A Cognitive and Usability Study of Speech and Language Pathologists Interface Design

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Abstract

This case study looks at the inclusion of Human Factors Integration into the Electronic Health Reporting interface design within the Speech and Language Pathology field. A comparison of two interfaces is conducted where one interface (TheraSpeech) is built utilizing cognitive system engineering methods such as Hierarchical Task Analysis, and the other (Therapy Corner) is a current system being used in the field. The research consists of the deployment of a functionality questionnaire along with secondary empirical research on domain-specific material. The TheraSpeech interface model utilizes task analysis findings and applies them to the interface design. Participants are asked to engage with both interfaces and provide feedback using the System Usability Scale questionnaire. Sample score results are used for measurement using the Paired t-test method and answer the research question. Significant statistical calculations showed TheraSpeech provided an improved interface engagement for domain experts. This case study shows how cognitive system engineering methods can improve interface design, potentially reducing clinical errors for Speech and Language Pathologists.

Keywords: Hierarchical Task Analysis, Speech and Language Pathologist, Electronic Health Reporting, Usability, Interface Design, System Usability Scale, Paired t-test, Cognitive System Engineering.

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Introduction

This explanatory case study intends to analyze Electronic Health Reporting (EHR) interface design for Speech and Language Pathologists (SLP) by comparing two interface platforms, Therapy Corner and TheraSpeech. The study analyzes how cognitive engineering and usability methods can be used to construct EHR interface designs to minimize cognitive task load inhibitors such as “click fatigue” within SLP therapy settings.

Significance of the Study

The introduction of EHR into the SLP industry has provided many benefits improving clinical, organizational, and social processes in the healthcare industry. Benefits in the accessibility of patient information on both the patient side and clinical side (insurance and pharmacy organizations) have increased, EHR systems have improved customization and expediency to meet the increased demand (McMullen et al., 2014). Technological advancements have also introduced safety concerns, ranging from bottlenecks in work processes to serious life-threatening safety events. In a study conducted by Menon et al. (2014), analyzing EHR engagement, more than half (53%) of patient safety professionals participants admitted to conducting at least one serious safety event in the last five years. One of the most common variables relating to those safety events dealt with interface design, issues such as "click fatigue," where healthcare practitioners are overcome with interface alerts and an oversaturation of dialog boxes (Menon et al., 2014). These issues result in administrative burnout and become a barrier in effectively using the EHR systems within therapeutic settings. A therapeutic setting for this study is an SLP who meets with a client to administer clinical procedures to improve a person's verbal/non-verbal communication and can have the goal of screening, assessment, or intervention therapy (Asha, 2021).

Purpose Statement

TheraSpeech intends to incorporate schematic engagement into the interface design by conducting a Hierarchical Task Analysis (HTA) with secondary empirical research and comparing it to Therapy Corner’s interface design through qualitative analysis by administering two questionnaires. One is conducted before the analysis, looking at domain functions and usability of the current platform by domain experts. The second questionnaire follows the System Usability Scale (SUS) method and is administered after the participants have engaged

with both interfaces to extract post-research feedback (Lewis, 2018). The SUS scores of all participants using both interfaces will be compared using the paired t-test method, which will assist in rejecting or failing to reject the hypothesis.

Research Question and Hypothesis

The research question is: Does the implementation of HTA in the design process of TheraSpeech improve EHR interface design and improve SLP engagement over Therapy Corner? Answering this question begins with acquiring expert information about EHR engagement experiences and conducting secondary empirical research meant to extract task-related information to construct an HTA plan. A heuristic breakdown of tasks and functions are used to design the interface utilizing Adobe XD software to add functionality and fidelity for testing purposes (Adobe XD by Adobe). Hierarchical Task Analysis is widely used in the Human Factors field to extract information pertaining to goals, sub-goals, and operations by deconstructing task activities and exposing any capabilities or limitations (Stanton, 2013). Next, a qualitative measurement is used to provide qualitative feedback using the SUS method. The SUS is a standardized questionnaire used to extract usability feedback and quantitatively translate it for measurement (Brooke, 1996). Because the same group is being tested on each interface, a within-subject paired t-test will be conducted. It will measure the means of all participant SUS scores and determine if there are statistical differences between the two groups.

This case study hypothesis that the implementation of HTA in the usability design process of the TheraSpeech interface will improve SLP's EHR interface engagement compared to Therapy Corner's interface engagement. The null hypothesis will result with no difference between the mean sample scores of both interfaces (H_o: $\mu 1-\mu 2=0$), and the alternative hypothesis will result in a significant difference between the two interface scores (H_a: $\mu 1-\mu 2\neq 0$).

Carrying out a fully functioning interface platform takes significant resources and time; therefore, this study will only provide interactive items related to carrying out navigation exercises in the qualitative analysis. Further analysis methods would be ideal for understanding other critical factors such as cognitive functions, risk assessment, and resiliency tests, for naming a few. This study intends to provide insight into interface design utilizing cognitive engineering and usability methods for optimal results that meet the human condition.

Methodology

Research Approach

The research approach is conducted in three stages, the first stage deals with research into functions, tasks, and goals of SLPs, the second stage looks at interface construction and usability methods to convert HTA functions into interface design, and the last stage implements analysis and measurement of the two interfaces to test the hypothesis statement and answer the research question. These three stages are meant to analyze usability within EHR interfaces by mapping domain functions using a traceable cognitive system engineering approach and measuring the results through statistical, qualitative analysis.

