CHATGPT FOR THERAPY? OPPORTUNITIES AND BARRIERS FOR CHATGPT IN SPEECH-LANGUAGE THERAPY

Anonymous authors
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ABSTRACT

Speech-language pathologists (SLPs) are health professionals who work with children and adults with various communication disorders that result in communication breakdowns in areas such as speech, language, hearing, and voice. The rise of voice assistants and chatbots brings new opportunities for clinicians and points to new barriers when adopted and implemented during clinical service delivery to support clients with complex communication needs. This paper explores the opportunities and barriers to using ChatGPT in speech-language therapy for individuals with receptive and expressive language disorders. By evaluating ChatGPT's responses to multiple prompts related to service delivery implications to determine clinical feasibility, future solutions for improving generative AI tools for speech-language therapy are also discussed.

1 INTRODUCTION AND BACKGROUND

The American Speech-Language-Hearing Association (ASHA) defines communication disorder as "an impairment in the ability to receive, send, process, and comprehend concepts or verbal, nonverbal and graphic symbol systems" (ASHA, 2023). Communication disorders can impact individuals' ability to communicate at the speech level (*e.g.*, difficulty producing speech sounds), language level (*e.g.*, difficulty formulating sentences and narrative stories), cognitive level (*e.g.*, difficulty retrieving and remembering salient information), and/or perceptual level (*e.g.*, difficulty processing and hearing). Speech-language pathologists (SLPs) are trained professionals who screen, assess, evaluate, treat, and monitor pediatric, adult, and geriatric clients with communication disorders across various educational and medical settings (*e.g.*, schools, hospitals, and rehabilitation centers). Despite the increased adoption of web and mobile technology tools during therapy among SLPs (Du et al., 2022), there is a growing need and knowledge gap regarding how to apply artificial intelligence (*e.g.*, natural language processing tools) to improve the efficiency and effectiveness of clinical service delivery across nine areas of SLP's professional scope of practice, also referred to as "ASHA Big 9" (ASHA, 2023). Prior research by (Wang et al., 2021) has investigated the utility of using OpenAI GPT models to analyze conversations during therapy sessions between caregivers of individuals with dementia and their therapists; however, this prior work was conducted during problem-solving therapy rather than speech-language therapy under the ASHA Big 9 domains. This paper examines the implications of using ChatGPT for one ASHA Big 9 domain - language. Language disorders can impact different age groups of individuals such as children with autism (Tager-Flusberg & Caronna, 2007) and adults with aphasia (Theodoros et al., 2008), further hindering their academic learning, social communication, and activities of daily living.

ChatGPT (OpenAI, 2022), based on InstructGPT (Ouyang et al., 2022), is the latest manifestation of large language models (LLMs) with a user-friendly conversational interface. InstructGPT is an enhanced version of GPT-3 (Brown et al., 2020), achieving better outputs with 100x fewer parameters (1.3B vs. 175B). The biggest algorithmic advancement in InstructGPT is the use of reinforcement learning from human feedback (RLHF) with two sets of special-purpose datasets: (1) the demonstration dataset for training supervised policy in the initial model where a prompt is sampled from the prompt dataset and human labeler demonstrates the desired output behavior; (2) the comparison dataset for fine-tuning the previously trained model using RL, where a model-written message is randomly selected and several completions are sampled, and then a human AI trainer is asked to rank them. Using these reward models, the model can be fine-tuned using proximal policy optimization (PPO) methods iteratively. The dataset mainly contains text prompts submitted to the

OpenAI API. To train the first InstructGPT models, human labelers were asked to write prompts themselves as an initial source of instruction-like prompts are needed to bootstrap the process.

