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Representation of an Interdisciplinary Approach for Evaluation of Precision of a Neurocognitive Screening Bundle: A Proposal

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ABSTRACT: *Neurocognitive disorders encompass a range of conditions characterized by cognitive impairments, presenting significant challenges to individuals, families, and healthcare systems worldwide. Traditional paper-and-pencil assessments have limitations, including restricted access, limited frequency, and subjective interpretation. This research proposal aims to address these limitations by developing a reliable digital platform, a neurocognitive screening bundle, for year-round monitoring of neurocognitive symptom domains. The proposed research project adopts an interdisciplinary approach by integrating knowledge and expertise from the fields of neurology, psychology, cognitive neuroscience, and computer science. Neurology provides clinical context and expertise in understanding neurocognitive symptom domains, ensuring that the chosen screening bundle aligns with clinical needs. Psychology contributes insights into human behavior and cognitive processes, aiding in the selection, adaptation, or development of assessments targeting specific neurocognitive functions. Additionally, psychologists contribute expertise in data analysis and interpretation, enabling the identification of meaningful patterns within the collected data. Cognitive neuroscience offers a deeper understanding of the underlying neural mechanisms associated with neurocognitive symptom domains. By identifying the neural networks, brain regions, and cognitive processes involved in specific cognitive functions, cognitive neuroscientists bridge the gap between cognitive assessment and neurobiological underpinnings, aiding in the selection and interpretation of neurocognitive measures. Computer science plays a pivotal role in developing and evaluating the digital platform for neurocognitive screening. Computer scientists leverage their expertise in software development, data analysis, and machine learning to design algorithms for data processing, ensure data security and privacy, and develop user-friendly interfaces for assessments. By integrating technical skills with knowledge from other disciplines, computer scientists enhance the accuracy, reliability, and usability of the digital platform. This interdisciplinary research project aims to provide a comprehensive, accessible, and reliable tool for year-round monitoring of neurocognitive symptom domains, surpassing the limitations of traditional assessment methods. By leveraging the expertise from neurology, psychology, cognitive neuroscience, and computer science, this study aims to advance the field and improve clinical outcomes for individuals with neurocognitive disorders. The findings of this research project have the potential to revolutionize neurocognitive assessments, leading to more effective diagnosis and monitoring of these challenging conditions.*

KEYWORDS: neurocognitive disorders, digital platform, interdisciplinary approach, neurocognitive screening, cognitive neuroscience, psychology, neurology, computer science

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INTRODUCTION

Neurocognitive disorders encompass a range of conditions characterized by impairments in cognitive functions, such as memory, attention, and executive functioning [1]. These disorders pose significant challenges to individuals, their families, and healthcare systems worldwide. Timely and accurate assessment of neurocognitive symptom domains is crucial for effective diagnosis, treatment planning, and monitoring of these conditions. Traditional paper-and-pencil assessments have limitations, including restricted access, limited frequency, and the potential for subjective interpretation.

To address these limitations, the integration of digital technologies and interdisciplinary approaches presents an opportunity to revolutionize the field of neurocognitive assessment. This research proposal aims to evaluate a neurocognitive screening bundle as a reliable digital platform for year-round monitoring of neurocognitive symptom domains. By integrating knowledge and expertise from the fields of neurology, psychology, cognitive neuroscience, and computer science, this interdisciplinary project seeks to advance the development of a comprehensive and accessible tool for neurocognitive assessment.

The fields of neurology and psychology contribute valuable clinical and psychological perspectives to this research. Neurology provides the necessary clinical context and expertise in understanding neurocognitive symptom domains[2], ensuring that the chosen screening bundle aligns with clinical needs. Psychology, on the other hand, offers insights into human behavior and cognitive processes, assisting in the selection, adaptation, or development of assessments targeting specific neurocognitive functions. Additionally, psychologists provide expertise in data analysis and interpretation, aiding in the identification of meaningful patterns and trends within the collected data.

Cognitive neuroscience brings a deeper understanding of the underlying neural mechanisms[3] associated with neurocognitive symptom domains. By identifying the neural networks, brain regions, and cognitive processes involved in specific cognitive functions, cognitive neuroscientists can help elucidate the neurobiological basis of these symptoms. Their expertise contributes to the selection and interpretation of neurocognitive measures, bridging the gap between cognitive assessment and neurobiological underpinnings.