Design and Procedures

The functional and task-related analysis consisted of a functionality questionnaire and secondary domain-specific empirical research followed by a SUS qualitative questionnaire. The functionality questionnaire consists of questions related to demographic, functional, and technical topics, as shown in Table 1. Empirical research explores peer-reviewed articles on SLP and EHR healthcare best practices. A significant source of information comes from the American Speech-Language-Hearing Association (Asha, 2021), an organization with over 218,000 members. The organization aims to provide scientific resources to audiologists, speech and language pathologists, support personnel, and students involved in the field. Resources provided by Asha include publications, continued education, practice management, and research (Asha, 2021). Other sources of research stem from peer-reviewed scientific journals dealing with SLP perspectives on processes and procedures in a variety of medical settings that support the aim of this case study.

Table 1

Functionality Questionnaire

Questions
Demographic Information
List your degrees and highest education level.
What is your length of experience working as an SLP / SLPA?
What settings have you worked in, and what is your current setting?
What is your typical caseload size?

Job Functions

Briefly summarize the overall goals or purposes of your role as an SLP/ SLPA in your organization.

What are the main functions of the reporting software you use for your day-to-day duties?

What major duties do you perform as an SLP?

My workload is too heavy.

My responsibilities include too many non-therapy tasks.

Routine non-therapeutic processes and reporting software take too long.

Technical Interaction

How satisfied are you with your job's current reporting software product/service?

How satisfied are you with the user-friendliness of the software product/service?

How easy is it to read the text/characters on the screen?

How satisfied are you with the organization of information on the screen?

How satisfied are you with the use of terms consistency throughout the system?

How satisfied are you with the position of messages on the screen?

How satisfied are you with the clarity relating to prompts for inputs?

How satisfied are you with the system informing you about the progress of a task?

How satisfied are you with the system informing you about error messages relating to specific job reporting responsibilities?

Have you made errors due to interface constraints or design (drop-down boxes, confusing icons, window configuration)?

Do you feel like the information on the screen is not related to your specific duties?

Do you feel it can be more simplified and specific to your responsibilities?

Do you feel the current software makes your job easier?

What is the most important information you want to see at a glance on a screen?

What would you suggest to improve your current software?

Note. Questions sent to SLPs to extract information to assist with the Hierarchical Task Analysis.

The SUS questionnaire came to fruition in the 1980s to measure computer systems usability and ease-of-use, becoming a reliable tool for usability evaluations. The SUS

questionnaire is made up of ten questions that alter between positive and negative tones shown in Table 2. Tonal switching prevents users from scoring in a biased manner and compels them to think about what the question is asking. Answers are in the form of a Likert Scale and flexible in the score value system, which depends on the administrator. In this case study, a 5-point Likert Scale is used (1=highly do not agree, 5=highly agree). The interpretation of scores requires converting raw scores into adjusted scores that fall anywhere from 0-100. Anything that falls above a score of 68 is considered above average; anything below is considered below average (Lewis, 2018). This score will then be used for statistical measurement using paired t-test.

Table 2

System Usability Scale Questions

Questions
I think that I would like to use this system frequently.
I found the system unnecessarily complex.
I thought the system was easy to use.
I think that I would need the support of a technical person to be able to use the system.
I found the various functions in the system were well integrated.
I thought there was too much inconsistency in this system.
I would imagine that most people would learn to use this system very quickly.
I found the system very cumbersome to use.
I felt very confident using the system.
I needed to learn a lot of things before I could get going with this system.

Note. These ten questions make up the System Usability Scale questionnaire.

The paired t-test is a statistical measurement between two entities to establish a mean difference, comparing two separate activities from the same participant (Paired sample t-test 2020). This case analysis follows a within-subject design; therefore, one set of scores will be taken for Therapy Corner, and another set will be from TheraSpeech using the same participants. The paired t-test scores will be used to answer the research question and reject or fail to reject the hypothesis. A null hypothesis would mean that the paired t-test results had no significant differences between the two SUS questionnaire scores, and the null hypothesis would

fail to be rejected. If there is a significant difference between the two SUS questionnaire scores, the alternative hypothesis will fail to be rejected.

Treatment of the Data

The functionality questionnaire produced insight into what SLP experts looked for in functionality interface improvements and was applied to the TheraSpeech interface design. Comments such as “Session history dates, previous weekly soap notes (intervention notes), and quarterly reports” were provided and applied to the interface design as a “Dashboard.” Other recommendations aligned with the HTA analysis findings, such as the need to display previous notes while entering current notes. Feedback on the functionality questionnaire provided support to the HTA analysis, and helped form a better understanding of SLP functions.

The HTA analysis process decomposed SLP functions and resulted with HTA plans that were used towards hierarchically and procedurally presenting information to improve interface functionality. The HTA task analysis found three main stages of the intake process for SLP services: screening, assessment, and intervention. The functions and tasks captured in this HTA analysis may not pertain to every SLP instance and differ depending on personal, regional, or organizational policies and laws. This analysis uses functions following ASHA and the World Health Organization (WHO) classification standards (World Health Organization, 2007). According to ASHA and the WHO, SLP functional goals revolve around three main factors, body structures and functions, activities and participation, and contextual factors. Body structures and functions consist of physiological factors such as cognitive function, swallowing, and communication. Activities and participation include analyzing speech and language capacity and performance demands on the individual’s everyday routine. Contextual factors consist of an individual’s environment, such as socioeconomic, cultural, and lifestyle attributes (ASHA, 2004).