2 Opportunities and Barriers Using ChatGPT for Treating Language Disorders

SLPs' language intervention typically focuses on either expressive language (*e.g.*, using words in sentences to express ideas and thoughts) or receptive language (*e.g.*, understanding the ideas and thoughts expressed in words) using various therapy materials, such as flashcards, toys, and games (Leochico et al., 2022). To explore ChatGPT's potential for clinical utility, several prompts were created by a licensed SLP to investigate ChatGPT's own perception of its implications for speech-language therapy. Table 1,2,3 illustrate these prompts and two responses per prompt from ChatGPT. Table 4 describes how receptive and expressive language, one of the ASHA Big 9 domains, could be supported using ChatGPT's responses and corresponding critiques by the same licensed SLP. ChatGPT has the potential to become an innovative tool in SLPs' clinical service delivery through translating and generating therapy materials (vocabulary development, narrative skills, language comprehension, literacy, bilingual therapy) and simulating human-like communication (grammar and syntax, pragmatics, cultural competence). These functions can offer clients, such as those with autism, a low-pressure communication environment without directly communicating with humans (Benford & Standen, 2009), improve clients' ability to use additional novel therapy materials for practice outside therapy (Leochico et al., 2022), and reduce clinicians' workload and therapy preparation costs (Cirrin et al., 2003).

Despite these opportunities, a preliminary critique of ChatGPT's responses revealed additional barriers to clinical implementation. First, using open-source training data leads to questionable data accuracy. For example, the common issue in deep learning models leads to low-data regime issues, which can impose bias, especially in low incidents and rare disease conditions. As a result, therapy materials generated may not be as tailored and customized to individuals with a less frequent therapy task compared to more generative activities that are more readily available on the internet. Second, using ChatGPT also raised additional questions regarding data ownership and usage. If ChatGPT requires client data input, how to determine which part of the patient-generated language data are protected sensitive information and who has the initial and final access and ownership of the private information and content? Discussions among multiple stakeholders (*e.g.*, clients, clinicians, caregivers, and data scientists) regarding data governance are required. Third, this paper did not perform a critical analysis of the implications of ChatGPT on social communication, conversational AI tools are prone to inappropriate social language, hate speech, and emotionally disturbing conversations (The Verge, 2023), which requires collaborative research effort across domains such as AI safety, fairness, *etc*.

3 Implications of the Future of Generative AI for Speech-Language Therapy

This paper explored the implications, opportunities, and barriers of using ChatGPT to support speech-language therapy services by SLPs for individuals with communication disorders. ChatGPT demonstrated opportunities and barriers as (1) a valuable assistive therapy tool for generating therapy materials, (2) a chatbot that simulates human-like communication during therapy, and (3) an intelligent assistant for the therapist. One unique opportunity for using ChatGPT for speech-language therapy is that depending on the client population and needs, it is possible that using existing database or knowledge base may already be adequate for clinicians to adopt generative AI tools such as ChatGPT because many conventional speech-language therapy materials are typically drawn from functional activities of daily living which are already available in the public domain. Additionally, ChatGPT could be used with other generative AI tools (Table 5) such as DALL-E to replace conventional "worksheets and flashcards" so that clients can participate in therapy using only nonfictional content but also fictional content to work with diverse and novel therapy tasks and activities. Future clinicians can envision a multi-modality generation AI which can serve as an AI conversational partner to directly communicate with clients, leading to a fundamental change in human-AI collaborative therapy across multiple ASHA Big 9 domains.

URM STATEMENT

The authors acknowledge that at least one key author of this work meets the URM criteria of ICLR 2023 Tiny Papers Track.

REFERENCES

Andrea Agostinelli, Timo I Denk, Zalán Borsos, Jesse Engel, Mauro Verzetti, Antoine Caillon, Qingqing Huang, Aren Jansen, Adam Roberts, Marco Tagliasacchi, et al. Musiclm: Generating music from text. *arXiv preprint arXiv:2301.11325*, 2023.

ASHA. American Speech-Language-Hearing Association (ASHA): The Big Nine, 2023. URL https://www.asha.org/events/slp-summit-glossary/.

Penny Benford and P Standen. The internet: a comfortable communication medium for people with asperger syndrome (as) and high functioning autism (hfa)? *Journal of Assistive Technologies*, 3(2): 44–53, 2009.

