Article

Futuristic applications of voice user interference on child language development

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ABSTRACT

Voice User Interface (VUI) is an Artificial Intelligence tool that enables children to access a computing device and complete tasks through speech instead of using learning methods. VUI, a form of AI (Artificial Intelligence), takes a sound that children articulate in a spoken statement and use intent recognition to understand the action required to fulfill the child's spoken request. The design and features of VUI have been developed to increase the interpersonal level of communication with users and, to some degree, make voice assistants behave like humans. The features that have been created, have been shaped in such a way as to improve learning efficacy and ease of use for early childhood learning development. The current available VUIs in the market have been geared to provide children with a simpler way to interact with access to educational technology learning tools. The research posits that there are two primary uses of VUI in childhood learning development exploration, whereby children use VUI as a form of entertainment and information seeking, and children use VUI to develop various knowledge facets. For children in the early language stages currently using language to communicate, VUI language stimulation can help children to engage in continuous communication processes, use and understand various words, and successfully complete more complex sentences. The research seeks to state the problems associated with VUI and the standard opinions based on research associated with the problem. Moreover, the study seeks to articulate the hypothesis that VUI is an effective tool for early childhood language learning through the use of peer-reviewed evidence and examples, to the hypothesis, to generate new and innovative perspectives.

1. Introduction

Unlike traditional communication mechanisms that require input and output devices [1], Voice User Interference (VUI) allows users to interrelate with electronic devices through speech. Users of VUI are able to interact with electronic devices by talking to them, comparable to a natural conversation. The primary advantage of a VUI is that it allows for a hands-free, eyes-free way in which users can interact with a product without having to hold the device. Because users normally associate voice with interpersonal communication rather than with person-technology interaction, they are sometimes unsure of the complexity to which the VUI can understand. Hence, for successful VUI interaction, it requires the ability to understand spoken language but also needs users who are aware of what type of voice commands they can use and what type of interactions they can perform. The elaborate nature of a user's

communication with a VUI indicates that a designer must be cognizant of how a user may potentially have high expectations. Hence, this is why it is important to design a product in such a simple manner to keep the user mindful that a two-way "human" conversation is impossible [2]. Moreover, the user's patience in building a communications "rapport" likely helps user satisfaction when the VUI becomes more familiar with the speaker's voice, and thus, provides the speaker with more accurate responses. In this context, hands-free interaction with VUI devices provides significant benefits for children as a means of language learning. For the purposes of this paper, we define children to include early adolescents: those 12 years of age and younger. VUI's support of children's learning has been well documented, and the trends suggest that VUI is altering the way children relate to technology as a means to develop language skills. The use of technology by children is increasing, and according to Brody [3], these users

are accessing digital devices, often before they are exposed to books. Moreover, global trends suggest that there are increases in the use and younger ages of first access to technology [4]. In counties with high rates of connectivity, young people outnumber other age demographics in terms of overall online populations [5]. Although research suggests that children prefer using the internet for gaming, chatting, and social networking purposes [6], there is limited research on VUI's impact on young children's language development and if there are any negative impacts of technology use. Having documented the promise of leveraging VUIs' ability to strengthen children's language development, application developers have increasingly created voice-based apps targeted at children's use. These apps have increasingly been developed as learning to engage in dialogue with children based on pre-designed dialogical flows and focused on activities with interactive speech-based content [7]. However, these designs are not without challenges. For example, a VUI's dialogic interactions are pre-defined, and the efficacy of a user's interaction with the VUI is reliant on the child answering in a manner that is predictable by the VUIs designers. Thus, when a child responds in an unexpected way, the VUI cannot reliably provide comprehensible feedback [8].

