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EMERGING TECHNOLOGIES

Emerging spaces for language learning: AI bots, ambient intelligence, and the metaverse

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Abstract

Looking at human communication from the perspective of semiotics extends our view beyond verbal language to consider other sign systems and meaning-making resources. Those include gestures, body language, images, and sounds. From this perspective, the communicative process expands from individual mental processes of verbalizing to include features of the environment, the place and space in which the communication occurs. It may be—and it is increasingly the case today—that language is mediated through digital networks. Online communication has become multimodal in virtually all platforms. At the same time, mobile devices have become indispensable digital companions, extending our perceptive and cognitive abilities. Advances in artificial intelligence are enabling tools that have considerable potential for language learning, as well as creating more complexity in the relationship between humans and the material world. In this column, we will be looking at changing perspectives on the role of place and space in language learning, as mobile, embedded, virtual, and reality-augmenting technologies play an ever-increasing role in our lives. Understanding that dynamic is aided by theories and frameworks such as 4E cognition and sociomaterialism, which posit closer connections between human cognition/language and the world around us.

Keywords *Artificial Intelligence, Chatbots, Place-based Language Learning, Sociomaterialism*

Language(s) Learned in This Study: *English*

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Introduction

Viewing communication from the perspective of varied semiotic resources expands our view beyond verbal language, creating new perspectives on the role of place and assigning more significance to physical movements and material objects. Technology tools and services have created more spaces for language use and therefore for second language learning. Language today is often mediated through digital networks, with the medium of communication affecting the communicative process substantially (Kern, 2014; Thorne, 2016). Online communication has become increasingly multimodal, with images and sound integrated with text in virtually all platforms and modes of consumption. Advances in artificial intelligence (AI) and a constant stream of new digital devices promise yet more potential spaces.

At the same time, mobile devices, especially smartphones, have become indispensable "cognitive artifacts," playing a major role in our communicative practices (Eilola & Lilja, 2021). Mobile devices figure prominently in location-aware learning, whether that be in investigating linguistic landscapes, creating digital maps, or engaging in augmented reality (AR). Advances in immersive technologies expand our perceptions of the world or create new spaces in which to interact (Chun et al., 2022). Virtual reality (VR) figures as the preferred entryway to a promised merged world of the digital and physical, the *metaverse*, built with advanced AI (Hwang & Chien, 2022). While the metaverse is currently "under construction," an integral component of that space, chatbots—artificial conversation partners—are widely used today,

including in language learning (Bibaux et al., 2022). The proliferation of *smart* devices, the much heralded "Internet of Things," may usher in a world endowed with "ambient intelligence" (Dunne et al., 2021).

To understand the ramifications of our coexistence with emerging technologies as spaces for language learning, new theories and frameworks are needed. It will be argued here that the use of 4E cognition theory (Ellis, 2019) and sociomaterialism (Guerrettaz et al., 2021) offer useful perspectives.

Beyond Words: Gestures, Media, Space

The case for understanding language use from the perspective of an expanded array of semiotic resources can be made by considering findings on how the human brain works. One of the theories in psychology and neuroscience that has come to the fore in recent years is that cognition (and therefore speech) is not exclusive to the brain, but rather is embodied, embedded, enacted, or extended (4E cognition theory; Ellis, 2019). The idea that cognition is embodied, that the body is involved in thought processes, is of obvious interest to applied linguists, who need to understand what the mind-body connection means when it comes to language learning.

Studies of conversations "in the wild" (such as Eskildsen & Cadierno, 2015 or Eskildsen & Theodórsdóttir, 2017) have shown the important role that gestures play in vocabulary learning and retention, while Churchill et al. (2010) demonstrate that they can be instrumental as well in learning grammar. Those studies highlight the fact that, in contrast to traditional views on the subject (Hall, 1959), gestures do not necessarily have fixed meanings, but rather often local, emerging significance that develops in combination with verbal exchanges. Such studies show the importance of embodiment in L2 use and in situated learning, emphasizing the idea that "humans use the entire body to participate in socially organized processes of understanding and learning" (Eskildsen & Wagner, 2015, p. 291). Those findings can inform technology-mediated communication, whether that be gestures in a VR environment (Biener et al., 2021; in this issue, Chen & Sevilla-Pavón, 2023; Vázquez et al., 2018) or facial expressions and hand gestures as used in virtual exchange (Gutiérrez et al., 2022). That applies to AR as well; Sydorenko et al. (2021) discuss the important role that co-constructed gestures, pointing, and embodied deixis play in participants collectively accomplishing AR game goals.

Rather than viewing gestures as peripheral to verbal language, an integrationist approach (Harris, 2014) views them "as a central aspect of language in use, integral to how we communicate" (Gullberg & McCafferty, 2008, p. 133). Similarly, multimedia has traditionally been seen as an add-on to verbal resources, as aids to understanding or retaining linguistic forms, the so-called "multimodal advantage" (Han, 2019; Mayer, 2009). That assistance can range from multimedia glosses for reading to subtitles for listening comprehension. Likewise, other semiotic resources accompanying speech (or language learning), whether they be bodily (gestures) or material (dictionaries, blackboards) have been treated as subordinate to verbal resources. However, if we accept the reality of 4E cognition, our understanding and interpretation of others' speech or actions involves more than just conscious attention to words. Stimuli beyond verbal language can be equally important. The physical environment in which language is used—the context for conversations—has increasingly been seen not merely as background but as integral to the communicative process (Lantolf & Thorne, 2006; Levine, 2020). From this perspective, multimodal communication needs to be examined not just in its connection to verbal utterances but also in relation to sociocultural contexts, the kind of "critical multimodal discourse analysis" advocated in Djonov & Van Leeuwen (2017, p. 570).