Tom Brown, Benjamin Mann, Nick Ryder, Melanie Subbiah, Jared D Kaplan, Prafulla Dhariwal, Arvind Neelakantan, Pranav Shyam, Girish Sastry, Amanda Askell, et al. Language models are few-shot learners. *Advances in neural information processing systems*, 33:1877–1901, 2020.

Frank Cirrin, Ann Bird, Larry Biehl, Sally Disney, Ellen Estomin, Judy Rudebusch, Trici Schraeder, and Kathleen Whitmire. Speech-language caseloads in the schools: A workload analysis approach to setting caseload standards. In *Seminars in Speech and Language*, volume 24, pp. 155–180. Copyright© 2003 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New . . . , 2003.

Yao Du, Sarah Choe, Jennifer Vega, Yusa Liu, Adrienne Trujillo, et al. Listening to stakeholders involved in speech-language therapy for children with communication disorders: Content analysis of apple app store reviews. *JMIR Pediatrics and Parenting*, 5(1):e28661, 2022.

Google. An important next step on our AI journey, 2023. URL https://blog.google/technology/ai/bard-google-ai-search-updates/.

Jonathan Ho, William Chan, Chitwan Saharia, Jay Whang, Ruiqi Gao, Alexey Gritsenko, Diederik P Kingma, Ben Poole, Mohammad Norouzi, David J Fleet, et al. Imagen video: High definition video generation with diffusion models. *arXiv preprint arXiv:2210.02303*, 2022.

Carl Froilan D Leochico, Edgardo Miguel V Austria, and Adrian I Espiritu. Global online interest in telehealth, telemedicine, telerehabilitation, and related search terms amid the covid-19 pandemic: an infodemiological study. *Acta Medica Philippina*, 56(11), 2022.

Midjourney. Midjourney: Art in the Age of Artificial Intelligence, 2023. URL https://www.midjourney.com.

OpenAI. ChatGPT, 2022. URL https://chat.openai.com/chat.

OpenAI. DALL-E 2 is an AI system that can create realistic images and art from a description in natural language., 2023. URL https://openai.com/product/dall-e-2.

Long Ouyang, Jeff Wu, Xu Jiang, Diogo Almeida, Carroll L Wainwright, Pamela Mishkin, Chong Zhang, Sandhini Agarwal, Katarina Slama, Alex Ray, et al. Training language models to follow instructions with human feedback. *arXiv preprint arXiv:2203.02155*, 2022.

Chitwan Saharia, William Chan, Saurabh Saxena, Lala Li, Jay Whang, Emily Denton, Seyed Kamyar Seyed Ghasemipour, Burcu Karagol Ayan, S Sara Mahdavi, Rapha Gontijo Lopes, et al. Photorealistic text-to-image diffusion models with deep language understanding. *arXiv preprint arXiv:2205.11487*, 2022.

Uriel Singer, Adam Polyak, Thomas Hayes, Xi Yin, Jie An, Songyang Zhang, Qiyuan Hu, Harry Yang, Oron Ashual, Oran Gafni, et al. Make-a-video: Text-to-video generation without text-video data. *arXiv preprint arXiv:2209.14792*, 2022.

StabilityAI. Stable Diffusion Public Release, 2023. URL https://stability.ai/blog/stable-diffusion-public-release.

Helen Tager-Flusberg and Elizabeth Caronna. Language disorders: autism and other pervasive developmental disorders. *Pediatric Clinics of North America*, 54(3):469–481, 2007.

The Verge. Microsoft has been secretly testing its Bing chatbot 'Sydney' for years, 2023. URL https://www.theverge.com/2023/2/23/23609942/microsoft-bing-sydney-chatbot-history-ai.

Deborah Theodoros, Anne Hill, Trevor Russell, Elizabeth Ward, and Richard Wootton. Assessing acquired language disorders in adults via the internet. *Telemedicine and e-Health*, 14(6):552–559, 2008.

Hugo Touvron, Thibaut Lavril, Gautier Izacard, Xavier Martinet, Marie-Anne Lachaux, Timothée Lacroix, Baptiste Rozière, Naman Goyal, Eric Hambro, Faisal Azhar, Aurelien Rodriguez, Armand Joulin, Edouard Grave, and Guillaume Lample. Llama: Open and efficient foundation language models, 2023.