2. Current available VUI in the market and features

An inclusive design approach that facilitates the participation of young users, their caregivers, and local communities in the life cycle of a VUI project is critical for children's empowerment and for responsible VUI innovation. If children are going to interact with VUI systems, for instance, by communicating by sharing their stories and emotions with a companion language application, their perspectives and preferences must be included in the design process so that the VUI application not only fits their language learning needs but also respects their rights. Hence, the involvement of children, their guardians, and stakeholders in the education community can help ensure that AI systems are fair and non-discriminatory [9]. Hence, to create satisfactory user experiences with VUI, designers need to understand how children naturally communicate with their voices, in addition to being cognizant of the fundamentals of voice interaction. In their book on voice interaction, Wired for Speech [10], Nass and Brave posit that users often relate to voice interfaces in a similar manner that they relate to other humans. This is due, in large part, because speech is innately fundamental to human communication. This suggests that to understand the user's fundamental hopes of VUI, developers must understand language principles that govern human communication. Since VUI cannot completely meet the expectations of users, a natural conversation partner for a child, thus it becomes increasingly important to design the voice user interface so that it encompasses an appropriate amount of information and handles children's expectations suitably. To amplify the benefits of VUI as a conversational agent for young children, it is imperative to recognize the cognitive abilities and specific communication needs of children. To maximize the market potential of VUI, developers must consider child development research complementing it with child–agent interaction research, so developers and educators will be better equipped to create evidence-driven methodologies for the improvement and evaluation of VUIs as children's language learning partners [11]. When creating a VUI, one does not begin with an existing Artificial Intelligence system. Initially, a robust foundation must be developed to process programmed dialogues. Upon this being successful, the VUI and user conversations must be continuously tested.

Therefore, the initial step is conceptual. For VUI, this idea is made possible through the user's voice. Supporting such comprehensive ideas requires data analysis; and upon inferences being drawn from these analyses, VUI design can then commence. Throughout the design process, all aspects of configurations must continuously progress through testing until a validated functional concept occurs. Amendments are an integrated and essential step of AI design before, during, and long after development. Only when a minimal viable product has been established based on a series of dialogues can you begin with big data collection gathered from user insights [12].

Considering the effort needed to create VUI, when developed appropriately, VUI offers substantial opportunities and learning applications for children through social interactions. As noted; however, these tools must be meticulously developed and designed to meet children's developmental needs, and this can be accomplished by implementing relevant information based on how they feel and act. Therefore, VUI design must naturally target the population it aims to serve because children's interactions with VUI influence their current actions and thoughts but have effects on how they will intermingle with other people in the future [13]. As a result of the escalating market demand for VUIs on the international market to support young children's language development, developers have created thousands of such VUI applications available to children [7]. These applications engage in conversation with children based on pre-designed dialogical flows and communicate with children via specific activities with collaborative speech-based content [14]. Moreover, these educational resources are particularly treasured for preschool-aged children who have not yet learned to read or write and who primarily depend on oral communication [13]. Similar to children's interactions with parents or teachers, language interactions with VUI apps must be thoughtfully designed to actualize their intended educational and developmental goals for children [15]. Many studies suggest that VUIs' conversation design should focus on human-to-human communication [16], but these recommendations are often not tailored for specific user groups [17]. Because of children's developing cognitive and language abilities, it is paramount that effective adult-child communication strategies be utilized when designing VUIs intended for use by young children [18]. However, there is limited research devoted to communication strategies that need to be incorporated into VUI apps for children.

Developers are continuously working on algorithms to give VUI, social characteristics, and specific personalities. The idea of providing voice interfaces for children's applications is not a new one; however, the scope of the systems that have been developed thus far has been relatively limited. Examples of spoken dialog system prototypes for children include word games for pre-schoolers [19], aids for reading, and pronunciation tutoring [20]. Historically, multimodal interfaces that combine speech with a variety of other input modalities such as text, touch, mouse clicks, handwriting, and gestures have been designed [21]. Results of these designs indicate that multiple modalities, rather than a single modality, lead to more efficient and natural interaction and enhance the overall user experience. Multimodality is deemed to be best in developing conversational interfaces for children becomes it has the ability to overcome speech technology limitations. Creating an effective user interface for children's language learning VUI entails consideration of the following: (i) the data requirements of the task, (ii) the constraints and

capabilities of the voice technology, and (iii) the expectations, knowledge, and inclinations of the user. By understanding these aspects, the VUI designer can anticipate challenges and incongruities that may impact the overall success of the VUI and design the interface to mitigate their impact. For ideal results, user interface design must be an essential and early factor in the whole design of a system. User interface design and application are most effective as an iterative process, with interfaces tested analytically on groups of children users, then amended as shortcomings are detected and rectified, and then retested until system performance is balanced and adequate [21]. Building VUI for children is stimulating and is a process encompassing several steps. The first step is creating a proof of concept for the use of speech as a practical way for children to interact with VUI in terms of viability and usability. Second, information from child users must be collected for quantifying the unpredictability present in their speech and to teach and test models for automatic speech recognition (ASR) and spoken language understanding (SLU). This must be done to ensure satisfactory levels of ASR and SLU operation across all ages and conditions. Finally, insight and conclusions from these data analyses and modeling [22] can be used to produce prototype systems.

