finding an optimal middle ground becomes even more difficult to define as it has also been shown that individuals can scaffold themselves to higher levels of speed and comprehension. (Enc & Stolurow, 1960). This also has increased variance in terms of

outcomes due to content difficulty. Individual differences in comprehension are also related to both the speaker, as there are changes in cadences and speed, and the listener's background (Blau, 1990).

Special Populations

Blind Populations

Historical precedence shows that certain demographics of people (blind) have been shown to process audio at rates nearing 5x original speed (Foulke, 1964). Other research indicates that the limit may be closer to 6x the original speed (Moos, 2007). Considering that these rates were found across an entire population of blind participants, anomalous situations likely have that limit substantially higher. Both populations in these studies were blind for the majority, if not all, of their lives. This may be because these same individuals would likely be more attuned to distinctions of intonation of a voice. Additional studies have confirmed this difference, adding that there are clear neurological differences between those who are blind and those who are normal sighted that may account for some of these differences (Röder et al. 2000). As technology becomes more accommodating and tools allow for the speeding up of audio material without inconvenience, it suggests that previous upper limits may need to be reassessed as both baselines and ceilings may have shifted.

Age Related Differences

Age related differences between ability to hear is a byproduct of older individuals being unable to discern between both frequency and pitch (Sommers et al., 2011). This difference in populations is not as pronounced so long as the speech is presented in a standardized frequency that an older individual may feel comfortable hearing (Gordon-Salant et al., 2015). Rather, the difference between the groups is most noticeable in sentences, or even words, that are more cognitively demanding (Gordon-Salant et al.,

2015). These are sentences that have a complex syntactical structure or multisyllabic words. These populations are also more susceptible to cognitive noise that causes the stimulus to deviate outside of the optimal comfort listen zone such as accents (Gordon-Salant et al., 2015). Interestingly, these populations do not have difficulty understanding audio material that is sped up to a 40%-time compressed piece of audio (Dias et al, 2019). This means that they would be able to comfortably listen and comprehend information up to 1.6 times regular speed assuming the average talking rate of 150 words per minute (Dias et al, 2019).

Emerging literature suggests that differences in age may be due to differences in perceptomotor processing speeds rather than age alone (Dias et al, 2019). It and executive function were shown to have a much larger effect on whether a person was able to understand time compressed speech than age alone.

Non-Native Speakers

Also, it should be noted that the literature, barring the data collected by Gordon-Salant et al. (2014), tends to have a skew toward the English language. This is only noted because of research conducted by Pallier et al. (1998) which finds that some languages have a harder/easier time processing faster speed. It is not just exclusive to entire languages, certain dialects have been found to speak faster than others (Jacewicz, 2009). These differences in language add an additional layer of complexity to the preexisting literature because it is unclear the “real” speed of the stimulus that was being manipulated. If optimization were to be pursued, the diversity of languages would need to be represented.

There is also a significant difference between the number of syllables uttered between languages which, assuming equal syllables to compose a word across these languages, equates to 27% and 26% increase in words per minute for Japanese and

Spanish speakers respectively (Rodero, 2012). There is limited research on the effect that a second language has on an individual's ability to understand speech at an increased rate outside of environments where the goal is learning a language.

The Rise of Podcasting

An under-discussed portion of the literature is the effect that podcasts are having on society . The podcasts of choice are becoming just as important as the podcasts themselves. This is because newer platforms for podcasts are adding additional features including the ability to manipulate playback speed. They also have the feature of smart silencing which reduces the delays in conversation (Hennig, 2017). These added features do not have much definitive literature regarding their utility. Furthermore, this particular platform exists solely in audio form. As previously mentioned, most of the existing literature combines audio and video feedback to test. This means that as it pertains to podcasts' effects, much of their impact is hearsay and has yet to be quantified. These exist beyond just recreational activity. They are also being integrated into the education system (Goldman, 2018). The lack of data regarding their utility is something that should be further discussed (Casares, 2020). Given podcasts' ubiquitous nature, it is important to recognize that a concentration of solely audio is necessary as they are becoming more prominent when coupled with other low cognitive load activities (Heshmat et al. 2018). During these same activities, individuals would be unable to engage with a video component (jogging, driving, tending to a garden). This lack of video cues likely affects comprehension to some capacity, thus further research in this domain is necessary.

Audio In Isolation

There have been several efforts that consist of increasing comprehension utilizing playback speed manipulation using both audio and visual feedback (Lang et al., 2020). Isolating audio has become increasingly important given the passive nature of

consumption that the rise of podcasts has created. One such study that highlights this specific modality that was written by Gabay et al. (2017) showed that limited training netted positive results when tested on levels of comprehension. This study used a gradual model within the test. This means the benefits were gained within a brief time period. Increasing speeds over time may have a positive effect on comprehension in certain situations. Research by Orr & Friedman (1968) has shown that reverting back to a “normal” speed following several sessions over the course of even just five days can lead to increased levels of comprehension (40% to 70%). That same research shows that scaffolding comprehension may have more positive effects through longitudinal exposure rather than sheer volume (Orr & Friedman, 1968; Orr et al., 1965; Banai & Lavner, 2014). Considering this, it would be important to see if this persists and if the ability would be flexible across different audio messages. Banai & Lavie (2021) find that trained time compressed speech is more becoming attuned with the speaker rather than the speed. Literature by Dupoux & Green (1997) suggests that an immediate transition to desired speeds may have a negative effect on comprehension.

For the research that does exist, measurements of comprehension are difficult to cross-compare outside of the specific study’s environment (Ahissar et al., 2001). For example, Tarabeih-Ghanayim et al. (2020) state, “...this learning is often specific to the stimuli encountered during practice, with little generalization to untrained materials. The factors limiting the transfer of perceptual learning, especially under more naturalistic circumstances (e.g., as in the case of perceptually difficult speech, such as rapid speech and speech in noise) are not well understood.”

Comprehension measurements range from yes or no responses to sentences (Nourski et al., 2009) to specific word recall (Heiman et al., 1986). Certain research has attempted to distinguish between mastery and comprehension through a multi-response

questionnaire where the participant must reach at least 80% correctness in order to achieve the designation of mastery (Fulford, 1993). Here, subjects were presented with both text and audio ranging from 175 words per minute (normal) to 262 words per minute (fast). Findings show that faster speeds were more efficient in terms of time commitment and course completion. Interestingly, Carver (1982) found that comprehension reached a maximum efficiency at 300 words per minute for both reading and listening.

Lerner et al. (2014) research uses both a dichotomous questioning structure coupled with a semantic understanding structure as well. They combine the results with a confidence interval provided by the participants. Their findings show that people tend to better understand the content holistically. However, individuals also tend to underestimate their performance (Lang et al., 2020). This perception of underperformance is not distinctly separated from the fact that, for many, being exposed to faster audio stimuli is a novel experience. As such, the concept of confidence in information obtained may be an important factor to consider. Research conducted by Behnke & Beatty (1977), has shown that confidence-weighted comprehension scores decline linearly with speeds of up to 275 wpm. This is despite the traditional comprehension score remaining relatively stable. Later research by Beatty et al. (1979), further supported this claim, increasing speeds up to 280 wpm.

Research has also implied that both audio (listening) and visual (reading) may have similar levels of working memory constraints (Kuperman et al., 2021). These constraints also mediate the information being processed as findings from Conrad (1989) show that language proficiency (native or non-native) directly affects the type of content that is received from the same stimulus. This process is further supported by research conducted by Adank & Esther (2009) showing that violations in expected speech patterns serve as a hindrance to understanding the related content.