Furthermore, computer science plays a pivotal role in developing and evaluating the digital platform for neurocognitive screening. With expertise in software development, data analysis, and machine learning, computer scientists can design and implement algorithms for data processing, ensure data security and privacy, and develop user-friendly interfaces for assessments. By

integrating their technical skills with the knowledge from the other disciplines, computer scientists enhance the accuracy, reliability, and usability of the digital platform.

This interdisciplinary research project not only addresses the limitations of traditional assessment methods but also aims to provide a comprehensive, accessible, and reliable tool for year-round monitoring of neurocognitive symptom domains. By leveraging the expertise from neurology, psychology, cognitive neuroscience, and computer science, this study aims to contribute to the advancement of the field and improve clinical outcomes for individuals with neurocognitive disorders. Ultimately, the findings of this research project have the potential to revolutionize the way neurocognitive assessments are conducted, leading to more effective diagnosis and monitoring of these challenging conditions.

Research Problem and Gap

Despite the growing recognition of the importance of neurocognitive assessment in the diagnosis and management of neurocognitive disorders, there remain significant challenges in implementing reliable and accessible tools for year-round monitoring of neurocognitive symptom domains. Traditional paper-and-pencil assessments have inherent limitations, including restricted access, limited frequency of assessment, and subjective interpretation, which can impede accurate and timely detection of changes in cognitive functioning.

Furthermore, the existing digital platforms for neurocognitive assessment completely lack a comprehensive screening bundle that encompass a wide range of neurocognitive domains. While some individual tests or tools may be available, there is a gap in the literature regarding the evaluation of a holistic and reliable digital platform that combines various neurocognitive measures into a comprehensive screening bundle for long term remote monitoring. Such a tool would provide a standardized and objective approach to monitor neurocognitive symptom domains consistently throughout the year, allowing for earlier detection of changes and facilitating personalized interventions.

Additionally, the integration of interdisciplinary perspectives from neurology, psychology, cognitive neuroscience, and computer science is crucial in the development of a comprehensive and reliable digital platform. The existing literature has mostly focused on isolated aspects of neurocognitive assessment, without fully harnessing the potential of interdisciplinary collaboration. Therefore, there is a gap in the research that explores the integration of these disciplines to develop a robust digital platform for year-round monitoring of neurocognitive symptom domains.

To address these research gaps, this study aims to evaluate a neurocognitive screening bundle as a reliable digital platform for year-round monitoring of neurocognitive symptom domains. By

integrating expertise from neurology, psychology, cognitive neuroscience, and computer science, this interdisciplinary research project seeks to fill the gap in the literature by providing a comprehensive, accessible, and standardized tool that can facilitate early detection and monitoring of neurocognitive changes. By doing so, this research project aims to contribute to the advancement of neurocognitive assessment and improve clinical outcomes for individuals with neurocognitive disorders.

Research Objectives:

The primary objectives of this research project are to-

1. Develop a comprehensive neurocognitive screening bundle: The first objective of this study is to develop a comprehensive screening bundle that encompasses a wide range of neurocognitive domains. Drawing upon existing measures and assessments from the fields of neurology, psychology, and cognitive neuroscience, this objective aims to create a standardized and validated set of neurocognitive tests and measures that can be administered digitally.
2. Assess the reliability and validity of the digital platform: The second objective is to evaluate the reliability and validity of the digital platform as a tool for year-round monitoring of neurocognitive symptom domains. This includes examining the internal consistency, test-retest reliability, and concurrent validity of the neurocognitive screening bundle administered through the digital platform. Statistical analyses will be conducted to determine the psychometric properties of the assessment measures and their consistency over time.
3. Investigate the sensitivity of the digital platform to detect changes: The third objective is to assess the sensitivity of the digital platform in detecting changes in neurocognitive symptom domains over time. This will involve administering the neurocognitive screening bundle to a sample of individuals with known neurocognitive disorders or at risk of developing such conditions. By analyzing the data collected at different time points, this objective aims to determine the platform's ability to detect subtle changes in cognitive functioning.
4. Examine user experience and acceptability of the digital platform: The fourth objective is to explore the user experience and acceptability of the digital platform among both individuals undergoing the neurocognitive screening and healthcare professionals who administer and interpret the results. This objective will involve qualitative assessments such as interviews or surveys to gather feedback on usability, accessibility, and perceived usefulness of the platform.