Lu Wang, Munif Ishad Mujib, Jake Williams, George Demiris, and Jina Huh-Yoo. An evaluation of generative pre-training model-based therapy chatbot for caregivers. *arXiv preprint arXiv:2107.13115*, 2021.

A Appendix

In this appendix, we are including Table 1,2,3, on ChatGPT's perception about its potential utility in speech-language therapy (with response #2 demonstrating more bullet points of potential utility compared to response #1); Table 2 illustrated ChatGTP's response inconsistency, marked by incorrect answer (response #1) and correct answer (response #2) to understanding ASHA Big 9 domain; Table 3 describes two accurate responses for ASHA Big 9 domain but each response showed random and uncontrollable examples.

Table 4 shows the analysis of ChatGPT's response for intervention in "language", one of the ASHA Big 9 domains.

Table 5 shows the type/modality of generative AI and clinical implications for speech-language therapy.

Table 1: Sample queries with ChatGPT.

1. How can speech language pathologists use chatgpt for speech-language therapy?	
ChatGPT Response #1	**ChatGPT Response #2**
As a language model, ChatGPT can be a useful tool for speech-language pathologists (SLPs) in providing speech-language therapy. Here are some ways SLPs can use ChatGPT: 1. Language Modeling: ChatGPT can model language for patients who have difficulty with expressive or receptive language skills. SLPs can use ChatGPT to generate appropriate sentences or paragraphs that demonstrate correct grammar, syntax, and vocabulary. The generated text can be used to model language structures, identify common errors, and provide examples of correct language usage. 2. Conversation Practice: SLPs can use ChatGPT to simulate conversations in a controlled environment. This can be particularly useful for patients who have social communication disorders or who struggle with maintaining conversations. The SLP can provide prompts and cues for the patient to initiate and maintain a conversation with ChatGPT, with the ultimate goal of transferring these skills to real-life conversations. 3. Vocabulary Building: ChatGPT can help patients expand their vocabulary by generating definitions, synonyms, and antonyms for specific words. This can be particularly helpful for patients with language disorders who struggle with finding the right words to express themselves. 4. Reading Comprehension: SLPs can use ChatGPT to generate questions and answers related to a reading passage. This can help patients develop their reading comprehension skills and improve their ability to answer questions related to text. It is important to note that ChatGPT should not be used as a replacement for human interaction and therapy. SLPs should always use ChatGPT as a supplement to their therapy sessions, and should always monitor patients' progress and adjust therapy goals as needed.	There are several ways in which speech language pathologists (SLPs) can use ChatGPT for speech-language therapy: 1. Conversation Practice: SLPs can use ChatGPT to provide their clients with conversation practice opportunities. Clients can have a back-and-forth conversation with ChatGPT on various topics to improve their conversational skills. 2. Vocabulary Expansion: SLPs can use ChatGPT to help clients expand their vocabulary. Clients can ask ChatGPT about new words they come across or learn new words by asking ChatGPT to define them. 3. Grammar Practice: SLPs can use ChatGPT to help clients practice grammar. Clients can ask ChatGPT to correct their sentences or ask for feedback on their grammar usage. 4. Pronunciation Practice: SLPs can use ChatGPT to help clients practice their pronunciation. Clients can ask ChatGPT to pronounce words or phrases correctly and try to imitate them. 5. Comprehension Practice: SLPs can use ChatGPT to help clients practice their comprehension skills. Clients can ask ChatGPT questions about a topic they are learning to check their understanding. It's important to note that ChatGPT should be used as a supplement to traditional speech-language therapy techniques and not as a replacement. SLPs should still provide personalized therapy sessions for their clients and use ChatGPT as a tool to enhance their therapy.

Table 2: Sample queries with ChatGPT (cont'd).