Purpose of the Study

This research attempts to answer if there are any positive benefits to comprehension when audio stimuli speed is increased and when the moment of comprehension experiences a precipitous decline evident by the sharpest decrease in scores compared to other groups. Based on previous literature, it is hypothesized that an increase in playback speed will increase comprehension up until the moment of unintelligibility. Additionally, groups will be assessed via demographic information, their experience podcasting, and why they podcast to see if there are any attributes that would lead to better performance. Notably the study was conducted remotely allowing the participants to be in an environment that more closely resembles where they would typically consume the associated content.

CHAPTER II: METHODOLOGY

Participants

The participants began with 45 University of Houston Clear Lake students. 4 were excluded due to duplicated work, inability to verify completion, or a survey design error. An a priori analysis was conducted using G*Power version 3.1.9.7 to determine the minimum sample size required to test the hypothesis. Results indicated that the required sample size of 40 to achieve 96% power for detecting a medium effect size of .3, at a significance criterion of $\alpha = .05$, was $N=40$ for a repeated measure within subject ANOVA. Thus, the obtained sample of 41 was adequate to test the study hypothesis. G power was used to validate the results of the research. Identifying the new critical F value of 4.08 and power was expected to be .953. Five groups were chosen because there are five differing variations of the independent variable that will be administered. Participants were incentivized to complete the survey using University of Houston Clear Lake's SONA class credit system. Participants ranged from 18-48 years of age.

Equipment

Several podcasts were used and manipulated using Audacity at different playback speeds creating different artifacts for each playback speed. Playback speed changes affect the speed at which time passes on the audio file. This means that for every second that passes in real-time the audio file elapses a multiplicative amount. Playback speed is used in lieu of time compression to maintain audio integrity and mitigate the effects of the pitch. This is done by changing the tempo on audacity to 25, 50, 75, and 100 "percent change". Additionally, high-quality stretching will be used to keep audio as clear and as close to the original audio integrity as possible. There were no restrictions on the device used to complete the survey. This means that they were allowed to complete it

either via desktop or mobile device. This was done to emulate the typical noise that one would experience when using these materials outside of a controlled environment. Comprehension of the audio files was evaluated using a created test consisting of 10 questions. The questions were completely fill-in-the-blank to limit the effect of the recognition heuristic. These responses used an association-based key where specific keyword or synonyms would count as correct answers. As such a key was made before the experiment was administered. A transcript for each of the podcasts is provided in Appendix A. The five sets of questionnaires and keys are provided in Appendix B.

Transcripts in the study were taken from the Freakonomics podcasts. The first audio file was from episode 389, “How to Make Meetings Less Terrible”. This audio file begins at :51 and continues until 5:01. There are a total of 751 words over the elapsed period. This means that there is an average of 180.24 wpm for this audio file. The second audio file was from episode 370, “How to Fail Like a Pro”. The audio file begins at 1:16 and continues until 6:40. There are a total of 897 words over the elapsed period. This means there is an average of 166.11 wpm for this audio file. The third audio file was from episode 475, “Why Does the Richest Country in the World Have So Many Poor Kids?”. The audio file begins at 6:25 and continues until 11:55. There is a total of 876 words over the elapsed period. This means there is an average of 159.27 wpm for this audio file. The fourth audio file was from episode 511, “Why Did You Marry That Person?”. The audio file begins at 2:40 and continues until 8:23. There are a total of 875 words over the elapsed period. This means there is an average of 153.06 wpm for this audio file. The fifth audio file was from episode 482, “Is Venture Capital the Secret Sauce of the American Economy?”. The audio file begins at 1:23 and continues until 5:16. There are a total of 577 words over the elapsed period. This means there is an average of 148.58 wpm

for this audio file. Overall, podcasts ranged from 148.58 words per minute to 180.24 words per minute.

Procedure

Participants had surveys distributed via an email link that redirected them to Qualtrics. There were 5 variations of the study with each having a differing starting point. Each study was distributed one at a time to make sure to have an even distribution of results.

Participants were informed that they could choose not to participate at any point during the study. All participants took part in all four condition variables of an increase of 1.25,1.5,1.75, and 2x times the original playback speed. The speed of the podcasts will progressively increase in the same previously mentioned order.

Participants were randomly assigned to begin at one of the five podcasts after listening to an audio file to adjust the volume to their liking. Each of the five variations had a different starting point and progressed with different podcasts in each of the speed variables 1, 1.25 ,1.5 ,1.75 , 2x speed so that all podcasts had been represented at least once at any given speed. After completing a podcast, the participant was administered a comprehension questionnaire. The participants attempted to answer the questionnaire to the best of their ability as all sections required a response. Upon completion, the answers were graded according to the key made prior to the administration of the survey. The researcher was the sole grader of the key and was only allowed to mark answers as “correct” if the participant’s responses fit within the predefined answers. All participants answered basic demographic questions including age, gender, and race before the test began. Additionally, these students identified their reasons for podcasts (to entertain, to get inspired, for background noise, etc.). These data were analyzed for possible relationships between the variables and comprehension. Each study lasted an estimated

40 minutes accounting for the demographic questionnaire, stimulus, and comprehension test. Participants did not partake in a post-stimuli sentiment analysis. Each comprehension test will be made available for replication.

Statistics

A repeated measures ANOVA with a single factor of playback speed was measured to see if there was a difference across all five groups that are being tested. After the ANOVA was conducted, a Tukey's post-test was conducted to measure the directionality of the results between the five variable speeds: 1x, 1.25x, 1.5x, 1.75x, and 2x. This is because the literature is unclear about the effects of the independent variable.

A one-way ANOVA with a single factor of age was measured to see if there was a difference in comprehension across ages. These age groups ranged from 10-19, 20-29, 30-39, and 40-49. These ranges were chosen to reflect the existing literature as it relates to age related listening declines (Sommers et al., 2011) A Tukey's post-test was done to determine which age groups over and underperformed other cohorts.

A one-way ANOVA with a single factor of education was measured to see if there was a difference between educational attainment and comprehension. These groups were separated into the categories of, "Associates or technical degree", "Bachelor's degree", and "Some college, but no degree". These groups reflect the standard options provided by Qualtrics. A Tukey's post-test was done to determine the over and underperformance of each group.

A one-way ANOVA with the single factor of "reason for listening to a podcast" was measured to see if there was a difference between comprehension scores based on podcast consumption purpose. Here, only participants that had mentioned that they had previous podcast listening experience were included. The categories included, for background noise, to relax, to entertain, to learn new things, to get inspired, and to stay

informed. Each reason and combination of reasons as to why a participant listens to a podcast was coded separately. As such, there were a total of 5040 (!7) possible combinations that could have been selected. Only 16 different combinations were selected by the participants. A Tukey's post-test was done to determine the degree of over or underperformance between groups.

A one-way ANOVA with the factor of if the participant had previous podcast exposure was used to determine if there was any significant difference between those that had experience with the modality and those that did not.

