Analyzing How Research on Telepsychology has Changed as a Result of the Coronavirus Pandemic
An Application of Natural Language Processing

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The Coronavirus pandemic has had a tremendous effect on all areas of life, perhaps the most salient being the rapid transition to remote life. This paper aims to understand how that shift has impacted academic work produced in the field of telepsychology. We used a variety of Natural Language Processing (NLP) techniques to explore keywords, named entities, topics, and more across articles published between 2016 and 2021. Furthermore, we compared the results for those articles published before 2020 and the outbreak of the COVID-19 Pandemic with those published during the pandemic in order to find the changes that have occurred as a result. We identified three major groups in the literature: 1. Implementation, barriers, and evidence-based treatment; 2. Training and ethics; and 3. Covid-19 and Stress related disorders. We also identified major shifts during the pandemic towards discussing stress and stress-related disorders and away from discussing depression and self-help technologies. This paper summarizes some of the existing research on telemental health and provides a model for systematically applying NLP to identify trends in literature.

Keywords: Telepsychology, telemental health, NLP, NER, Topic Modeling, Text Mining, Covid-19, NMF

Over the last year the Coronavirus pandemic has had an impact upon every conceivable area of life, from how we work and collaborate, to how we socialize, to how we receive medical care. The need for social distancing led many services and workplaces to move to remote services and telework, and in the wake of this shift came a scramble for information on how tele-communication impacts life, productivity, health, and the quality of services.

Mental health is among the areas most profoundly impacted by both the pandemic and the myriad of other systemic and endemic traumas extant throughout the U.S. and the world in 2020. Research performed by the American Psychological Association found a marked increase in perceived stress levels among U.S. adults in the prior month, with an average reported stress level of 5.6 in their 2021 report (out of 10), up from 5.4 in April-May of 2020 and 4.9 in the 2019 Stress in America Reports (American Psychological Association (APA), March 2021; APA, 2020; APA 2019). Supporting this finding, a survey of health service psychologists and their treatment patterns showed increases in the treatment of anxiety, depression, and trauma related disorders due to the pandemic (APA, 2021). This survey also showed that 96% of psychologists had transitioned to offering services remotely, either entirely or partially, thus demonstrating the intense need for knowledge and research around providing remote mental health care. Such considerations range from available methods and therapies to relative efficacy and the ethical considerations this new situation brings. This is further supported by research from the CDC showing large increases in the use of telehealth during even the early months of the COVID pandemic (Koonin et al., 2020).

In response to this need, there was a scramble to publish as much research as possible on the COVID-19 pandemic’s impact, including on telehealth, telepsychology, and remote provision of services. On top of the demand for papers, the shift to remote work led many researchers who would otherwise have been performing in-person research, to transition to work that lent itself to a remote setting, specifically, writing and publication. The sum of which was a boom in the number of papers published in 2020, specifically those related to the pandemic and the associated dependence on technology.

The present study proposes to investigate how the coronavirus pandemic has affected the approach researchers are taking with respect to studying tele-mental health and the use of technology in psychology. What are the key topics overall from the body of existing literature on telepsychology? How have the central topics stayed the same or changed because of the pandemic, and, if they
have changed, in what ways? We hope to answer some of these questions by analyzing the text of articles related to tele-mental health or telepsychology that were published from 2017 through February 2021 (15 pre-pandemic, 29 during-pandemic). With this project, we aim to produce a summary of the existing knowledge surrounding telepsychology and tele-mental health, as well as an examination of the quality of that work with the hopes of directing future research. We posit that using a natural language processing approach rather than a manual review will help us find less biased insights and lead to a higher quality understanding of the existing research.

Before proceeding, we must acknowledge the relative novelty of this application of natural language processing (NLP). While there is a growing collection of literature in the field of NLP, current research on its use and methods to perform literature reviews are limited, although NLP techniques have been used extensively to analyze a variety of other literature types (Grimer & Stewart, 2013; Haque et al., 2013; Merchant & Pande, 2018). Research specific to using NLP for comparing shifts in text over time include the 2006 article by Blei and Lafferty (2006) which outlined the use of time series models to analyze the evolution of topics in large document collections. Specific to literature review, in 2016, Tong & Zhang published their paper which suggested applications of topic modelling for social and business research in the future and Murakami et al. published a paper in 2017 regarding the use of topic modelling for the purpose of gaining valuable insights from an academic corpus. Asmussen and Møller (2019) brought this trend to the next level of significance when they proposed the retirement of manual exploratory literature reviews in favor of machine learning methods. Studies which utilized topic modelling for literature reviews across many fields have started to pop up more recently, such as the study done by Westerlund, Leminen & Rajahonka (2018) utilizing topic modeling on the Technology Innovation Management Review; analysis of the history of American sociology by Giordan, Saint-Blancat, & Sbalchiero (2018); a review of mindfulness research by Kee et al. (2019); and an exploration of ethnic marketing research by Moro et al. (2019). As such it is clear that the use of NLP for understanding corpora of literature is growing in popularity across research disciplines.