2. What are ASHA big 9?	
ChatGPT Response #1	**ChatGPT Response #2**
ASHA, which stands for the American Speech-Language-Hearing Association, identifies the "Big Nine" areas of practice in the field of speech-language pathology. These areas are: 1. Articulation: the ability to produce speech sounds accurately and fluently 2. Fluency: the ability to speak without stuttering or other disruptions 3. Voice: the quality, pitch, and loudness of the voice 4. Language: the ability to understand and use language for communication 5. Cognitive aspects of communication: the ability to use language for problem-solving, reasoning, and other cognitive tasks 6. Social aspects of communication: the ability to use language appropriately in social contexts 7. Swallowing: the ability to safely swallow food and liquid 8. Hearing: the ability to hear and understand speech and other sounds 9. Balance and dizziness: the ability to maintain balance and avoid falls. These areas are the focus of ASHA's scope of practice and form the basis of the profession's standards of clinical practice.	The "ASHA Big 9" is a term used by the American Speech-Language-Hearing Association (ASHA) to describe the nine areas of communication in which speech-language pathologists and audiologists work. These areas are: 1. Articulation: the production of speech sounds 2. Fluency: the smoothness of speech, including stuttering 3. Voice: the quality of sound produced by the vocal cords 4. Receptive language: the ability to understand spoken language 5. Expressive language: the ability to use language to express thoughts and ideas 6. Hearing: the ability to perceive sound 7. Swallowing: the ability to swallow food and liquids safely 8. Cognitive-communication: the ability to use language to solve problems, make decisions, and engage in conversation 9. Augmentative and alternative communication: the use of communication devices and strategies for people with communication disorders who cannot rely on speech alone. These areas of communication are the focus of assessment, diagnosis, and treatment by speech-language pathologists and audiologists, who work to help individuals overcome communication disorders and improve their quality of life.

Table 3: Sample queries with ChatGPT (cont'd).

3. Can you give specific examples of how chatgpt can be integrated for each of the asha's big 9 areas?	
ChatGPT Response #1	**ChatGPT Response #2**
Certainly! Here are some specific examples of how ChatGPT can be integrated for each of ASHA's "Big 9" areas: 1. Articulation: ChatGPT can generate words and phrases with target sounds for patients to practice their articulation skills. SLPs can use ChatGPT to generate words that contain the patient's target sound(s) and can provide feedback on the patient's articulation accuracy. 2. Language: As mentioned earlier, ChatGPT can be used to model language and provide examples of correct grammar, syntax, and vocabulary. SLPs can also use ChatGPT to generate questions to assess a patient's understanding of language concepts or to provide practice for language skills such as grammar, vocabulary, and comprehension. 3. Fluency: SLPs can use ChatGPT to practice techniques for stuttering modification and fluency shaping. ChatGPT can generate words and phrases with controlled pacing for patients to practice their fluency techniques, such as slow, stretched speech or easy onset. 4. Voice: ChatGPT can be used to practice vocal exercises and relaxation techniques to improve voice quality. SLPs can use ChatGPT to generate prompts for exercises such as breath support, pitch control, or resonance shaping. 5. Swallowing: ChatGPT can be used to provide education and training in swallowing strategies and exercises. SLPs can use ChatGPT to generate prompts for exercises such as the Mendelsohn maneuver or the Masako maneuver and provide feedback on the patient's technique. 6. Cognitive Communication: ChatGPT can be used to provide cognitive stimulation and practice for patients with cognitive communication disorders. SLPs can use ChatGPT to generate prompts for memory or problem-solving tasks, as well as to model language use in social communication. 7. Social Communication: As mentioned earlier, ChatGPT can be used to practice conversation skills in a controlled environment. SLPs can use ChatGPT to generate prompts for social scenarios and provide feedback on the patient's use of appropriate social communication skills. 8. Hearing: ChatGPT can be used to provide auditory training and speech perception practice for patients with hearing impairments. SLPs can use ChatGPT to generate spoken words and phrases at different levels of loudness and clarity for patients to practice their speech perception skills. 9. Augmentative and Alternative Communication (AAC): ChatGPT can be used to generate messages for patients who use AAC systems. SLPs can use ChatGPT to generate phrases and sentences that patients can use to communicate with others, as well as to model language use and provide feedback on the patient's use of their AAC system.	Certainly! Here are some specific examples of how ChatGPT can be integrated for each of the ASHA's Big 9 areas: 1. Fluency: ChatGPT can be used to help individuals who stutter practice their fluency techniques in a low-pressure environment. For example, clients can practice using breathing techniques and slow, relaxed speech patterns while engaging in conversation with ChatGPT. 2. Articulation and Phonology: ChatGPT can be used to help individuals practice correct pronunciation of specific speech sounds. Clients can ask ChatGPT to pronounce specific words or phrases, and then try to imitate the correct pronunciation. 3. Voice and Resonance: ChatGPT can be used to help individuals practice their vocal resonance and pitch. Clients can ask ChatGPT to provide feedback on their speaking voice and work on techniques to improve their resonance and pitch. 4. Language: ChatGPT can be used to help individuals practice their language comprehension and expression. Clients can ask ChatGPT questions about a topic they are learning and practice using new vocabulary words. 5. Social Communication: ChatGPT can be used to help individuals practice their social communication skills. Clients can engage in conversation with ChatGPT and practice using appropriate nonverbal cues and turn-taking skills. 6. Cognitive Communication: ChatGPT can be used to help individuals with cognitive communication impairments practice their communication skills. Clients can engage in conversation with ChatGPT on various topics and practice organizing their thoughts and expressing them clearly. 7. Dysphagia: ChatGPT can be used to provide individuals with dysphagia with information and education about safe swallowing techniques. Clients can ask ChatGPT questions about swallowing exercises and techniques to improve their swallowing abilities. 8. Augmentative and Alternative Communication (AAC): ChatGPT can be used as an AAC device to provide individuals with communication impairments with a way to communicate. Clients can use ChatGPT to express their wants and needs, ask questions, and engage in conversation. 9. Hearing: ChatGPT can be used to provide individuals with hearing impairments with auditory training. Clients can listen to ChatGPT's voice and practice discriminating between different speech sounds and words.