CHAPTER III:

RESULTS

Test Results

An ANOVA was used to test the following data. There was a significant difference in performance based on speeds ($F_{5,40}=7.05$, $p<.001$). The mean scores for 1, 1.25, 1.5, 1.75, 2 were 53.2% (S.D.= 27.8), 50.1% (S.D.=23.7), 44.4% (S.D.= 25.1), 33.7% (S.D.= 23.8), and 28.8% (S.D.=25.7) respectively. A Tukey post-hoc test showed a significant difference between 1- and 1.75-times speed ($p=.005$). There was also a significant difference between 1- and 2-times speed ($p<.001$)

There was a significant difference in ages ($F_{4,40}=4.08$, $p<.008$). A Tukey post-hoc test showed differences between the age ranges 10-19 ($n=3$) and 30-39 ($n=12$) ($p=.005$). The mean scores for these groups were 61.1% (S.D.= 26.4) and 35.9% (S.D.= 25.4) respectively.

There was a significant difference in level of education and level of performance ($F_{3,40}=4.03$, $p=.019$). A Tukey Post-Hoc test showed significant differences between those with a bachelor's degree ($n=3$) and those with an associate degree ($n=27$) ($p=.014$). The means of the two groups were 60.3% (S.D.=13.4) and 39.9% (S.D.27.0) respectively.

There were no significant findings for individuals who reported listening to podcasts on a consistent basis (≥ 1 or more times a week) ($F_{2,40}=.0780$, $p=.78$, n.s.).

There not any significant findings for people that were aware of an used the playback speed manipulation feature on the podcast platform of their choice ($F_{4,15}=1.39$, $p=.247$, n.s.).

There was a not a significant difference in performance based on why people listened to podcasts ($F_{15,25}=2.91$, $p<.001$).

Significant findings regarding age, education, and why people listened to podcasts had a Shapiro-Wilk value of $p < .05$. This indicates that groups were not evenly distributed and consequently the significance that was found may be a result of the size of the sample. Additional research is needed in order to confirm if these variables are significant and, if so, their level of significance.

CHAPTER IV:

DISCUSSION

Data Findings

There were several interesting findings from the study. The primary one was there was not an increase in comprehension scores at any point. Rather, there seems to be a drop-off in comprehension between speeds of 1.5 and 1.75 relative to using 1 times speed as the reference point. It seems to be linear given that there is no significant difference between 1.5 and 1.75 but there is a significant difference between 1.5 and 2 . This may suggest that there is an optimal speed at this range. Such a suggestion would align with a significant portion of the research.

Given that the average speaking speed is 150 wpm, this equates to intelligible words per minute between the range of 225 and 262.5. However, the podcasts that were used were on average faster than the average speaking speed. This means that it should be expected for individuals to be able to listen to speed without a decrease in comprehension at speeds of 185 words per minute and 225 words per minute at 1.25 speed and 222.87 words per minute and 270.36 at speeds of 1.5. Juxtaposing this with the average reading speed of 200 to 250 wpm, this would suggest that the ability to process information at near baseline (~10% difference) is similar between these two modalities, assuming comparable levels of comprehension.

As speeds were increased to twice the original speed, there was a clear drop-off in terms of comprehension (28.8%). This would strengthen the literature that suggests speeds above the 1.5 range (Ritzhaupt et al., 2008) were optimal but that there are limitations near the 2-times speed range.

There were certain individuals who scored highly across all trials despite never having exposure to playback manipulation or listening to podcasts on a consistent basis.

This would suggest that some individuals have a significantly higher capacity to comprehend spoken information at significantly higher speeds. This study also did not find the natural limit for those individuals, as they consistently scored high on trials with speeds ranging from 1-2 times speed. Additional research is needed to see what the upper limits of these individuals are.

The significant difference between age groups 10–19 and 30-39 could not fully be explained as a result of age alone, considering that there is a population that is older than 30-39 represented in the sample and these individuals did not perform worse than those who were younger than them. The significant finding was shown to have a Shapiro-Wilk value of $p > .05$ indicating that it is possible that the sampled population may not be generalizable. Additional research with this population is needed to verify the differences.

The results regarding level of education showed statistical significance between scores but given that one group only had 3 participants it is very possible that these were all on the higher end of the distribution. This is because their standard deviation variance was significantly smaller than the other two groups. The significant finding was shown to have a Shapiro-Wilk value of $p > .05$ indicating that it is possible that the sampled population may not be generalizable. Additional research on this population is needed to verify the differences.

Limitations

During the data collection of the study, there were limitations that became more apparent. The first of which was that the means of gathering the data allowed for additional noise that may not accurately reflect the upper bounds of an individual's understanding. Furthermore, this noise was not consistent across trials meaning that certain participants may have had an artificially lower score. While this was intentional to

better emulate the environment that an individual may engage with podcast material, it significantly decreases power nonetheless.

Podcast 3's questionnaire had to have a question removed as it was inputted into the survey incorrectly. As a result, it was removed from all participant's answers. This means that podcast 3's answers were more heavily weighted leaving less room for error.

With the podcasts being presented at increasing speeds instead of at random intervals, participants could have their average score increased as they would have been able to work their way up to increasing speeds. Had podcasts been presented in different orders, namely 2 times speed first, individuals could have performed worse given that they would not have been able to become accustomed to the speaker's cadences and speech patterns.

While there was not a significant difference in performance based on why individuals listened to podcasts, this may be a result of how the data were gathered. Specifically, there could have been an overarching motive that may have outperformed others but it may have been combined with another reason limiting its performance. This same mechanism of gathering listener preference also did not identify the primary reason for listening to podcasts through a rank order system. This means that it was likely unsuitable to accurately gauge the primary reason for podcasts consumption.

Another limitation was that there may have been participants who manipulated the speed of the podcast on their own. The hosting platform grants users the ability to manipulate playback speed and pilot testing reflected this tendency. While it was explicitly stated to avoid in the instructions, it is possible that participants failed to adhere to the instructions and increased the speed anyway. There was no checkback to this system as the question was time-locked to reflect how long the podcast should have taken.

Comprehension within the study at baseline (53.2%) was slightly lower than previous literature (Kuperman et al., 2021), which would suggest (60%). However, this could largely be a result of three things. The first being that the questions asked of the students were completely open response and many required additional thoughts in order to extract context beyond what the podcast said on face value. The second is that there was no control over the environments in which the individuals completed the study. The third is the type of content that the participant was exposed to. Given that the podcasts that were chosen were from one source, variance may be described in subject matter or manner of speaking, in terms of lexicon, that the host presented in.

The last limitation to the study that should be recognized was that podcasts had sections with music for a transition. These sections typically did not exceed 10 seconds. However, since WPM was calculated using the number of words spoken divided by the amount of time, these music sections artificially decreased the WPM of the podcasts. Additionally, this could affect the participant's ability to reset their focus if they had previously gotten lost.

Future Applications

While the findings have thus far been tempered with several qualifiers, there are several distinct possibilities regarding the future applications. One of which would be a bigger pedagogical focus on an alternative style of learning. With further standardization of key identifiers such as WPM being readily available, increased playback speed can be better advised. Another application would apply a similar working model that would emulate speed reading allowing for better comprehension of speed listening. Such, a training plan would have to include a diverse set of pitches, accents, and audio quality in order for it to be better generalizable. If listening to information at

faster speeds becomes more normalized and becomes more efficient, platforms may find it in their best interest to provide higher speed ceilings than the standard 3 times speed.