Method

Data Collection. Articles were collected from the APA PsycNet search engine using the keyword terms ‘telepsychology’ and ‘telemental health’. Only peer-reviewed articles that were published in the last 5 years (inclusive from January 2017 to February 2021) in an APA journal and freely available online were included in the final dataset for a total of 44 journal articles. Of these 44 articles, 15 were published in 2017 through 2019, comprising the pre-COVID publications. The remaining 29 articles make up the during COVID publications. 18 different APA Journals were represented in the dataset.

Packages and Software. Data cleaning and analysis were performed using python version 3.0 in Google Colab. A detailed description of the project, associated notebooks, and a list of required libraries can be found in the Github repository: https://github.com/VintageGold/Text_Summarization

Data Cleaning. The text of all 44 articles and associated metadata were collected in two files, merged on an index, converted to a data frame and exported to a csv. Data features included the journal title where the article was published, the title of the article, year that the article was published, the authors, the provided abstract, provided keywords, and the complete citation, as well as the text of the article.

Basic text cleaning was performed on the text of the articles to remove noise in the analysis by removing stop words and punctuation, converting text to lowercase, removing whitespace, and standardizing words to their dictionary base forms with lemmatization. In addition, the keywords provided were reformatted into a list object for easier analysis. Common abbreviations used throughout the corpus were identified using SpaCy’s Abbreviation Detector and were expanded into unabbreviated form when possible (ex. PTSD to post traumatic stress disorder). The final dictionary is included in the project Github repository.

Design. For our analysis, we utilized natural language processing techniques, including topic modeling, keyword extraction, and extractive summarization, to review and identify key insights from the existing body of literature on telepsychology and telemental health. We make the argument that performing this type of text analysis has several advantages to manual literature review, which provides more opportunities for bias from the researchers performing the analysis in addition to being potentially less thorough.

This analysis focused on two points of inquiry:
1. Summarizing the body of knowledge that currently exists pertaining to tele-mental health and telepsychology.
2. Identifying differences between articles published before the COVID-19 pandemic (2017 through 2019) and those published during the pandemic (2020 through February 2021).

With respect to item two, we hypothesize that the corpus of articles published before the pandemic will have different priorities, which will be reflected in different findings at each stage of the analysis listed below.

For each step of the analysis, we applied the methods to the entire corpus (all 44 articles) as well as to the pre-pandemic and during-pandemic corpora for comparison. The stages of analysis are shown in Figure 1.

Work for each step of analysis was performed by one or more of the authors and reviewed by the remaining authors for accuracy.

Figure 1. Project Framework

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**Figure 1. Project Framework**

- **Data Collection**
- **Pre-processing**
  - Clean Documents
  - Check Quality of Cleaning
- **Text Summarization/Analysis**
  - Keyword Extraction
  - Topic Modeling
  - Clustering
  - Text Similarity Analysis

**Database:** PsycNet
**Search terms:** Telepsychology, Telemental health

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**Table 1.** Journal Title, Year, Authors

<table>
<thead>
<tr>
<th>Journal Title</th>
<th>Year</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Journal A</em></td>
<td>2017</td>
<td>Smith et al.</td>
</tr>
<tr>
<td><em>Journal B</em></td>
<td>2018</td>
<td>Jones and Doe</td>
</tr>
<tr>
<td><em>Journal C</em></td>
<td>2019</td>
<td>Chen et al.</td>
</tr>
</tbody>
</table>
Results

Keyword Extraction. We began the analysis by looking at word frequencies. Our first step in keyword extraction is simple word frequency analysis. We performed this analysis for both individual words and for bi-grams, or two-word phrases, in order to better understand the context for each word. The results are shown in Figure 2 and the analyses can be viewed in the Github repository.

Based on these results we identified ‘telemental health’ as the most frequent bi-gram overall and in both pre- and during-pandemic papers. In the pre-COVID corpus, we did not observe many clear themes, with the general focus being on terms related to telemental health as well as subjects related to independent treatment like ‘self-help’ and ‘internet guided’. In contrast, the during-pandemic corpus, appears to have shifted towards treating stress disorders and post-traumatic stress, along with the high frequency of mentions for COVID-19. This may reflect increases in the appearance of stress-based disorders in clinical settings, as well as increased demand for the related treatments.