Large vendors of commercial voice assistants offer their own distinct guidelines for VUI developers [23]. These guidelines offer support for developing applications for specific platforms. In this context of platform-independent options, models, and design tools, presented a set of design principles for the VUI applications, taking a role as a faithful servant, while [24] analyzed and modeled users' behavior patterns in interaction with unfamiliar VUIs. Researchers have built several tools in support of VUI design [25], SUEDE-enabled Wizard-of-Oz style prototyping of VUIs. SPICE and SToNE are toolkits for helping developers and researchers design speech recognizers for VUI applications [21]. To assist designers to modify the integrated voice in more useful and cost-effective ways, Amazon and IBM created their own innovative SSML (Speech Synthesis Markup Language) tags that contain the effects of various primitive standard SSML tags [26].

To design effective VUI, developers must enhance mechanisms to provide children with missing information about what they can do and how they can do it without confusing them. Hence, developers are responsible for measuring the expectations users have from their experience with daily and routine conversations. Considering that human communication is context-bound, however, in voice interaction, child users must be taught how to express their needs in a manner that the VUI can comprehend. Moreover, developers can impact the ease of use by providing information about what child users can do and what functionality they are using, informing them how to communicate their goals in a way that the system understands, keeping sentences short, and offering visual feedback so they know if the VUI is comprehending their intentions. VUI presents additional challenges in some regards than a graphically based system; however, VUI is becoming more predominant as more aspects of everyday life feature voice-controlled interaction [2].

3. Importance of speech and language stimulation in children

Language is the ability to communicate with others. Languages include all forms of communication, expressed in multiple ways, such as oral, written, sign language, gestures, facial expressions, or art. Spoken language is the most valuable form of communication and the most significant and commonly used [27]. Language learning is a consequence of the collaboration between a children's learning capabilities and the language setting [28]. General language stimulation approaches include modifications of the physical and linguistic situations to expand opportunities for children to hear the developmentally suitable language and to use language built on their abilities. General language stimulation does not focus on specific language types or communication actions, and the intervention agent never tells the child directly to create any particular words, word patterns, or grammatical structures. Instead, the intervention concentrates on establishing a rich language atmosphere that is designed to the child's concerns and talents. Children may then concentrate on those facets of language that they are mainly ready to learn [29]. Some researchers imply that VUI-led communication is a collective interaction related to interpersonal communication, with the VUI taking the role of a partner in children's language learning [30]. However, there are questions remaining regarding the effectiveness of VUI in assisting in children's language development.

4. VUI's contribution to children's language development

The sociocultural theory defines language development as a process where children learn language skills through cooperative dialogue with members of society in daily activities [31]. Through back-and-forth conversations with knowledgeable language partners who offer to scaffold and facilitate active participation, children gain knowledge by concentrating attention, expressing thoughts, and reflecting on the discussed topics [32]. Language development is a primary indicator of the comprehensive development of children's cognitive abilities related to success in school [33]. In the beginning, children's language was egocentric, that is, a form of language that emphasizes itself more. Then it gradually develops into a social language, which is used to relate or exchange ideas and influence others. In this case, the form of language used is often in the form of complaints, bad comments, criticisms, and questions. When a child's language changes from egocentric to social language, the union between language and thought is essential for the formation of the child's mental or cognitive structure. In the first years of life, language must be learned as a way of communication and a way to enter into a community and society. Children have a yearning to belong and to effectively communicate their needs and interests. To accomplish this, they must master the skills to communicate with others, which entails expressing themselves and understanding others. Initially, they accomplish this via expressions, sounds, touches, and body movements. Children progressively develop more particular means to express themselves, such as nonverbal gestures and facial expressions, tone of voice and sounds, and verbal words and sentences. However, the distinction between these modes is primarily analytical: Children need to express themselves, and they make use of all available means to accomplish that. For young children, language is just one instrument in the ensemble of all means of expression Language is not all-encompassing but instead provides higher-level goals and the learning of specific communication tasks. Within a child's educational context, language achievement is critical and has lifelong consequences. Early language abilities and the quality of early education and care settings have been proven to be linked with successful school performance in older children and adolescents. Inadequate language competencies hamper the achievement of cognitive,

emotional, and social abilities. Moreover, early language education helps in the initial integration of children in successful language retention in that already prior to entering the school system, the children become familiar with learning opportunities in their social environment, the neighborhood, the community, and the educational system (schools), and in that they have social contact with and play with other children and can develop the language of their social environments in conversations with caregivers and other children. Early language attainment can be hindered by young children's individual characteristics, for example, physical limitations, conditions in their social environment, for example, poverty, lack of parental involvement, negative media utilization, or a mixture of personal and social factors. Thus, it is paramount to support children's early language acquisition in all of their contexts and to solely concentrate on children's or parents' language shortfalls. Promoting language development should entail building the capacity of children and parents to use accessible resources to enhance children's language development. This resources-based strategy supports the building of trusting educational partnerships, including information technology and more specifically, VUI to advance children's educational competencies.