5. Explore the feasibility of integrating interdisciplinary approaches: The fifth objective is to examine the feasibility and potential benefits of integrating interdisciplinary perspectives from neurology, psychology, cognitive neuroscience, and computer science in the development and evaluation of the digital platform. This objective aims to identify the added value and synergistic effects that arise from interdisciplinary collaboration and provide insights into the practical implementation of such approaches.
6. Mitigate the potential risks of being misdiagnosed or remaining undiagnosed: The research project has the potential to mitigate the risks of false positives and false negatives associated with subjective cognitive task-dependent neurocognitive screening tools such as the Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), and Self-Administered Gerocognitive Examination (SAGE) tests. The following approaches can be implemented:

A. Standardized and comprehensive assessment: The proposed digital platform aims to develop a comprehensive neurocognitive screening bundle that includes a wide range of objective measures. By incorporating multiple neurocognitive domains and objective assessments, the platform reduces reliance on a single cognitive task or subjective interpretation, which can contribute to false positives or false negatives. A comprehensive assessment can provide a more nuanced understanding of cognitive functioning, minimizing the risks of misdiagnosis or overlooking specific cognitive impairments.

B. Sensitivity and specificity analysis: Statistical analyses can be employed to evaluate the sensitivity and specificity of the digital platform's neurocognitive screening bundle. By examining these measures, the research project can optimize the assessment algorithms, thresholds, and criteria to strike a balance between sensitivity and specificity. This optimization aims to minimize the risks of false positives and false negatives, ensuring accurate identification of individuals with cognitive impairments while correctly identifying those without impairments.

C. Longitudinal monitoring and trend analysis: The year-round monitoring capability of the digital platform enables longitudinal assessments, facilitating the detection of cognitive changes over time. By collecting data at multiple time points, the research project can identify cognitive trends and patterns, reducing the likelihood of false positives or false negatives resulting from isolated assessments. Longitudinal monitoring provides a more comprehensive picture of cognitive functioning, enabling the detection of subtle changes that may be missed in single-point assessments.

D. Machine learning algorithms: The integration of machine learning algorithms within the digital platform can enhance its ability to detect meaningful patterns and trends in neurocognitive data. These algorithms can learn from the collected data, identify complex relationships, and refine the assessment models over time. This iterative process can improve the accuracy of the platform in detecting cognitive impairments, reducing the risks of false positives and false negatives by leveraging the power of data-driven analysis.

E. Interdisciplinary collaboration: The interdisciplinary collaboration among experts in neurology, psychology, cognitive neuroscience, and computer science can mitigate the risks of false positives and false negatives. By integrating diverse perspectives and methodologies, the research project can develop a more robust and balanced assessment approach. Different disciplines bring their expertise in understanding the complexities of neurocognitive functioning, developing accurate assessment measures, and implementing advanced data analysis techniques, collectively minimizing the risks of false positives and false negatives.

By incorporating these approaches, the research project's digital platform for neurocognitive screening can potentially reduce the risks of false positives and false negatives associated with subjective cognitive task-dependent screening tools. This can lead to more accurate identification and monitoring of neurocognitive impairments, enabling timely interventions, and improving the overall diagnostic accuracy and effectiveness of the assessment process.

LITERATURE REVIEW

A systematic review[4] that evaluated the diagnostic accuracy of the Mini-Mental State Examination (MMSE) for predicting the progression from mild cognitive impairment (MCI) to dementia, including Alzheimer's disease and other types of dementia, reviewed 11 studies with a total of 1,569 MCI patients. The findings showed that the MMSE had varying accuracy in identifying individuals who would develop dementia, with sensitivities ranging from 23% to 76% and specificities from 40% to 94% for dementia in general, and sensitivities from 27% to 89% and specificities from 32% to 90% for Alzheimer's disease dementia. Limited data were available for vascular dementia. Overall, the review did not find strong evidence supporting the use of the MMSE as a stand-alone test for predicting dementia in individuals with MCI. Additional tests and longitudinal assessments may be necessary for better management of MCI patients. Future research should explore alternative approaches and combinations of tests to improve the accuracy of predicting conversion from MCI to dementia.

A cross-sectional study aimed to evaluate the criterion validity of the Montreal Cognitive Assessment (MoCA) as a screening tool for mild cognitive impairment (MCI) and mild dementia (MD) in an old age psychiatry cohort. The study used a reference standard based on international

criteria for diagnosis. Additionally, the study investigated the effects of case-control spectrum bias by including healthy community older adults as additional comparisons[5].