In addition to a basic keyword search, we also performed named entity recognition (NER) to determine the top entities discussed across the corpus. For this analysis we used “en_core_web_trf”, spaCy roberta base transformer model, which is trained on a text corpus of news, conversational telephone speech, weblogs, usenet newsgroups, and talk shows. This model gave better results than alternative spaCy models used to label the text based upon entity type and examine the top entities in the corpus.

Based on this analysis, organization, person, and product entities were identified as the most useful classifications. Figure 3 examines these entities more closely, showing the top 10 entities in each category of interest. Based on this, we were able to identify the most cited researchers in the corpus as well as the most influential organizations in telepsychology, the American Psychological Association (APA), Veteran’s Affairs (VA), and the Veteran’s Health Administration (VHA).

Technology companies such as Apple and Google were overshadowed by government organization in their referenced amount. In context, this tracks well with what we know of telehealth adoption, as the VA was one of the primary users of telehealth technology prior to the COVID-19 pandemic (N-MHSS, 2019). Finally, we were able to see what
products are being mentioned most in the context of telepsychology. These included telecommunication platforms like Skype, TMH-V (telemental health – video), google hangouts, zoom and facetime, as well as psychological products such as, WISC-V (Wechsler Intelligence Scale for Children) and I-PCIT (Internet-based Parent-Child Interaction Therapy). One limitation to this analysis is that since the articles were pulled from APA journals, there may be a bias in author awareness of APA research and its influence.

**Topic Modeling**. After testing several models for topic modeling, including Latent Semantic Indexing (LSI) and Latent Dirichlet Allocation (LDA), we found the best performance with respect to distinguishable topics using Non-negative Matrix Factorization (NMF). Like LSI, NMF is a matrix decomposition technique that takes an input of a term-document matrix, in this case TF-IDF, and returns two non-negative matrices whose product is a final non-negative matrix. When compared with LDA, NMF has the advantage of allowing for easier tuning (Sarkar, 2016). Table 1 shows the first 10 topics identified using NMF for the entire corpus. The complete list of topics is available in the Github repository but are not included here due to space constraints.

**Table 1. First 10 topics identified in the entire corpus using NMF.**

<table>
<thead>
<tr>
<th>Topic Number</th>
<th>Key Themes within Topics</th>
<th>Generated Topic Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic 1:</td>
<td>Pandemic and Stress</td>
<td>trauma, 2020, pandemic, disorder, disease, 2019, stress, posttraumatic, coronavirus, telepsychotherapy</td>
</tr>
<tr>
<td>Topic 2:</td>
<td>American Psychological Association and telepsychology</td>
<td>psychology, concern, american, psychological, association, client, state, practice, psychologist, telepsychology</td>
</tr>
<tr>
<td>Topic 3:</td>
<td>Veteran affairs and veteran care</td>
<td>service, healthcare, care, york, harbor, affairs, telemental, hub, veteran, veterans care</td>
</tr>
<tr>
<td>Topic 4:</td>
<td>Online technologies</td>
<td>bit, service, providers, online, couple, technologies, module, client, intervention, telemental</td>
</tr>
<tr>
<td>Topic 5:</td>
<td>Research</td>
<td>randomized, meta, clinician, veteran, deliver, studies, face, intervention, analysis, telepsychology</td>
</tr>
<tr>
<td>Topic 6:</td>
<td>Supervision and Training</td>
<td>Director, transition, supervision, student, telepsychology, supervisor, tele supersision, training, clinic, trainee</td>
</tr>
<tr>
<td>Topic 7:</td>
<td>Caregiver and skill based treatment</td>
<td>care, caregiver, posttreatment, tutorial, behavior, skill, therapy, interaction, child, parent</td>
</tr>
<tr>
<td>Topic 8:</td>
<td>Methods of self help</td>
<td>television, book, user, guide, internet, patient, borgueta, self, help, guided</td>
</tr>
<tr>
<td>Topic 9:</td>
<td>Rural Care and Latinx Communities</td>
<td>family, model, integrate, primary, community, disparity, brazil, rural, care, latina</td>
</tr>
<tr>
<td>Topic 10:</td>
<td>Remote testing/assessment</td>
<td>kbit, taker, index, examinee, proctor, subtest, remote, wisc, test, administration</td>
</tr>
</tbody>
</table>

Tables 2 and 3 show the first 5 topics extracted for each of the time periods, pre-COVID and during COVID. Examination of these topics revealed a few important differences. The major topics apparent in the pre-COVID corpus include the VA, security, rural communities, access to care, farming populations, depression, and family-based treatments. The topics identified in the during COVID corpus were, unsurprisingly, the pandemic, stress and posttraumatic stress, loneliness and caregivers, provider attitudes, licensure and interstate practice, and clinical training. These are strong indicators of the issues that researchers are trying to address in this field and can indicate the areas where more focus is needed, such as treating loneliness and stress, as well as supporting caregivers.