REFERENCES

- Adank, P., & Janse, E. (2009). Perceptual learning of time-compressed and natural fast speech. *The Journal of the Acoustical Society of America*, 126(5), 2649-2659. doi:[1.3216914](https://doi.org/10.1121/1.3216914)
- Ahissar, E., Nagarajan, S., Ahissar, M., Protopapas, A., Mahncke, H., & Merzenich, M. M. (2001). Speech comprehension is correlated with temporal response patterns recorded from auditory cortex. *Proceedings of the National Academy of Sciences*, 98(23), 13367-13372. doi:[0.1073/pnas.201400998](https://doi.org/10.1073/pnas.201400998)
- Banai, K., & Lavner, Y. (2014). The effects of training length on the perceptual learning of time-compressed speech and its generalization. *The Journal of the Acoustical Society of America*, 136(4), 1908-1917. doi:[1.4895684](https://doi.org/10.1121/1.4895684)
- Banai, K., & Lavie, L. (2020). Rapid perceptual learning and individual differences in speech perception: The good, the bad, and the sad. *Auditory Perception & Cognition*, 3(4), 201-211. doi:[25742442.2021.1909400](https://doi.org/10.25742/442.2021.1909400)
- Beatty, M. J., Behnke, R. R., & Goodyear, F. H. (1979). Effects of speeded speech presentations on confidence-weighted and traditional comprehension scores. *Communications Monographs*, 46(2), 147-151. doi:[03637757909376001](https://doi.org/10.1080/03637757909376001)
- Blau, E. K. (1990). The effect of syntax, speed, and pauses on listening comprehension. *TESOL Quarterly*, 24(4), 746-753. doi:[10.2307/3587129](https://doi.org/10.2307/3587129)
- Behnke, R. R., & Beatty, M. J. (1977). Effects of time-compressed speech on confidence-weighted comprehension scores. *Southern Speech Communication Journal*, 42(4), 309-317. doi: [10417947709372358](https://doi.org/10.4179/47709372358)

- Carver, R. P. (1982). Optimal rate of reading prose. *Reading Research Quarterly*, 56-88. doi:[10.2307/747538](https://doi.org/10.2307/747538)
- Casares Jr, D. R. (2022). Embracing the podcast era: Trends, opportunities, & implications for counselors. *Journal of Creativity in Mental Health*, 17(1), 123-138. doi:[10.1080/15401383.2020.1816865](https://doi.org/10.1080/15401383.2020.1816865)
- Conrad, L. (1989). The effects of time-compressed speech on native and EFL listening comprehension. *Studies in Second Language Acquisition*, 11(1), 1-16. doi:[s0272263100007804](https://doi.org/s0272263100007804)
- Dias, J. W., McClaskey, C. M., & Harris, K. C. (2019). Time-compressed speech identification is predicted by auditory neural processing, perceptuomotor speed, and executive functioning in younger and older listeners. *Journal of the Association for Research in Otolaryngology*, 20, 73-88. doi:[10.1007/s10162-018-00703-1](https://doi.org/10.1007/s10162-018-00703-1)
- Davidesco, I., Thesen, T., Honey, C. J., Melloni, L., Doyle, W., Devinsky, O., & Hasson, U. (2018). Electrocorticographic responses to time-compressed speech vary across the cortical auditory hierarchy. *BioRxiv*, 354464. doi:[10.1101/354464](https://doi.org/10.1101/354464)
- Dupoux, E., & Green, K. (1997). Perceptual adjustment to highly compressed speech: Effects of talker and rate changes. *Journal of Experimental Psychology: Human Perception and Performance*, 23(3), 914–927. doi: [10.1037/0096-1523.23.3.914](https://doi.org/10.1037/0096-1523.23.3.914)
- Enc, M. E., & Stolurow, L. M. (1960). A comparison of the effects of two recording speeds on learning and retention. *Journal of Visual Impairment & Blindness*, 54(2), 39-48. doi:[10.1177/0145482x6005400201](https://doi.org/10.1177/0145482x6005400201)

- Foulke, E. (1964). *The Comprehension of Rapid Speech by the Blind—Part II. Cooperative Research Project #1370, Office of Education, Washington, D.C.: U.S. Department of Health, Education, and Welfare*, doi:[10.1177/001440296202900306](https://doi.org/10.1177/001440296202900306)
- Fulford, C. P. (1993). Can learning be more efficient? Using compressed speech audio tapes to enhance systematically designed text. *Educational Technology*, 51-59.
- Gabay, Y., Karni, A., & Banai, K. (2017). The perceptual learning of time-compressed speech: A comparison of training protocols with different levels of difficulty. *PLoS one*, 12(5), e0176488. doi:[10.1371/journal.pone.0176488](https://doi.org/10.1371/journal.pone.0176488)
- Goldman, T. (2018). The impact of podcasts in education. *Advanced Writing: Pop Culture Intersections*, 29
- Gordon-Salant, S., Yeni-Komshian, G. H., Fitzgibbons, P. J., & Cohen, J. I. (2015). Effects of age and hearing loss on recognition of unaccented and accented multisyllabic words. *The Journal of the Acoustical Society of America*, 137(2), 884-897. doi:[10.1121/1.4906270](https://doi.org/10.1121/1.4906270)
- Gordon-Salant, S., Zion, D. J., & Espy-Wilson, C. (2014). Recognition of time-compressed speech does not predict recognition of natural fast-rate speech by older listeners. *The Journal of the Acoustical Society of America*, 136(4), EL268-EL274. doi:[10.1121/1.4895014](https://doi.org/10.1121/1.4895014)
- Hausfeld, S. (1981). Speeded reading and listening comprehension for easy and difficult materials. *Journal of Educational Psychology*, 73(3), 312. doi:[10.1037/0022-0663.73.3.312](https://doi.org/10.1037/0022-0663.73.3.312)

- Heiman, G. W., Leo, R. J., Leighbody, G., & Bowler, K. (1986). Word intelligibility decrements and the comprehension of time-compressed speech. *Perception & Psychophysics*, 40(6), 407-411. doi:[10.3758/bf03208200](https://doi.org/10.3758/bf03208200)
- Hennig, N. (2017). Recommended tools for podcast listening. *Library Technology Reports*, 53(2), 10-15.
- Heshmat, Y., Yang, L., & Neustaedter, C. (2018). Quality 'Alone' Time through Conversations and Storytelling: Podcast Listening Behaviors and Routines. *Graphics Interface*, 76-83.
- Jacewicz, E., Fox, R. A., O'Neill, C., & Salmons, J. (2009). Articulation rate across dialect, age, and gender. *Language Variation and Change*, 21(2), 233-256. doi:[10.1017/s0954394509990093](https://doi.org/10.1017/s0954394509990093)
- Kao, C. T., Liu, Y. T., & Hsu, A. (2014). Speeda: adaptive speed-up for lecture videos. In *Proceedings of the Adjunct Publication of the 27th Annual ACM Symposium on User Interface Software and Technology*, 97-98. doi:[10.1145/2658779.2658794](https://doi.org/10.1145/2658779.2658794)
- Kuperman, V., Kyröläinen, A. J., Porretta, V., Brysbaert, M., & Yang, S. (2021). A lingering question addressed: Reading rate and most efficient listening rate are highly similar. *Journal of Experimental Psychology: Human Perception and Performance*, 47(8), 1103. doi:[10.1037/xhp0000932](https://doi.org/10.1037/xhp0000932)
- Lang, D., Chen, G., Mirzaei, K., & Paepcke, A. (2020). Is faster better? a study of video playback speed. In *Proceedings of the Tenth International Conference on Learning Analytics & Knowledge* 260-269. doi:[10.1145/3375462.3375466](https://doi.org/10.1145/3375462.3375466)