The results showed that when using healthy controls in a case-control design, the MoCA demonstrated satisfactory criterion validity for cognitive impairment (MCI + MD) with an area under the curve (AUC) of 0.93 and a specificity of 73% (using a cutoff score of less than 26). However, in the cross-sectional design using referred individuals without cognitive impairment as comparisons, the criterion validity declined with an AUC of 0.77 and a specificity of 37% (using the same cutoff score).

In an old age psychiatry setting, the MoCA was found to be valuable for confirming normal cognition (cutoff score greater than or equal to 26; sensitivity of 95%), excluding MD (cutoff score greater than or equal to 21; negative predictive value [NPV] of 98%), and excluding MCI (cutoff score greater than or equal to 26; NPV of 94%). However, it was not effective for diagnosing MD (cutoff score less than 21; positive predictive value [PPV] of 31%) or MCI (cutoff score less than 26; PPV of 33%).

In conclusion, this study indicates that using healthy controls to validate the MoCA may overestimate its specificity. In an old age psychiatry setting, considering clinical and demographic characteristics, the MoCA can be a suitable screening tool for determining the need for further diagnostic investigations, but it is not reliable for diagnosing cognitive impairment.

Results of a cohort study aimed to compare the longitudinal scores of the Self-Administered Gerocognitive Examination (SAGE), a self-administered cognitive assessment tool, with the non-self-administered Mini-Mental State Examination (MMSE) in different diagnostic subgroups showed that SAGE scores declined annually for MCI converters to AD dementia and AD dementia subjects, while they remained stable for SCD and MCI non-converters. The decline in SAGE scores occurred at least 6 months earlier than MMSE scores for MCI converters to AD dementia, MCI converters to non-AD dementia, and AD dementia individuals. Based on these findings, the study concludes that SAGE can detect MCI conversion to dementia at least 6 months earlier than MMSE. Additionally, since SAGE is self-administered, it helps overcome barriers in performing cognitive assessments. However, the study acknowledges limitations such as potential referral and sampling biases. The repetitive use of SAGE may provide clinicians with an objective cognitive biomarker that can impact evaluation and management decisions[6].

Results from a comprehensive study showed that a baseline MIS score of 0 or 1 predicted conversion to Alzheimer's disease with a sensitivity of 42.9%, specificity of 98%, and positive predictive value of 96%. The area under the curve for the predictive value of the MIS was 0.76. In a clinical setting with patients presenting memory complaints, the MIS score at baseline (0 and 1)

is useful in predicting the development of Alzheimer's disease within at least a year[7]. However, combining the MIS with a test with higher sensitivity would enhance its usefulness.

A study on 103 patients regarding evaluation of precision of the Animal Naming Test (ANT) concluded that ANT is a simple and accurate tool for diagnosing MHE and predicting overt episodes of HE in patients with liver cirrhosis. ANT also correlates well with Child-Pugh and MELD scores [8].

In contrast to the aforementioned reports, misclassification in brief cognitive assessments for dementia is a common issue, leading to false-positive and false-negative results. A population-based study aimed to identify predictors of misclassification in three widely used assessments: the Mini-Mental State Examination (MMSE), Memory Impairment Screen (MIS), and animal naming (AN). Analyzing data from 824 older adults with adjudicated dementia diagnoses, found that predictors varied for each assessment. Years of education were associated with higher false-negatives and lower false-positives in the MMSE, while nursing home residency predicted lower false-negatives and higher false-positives in AN. Across the assessments, the absence of informant-rated poor memory consistently predicted false-negatives, while age, nursing home residency, and non-Caucasian ethnicity were consistent predictors of false-positives[9]. Overall, brief cognitive assessments exhibited test-specific biases, highlighting the need for improved evaluation and interpretation of results in dementia diagnosis.

Moreover, a study that investigated the likelihood of misclassification regarding brief cognitive assessments found that both executive control function (ECF) and memory impairment were significantly associated with functional impairment, independently of age. Approximately 6-10% of the subjects had memory impairment, and among them, 25-35% had comorbid ECF impairments[10]. Additionally, 4-7% of the subjects had isolated ECF impairment. The findings suggest that a significant portion of individuals who meet the criteria for "mild cognitive impairment" may actually have comorbid ECF impairment, raising the question of whether they should be classified as "demented" instead. Moreover, isolated ECF impairment, which affects a similar number of individuals as isolated memory impairment, is not consistent with the natural history of preclinical Alzheimer's disease and may indicate other conditions. The study highlights the disabling impact of isolated ECF impairment, independent of age and memory loss.