Language is a cultural implement and is developed in social interaction [34], therefore environmental context plays an integral important role in language acquisition. Heath [35], suggested that the following contexts be considered: Under what spatial-material conditions do children grow up? What caregivers- parents, siblings, grandparents, and other familiar persons- do they have at hand in their daily lives? What languages are they exposed to? How do people in their surroundings communicate, play, teach, and learn? What media do the children have access to, and how are they used? How does the family spend their everyday time and their leisure time? The economic, social, and cultural capital of families creates very different conditions for language acquisition [35]. Individual circumstances, it is not so many structural factors, such as parents' educational background or socioeconomic conditions, that are most significant; but what is pivotal are the definitive language and education traditions in daily family life [36]. For example, there is a constructive association between children's language abilities and the accessibility of age-suitable books in the home, and the occurrence and linguistic intricacy of language exchanges [37]. As has been noted, early learning is important in children's language progress in receptive and beneficial linguistic abilities. Language acquisition through experience is what happens during early childhood, where the language is ingrained into the child's mind subconsciously [38]. In this regard, in contemporary society, the use of technology is an important factor that impacts the language development of children. Pauwels [39] indicated that technology is often a part of children's everyday environment and its impact and effect on language is unquestionably meaningful. As a result of the promising development of artificial intelligence, children are increasingly interacting with non-human intelligent agents through speech, gesture, or writing. VUI that supports natural speech interaction is especially valuable for young children, whose lack of language literacy causes difficulty in figuring out digital environments [15]. Research suggests that in some cases of language development, obstacles occur as a result of VUI because children spend more time interacting with the gadget than talking to their peers and interacting with humans. However, when used in the proper context the use of VUI provides excellent

stimulation that can be used for increased language development. These points are further alluded to by [40], who suggest that VUI impacts early childhood language development.

5. Various uses of VUI in children's learning

The importance of VUI has been proven to provide support for educators and caregivers in home and classroom supervision, all the while availing opportunities for voice-driven learning with dialogue-driven interactions with numerous and singular turn-takings; opportunities to enhance fluency, as well as active (speaking) and passive (listening) competencies; access to a range of actions or skills involving knowledge seeking behaviors; one-on-one individualized language learning and language practice support [41]; and instant access to subject matter that is accurate and objective. Working with VUI in the language development setting involves developing significant speaking opportunities incorporated in a manner that gives children the tools to use that language in the future [42]. This is particularly pertinent because children are now living with Artificial Intelligence and VUI as part of their daily lives, and many children are using voice-assisted technologies primarily for data searches; engaging in questions and answers, and entertainment [43]. However, students need to be empowered with the skills to know how to evaluate this information and decide the best manner to make it relevant to their requirements, resolve challenges, for accomplishing specific responsibilities, or for attaining specific conclusions. A study by Sowmya et al. [44] implies that children with frequent gadgets, including VUI usage scored higher on language development tests than children with low gadget usage. Thus, it can be understood that gadgets and VUI use generate an encouraging impact on children's language development. According to UNICEF, as the influence of VUI and gadgets grow, children broaden their knowledge base, thus it is important that VUI innovation is triggered by children's developmental needs [45]. Distinct VUI for children has now also demonstrated how VUI, an AI technology, could influence children's development in a positive manner [46]. The fast creation of VUI is redefining language partnerships mean. Language partners are no longer restricted to humans but also extended to VUIs with agents that are created to understand complex speech input [15]. According to Tomasello [47], countless children now cooperate regularly with VUI in their own homes, and researchers see this child-agent conversation as a meaningful addition to children's daily language encounters. A promising wealth of research using interviews, observations, and in-home audio recordings has illustrated two types of exchanges children commonly have with VUIs: open-domain conversations with general assistant tools [48]. In agent-led context-specific conversation, the VUI leads children down an earlier-designed dialogic conversation journey on a specific topic [49]. Several research projects have created experimental VUIs that combine helpful guided conversation approaches as found in the traditional literature, specifically, the prompt-response-scaffolding cycle [14]. Prompt-response-scaffolding involves the use of written or voice prompts or cues to assist children to perform a task or use a strategy, and children can use these as a reference to reduce confusion and frustration [50]. For example, one study developed a storytelling app that asks children open-ended questions, provides responses, and follows up on children's incorrect responses with helpful hints [14]. Effective conversation design is significantly important when the objective entails agent-led interactions