**Table 2. First 5 topics identified in the pre-pandemic corpus using NMF.**

<table>
<thead>
<tr>
<th>Topic Number</th>
<th>Key Themes within Topics</th>
<th>Generated Topic Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic 1:</td>
<td>VA and telemental health care</td>
<td>administration, new, service, veterans, affairs, healthcare, harbor, hub, york, telemental</td>
</tr>
<tr>
<td>Topic 2:</td>
<td>Rural communities and care disparities</td>
<td>local, disparity, rural, family, global, community, primary, brazil, mental, care</td>
</tr>
<tr>
<td>Topic 3:</td>
<td>Security and privacy</td>
<td>security, psychological, privacy, american, association, agency, client, psychologist, therapy, telemental</td>
</tr>
<tr>
<td>Topic 4:</td>
<td>Remote child and parent interaction therapy</td>
<td>month, datum, participant, interaction, remotely, parent, session, technology, child, family</td>
</tr>
<tr>
<td>Topic 5:</td>
<td>Depression interventions and self help</td>
<td>depression, responsibility, internet, therapist, issue, guide, intervention, self, patient, help</td>
</tr>
</tbody>
</table>

**Table 3. First 5 topics identified in the during-pandemic corpus using NMF.**

<table>
<thead>
<tr>
<th>Topic Number</th>
<th>Key Themes within Topics</th>
<th>Generated Topic Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic 1:</td>
<td>Pandemic and stress disorders</td>
<td>2020, care, disorder, pandemic, telepsychotherapy, posttraumatic, 2019, stress, disease, coronavirus</td>
</tr>
<tr>
<td>Topic 2:</td>
<td>Telepsychology service concerns</td>
<td>psychology, association, concern, affairs, service, participant, state, client, psychologist, telepsychology</td>
</tr>
<tr>
<td>Topic 3:</td>
<td>Measurement and feedback</td>
<td>https, measure, feedback, care, clinician, based, client, measurement, telemental, mbc</td>
</tr>
<tr>
<td>Topic 4:</td>
<td>Research and analysis</td>
<td>provider, increase, service, analysis, studies, attitude, patient, care, providers, telemental</td>
</tr>
<tr>
<td>Topic 5:</td>
<td>Court and custody evaluation, forensic psychology</td>
<td>research, datum, interview, court, child, videoconferencing, evaluation, custody, evaluator, forensic</td>
</tr>
</tbody>
</table>

**Clustering Analysis.** Following our topic extraction analysis, we were interested in whether there were any clusters identifiable in the documents of the corpus, which would help us identify groups where specific topics were present or possibly differences in the article distribution by COVID status. To address these questions, we vectorized each article by passing it through a pre-trained BERT model. This is a model that was originally developed by Google and has already been trained on a massive amount of data, meaning that it already ‘knows’ a lot about English language structure. This model is therefore able to create a numerical representation of each article (Devlin et al., 2018).

Following vectorization, we used the dimensionality reduction methods principal component analysis (PCA) and t-distributed Stochastic Neighbor Embedding (t-SNE) in order to reduce the
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complexity of the dataset and identify the features that are responsible for the most inter-article variation (Wattenberg et al., 2016). A detailed description of the parameter tuning performed at this step is available in the Github repository but excluded from this report to conserve space.

Figure 4. Clustered Articles using t-SNE dimensionality reduction and DBSCAN

Finally, we were able to use density-based special clustering of applications with noise (DBSCAN) to identify clusters in the data. We were unable to see distinct clusters based on COVID status; however, we were able to identify clusters using DBSCAN. Figure 3 shows the clustering model that produced the best separation and included the most articles in the clusters. By reviewing the articles in each cluster, we were able to detect some of the key characteristics of those clusters. A complete list of the titles and which cluster they belong to can be found in the Github repository.

The model, shown in Figure 4 identified three main clusters with the following themes: cluster 0 in the figure contained articles primarily focused on implementation, barriers to care, and evidence-based treatments via telepsychology, while cluster 1 contained articles pertaining to training and ethics of telehealth and telepsychology. Cluster 2 appears to focus on the impact of COVID-19 and the treatment of stress related disorders. These themes were determined based on manual review of the article titles and modeled topics in each cluster.