METHODOLOGY

Research Design:

The proposed research will employ a mixed-methods approach, integrating quantitative and qualitative methods to address the research objectives. This will allow for a comprehensive evaluation of the neurocognitive screening bundle as a reliable digital platform for year-round

monitoring of neurocognitive symptom domains. Additionally, an AI-powered wake word detection system will be incorporated to explore vocal or speech biomarkers as an additional component of the assessment.

Participants

The study will recruit a diverse sample of participants, including individuals with diagnosed neurocognitive disorders, individuals at risk of developing such conditions, and a control group of individuals without cognitive impairments. The sample size will be determined based on power analysis, considering the sensitivity and specificity requirements for the statistical analyses. Efforts will be made to ensure a representative sample in terms of age, gender, educational level, and cultural background.

Development of the Neurocognitive Screening Bundle:

The comprehensive neurocognitive screening bundle will be developed through a systematic review of existing neurocognitive measures and assessments. Measures from neurology, psychology, and cognitive neuroscience will be selected based on their validity, reliability, and relevance to the targeted neurocognitive symptom domains. The selected measures will be adapted for digital administration and incorporated into the platform. In addition, an AI-powered wake word detection system will be integrated into the platform to capture vocal or speech biomarkers for further analysis.

Platform Development

The digital platform, developed by a team of computer scientists, software engineers, and AI experts in collaboration with neurocognitive experts, will incorporate the neurocognitive screening bundle and the AI-powered wake word detection system. The platform will be designed to ensure usability, accessibility, and compatibility across different devices (e.g., computers, tablets, smartphones). It will provide standardized instructions for each assessment measure, automated scoring, data storage capabilities, and the ability to capture and analyze vocal or speech biomarkers.

Quantitative Data Collection and Analysis

Quantitative data will be collected through the digital platform at multiple time points throughout the year. Participants will complete the neurocognitive screening bundle, and their responses will be recorded. Descriptive statistics will be used to summarize participants' demographic characteristics. The psychometric properties of the assessment measures will be evaluated, including internal consistency, test-retest reliability, and concurrent validity. Sensitivity and specificity analyses will be conducted to determine the accuracy of the digital platform in detecting

neurocognitive impairments. Statistical tests, such as t-tests and analysis of variance (ANOVA), will be employed to examine group differences and cognitive changes over time. Additionally, the AI-powered wake word detection system will analyze vocal or speech biomarkers, providing insights into potential correlations between these biomarkers and neurocognitive functioning.

Qualitative Data Collection and Analysis

Qualitative data will be collected to explore the user experience and acceptability of the digital platform, including the wake word detection system. Semi-structured interviews or surveys will be conducted with participants and healthcare professionals to gather their feedback on the platform's usability, accessibility, and perceived usefulness. Thematic analysis will be employed to identify common themes and patterns in the qualitative data, providing insights into the strengths, limitations, and potential improvements of the platform, as well as participants' experiences with the vocal or speech biomarkers.

Ethical Considerations

Ethical approval will be obtained from the relevant research ethics committee to ensure participant safety, privacy, and informed consent. Participants will be provided with clear information about the purpose and procedures of the study, including the collection and analysis of vocal or speech biomarkers. Their confidentiality and data protection will be ensured throughout the research process.

Limitations and Challenges

Potential limitations and challenges of the study include participant attrition over the course of the year, potential biases associated with self-reported data, technological issues related to the digital platform, and the need for careful interpretation of vocal or speech biomarkers. Efforts will be made to address these limitations through appropriate participant recruitment, data quality checks, rigorous testing of the digital platform's functionality, and collaboration with experts in speech analysis and AI algorithms.

By employing this methodology, the research project aims to provide a comprehensive evaluation of the neurocognitive screening bundle as a reliable digital platform for year-round monitoring of neurocognitive symptom domains, including the exploration of vocal or speech biomarkers as potential indicators of neurocognitive functioning. The combination of quantitative and qualitative data, along with AI-powered analysis of vocal or speech biomarkers, will offer a deeper understanding of the platform's psychometric properties, accuracy in detecting cognitive changes, user experience, and the potential utility of vocal or speech biomarkers in neurocognitive assessment.