The HTA breakdown of screening, assessment, and intervention procedures using a tabular format are shown in Figure 1. Non-medical processes such as “Elective Communication Modification” are left out due to the scope of work and focus of the case study on medical tasks and functions within an EHR interface. There are similar functions across multiple clinical paths, such as “Case History Review” or “Follow-up Services,” which give some insight into efficient interface design. According to the Process Fluency Theory (PFT), these patterns can be treated with repetitive visual modality and act as priming agents to make functions less strenuous on the SLP agents (Sarasso et al., 2020).

Figure 1

SLP Screening, Assessment, and Intervention in HTA Tabular Format

Number	Element
1 Screening Process	
1.1	Speech-Language Screening Session
1.1.1	Oral Motor Function Analysis
1.1.2	Societal Communication Analysis
1.1.3	Speech Production Analysis
1.1.4	Spoken and Written Language Analysis
1.2	Swallowing Screening
1.2.1	Interview or Questionnaire
1.2.2	Oropharyngeal Swallowing Observation
1.2.3	Feeding Observation
1.2.4	Extensive Swallowing Assessment
1.2.5	Ext. Stakeholder Swallowing Communication

Number	Element
1.3	Audiologic Screening
1.3.1	Hearing Impairment
1.3.2	Middle Ear Disorders
1.3.3	Hearing Disability
1.4	Screening Documentation
1.4.1	Identifier Information
1.4.2	Screening Results
1.4.3	Recommendations

Number	Element
2 Assessment Process	
2.1	Comprehensive Speech-Language
2.1.1	Relevant Case History Review
2.1.2	Review of Medical Status
2.1.3	Patient and Family Interview
2.1.4	Standardized/Non-Standardized Observation
2.1.5	Environmental Analysis
2.1.6	Follow-up Services
2.2	Speech Sound
2.2.1	Relevant Case History Review
2.2.2	Speech Sound Clinical Case Review
2.2.3	Articulation Tests
2.2.4	Spontaneous Speech Samples
2.2.5	Error Analysis
2.2.6	Phonetic Inventory
2.2.7	Relational Analysis
2.2.8	Observation of Intelligibility
2.2.9	Standardized Articulation and Phonological Measurements
2.2.10	Follow-up Services
2.3	Spoken and Written
2.3.1	Relevant Case History Review
2.3.2	Language Form, Content, Pragmatics Measurements
2.3.3	Natural Communication Measurement
2.3.4	Oral, Motor, and Speech Measurement
2.3.5	Identification of Contextual Barriers
2.3.6	Follow-up Services
2.4	Cognitive Communication
2.4.1	Relevant Case History Review
2.4.2	Review of Medical Status
2.4.3	Review of Goals and Preferences
2.4.4	Standardized/Non-Standardized Observation
2.4.5	Follow-up Services
2.5	Severe Communication Impairment
2.5.1	Review of Medical Status
2.5.2	Relevant Case History Review
2.5.3	Standardized/Non-Standardized Observation
2.5.4	Assessment of Patient's Resources
2.5.5	Assessment of Communication Patterns
2.5.6	Assessment of Contextual Factors
2.5.7	Selection of Observation and Analysis Techniques
2.5.8	Follow-up Services

Number	Element
2.6	Augmentative and Alternative
2.6.1	Review of Medical Status
2.6.2	Relevant Case History Review
2.6.3	Standardized/Non-Standardized Observation
2.6.4	Identification of Contextual Barriers
2.6.4	Examination of Specific Aspects of Communication
2.6.5	Varied Parameters of AAC Assessment
2.6.6	Selection of AAC Assessment Measurements
2.6.7	Assessment of Potential AAC Systems
2.6.8	Follow-up Services
2.6.9	Evaluation of AAC System Use by Patient
2.7	Prosthetic/Adaptive Device
2.7.1	Review of Medical Status
2.7.2	Relevant Case History Review
2.7.3	Standardized/Non-Standardized Observation
2.7.4	Prosthetic Device Measurement Selection
2.7.5	Follow-up Services
2.7.6	Review Device Use with Patient
2.7.7	Review Dispensing Compliance
2.8	Fluency
2.8.1	Review of Medical Status
2.8.2	Relevant Case History Review
2.8.3	Standardized/Non-Standardized Observation
2.8.4	Assessment of Fluency Variables
2.8.5	Optimization of Treatment Planning
2.8.6	Follow-up Services