Table 4: Analysis of ChatGPT's Response for Intervention in "Language", One of the ASHA Big 9 Domains.

ChatGPT's Response	**SLP Critique**
Vocabulary Development: ChatGPT can be used to help individuals build their vocabulary. Clients can ask ChatGPT to define new words they come across or ask for synonyms for words they already know.	Word definitions and synonyms are common therapy targets for children with expressive language disorders. Conventional therapy focuses on activities such as using flashcards, worksheets, and dictionary with support from SLPs. ChatGPT could be utilized to ***generate therapy materials***.
Grammar and Syntax: ChatGPT can be used to help individuals practice correct grammar and syntax. Clients can ask ChatGPT to provide feedback on their sentence structure and ask for suggestions on how to rephrase their sentences.	Asking for and providing feedback on rephrasing and using correct sentence structure are activities provided by SLPs. ChatGPT could be utilized as ***a simulated human-like therapy assistant*** as SLPs deliver therapy activities.
Narrative Skills: ChatGPT can be used to help individuals practice their storytelling skills. Clients can ask ChatGPT to tell a story, and then practice retelling the story in their own words.	During conventional intervention, SLPs may work with clients using clients' personal experiences, commercially available storybooks, and/or create novel stories for therapy. ChatGPT could be utilized to ***generate therapy materials***.
Pragmatics: ChatGPT can be used to help individuals practice their social communication skills. Clients can engage in conversation with ChatGPT and practice using appropriate nonverbal cues, turn-taking skills, and topic maintenance.	During conventional therapy, clients need to practice conversations with human beings; with ChatGPT, clients can engage in conversations (currently via text chat only) with ChatGPT which can work as ***a simulated human-like therapy assistant***.
Comprehension: ChatGPT can be used to help individuals practice their comprehension skills. Clients can ask ChatGPT questions about a topic they are learning and practice answering comprehension questions.	During conventional therapy, comprehension activities are typically provided by clinicians using materials such as worksheets and stories; ChatGPT could ***generate therapy materials*** such as sample learning content and facilitate comprehension questions.
Literacy: ChatGPT can be used to help individuals develop their literacy skills. Clients can engage in conversation with ChatGPT about a topic they are learning and practice reading and writing skills.	Conventional literacy intervention typically involves SLPs working with SLPs using a variety of reading and writing aids (*e.g.*, graphic organizers) to target specific reading and writing goals. ChatGPT could be utilized to ***generate therapy materials*** such as creating templates to support reading and writing.
Bilingualism: ChatGPT can be used to help individuals who are bilingual practice their language skills in both languages. Clients can engage in conversation with ChatGPT in one language and then switch to another language to practice their language skills in both languages.	Conventional bilingual therapy typically requires support from an interpreter. With ChatGPT, ***translation of therapy materials*** can be readily available for clinicians. It is important to note that localization and translation may not always be culturally and linguistically sensitive to clients' needs.
Cultural Competence: ChatGPT can be used to help individuals develop their cultural competence by providing information about different cultures and their languages. Clients can engage in conversation with ChatGPT about cultural differences in language usage and practice using culturally appropriate language.	In conventional therapy, clinicians need to rely on searching information prior to therapy to increase cultural competence of diverse cultures and languages. ChatGPT could serve as ***a simulated therapy assistant for information seeking***, although the reliability of sources can be questionable.