- Lerner, Y., Honey, C. J., Katkov, M., & Hasson, U. (2014). Temporal scaling of neural responses to compressed and dilated natural speech. *Journal of Neurophysiology*, *111*(12), 2433-2444. doi:[10.1152/jn.00497.2013](https://doi.org/10.1152/jn.00497.2013)
- Moos, A., & Trouvain, J. (2007). Comprehension of Ultra-Fast Speech—Blind vs. 'Normally Hearing' Persons. In *Proceedings of the 16th International Congress of Phonetic Sciences*, *1*, 677-680
- Ness, I., Opdal, K., & Sandnes, F. E. (2021). On the convenience of speeding up lecture recordings: Increased playback speed reduces learning. In *Innovative Technologies and Learning: 4th International Conference, ICITL 2021, Virtual Event, November 29–December 1, 2021, Proceedings*, *4*, 461-469. doi:[10.1007/978-3-030-91540-7_47](https://doi.org/10.1007/978-3-030-91540-7_47)
- Nourski, K. V., Reale, R. A., Oya, H., Kawasaki, H., Kovach, C. K., Chen, H., ... & Brugge, J. F. (2009). Temporal envelope of time-compressed speech represented in the human auditory cortex. *Journal of Neuroscience*, *29*(49), 15564-15574. doi:[10.1523/jneurosci.3065-09.2009](https://doi.org/10.1523/jneurosci.3065-09.2009)
- Orr, D. B., & Friedman, H. L. (1968). Effect of massed practice on the comprehension of time-compressed speech. *Journal of Educational Psychology*, *59*(1), 6. doi:[h0025366](https://doi.org/10.1037/h0025366)
- Orr, D. B., Friedman, H. L., & Williams, J. C. (1965). Trainability of listening comprehension of speeded discourse. *Journal of Educational Psychology*, *56*(3), 148. doi:[h0021987](https://doi.org/10.1037/h0021987)

- Pallier, C., Sebastian-Gallés, N., Dupoux, E., Christophe, A., & Mehler, J. (1998). Perceptual adjustment to time-compressed speech: A cross-linguistic study. *Memory & Cognition*, 26(4), 844-851. doi:[10.3758/bf03211403](https://doi.org/10.3758/bf03211403)
- Ritzhaupt, A. D., Gomes, N. D., & Barron, A. E. (2008). The effects of time-compressed audio and verbal redundancy on learner performance and satisfaction. *Computers in Human Behavior*, 24(5), 2434-2445. doi:[10.1016/j.chb.2008.02.017](https://doi.org/10.1016/j.chb.2008.02.017)
- Rodero, E. (2016). Influence of speech rate and information density on recognition: The moderate dynamic mechanism. *Media Psychology*, 19(2), 224-242. doi:[10.1080/15213269.2014.1002942](https://doi.org/10.1080/15213269.2014.1002942)
- Rodero, E. (2012). A comparative analysis of speech rate and perception in radio bulletins. *Text & Talk*, 32(3), 391-411. doi:[10.1515/text-2012-0019](https://doi.org/10.1515/text-2012-0019)
- Röder, B., Rösler, F., & Neville, H. J. (2000). Event-related potentials during auditory language processing in congenitally blind and sighted people. *Neuropsychologia*, 38(11), 1482-1502. doi:[10.1016/s0028-3932\(00\)00057-9](https://doi.org/10.1016/s0028-3932(00)00057-9)
- Sommers, M. S., Hale, S., Myerson, J., Rose, N., Tye-Murray, N., & Spehar, B. (2011). Listening comprehension across the adult lifespan. *Ear and Hearing*, 32(6), 775. doi:[10.1097/aud.0b013e3182234cf6](https://doi.org/10.1097/aud.0b013e3182234cf6)
- Song, K., Chakraborty, A., Dawson, M., Dugan, A., Adkins, B., & Doty, C. (2018). Does the podcast video playback speed affect comprehension for novel curriculum delivery? A randomized trial. *Western Journal of Emergency Medicine*, 19(1), 101. doi:[10.5811/westjem.2017.10.36027](https://doi.org/10.5811/westjem.2017.10.36027)

- Tarabeh-Ghanayim, M., Lavner, Y., & Banai, K. (2020). Tasks, talkers, and the perceptual learning of time-compressed speech. *Auditory Perception & Cognition*, 3(1-2), 33-54. doi:[10.31219/osf.io/hnp74](https://doi.org/10.31219/osf.io/hnp74)
- Trauzettel-Klosinski, S., Dietz, K., & IReST Study Group. (2012). Standardized assessment of reading performance: The new international reading speed texts IReST. *Investigative Ophthalmology & Visual Science*, 53(9), 5452-5461. doi:[10.1167/iovs.11-8284](https://doi.org/10.1167/iovs.11-8284)
- Vemuri, S., DeCamp, P., Bender, W., & Schmandt, C. (2004). Improving speech playback using time-compression and speech recognition. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 95-302. doi:[10.1145/985692.985730](https://doi.org/10.1145/985692.985730)

APPENDIX A:
TRANSCRIPTS

How to Make Meetings Less Terrible

I'd like you to be particularly open-minded today. I'd like you to entertain the possibility that two absurdly disconnected stories may in fact have a deep connection — and that if you're willing to see it through, this connection may yield insights that substantially improve your life. Or not. But let's try. The first story is set in the [Okavango Delta](#) in Botswana.

Hallie WALKER: The Okavango is absolutely beautiful. It's the world's largest inland delta. So it's surrounded by desert, and it's this kind of emerald jewel in the middle of sub-Saharan Africa.

[Hallie Walker](#) is a Ph.D. student.

WALKER: I study behavioral ecology at the University of Idaho.

When we spoke, she was in Mozambique.

WALKER: Yeah, right now I'm studying three species of spiral horned antelopes.

In the Okavango, Walker was studying a species known as the African wild dog.

WALKER: So what's amazing about this study site is these dogs have been followed for 25 years. So they are raised with vehicles right there. And they're so habituated that they really don't recognize the vehicle.

This allows the researchers to get close enough to record really good video.

WALKER: So the recordings are pretty intimate.

In the videos the dogs lie around, keeping cool in the shade. Sometimes they pile on each other and play. And sometimes the dogs make these strange sounds.

WALKER: It's really odd. The sounds they make are unvoiced, kind of like sneezes.

[Here's what it sounds like.](#)

WALKER: So sneezes really only happened in those rally events that I was observing. And what is a "rally event"?

WALKER: Yeah, a rally is— African wild dogs are incredibly social animals. So they spend their whole lives in packs.

In each pack, there are dominant dogs and less-dominant dogs. Let's say the pack has just been lying around, and the dominant dog gets up.

WALKER: And he greets other dogs. Just like your dog greets you when you get home from work. They try to recruit other pack members to stop resting and sleeping in the shade, to go hunt. And that either ends in a successful rally, where the whole pack leaves the resting site and goes to hunt, or an unsuccessful rally, where they lie back down.

And the sneezes, remember:

WALKER: Sneezes really only happened in those rally events. The only other sneezes that we observed, it was 15 percent of them, looked like they were just sneezing because they got dust in their nose.

So what did the sneezing have to do with the rally events? Were they some kind of communication? Well, consider our second story. It's about this person:

Priya PARKER: [Priya Parker](#). And I'm a group-conflict-resolution facilitator.

How does one become a group-conflict-resolution facilitator?

PARKER: One grows up in complicated family.