Number	Element
3 Intervention Process	
3.1	Comprehensive Speech-Language - Intervention
3.1.1	Receptive Language Skills
3.1.2	Expressive Language Skills
3.1.3	Play, Social Interaction, Literacy Skills
3.1.4	Oral Narrative Skills
3.1.5	Alternative and Augmentative Communication - Intervention
3.2	Speech-Sound - Intervention
3.2.1	Selection of Articulation and Phonological Targets
3.2.2	Improvement of Discrimination and Production
3.2.3	Facilitation of New Articulation and Phonological Skills
3.2.4	Increase Phonological Awareness
3.3	Spoken and Written - Intervention
3.3.1	Social, Educational, and Vocational Activities
3.3.2	Contextual Factors
3.3.3	Compensatory Communication Techniques
3.3.4	Training of Outside Stakeholders
3.3.5	Plan Development
3.4	Cognitive Communication - Intervention
3.4.1	Information Processing
3.4.2	Executive or Self-Regulatory Control
3.4.3	Modification of Cognitive & Communication Demands
3.4.4	Modification of Cognitive & Comm. Support Competencies
3.4.5	Development of Compensatory Behavior
3.4.6	Plan Development - Cognitive Communication
3.5	Severe Communication Impairment - Intervention
3.5.1	Value of Communication
3.5.2	Maladaptive Behaviors
3.5.3	Contextual Factor Modification
3.5.4	Plan Development - Severe Communication Impairment
3.6	Augmentative and Alternative Communication (AAC)
3.6.1	AAC System Operation Education
3.6.2	AAC Optimum Use Planning
3.6.3	AAC Use - Targeting
3.6.4	AAC Use - Multi-function
3.7	Prosthetic/Adaptive Device - Intervention
3.7.1	Information and Guidance
3.7.2	Operation and Maintenance Education
3.7.3	Facilitation of Repair, Maintenance, and Modification
3.8	Fluency - Intervention
3.8.1	Information and Guidence - Fluency
3.8.2	Complexities of Fluency
3.8.3	Defensive Behaviors and Coping Strategies
3.8.4	Frequency Reduction
3.8.5	Severity, Duration, and Abnormality Reduction
3.8.6	Defensive Behavior Reduction
3.8.7	Barrier Removal or Reduction
3.8.8	Fluency Assistance
3.8.9	Attitude, Belief, and Thought Process Reduction
3.8.10	Emotional Reaction Reduction
3.8.11	Plan Development - Fluency
3.9	Motor Speech - Intervention
3.9.1	Intelligibility of Speech Improvement
3.9.2	Accuracy, Timing, and Coordination Improvement
3.9.3	Rate Modification
3.10	Voice
3.10.1	Enhance Participation
3.10.2	Voice Care and Conservation Guidelines
3.10.3	Respiratory, Phonatory, and Resonatory Processes
3.10.4	Alaryngeal Speech Selection
3.10.5	Materials and Strategies
3.10.6	Voice Disorder Assistance
3.10.7	Plan Development - Voice
3.11	Resonance and Nasal Airflow
3.11.1	Preferences, Special Needs, and Goals
3.11.2	Enhancement Treatement
3.11.3	Team Consulation and Collaboration
3.11.4	Follow-up - Resonance and Nasal Airflow
3.12	Orofacial Myofunctional
3.12.1	Lingual and Labial Alterations
3.12.2	Muscle Excercises
3.12.3	Handling and Swallowing of Solids, Liquids, & Saliva
3.13	Swallowing Function
3.13.1	Oral Presentation of Food or Liquids
3.13.2	Swallowing Behavior Strategies
3.13.3	Oral Improvement and Techniques
3.13.4	Swallowing Activitiy Modification
3.13.5	Feeding Technique Education
3.13.6	Caregiver Counseling
3.14	Cognitive Communication
3.14.1	Intervention Plan Formulation
3.14.2	Resource Enhancement
3.14.3	Optimization and Barrier Removal
3.14.4	Auditory Processing Improvement
3.14.5	Generalization of Skills and Strategies
3.14.6	Caregiver Counseling - Cognitive Comm.
3.15	Aural Rehabilitation
3.15.1	Early Communication Development
3.15.2	Comprehension and Production of Language
3.15.3	Clinical and Natural Environments
3.15.4	Functional Communication Goals

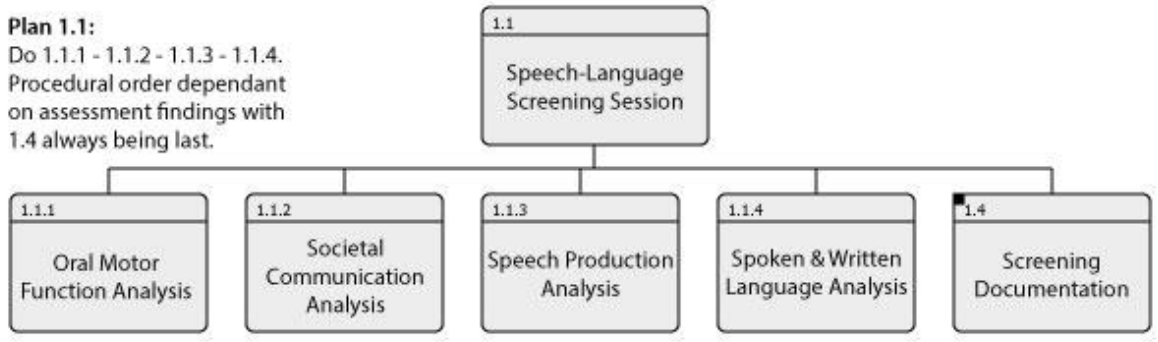
Note. A decomposition of SLP structures within Screening, Assessment, and Intervention

Therapy Sessions.

Next, an HTA plan is constructed to demonstrate how an SLP could procedurally carry out specific HTA functions such as a Severe Communication Impairment intervention. It is important to note that because this is a complex open system, an HTA path should not be the sole method for carrying out a specific goal. The "Severe Communication Impairment" procedure is used to demonstrate the process of converting an HTA plan into an EHR interface design. The process begins with screening an individual who is prescribed a Speech-Language Screening Session to determine if the patient needs further assessment. If an SLP finds that further observation is needed, the process moves on to the assessment process. The Assessment stage of Severe Communication Impairment, shown in Figure 3, takes a more concentrated look and measurement of a patient's state through static procedural strategies or dynamic hypothetical strategies to confirm the clinical status and intervention strategies (ASHA, 2004). Finally, in Figure 4, the intervention plan is shown, and ongoing therapy functions are documented with the expectation of reaching goals set by the SLP agent. The hierarchical breakdown of HTA plans shown in Figures 2, 3, and 4 provide insight into different SLP functions through decomposed procedural tasks that lead to the design of interface functionality.