Table 5: Type/Modality of Generative AI and Clinical Implications for Speech-Language Therapy.

Type	**Description**	**Clinical Implication**
Text Generation: ChatGPT (OpenAI, 2022), LLaMA (Touvron et al., 2023), Bard (Google, 2023), *etc*.	The SOTA text generation is primarily based on transformer-based large language models that are trained on large-scale language corpus using self-supervised learning. The user will provide a text-based prompt, and the text generation model will produce a plausible answer. The conversation can continue alternately between the user and the chatbot, and the generative model can produce answers based on the chat history so far.	(1) Generate therapy stimuli for use during therapy and after therapy for additional exercises; (2) Provide or brainstorm therapy activity ideas and generate lesson plans for therapy; (3) Serve as a chatbot to communicate with clients directly.
Image Generation: DALL-E 2 (OpenAI, 2023), Midjourney Midjourney (2023), Stable Diffusion (StabilityAI, 2023), Imagen (Saharia et al., 2022), *etc*.	The SOTA image generation is primarily based on vision transformer or CNN-based probabilistic diffusion models. The user will provide source images and accompanying text prompts as instructions, and the image generation model will produce a plausible picture according to the user's specifications in the instruction. The user can also specify the exact bounding box locations or object mask regions in order to precisely generate certain contents at certain locations.	Generate visual stimuli for therapy materials (*e.g*., picture cards, visual schedules, stories, memory aids) and parent education materials (*e.g*., additional homework exercises)
Video generation: Make-a-Video (Singer et al., 2022), Imagen Video (Ho et al., 2022), *etc*.	The SOTA video generation is primarily based on extending the image generation capabilities with additional temporal consistency constraints. The user will provide source image, or image set, or video clips and accompanying text prompts as instructions, and the video generation model will produce a plausible video clip according to the user's specification in the instruction.	Create additional homework videos with avatars for caregiver training
Music generation: MusicLM (Agostinelli et al., 2023), *etc*.	The SOTA music generation is primarily based on transformer or RNN-based large-scale sequence-to-sequence models. The user will provide a source melody and accompanying text prompts as instructions, and the music generation model will produce the music clip according to the user's specification in the instruction.	Support therapy materials for language, memory, and voice (*e.g*., melodic intonation therapy, reminiscence therapy, singing exercises)
Multi-modality generation AI: putting everything together	The aforementioned generative capabilities can be combined either sequentially or in parallel to produce multi-modality and multimedia contents. Also, cross-modality multimedia generation will be made possible such as text2 (video+music), music2text, music2video, image2video, image2music, image2(text+video), *etc*.	Create simulated robots as future human-AI cooperative therapy delivery agents