Specifically:

PARKER: Well, I'm biracial. I'm half-Indian, half-white American. And when I was nine, my parents divorced and they both remarried other people, who were radically different from their original marriage. And they had joint custody. So every two weeks I would go back and forth between these two households. And my mother's household was Indian and British, Buddhist, atheist, agnostic, liberal, democratic, vegetarian household. And my dad and stepmother are white American, evangelical Christian, conservative Republican, twice-a-week churchgoing, family. And I was part of both families.

So: plenty of opportunity for conflict resolution in a family setting. Parker went on to formally study conflict resolution and she ultimately resolved actual conflicts, or at least tried to, in Africa, India, the Middle East. These days, she's hired primarily by companies

in conflict. Companies, it turns out, often try to resolve their conflicts by holding meetings. And a lot of these meetings are unsuccessful. Why?

PARKER: There is a belief, sometimes spoken, sometimes unspoken, that all meetings should be de-risked. Yes there is an opportunity to kind of be embarrassed or to lose face. But we have so over-indexed on not wanting that to happen that we've drained the meaning and the relevance out of so many of our meetings.

Have you ever been to a meeting where no one says what they really think? Of course you have.

PARKER: But unhealthy peace can be as threatening to human connection as unhealthy conflict. And in my experience, because of the norms of our culture, and particularly in the U.S., most of our gatherings suffer from unhealthy peace, not unhealthy conflict.

So Priya Parker likes to introduce healthy conflict into meetings. To turn the meeting from a time-wasting orgy of passive-aggression into a well-oiled decision-making machine.

How to Fail Like a Pro

In previous episodes of our “How to Be Creative” series, we’ve talked to artists, scientists, inventors, and others about their creative process; about having good ideas and, even more important, how to execute those ideas. Today, we’ll hear about a part of the creative process that everyone can relate to — even if you don’t think of yourself as a “creative person.” This is something we all do, probably more than we’d like to admit; it’s something that almost no one enjoys; but it’s an inevitable, and absolutely essential, component of any success. I’m going to let you figure out what it is. Don’t worry, it won’t take long. Let’s start back in the late 1980’s. A young physicist named Saul Perlmutter, at the University of California-Berkeley, was looking around for a good research project.

Saul PERLMUTTER: And at that time I was lucky enough to come across the possibility that we could go back and make a measurement that people had wanted to do ever since

the times of Einstein and Hubble, which was the measurement of how much the universe has been slowing down in its expansion over its lifetime.

Ever since Einstein theorized it, and Edwin Hubble observed it, everyone knew the universe was expanding. But another thing everyone knew was that all the matter in the universe — all the galaxies and nebulae and stars and planets and moons and comets and asteroids — all the stuff in the universe has gravitational attraction. So physicists assumed that, eventually, that gravitational attraction would slow down the expansion of the universe. For a physicist, understanding this dynamic was itself an attraction.

PERLMUTTER: If you could measure how much it was slowing, it would tell you a couple really amazing things. Like, first of all, you could find out: is it slowing enough so someday it could come to a halt and then collapse? And this was just before the millennium, so we thought we could walk around with those signs saying “The universe is coming to an end.” But if we found out that it wasn’t, then we would have shown that the universe will last forever. And also we would have shown that we live in an infinite universe. It just seemed like, whatever we found would be a great story, and we’d love to know the answer.

Stephen DUBNER: I have to say, I think the latter headline is much more exciting, personally — not just because of infinity and because long-lasting but it’s optimistic, yes?

PERLMUTTER: Yeah, I think that’s right. You start getting a little personally invested in our universe even though we’re talking about billions of years from now. We sort of would like it to go on, you know.

So you can see why it’d be valuable to measure the rate of the universe’s expansion. But conducting this sort of measurement — even for an astrophysicist — is, well, it’s hard.

Saul Perlmutter had an idea. It involved measuring the light coming off of supernovas. But they had to be a particular kind of supernova. And they had to be very far away.

PERLMUTTER: We needed to find these very distant ones because we want to look way back in history. And the further away you look in astronomy, the further back in time you're getting to see, because it's taking light that time to travel to you from those very, very distant locations. We needed to look some, three, four, five billion years back in time for us to be able to see the slowing effects that we thought we were trying to track.

Given the specificity of what they needed, and the overall degree of difficulty, Perlmutter knew the project would take some time.

PERLMUTTER: We wrote the original proposals saying that we did not expect to be able to find the 30-some-odd supernovae that we would need to make those measurements in anything less than three years. And we thought this was going to be like a long three-year project.

Perlmutter and his team built a tool for this project: a new kind of high-resolution, wide-field digital camera that could be attached to the big telescopes you find in observatories. Now all they had to do was get some time on one of those big observatory telescopes.

PERLMUTTER: Telescope time on these biggest telescopes in the world is really precious.

One observatory, in Australia, was open to a deal.

PERLMUTTER: And we traded the use of that camera for 12-and-a-half nights of telescope time. And so you're doing everything you can to try to find the time that you'll

need to make the measurements you want. In those 12-and-a-half nights, we got two-and-half nights of good weather.

Two-and-a-half nights of useful telescope time, over three years. Remember, they needed to find “30-some-odd” supernovas to make their measurements. So how many did they find?

PERLMUTTER: At the end of three years, we had not yet found a single supernova.

So, picture that. You started with a quest, a creative scientific idea. Drawing on all the knowledge you’ve amassed over time, and all the knowledge amassed by earlier generations, you formulate a plan of attack. You write the grant proposals; you get the grant. You invent a special tool to facilitate your plan, and use that tool as leverage to gain access to an even more important tool. You’ve done everything possible, and you’ve done everything right. But you know what? You still failed.

“Why Does the Richest Country in the World Have So Many Poor Kids?”

We know that developmental delay, language delay, is more common among children from disadvantaged backgrounds.

That is Kimberly Noble, a neuroscientist and pediatrician at Teachers College, Columbia University. Noble likes to say that the brain is not destiny.

By which I mean, the brain is highly malleable to ongoing experience. That means if we change the experience, the brain is likely to change as well.

Decades of research has shown that growing up in poverty is correlated with many bad outcomes: cognitive development, school performance, even later, in the job market.

But correlational work really doesn't speak to causality, by which I mean we can't say for sure whether poverty is simply associated with those differences or whether poverty is really causing those differences. And so, to address that question from a scientific perspective, we need to employ the randomized controlled trial.

So Noble helped design and run exactly such a trial. It's called Baby's First Years. Her collaborators are Lisa Gennetian, Katherine Magnuson, Greg Duncan, Nathan Fox, Hiro Yoshikawa, and Sarah Halpern-Meekin. It is the first project to analyze the causal impact of poverty on brain development. How do you run a randomized trial on that?

So, of course, you can't randomize people to live in poverty or not live in poverty, but you can randomize people to receive different amounts of poverty reduction.

By "poverty reduction," Noble means money. The researchers recruited 1,000 low-income mothers from four metropolitan areas. These were women who had just given birth.

Right there, in the labor and delivery floor, we approached them about enrolling in the study. They were told they had the opportunity to receive a monthly unconditional cash gift, which they would be free to spend however they like.

This is where the randomization comes in: Different mothers would receive different amounts of money.

So, what we call the high-cash gift group receives \$333 a month, which amounts to \$4,000 a year. And what we call the low-cash gift group receives \$20 a month, or \$240 a year. And that difference in annual income has been associated in the correlational literature with improvements in school achievement, improvements in time spent in the

labor force as adults, and even improvements in health as adults. But now, we're actually going to be able to test whether there's a causal relation there.