Figure 2

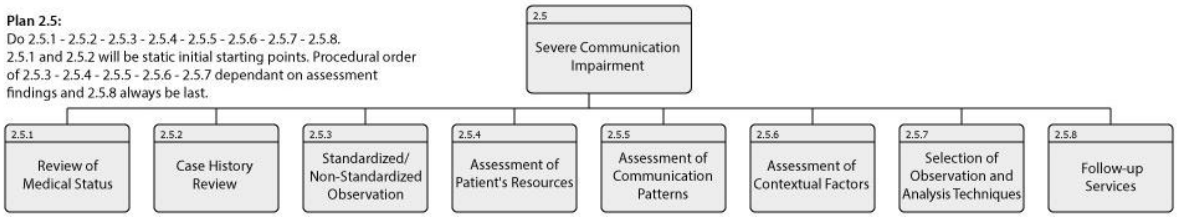
HTA Severe Communication Screening Plan



Note. Hierarchical structure of a Speech-Language Screening Session process.

Figure 3

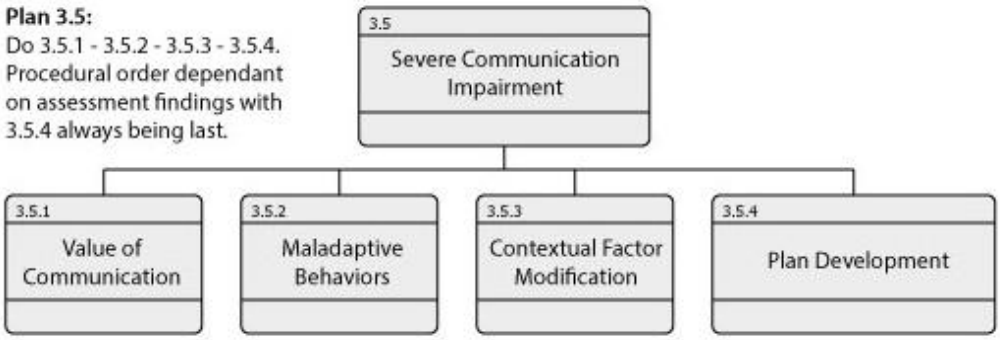
HTA Severe Communication Assessment Plan



Note. Hierarchical structure of a Severe Communication Impairment assessment process.