Ethical Considerations

Informed Consent:

Obtaining informed consent from participants will be a fundamental ethical consideration. Participants will be provided with clear and understandable information about the purpose, procedures, risks, and benefits of the study. They will have the opportunity to ask questions and make an informed decision about their participation. Written consent will be obtained from all participants or their legally authorized representatives.

Participant Confidentiality and Privacy:

Ensuring participant confidentiality and privacy will be of utmost importance. All participant data, including demographic information and assessment results, will be securely stored and anonymized. Only authorized research personnel will have access to the data, and strict protocols will be followed to prevent unauthorized disclosure or access. Any published findings will maintain participant anonymity and confidentiality.

Protection of Vulnerable Populations:

Special care will be taken to protect the rights and welfare of vulnerable populations, including individuals with diagnosed neurocognitive disorders. Their capacity to provide informed consent will be assessed, and additional measures, such as consulting with caregivers or legally authorized representatives, will be implemented as necessary to ensure their well-being and rights are respected.

Research Ethics Approval:

The research proposal will undergo a comprehensive ethical review process by the relevant research ethics committee or institutional review board. The committee will evaluate the study's design, participant recruitment, consent process, data storage, and protection measures to ensure compliance with ethical guidelines and regulations. Any modifications or amendments to the study will also require ethical approval.

Data Security and Storage:

Stringent measures will be implemented to ensure the security and confidentiality of participant data. All digital platforms and data storage systems will adhere to industry best practices for data security. Data encryption, password protection, and restricted access will be employed to safeguard participant information from unauthorized use or disclosure. Data will be stored for the required duration as per ethical guidelines and then securely disposed of following appropriate protocols.

Potential Risks and Benefits:

The research project will carefully assess and mitigate potential risks associated with participation. These may include temporary emotional distress during assessments or potential breaches of data security. Measures will be in place to provide support and referrals to participants if necessary. The potential benefits of the study, such as contributing to the development of a reliable neurocognitive screening platform and improving early detection of cognitive impairments, will be clearly communicated to participants.

Transparency and Integrity:

The research project will uphold principles of transparency and scientific integrity. Accurate representation of findings, appropriate acknowledgment of contributions, and responsible data management practices will be followed. Any conflicts of interest or potential biases will be disclosed and managed in an ethical and transparent manner.

Continuous Monitoring and Ethical Review:

Throughout the research project, continuous monitoring of ethical considerations will be maintained. Regular reviews will assess the ongoing ethical compliance of the study, ensuring participant well-being and the adherence to ethical guidelines. Any concerns or issues identified during the study will be promptly addressed and reported to the relevant ethics committee.

By adhering to these ethical considerations, the research project will prioritize participant welfare, data confidentiality, and scientific integrity, thereby ensuring that the study is conducted ethically and with the utmost respect for the rights and well-being of all participants involved.

Expected Results and Significance:

Expected Results:

The research project expects to yield several important results:

- Development of a comprehensive neurocognitive screening bundle: The project aims to create a digital platform that incorporates a wide range of objective neurocognitive measures from various domains. This will result in a comprehensive assessment tool that can reliably evaluate neurocognitive symptom domains.

- Evaluation of the digital platform's psychometric properties: Through quantitative analyses, the research project will assess the reliability, validity, and sensitivity of the digital platform in detecting neurocognitive impairments. This will provide evidence for the platform's effectiveness in accurately identifying individuals with cognitive difficulties.

- Identification of vocal or speech biomarkers: By integrating an AI-powered wake word detection system, the research project will explore the potential use of vocal or speech biomarkers as additional indicators of neurocognitive functioning. The identification of such biomarkers may offer novel insights into cognitive assessment and monitoring.

- Longitudinal monitoring of neurocognitive changes: The year-round monitoring capability of the digital platform will enable the detection of subtle cognitive changes over time. The project expects to observe cognitive trajectories and identify patterns of change, providing valuable information for early detection and intervention.

Significance

The research project holds significant implications for multiple stakeholders:

- Clinical Practice: The development of a reliable neurocognitive screening bundle can enhance clinical practice by providing healthcare professionals with a standardized and comprehensive tool for assessing neurocognitive symptom domains. This can facilitate early detection, accurate diagnosis, and personalized interventions for individuals at risk or already affected by neurocognitive disorders.

- Improved Diagnostic Accuracy: By mitigating the biases and risks of false positives and false negatives associated with subjective cognitive task-dependent screening tools, the digital platform has the potential to improve the accuracy of neurocognitive assessments. This can reduce misdiagnosis and ensure that individuals receive appropriate care and support based on their actual cognitive functioning.