A couple months ago, the researchers published their first batch of results. They analyzed the brain activity of the babies in the study; they're now about a year old. The children born into families that received more cash each month had greater brain activity, patterns associated with developing cognitive skills. The researchers still have a lot to understand about this — like, will these results last over time? And: what's causing the increased activity? Does it have to do with how the families are spending the money? Does it have to do with lowering stress in the family? So: we'll have to keep an eye on that.

But let's pull back for a moment and look at the big picture. As of 2019, 14.4 percent of U.S. children lived in poverty. As I mentioned earlier, that's about one in seven kids. Broken down by race: One in four Black kids lives in poverty; for Hispanics, it's one in five; and for non-Hispanic white kids, one in 12. Still, that's more than 3 million white kids in poverty in the U.S. All these numbers, remember, are pre-pandemic; Covid has made things even worse for low-income families. How does the U.S. do with child poverty compared to other countries? Not very well. If you look at a graph of child-poverty rates among countries in the O.E.C.D., the U.S. is among the very worst, bunched up with Mexico and Chile, Turkey and Spain. Among the countries with the least child poverty are Finland and Denmark, even Poland and Ireland. The U.S. spends a much smaller share on child poverty than the O.E.C.D. average, with very little in the way of direct financial aid.

One major form of aid is the E.I.T.C., or Earned-Income Tax Credit. As the name implies, this is aid connected to income, which makes it conditional on employment. For a lot of parents, this can be a Catch-22 since employment often requires child care, which in the U.S. can be expensive — unlike a lot of other O.E.C.D. or European Union countries, which provide or at least subsidize child care. There are a variety of other

conditional-aid government programs, including TANF — Temporary Assistance for Needy Families, often known as welfare — and the SNAP program, formerly known as food stamps. But the desperation of the pandemic has also led to more unconditional aid. The Biden administration, as part of the American Rescue Plan, expanded the Child Tax Credit, which provides monthly cash payments to families under a certain income level. The payments were scheduled to last only a year, but as we'll hear later, there was a good chance for extended aid. The Biden payments seem to have been inspired by a 2019 report called "A Roadmap to Reducing Child Poverty." It was written by a National Academies of Sciences panel that Congress had asked to identify evidence-based policies that would reduce child poverty by half within a decade.

Why Did You Marry That Person?

As for her optimism about marriage — if you look at the marriage data, that optimism may seem misplaced. Consider the U.S. Before the Great Depression, there were more than nine marriages each year per 1,000 people; it fell to around eight during the Depression, but after World War II, it shot up to 16. There has since been a long decline. By the early 2000s, we were back to around eight marriages per 1,000 people, and by 2019 the rate had fallen to roughly six. In 2020, the last year for which we have the data — and, to be fair, it was the first year of Covid — that rate fell even further, to roughly five marriages per 1,000 Americans. But Helen Fisher says that within those numbers, there is some good news — at least what she thinks is good news.

What we're seeing now is we're marrying later and later. In my day — I'm a baby boomer — people married in their very early twenties, about age 21 for women, 22, 23 for men. Now they're marrying at age 28, 29 for women and age 30, 31 for men. So there's this long period of what I call pre-commitment, all through your twenties, during which singles are growing up. They are learning what they want, they are learning what they don't want.

And while this may lead to fewer marriages, it's also leading to better, more durable marriages.

I've looked at the divorce data through the demographic yearbooks of the United Nations since 1947 to 2011. That's millions of people. And as it turns out, the longer you court, and the later you marry, the more likely you are to stay together. And that's exactly what we're seeing in America today.

The U.S. divorce rate peaked in the 1980s, with nearly 23 divorces per thousand marriages each year. As of 2019, there were around 15 divorces per thousand, and the rate has hit a 50-year low. So that's interesting. But it does raise a question — a big, existential question: why, exactly, do people get married anyway? There's good evidence that marriage leads to better life outcomes — health and wealth outcomes; also, the children of married people tend to do better than the children of unmarried people. We should say: it can be hard to pin down the causality on the benefits of marriage. It may be that people who aren't doing as well on the health and wealth fronts simply have a harder time finding a mate. Still, even when you control for demographic differences, it does look like marriage has real material benefits. And, as Helen Fisher will tell you, there is also a metaphysical reason to marry. It's called love.

People pine for love. They live for love. They kill for love, and they die for love. And when you think about — I mean the myths, the legends, the poems, the stories, the novels, the sitcoms, the operas, the plays, the symphonies, the ballets, the therapists, the holidays. We're drowning in this thing.

So that's an anthropologist's perspective. For an economist, love is tricky. What sort of dataset can you use to measure love?

This is quite the fundamental question.

That, again, is Marc Goñi, who studies marriage markets. The word “market” implies buyers and sellers of goods and services.

There’s several differences, of course, in the marriage market. It’s a market in the sense that there’s single people looking to form a match as in a goods market I would be looking for a particular product that I like. It captures the idea of two sides looking to form a match. Typically, we don’t have prices — although in some cultures, there’s dowries and there’s bride prices.

Dowries are still common in rural India, for instance. That, of course, is not how marriage works in the U.S. and most other high-income places. Marriage here is mostly an autonomous decision, and it involves a search. You go on some bad dates and maybe a few good ones; you evaluate potential partners until you find the right one. In some cases, you do nearly everything associated with marriage, including living together, before you actually marry. In some places, you do all this and you never marry.

I totally consider myself as married, although I haven’t done the formal thing. It’s not entirely clear that I will do it.

Goñi, remember, is Spanish.

If I compare myself and my friends to the generation of my parents, you see that both ended up in long-term relationships, but the marriage rate is much lower nowadays. The marriage rate in Europe since the 1960s has halved. So, although we still observe many long-term relationships, most of these long-term partnerships now take a different form.

Americans consider this type of long-term partnering, including having children together, as a European style. But it’s happening more here, too. Since 1990, the share of

cohabiting, non-married couples has more than doubled. So that may help explain a bit of the U.S. marriage decline. Another factor is education. The economist Amalia Miller, in a recent series we ran on college, told us that attending a prestigious school has a big impact on women's incomes — and other aspects of their lives, too.

Is Venture Capital the Secret Sauce of the American Economy?

That's Vinod Khosla. He did come to Silicon Valley, and in 1982 he co-founded the technology firm Sun Microsystems. Today he runs one of the biggest venture capital firms in the U.S. — and, therefore, one of the biggest V.C. firms in the world. It's called Khosla Ventures. Since 2004, it has invested in nearly 1,000 startup companies. Khosla often invests in little more than an idea.

Pat Brown was a professor at Stanford, and he came to us and said, "I want to change animal husbandry on the planet." That was his entire pitch.

Pat Brown was a very well-regarded biomedical researcher. Now he wanted to do something different. He had come to believe that the production of meat was really bad for the planet. And that's what Brown would tell the venture capitalists.

My pitch to them was very naive from a fund-raising standpoint. I just told these guys, "Look, this is an environmental disaster. No one's doing anything about it. I'm going to solve it for you."

As ridiculous as that sounded, it took us a half-hour to say, "Love the passion, love the mission, love Pat's credentials." And we said, "We'll back you."