with young children's language development. This is especially important because young children are continuously l developing their cognitive aptitudes, communicative abilities, and mental representation to interact with a digital speaker [51]. Conversely, because a VUI's interpretation of what a child is attempting to express is centered primarily on the predesigned dialogic roadmap, VUIs are not compatible with adjusting the conversation ebbs and flows as naturally as a human language partner [52]. These two factors lead to child-agent conversations being susceptible to failure. Many studies detailing such conversation interruptions have concentrated on how children struggle to adapt their communication strategies to prevent possible conversation breakdowns [52].

Hill et al. [15], in their study of VUI for young children, found three reasons for their engagement: exploration for enjoyment, information-seeking, and as a way of operating a specific device. In this context, Winkler et al. [54] developed Zhorai, a Conversational Agent (CA) that supports children's exploration of AI algorithms and machine learning. Lin et al. also revealed that by training an agent, examining its mistakes, and reorienting the agent, children could appreciate the agent's ability to learn and recognize the learning algorithms used by it. Researchers have shown awareness of using CAs, as well as social robots, as a positive intervention for children with special needs [54]. One such example is PunkBuddy, a tool that has a chatbot that assists dyslexic children to learn through interaction. The chatbot informs children on the rules of using punctuation, using clear instructions [55]. Xu and Warschauer [56] created a VUI for children with ADHD to help with their daily tasks. The VUI provides vocal feedback to the child and urges them to complete the task, and equally, the child provides feedback to the VUI about their progress. Moreover, Wu et al. [57] developed a chatbot for children with autistic spectrum disorder (ASD) to enhance their ability to hold a conversation. Their chatbot stimulates the curiosity of children and tries to assist them in better understanding conversations. Social-assistance CAs are frequently used to assist children and adults with special needs, especially children with ASD [58], and some researchers have suggested that a child with ASD could find it simpler to relate with a social robot than with a human educator or caregiver [57]. Additionally, Ziyad [58] developed a social robot to improve the social-communication skills of children with ASD. The robot can move or talk based on a selected assignment defined by the caregiver. The researchers indicated that after a one-month deployment, the children with ASD improved their behavior and increased their independence levels. Moreover, [36] developed QTrobot, a social robot to assist children with ASD to focus their minds, emulate positive conduct, and decrease monotonous behaviors.

6. Conclusion and future perspective

Recognizing the potential benefits and identified challenges, global and nationally contextualized VUI strategies have now begun to concentrate on mechanisms to improve the delivery of educational services to improve young children's language development [34]. As noted, VUI-based interactive games, chatbots, and robots have presented innovative platforms for children to communicate with others and think creatively, which are significant skill sets that are necessary for the digital age in which children are being raised [22]. It must be stated that VUI if it intends to gain educational significance, needs to embrace more learning tools beyond being question-and-answer gadgets [9]. As

innovation occurs and technology develops, society, educators, and caregivers must embrace the opportunity for these stakeholders in children's development to facilitate learning and supplement it with VUI technology to enhance children's imagination and encourage active language acquisition. Going forward, VUI requires an inclusive design method that incorporates the participation of children, caregivers, and local communities in the life cycle of VUI projects that support language development is essential for children's empowerment and for responsible VUI innovation. If children are going to interact with VUI in their language development, their viewpoints and needs should be incorporated into the design process so that the VUI application not only suits their needs but also respect their rights as children. Finally, the inclusion of children, caregivers, and other relevant stakeholders can assist in guaranteeing that VUI systems are fair and non-discriminatory.

Ethical issue

The authors are aware of and comply with best practices in publication ethics, specifically with regard to authorship (avoidance of guest authorship), dual submission, manipulation of figures, competing interests, and compliance with policies on research ethics. The authors adhere to publication requirements that the submitted work is original and has not been published elsewhere.

Data availability statement

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Conflict of interest

The authors declare no potential conflict of interest.

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