- Enhanced Remote Monitoring: The year-round monitoring capability of the digital platform enables remote assessment and monitoring of individuals' neurocognitive functioning. This can be especially beneficial for individuals who face challenges in accessing healthcare facilities or those living in remote areas. It allows for timely identification of cognitive changes and facilitates remote interventions and support.

- Advancement in Neurocognitive Research: The research project's interdisciplinary approach brings together experts from neurology, psychology, cognitive neuroscience, and computer science. The integration of AI-powered analysis and exploration of vocal or speech biomarkers contributes to the advancement of neurocognitive research and understanding. The findings may open avenues for further investigations into the relationship between vocal or speech patterns and cognitive functioning.

- Societal Impact: Neurocognitive disorders have a significant impact on individuals, families, and society as a whole. By improving the accuracy and accessibility of neurocognitive assessments, the research project has the potential to enhance early detection and intervention, leading to improved quality of life, reduced healthcare costs, and greater societal well-being.

Overall, the expected results and significance of the research project lie in the development of a comprehensive, reliable, and accessible digital platform for neurocognitive screening. The project's findings can have a transformative impact on clinical practice, diagnostic accuracy, remote monitoring, neurocognitive research, and the well-being of individuals affected by neurocognitive disorders.

Timeline

The proposed research project will be conducted over a period of three years, following a systematic timeline. The timeline below provides an overview of the major milestones and activities:

Year 1:

- Month 1-3: Conduct a comprehensive literature review on neurocognitive screening tools, digital platforms, and vocal/speech biomarkers.

- Month 4-6: Formulate the research questions, refine the objectives, and develop the initial research design.

- Month 7-9: Recruit participants for the study, including individuals with diagnosed neurocognitive disorders, individuals at risk, and a control group.

- Month 10-12: Develop the digital platform and adapt existing neurocognitive measures for digital administration.

Year 2:

- Month 1-3: Pilot test the digital platform and neurocognitive screening bundle with a small sample of participants. Collect feedback and make necessary refinements.

- Month 4-6: Begin the data collection phase, including quantitative assessment measures and vocal/speech biomarker analysis.

- Month 7-9: Continuation of data collection and ensure adherence to the research ethics guidelines.

- Month 10-12: Initiate qualitative data collection through interviews or surveys to gather participants' feedback on the platform's usability and acceptability.

Year 3:

- Month 1-3: Complete the data collection phase, ensuring an adequate sample size across participant groups.

- Month 4-6: Analyze the collected data, including psychometric properties of the neurocognitive screening bundle, accuracy of the digital platform in detecting cognitive impairments, and exploration of vocal/speech biomarkers.

- Month 7-9: Conduct thematic analysis of qualitative data to gain insights into the user experience and acceptability of the digital platform.

- Month 10-12: Summarize the research findings, draw conclusions, and prepare the final research report.

- Month 12+: Disseminate the research findings through conference presentations, scientific publications, and relevant stakeholders.

Throughout the three-year timeline, regular team meetings, data monitoring, and quality control measures will be implemented to ensure the smooth progression of the research project. Adjustments to the timeline may be made based on unforeseen circumstances or challenges encountered during the research process.

The proposed timeline aims to provide sufficient time for each phase of the research, from the development of the digital platform and data collection to the analysis of results and dissemination of findings. This ensures a comprehensive and rigorous approach to the evaluation of the neurocognitive screening bundle and its potential for integrating vocal/speech biomarkers, contributing to the advancement of interdisciplinary research in the field of neurology, psychology, cognitive neuroscience, and computer science.

Resources and Budget:

Personnel:

The successful completion of this research project requires a multidisciplinary team with expertise in neurology, psychology, cognitive neuroscience, computer science, and data analysis. The following personnel will be involved:

- Principal Investigator: Responsible for overseeing the entire research project, coordinating activities, and ensuring adherence to timelines and ethical guidelines.

- Co-Investigators: Experts in neurocognitive assessment, digital platforms, and AI algorithms. They will provide guidance and contribute to the research design, data analysis, and interpretation of findings.

- Research Assistants: Assist with participant recruitment, data collection, data entry, and other administrative tasks.

- Software Engineers: Responsible for developing the digital platform, ensuring its functionality, usability, and compatibility across devices.
- AI Experts: Involved in the integration of the wake word detection system and the analysis of vocal/speech biomarkers.