Khosla — and other V.C. firms — did back Pat Brown. After several years and more than a billion dollars in venture money, his company became a sensation. It's called Impossible Foods, and it makes plant-based substitutes for meat products. It is still

privately held, and it's already thought to be worth around \$7 billion. Eventually the venture capitalists will get their money back, and much more. Now, what would have happened to Pat Brown's idea in a different time, or a different place — I mean, a time and place without venture capital? Access to that kind of money for nothing more than an idea is a decidedly American phenomenon. If you look at the 10 biggest companies in the world as measured by market capitalization, seven are American and six of those raised venture capital: Apple, Microsoft, Amazon, Tesla, Facebook, and Alphabet (the parent of Google). The seventh is Berkshire Hathaway, Warren Buffett's holding company, which essentially gobbles up existing firms. That is a much safer way to extract billions of dollars. Venture capital is inherently risky, especially at the early stage of a startup. For every Apple or Impossible Foods, there are thousands of failures. So you need a temperament that can handle it. Vinod Khosla has it.

I don't mind a 90 percent chance of failure if the consequences of success are consequential, like changing animal husbandry on the planet or making fusion reactors possible. If 10 percent of the time you make a large multiple, then you're in pretty good shape.

Do you think you were born with that ability, to see that losing one times your money was really not that big a risk if the upside was 50 times, or did you learn that?

I think there was a whole lot of naïveté on my part. Probably a whole bunch of hubris. But naïveté, hubris, trying the impossible is very much Silicon Valley culture. It makes for a great story when Elon Musk builds a Tesla in a way that General Motors can't.

Today on Freakonomics Radio: The U.S. economy is one of the most dynamic economies in the history of the world. Is venture capital the secret sauce?

In societies where there's a larger V.C. capital market, we are going to observe more radical, risk-taking innovations.

APPENDIX B:
QUESTIONNAIRES AND KEYS

How to Make Meetings Less Terrible

1. Where is the first story set? Botswana/ Okavango Delta/Africa/ Sub-Saharan Africa/In-land delta
2. Describe the setting of the first story. Beautiful surrounded by desert/emerald jewel
3. What is a rally event? When the dogs attempt to recruit other dogs, who are lounging around/getting the pack together for a purpose
4. What is the purpose of a rally event? To start a hunt.
5. What was unique about the dog sneezes? They were likely a form of communication. There were few instances where they occur outside of rally events.
6. Why did Priya Parker become a group-conflict-resolution facilitator? Any mention of the family dynamic will do.
7. Name one area/country, outside of her home, that Priya has resolved conflict. Africa, India, or the middle east
8. What was an outcome of having a meeting as we are currently having them? trying to save face. Not willing to take a chance on ideas because of embarrassment.
9. What does Priya Parker hope to introduce to meetings? Healthy conflict/ a way to “derisk” meetings. Get people to talk about what actually matters
10. How do you think that the two stories relate? Anything relating to communication and effective direction-based communication.

How to Fail Like a Pro

1. What was the measurement that Saul Perlmutter was hoping to do?
Measuring the slowing of the expansion of the universe. Effects of gravitational attraction
2. What is a property shared by all of the “stuff” in the universe? Attraction (from matter)
3. Due to the pull from everything in the universe what was theorized to be happening to the universe. Slowing, maybe to a halt.
4. Why is the theory that the universe is forever expanding more attractive? It is optimistic, it sets up the idea of an infinite universe. It would be a great story
5. What did Saul intend to measure to test his theory? (Light) from (Supernovas)
6. Why did they choose to look for supernovas that were very far away? In order to look as far back in time as possible. It shows the history
7. About how much time did they expect the original project to take? about 3 years
8. What did Saul build in order to search for the supernovas? A high-resolution camera (this will suffice) to attach to the telescope.
9. Out of the twelve and a half nights that they had access to the telescope how many of them did they have weather that was suitable for viewing? 2 and a half? Round both ways.
10. What do you think the message that the podcast was trying to convey based off of what you heard? Failure is a necessary part of success. Everything can be right and you can still fail.

Why Does the Richest Country in the World Have So Many Poor Kids?

1. How many low-income mothers were recruited for the study Baby's First Year's study? 1000
2. What were the two groups of the Baby's First Year's study? A high-income group and low-income group.
3. Given previous academic literature, what correlation does additional money have on child outcomes? Lower income leads to less cognitive development worse life outcomes. Improvements to health and time spent in the labor force.
4. What countries is the US near when looking at the O.E.C.D? Mexico, Chile, Turkey, and Spain
5. Relative to the other countries in the O.E.C.D. What does the US spend? A smaller amount. (Had to exclude as it was incorrectly inserted into Qualtrics).
6. According to the podcast, what is the major form of financial aid does the US offers its citizens? The earned income tax credit. TANF, SNAP
7. According to the podcast, why were cash payments expected to be extended? Because they were a COVID response and COVID was still continuing.
8. What is one of the two reasons the podcast gives for why child poverty is so high in America? We do less in terms of social safety programs and/or wages are fairly low.
9. What is the goal of the 2019 report called "A Roadmap to Reducing Child Poverty"? Reduce child poverty/ by half within a decade.
10. Based on the information provided in the podcast, why has it been difficult to accurately study the causal effects of poverty? Confounding variables, cannot randomize.

Why Did You Marry That Person?

1. Before the Great depression how many marriages were had per 100 people? 9” more than 9”
2. Based on the information provided by the podcast, why is there so much variation of birthrates in a given time frame? Major events that shape behavior, access to modern tech (birth control), education on the rise, marrying later
3. What is the reason that the guest gives as to why marriage is on the decline? We are marrying later, we are learning what we want/do not want, marriages are more stable.
4. When did the US divorce rate peak (reach its highest point)? 1980s
5. According to the podcast, what are outcomes associated with marriage? Better health and wealth outcomes, children tend to fair better, “material benefits”.
6. What does Marc Goni (the second speaker introduced) study? Marriage markets
7. According to Goni (the second speaker introduced), how is his field of study similar to a traditional goods market? There is a consumer looking for a particular product, some cultures have prices, two sides come together to form a match.
8. What has happened to the marriage rate in Europe since the 1960s? It has halved. Gone Down
9. According to the podcast, what do Americans call long term partnering, including having children together? The European style.
10. Given the information provided by the podcast what is likely to happen to US marriage rates? Why? They will either decline or stay the same. The education opportunities are becoming more available, there will be more adopting of the European style.

Is Venture Capital the Secret Sauce of the American Economy?

1. What company did Vinod Khosla come to the US and found? Sun Microsystems.
2. What is the name of the VC company that Vinod Khosla runs? Khosla Ventures.
3. What was Pat Brown's pitch? Animal husbandry, meat is bad for the planet, impossible foods, meat substitutes.
4. How much is Pat Brown's idea thought to be worth? 7 billion dollars
5. According to the podcast, name two companies, not Pat Brown's, that raised venture capital. Apple, Microsoft, Amazon, Tesla, Facebook, Google.
6. How does Khosla rationalize failure? The long-term benefits outweigh, the 10 percent times that you are right it is multiple times worth more.
7. According to the podcast, what is true for societies that have larger venture capital markets? There is more radical/risk taking behaviors/innovations.
8. According to the podcast, what does Berkshire Hathaway, Warren Buffet's holding company do? It buys out [(gobbles up) any variation is valid] existing companies.
9. How common is failure in the venture capital field? Try to provide a ratio if possible (example for everyone one success there is one failure). It is very common, there is a mention of 1000s+ to one ratio.
10. Based on what was described in the podcast, what is one of the most important things that all venture capitalist must have in order to be successful? Something that is innovative, the ability to fail (often)