Figure 4

HTA Severe Communication Intervention Plan

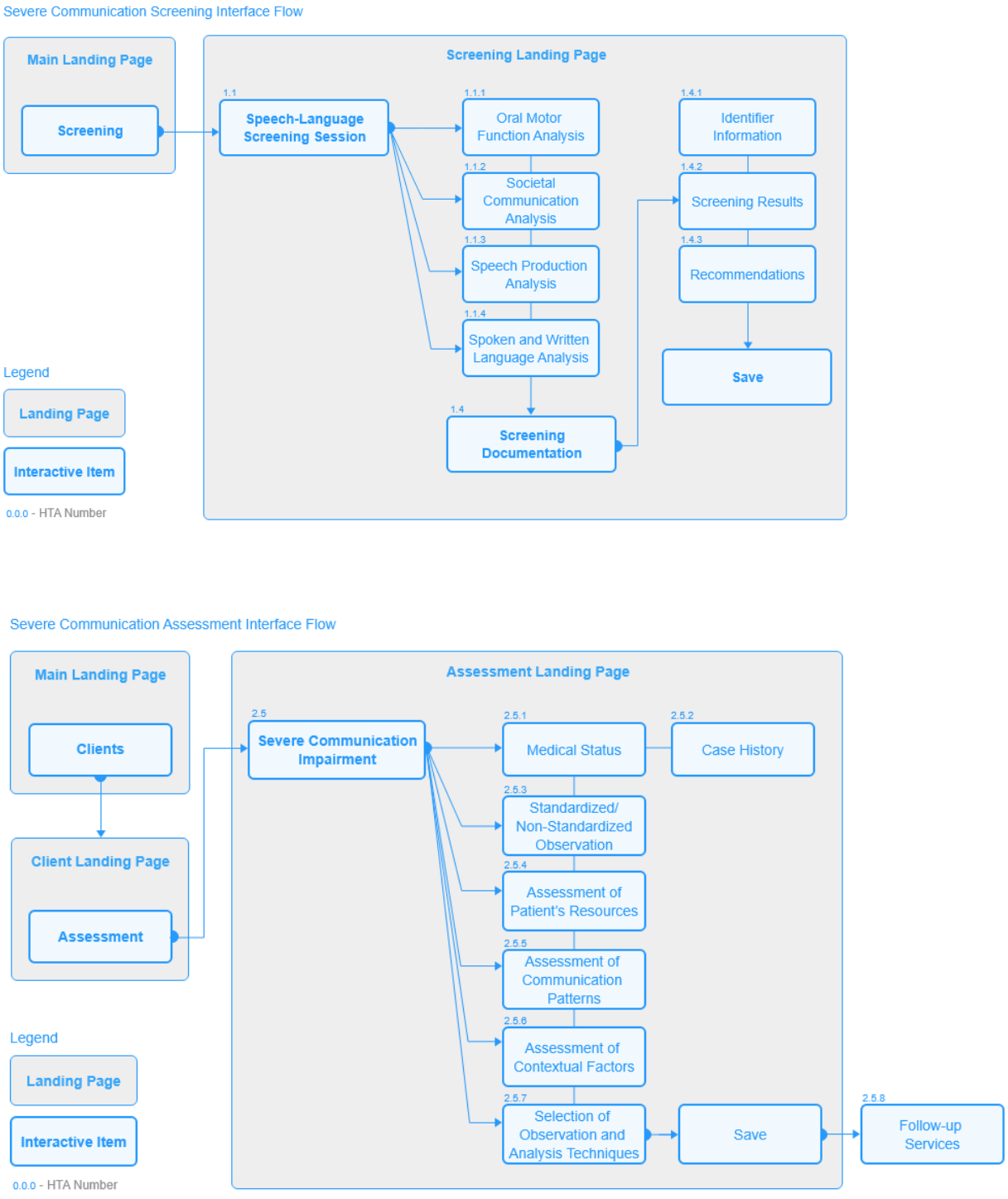


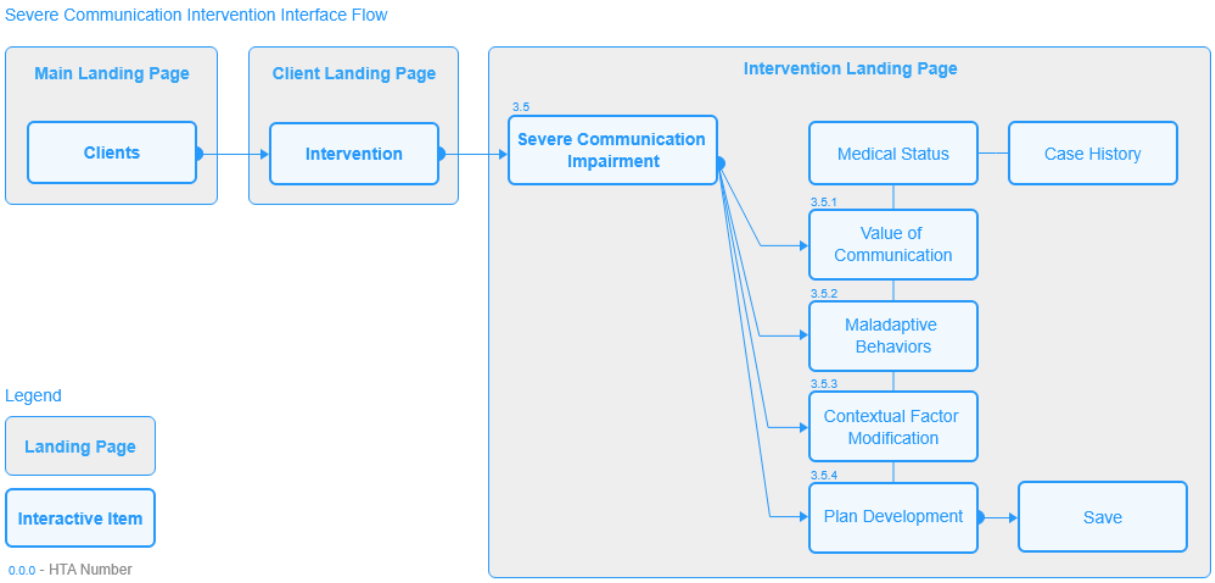
Note. Hierarchical structure of a Severe Communication Impairment intervention process.

The user flow process shown in Figure 5 was used to convert Severe Communication Impairment HTA functions into interface navigable objects by displaying the procedural steps an SLP might take to carry out a function. With HTA paths resolved, a higher fidelity design process can begin through Adobe XD, incorporating design elements such as color, spacing, and form to assist the SLP agent's navigation. Additional design elements include functions that support ASHA's three functional goals: body structures and functions, activities and participation, and contextual factors. Elements such as email access, support participation activities, and alerts communicate essential contextual factors. The higher fidelity design allows an interface model to have some functionality for a more immersive testing experience. In this instance, the model had enough functionality for an SLP to carry out the assessment scenario.