- Statisticians: Provide statistical expertise for data analysis, including psychometric analyses, sensitivity and specificity calculations, and longitudinal data modeling.

- Ethics Advisor: Consults on ethical considerations, ensures compliance with ethical guidelines, and assists with the preparation of ethical approval documents.

Equipment and Facilities

The research project requires access to appropriate equipment and facilities for data collection, storage, and analysis. This includes:

- Computers, laptops, or tablets for participants to complete the digital assessments.

- Secure servers or cloud storage for storing participant data, ensuring data privacy and protection.

- Statistical software for quantitative data analysis.

- Speech analysis software and AI algorithms for vocal/speech biomarker analysis.

Participant Recruitment and Compensation:

Efforts will be made to recruit a diverse sample of participants, including individuals with diagnosed neurocognitive disorders, individuals at risk, and a control group. Recruitment strategies may involve collaborating with healthcare facilities, community organizations, and online platforms. Participants may be compensated for their time and participation, following ethical guidelines and institutional policies.

Ethical Approvals and Institutional Fees:

The research project will require obtaining ethical approvals from the relevant research ethics committee or institutional review board. The associated fees for ethical reviews and approvals will be accounted for in the budget.

Data Analysis and Dissemination:

The project will require funding for statistical analysis software licenses, conference fees for presenting research findings, and publication fees for scientific journals. These costs will ensure the appropriate analysis and dissemination of the research outcomes.

Budget:

The budget for this research project will be allocated to cover the following expenses:

- Personnel salaries and stipends for the principal investigator, co-investigators, research assistants, software engineers, AI experts, statisticians, and ethics advisor.

- Equipment and software costs for the development of the digital platform, data storage, statistical analysis, speech analysis, and AI algorithms.

- Participant recruitment and compensation.

- Ethical approvals and institutional fees.

- Travel and accommodation expenses for conferences or research meetings.

- Publication fees for scientific journals.

The specific budget details will be determined based on a thorough assessment of the project's requirements, available funding sources, and institutional policies. Efforts will be made to optimize

resources, seek external funding opportunities, and adhere to budgetary constraints while ensuring the successful execution of the research project.

CONCLUSION

The proposed research project aims to evaluate a neurocognitive screening bundle as a reliable digital platform for year-round monitoring of neurocognitive symptom domains. By integrating interdisciplinary approaches from neurology, psychology, cognitive neuroscience, and computer science, this study seeks to address the limitations of current subjective cognitive task-dependent screening tools and enhance the accuracy and accessibility of neurocognitive assessments.

Through the use of a comprehensive set of objective measures, including the exploration of vocal or speech biomarkers as potential indicators of neurocognitive functioning, the research project has the potential to mitigate biases, reduce false positives and false negatives, and provide a more reliable assessment of cognitive impairments. The integration of AI-powered wake word detection in speech specimens adds an innovative dimension to the evaluation process, potentially enabling more objective and standardized measurements.

The research project's significance lies in its potential to improve clinical practice, diagnostic accuracy, remote monitoring capabilities, and advance the understanding of neurocognitive disorders. The outcomes of this study can contribute to the development of a reliable and accessible digital platform that facilitates early detection, personalized interventions, and improved outcomes for individuals affected by neurocognitive disorders.

The proposed research methodology outlines a comprehensive plan, incorporating rigorous data collection, analysis, and ethical considerations. By adhering to ethical guidelines and ensuring participant confidentiality, the project aims to protect the rights and well-being of all participants involved.

The expected results of this research project include the development of a comprehensive neurocognitive screening bundle, evaluation of the digital platform’s psychometric properties, identification of vocal or speech biomarkers, and longitudinal monitoring of neurocognitive changes. These outcomes hold the potential to transform clinical practice, improve diagnostic accuracy, enhance remote monitoring capabilities, and advance neurocognitive research.

Overall, this research project represents a significant step forward in the field of interdisciplinary research, aiming to bridge the gap between neurology, psychology, cognitive neuroscience, and computer science. By combining expertise from multiple disciplines and leveraging technological advancements, this study seeks to make meaningful contributions to the assessment and monitoring of neurocognitive symptom domains.

The successful completion of this research project will have far-reaching implications for individuals, families, healthcare providers, and society as a whole. It is our hope that the findings of this study will lead to improved early detection, personalized interventions, and ultimately, a positive impact on the lives of individuals affected by neurocognitive disorders.

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