Text Similarity. In the final stage of our analysis, we chose to perform an analysis of text similarity. In order to best analyze the two corpora (pre-COVID vs. during COVID) we used a BERT model to vectorize each article and calculated the pairwise cosine similarities. The results are displayed in Figure 5. Using this method, we observed cosine similarity values ranging from 0.475 to 1.00 in our sample, indicating at least some similarity across all articles, as expected for a corpus of the same type and field of article. One trend we did observe is that the articles published during COVID were more homogenous to a statistically significant degree, than the pre-COVID corpus.2 This indicates a narrowing of focus within the literature on COVID-related use of telemental health.

Figure 5. Cosine Similarity Across Articles in the Corpus

Discussion

Through the application of thorough text analysis and summarization we were able to identify several key insights from the corpus of telemental health and telepsychology related articles. Key findings included the status of the APA, VA and VHA as consistently important voices and organizations in the field of telepsychology, whether that is in terms of advocacy, implementation, or training. Furthermore, trends in the field were revealed, and the influence of the COVID-19 pandemic specifically was observable as technology products such as zoom, skype and hangouts increased in mentions along with major health organizations, like WHO and the CDC.

We were also able to identify some of the main topics discussed in the corpus, specifically three clusters of topics overall which included implementation, barriers, and evidence-based treatments via telepsychology; training and ethics of telehealth and telepsychology; and the impact of COVID-19 and the treatment of stress related disorders.

When examining the pre-COVID and during COVID corpora independently, we identified shifts in treatment focus, such as a shift from depression disorders to stress and stress related disorders as well as loneliness and caregivers. We also saw a heavier emphasis in pre-COVID articles on security, rural communities, and access to care while during COVID papers were more likely to discuss licensure and interstate practice.

These findings are reflective of the massive shift in research in response to the COVID-19 pandemic. Even with respect to amount of research produced, the literature produced in the 3 years prior to the COVID pandemic was half of what has been published since. These findings speak to the flexibility and versatility of the psychology research workforce.

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2 t(509) = -5.34, p < 0.0001
We see very clear calls to action in the literature. The need for training and interstate licensure agreements as well as the increased demand for stress and stress-related services that have all risen to the forefront of our awareness during the events of 2020 is reflected in the research produced since. Despite this, it is important that we maintain momentum. Articles published prior to COVID included critical topics, such as accessibility, equity, and meeting the needs of rural populations. Our similarity analysis found greater homogeneity in articles published since the start of the pandemic. This could indicate that many critical topics related to telehealth and telemental health services have been set aside in favor of COVID specific topics. Ignoring ongoing issues in these areas in favor of the needs directly related to the pandemic may mean that research in the field of telepsychology is destined to lose momentum once the pandemic passes. These needs remain important and should therefore continue to be the focus for research in the future.

That said, the findings related to treatment areas are important in terms of informing the workforce on the areas of greatest growth and need for support. It is true that the demand for treatment related to stress and loneliness has exploded as a result of the anxiety and isolation caused by the pandemic and quarantine measures. It is also unlikely that these needs will end with the end to government mandates, quarantines and restrictions. This has strong implications for the needs of the workforce going forward and the importance of research which produces evidence based and effective remote treatments for these disorders.

**Limitations.** This research was performed as part of a course assignment, which limited the size and scope of data we could include in the initial study. For this reason, we chose to limit the search terms used as well as, only including freely available articles from the PsycNet database that were published in APA journals. This may be a source of bias in terms of focus and especially the named entity recognition findings, which identified the APA as a highly influential organization in the field of telepsychology.

The text analyses that were applied, while broad, were not comprehensive, and there is significant space to perform additional analysis in order to better understand key topics and trends in the corpus. Future research may include digging deeper into specific analyses performed in this paper to identify the optimal methods for text analysis and understanding.

**Recommendations.** This study lays the groundwork for a more expansive dive into the evolution of academic literature on telepsychology services. Furthermore, future research is clearly needed in the field of telepsychology. Our recommendations are therefore two-fold: the first being that researchers continue to explore the use of NLP to identify key research needs and action points in the field of mental health and teleservices.

Second, to emphasize the need for telepsychology research. If we have learned anything, it is that the field is growing and growing quickly as a result of the pandemic and the sudden need for virtual services. Our work has identified the areas which demonstrate the highest needs, specifically stress-based virtual care, treating loneliness, supporting caretakers, and making interstate licensure more accessible. Addressing these needs will be vital to meeting the demands on the psychology workforce now and following the pandemic.

**References**


Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration, National Mental Health Services Survey (N-MHSS). 2019. Table 3.3b