Figure 5

User Flow of Severe Communication Impairment Process



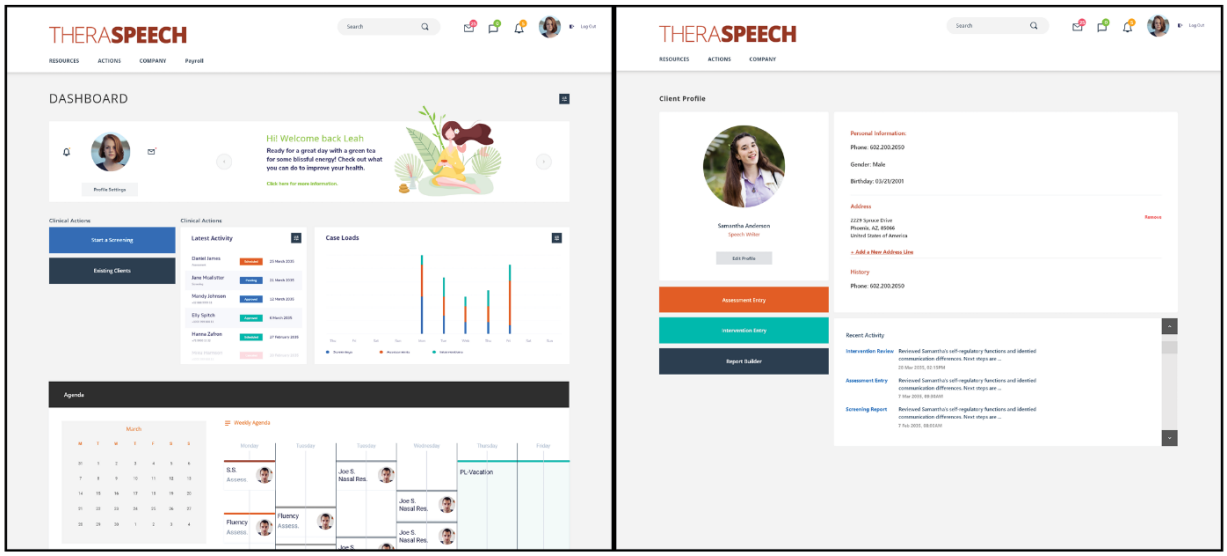


Note. Interface user flows for Screening, Assessment, and Intervention scenarios.

A comparison of both TheraSpeech and Therapy Corner's interfaces is shown in Figures 6 and 7, displaying both the "Dashboard" and "Client List" webpages and what participants experienced to provide qualitative feedback through the SUS questionnaire.

Figure 6

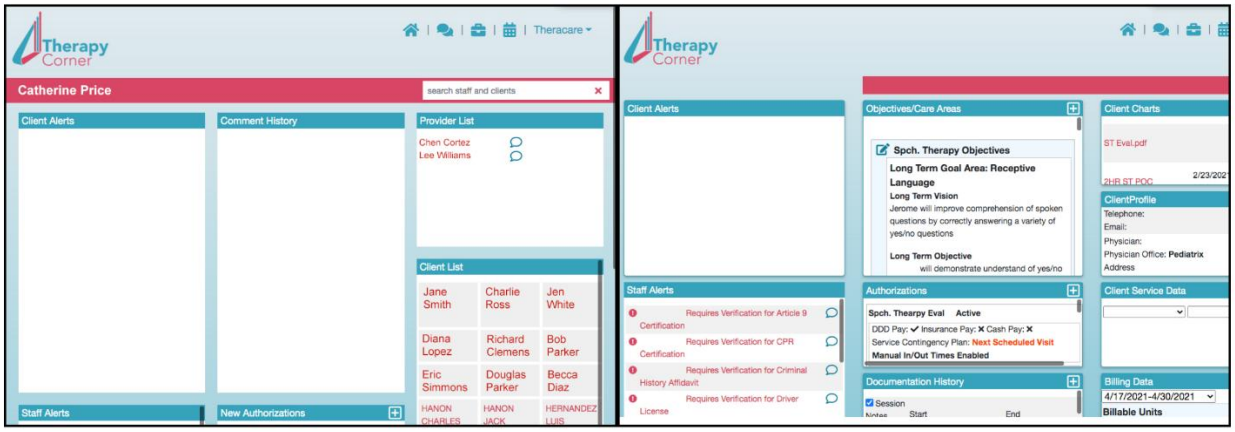
TheraSpeech Interface Screenshots



Note: The screenshots represent the Dashboard and Client Profile page for TheraSpeech.

Figure 7

Therapy Corner Interface Screenshots



Note: The screenshots represent the Dashboard and Client Profile page for Therapy Corner.

Results and Discussion

Participant Information

Prerequisites for participants were based on having higher education degree and work experience in the SLP field with experience using EHR interfaces in their day-to-day responsibilities. A participation request was sent to a group of SLPs that resulted in 8 participants with an educational background ranging from Bachelors of Science in Communication Disorders to Masters of Science in Speech and Language Pathology. Work experience ranged from 3-25 years in the SLP field. Working environments varied, involving clinical, school-based, and home-health situations spanning a wide variety of clinical needs.

Results

The final stage of the research process involved qualitatively measuring Therapy Corner and TheraSpeech through a SUS questionnaire, with results being statistically measured to answer the research question. The raw SUS scores shown in Table 3 show TheraSpeech result scores, and Table 4 shows Therapy Corner results.

Table 3

System Usability Scores for TheraSpeech

Sample Score	SUS Score
s1	82.5
s2	65
s3	87.5
s4	72.5
s5	70
s6	90
s7	77.5
s8	50

Note: System Usability Scores for TheraSpeech's participants. Participants are shown as s(*n*).

Table 4

System Usability Scores for Therapy Corner

Sample Score	SUS Score
s1	20
s2	40
s3	50
s4	62.5
s5	50
s6	30
s7	62.5
s8	47.5

Note: System Usability Scores for Therapy Corner's participants. Participants are shown as s(*n*).

A statistical measurement of SUS scores using a paired t-test to answer the research question resulted in significant findings and answered the research question. The alternative hypothesis (H_a: $\mu 1-\mu 2 \neq 0$) states that there will be a significant difference between TheraSpeech and Therapy Corner mean sample scores, and the null hypothesis (H_o: $\mu 1-\mu 2=0$) states that there will be no significant difference between mean sample scores. The level of confidence

chosen for this test is 95%, or a significance level of .05 (α=.05). A calculation using StatCrunch is displayed in Table 5, showing statistical results, and a t-distribution graph is shown in Figure 8 (Pearson Education Inc., 2021). The region of acceptance for t-distribution is [-2.3646:2.3646] and the t-value equated to -3.67, which falls outside of the distribution region. The p-value equated to 0.007964, which is smaller than .05; therefore, the null hypothesis is rejected.

Table 5

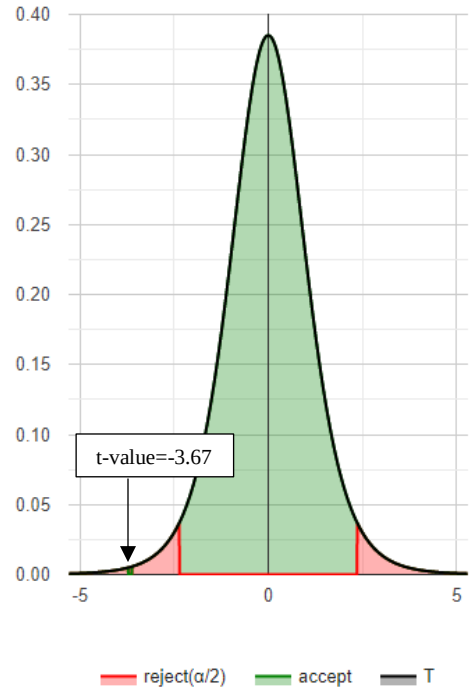
Paired t-test Results

Mean (μ)	Std. Err.	DF	T-Stat	P-value
29.0625	7.9189	7	3.67	0.007964

Note: Statistical calculations of a paired t-test comparison between TheraSpeech and Therapy Corner system usability scale scores.

Figure 8

T-Distribution Graph of Paired t-test Results



Note: T-distribution graph depicting region of acceptance or rejection of the null hypothesis. Red shows the significance zone, green shows the non-significant zone and the black bar depicts the location of the t-value.

Discussion and Recommendations

This explanatory case study looked at the effects of applying HTA to EHR interface design to decrease task loads on SLPs carrying out reporting responsibilities by utilizing Human Factors Integration (HFI), beginning with an understanding of the process and people, then the development of a prototype, and finally assessing domain expert engagement (Stanton, 2013). The case study aimed to determine if the application of HTA within the design process of TheraSpeech's interface improved SLPs engagement over Therapy Corner's interface engagement. By improving EHR interface engagement, reporting issues that may cause serious mistakes or life-threatening events could be decreased or completely remedied. Statistical measurement resulted in a significant difference between both interfaces as it pertained to SLP interface engagement. Although research results showed promise towards the use of HFI methods for improving interface engagement, further analysis would be beneficial.

Depending on the size of the system being assessed, HFI could be extensive and highly complex, demanding time and energy beyond the scope of this research. In this case, further analysis into cognitive functions, human error, and further interface testing would be beneficial in further developing an SLP EHR system that decreases cognitive task loads and improves safety issues. Regarding cognitive functions, it would be beneficial to conduct a Cognitive Work Analysis (CWA), following Vicente's (1999) five-stage process, which includes conducting a work domain analysis, control task analysis, strategies analysis, social organization and cooperation analysis, and worker competencies analysis. A CWA would provide in-depth insight into SLP's decision-making activities and constraints. This case study has expressed and found that a high degree of SLP errors occurs due to interface design or constraints. The functionality question "Have you made errors due to interface constraints or design (drop-down boxes, confusing icons, window configuration)" resulted in a 77.8% of participants answering yes, which expresses a significant need to examine error-prone activities. A Systematic Human Error Reduction and Prediction Approach (SHERPA) would be beneficial to resolving any risky behaviors or mechanisms. Carrying out a SHERPA includes analysis into task classifications, consequences, recovery, ordinal probabilities, error criticalities, and remedies (Stanton, 2013).

The HTA would be an extension within the SHERPA model, serving as the first step in understanding SLP behaviors through task decomposition.

Because this is a human-machine interface endeavour, a comprehensive examination into the machine interface would be warranted, looking at factors that include layout, heuristics, links, and testing. The layout analysis would examine schematic behaviors, grouping functionality, and arrangement of interface items. A Nielson's 10 Heuristics analysis would look at the system's real-world matching of information, recall, and recognition to decrease memory load, flexibility and efficiency, error recovery, aesthetics, and user control and freedom (Nielsen, 1994a). A link analysis would determine the frequency, nature, and importance of links, striving for optimization of interface engagement and ensuring interface paths are complete. Finally, comprehensive testing would provide feedback on how well the interface performs under many scenarios and conditions. When dealing with complex SLP EHR open systems, a combination of testing techniques and software are required. Techniques such as user trials, walkthrough analysis, and questionnaires allow qualitative participant feedback. Software testing such as eye-gazing, time trials, performance loading, and integration testing can provide quantitative feedback on interface engagement.

Conclusion

This explanatory case study analyzed two interfaces to measure the significance of applying HFI into SLP interface design with the ultimate goal of reducing task loads and decreasing errors. This research has shown that the application of cognitive system engineering to interface design can significantly improve SLPs' EHR functions and be part of a larger HFI endeavor. As described by Bentley et al. (2021), Human Factors is a design discipline concerned with human work that involves systems, people, and machines to improve human performance and well-being. This research accomplishes these goals by providing an improved manner of designing human-machine interface EHR systems and improve the lives of SLPs and their patients.

List of Acronyms

Abbreviation	Explanation	Page
ASHA	American Speech-Language-Hearing Association	3
CWA	Cognitive Work Analysis	22
EHR	Electronic Health Reporting	2
HTA	Hierarchical Task Analysis	3
HFI	Human Factors Integration	22
PFT	Process Fluency Theory	12
SLP	Speech and Language Pathologist	2
SHERPA	Systematic Human Error Reduction and Prediction Approach	23
SUS	System Usability Scale	3
WHO	World Health Organization	11

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