Assigning an essential role to context aligns with an ecological perspective in second language acquisition (SLA; van Lier, 2004) and in computer-assisted language learning (CALL; Chun, 2016). This orientation emphasizes situated communication: "Language works with an assemblage of semiotic resources, artifacts, and environmental affordances in specific settings to facilitate communicative success" (Canagarajah, 2018, p. 36). Canagarajah (2018) labels these localized configurations of communicative resources "spatial repertoires" (p. 36). A spatial orientation to human speech has gained currency in applied linguistics, as it has in other fields (Canagarajah, 2018). Rather than viewing language as something set apart from spatio-

temporal contexts, as was the case in structuralism or Chomskian linguistics, scholars such as Pennycook and Otsuji (2015), Bloomaert (2010), and Canagarajah (2018) view the spatial context not as irrelevant or secondary but as central to meaning-making: "Treating spatiality as significant means understanding every practice as situated, holistic, networked, mediated, and ecological, thus integrated with diverse conditions, resources, and participants" (Canagarajah, 2018, p. 33). Human speech is highly contingent, shaped by local conditions, as speakers draw on stored linguistic resources and formulate utterances to fit the social context.

This aligns with a *usage-based* view of language, with its core thesis that language structures derive from real-world language use (Ellis, 2017; Tomasello, 2005). A central component of usage-based linguistics is that language is best understood not as a set of abstract rules, but rather "in the form of stored co-occurrences of stimulus elements, also known as chunks" (Hulstijn, 2015, p. 32). That places importance on the use and reuse of *multi-word expressions* (MWE). Situations which enhance the opportunities for encountering MWEs are therefore valuable to L2 learners. Recent studies have shown how that can occur through repeated contact with a set of semiotic resources recycling similar language, as through watching videos of soap operas or situation comedies or listening repeatedly to favorite pop songs (Sockett, 2014; Sundqvist & Sylvén, 2016). Another opportunity is through online gaming (Scholz & Schulze, 2017); collaborative activities in gaming have been shown to be beneficial. In one recent study, English learners playing an AR game were shown to be using language "collaboratively constructed across turns-at-talk as linguistic items are reused and repurposed" (Hellermann & Thorne, 2022, p. 16). Such activities build group cohesion, while providing opportunities to vary contextual uses of introduced MWEs. Additionally, that study provided evidence for a "possible physical proximity effect" (p. 16): "Collaboratively produced linguistic units, supported by an exostructure of interbodied cooperative practices, occurred more frequently when participants were in close proximity to one another" (p. 16). That analysis suggests that there is value in expanding attention from an individualist frame to group dynamics.

Usage-based linguistics stresses the centrality of pragmatics, as *in situ* conversations rely not on abstract language and grammar rules, but on contextual appropriateness leading to mutual intelligibility and intersubjectivity (Culpeper et al., 2018). In his study of pragmatics in teaching and learning, Taguchi (2021) includes multimodal resources such as gestures and gaze as resources speakers use to establish common ground through strategies of accommodation and affiliation. As is the case with verbal negotiation of meaning, socially appropriate body language is "co-constructed and negotiated during communication, rather than fixed or predetermined prior to communication" (Taguchi, 2021, p. 616). Pragmatics is embedded in all social language use, including in technology-mediated environments such as social media, providing a powerful learning potential: "Technology can provide environments to expose language learners to a larger variety of sociopragmatic situations, as well as opportunities and spaces to test and develop their L2 pragmatic competence" (González-Lloret, 2021, p. 91).

Technologies that simulate real-world conversational environments are particularly conducive to experiencing (and learning) pragmatics—extended realities, virtual exchange, chat—as they put L2 users in specific situations in which they need to interact appropriately (linguistically and physically) by means of all the semiotic resources at their disposal. Computer-based simulations, such as *SimCon*, incorporating video clips and audio recordings, provide a branching structure to allow users different pragmatic choices (Sydorenko et al., 2018, 2019, 2020). Depending on choices made, that system can supply either implicit or explicit feedback. Spoken dialogue systems as well can be used to simulate real-world conversations through the use of role play scenarios, as shown in Timpe-Laughlin & Dombi (2020). While conversations with an automated agent can provide practice in both linguistic forms and sociopragmatic behavior, the absence of body language may make those exchanges less authentic and satisfying than face-to-face encounters, as discussed in Klimanova and Hellmich (2021a). While not matching the characteristics of human bodies, robots incorporating movable limbs and facial expressions may provide a means to bring machine partners closer to human interlocutors in terms of embodied communication (see Randall, 2019).

The process of drawing on available semiotic resources may include more than one language. Studies on

bilingualism, as well as recent work on translingualism, have shown that languages are not, as long assumed, separate cognitive areas; multiple languages are continually mentally present and available as potential resources (Canagarajah, 2012; Ma & Yan, 2022). That may translate into code-switching, but may also affect areas of L2 use, such as word choice, pragmatics, or conversation management mechanisms. The role that the L1 may play in L2 communication has been particularly a source of study in English as a lingua franca (ELF; Canagarajah, 2007; Godwin-Jones, 2018b). Studies of ELF exchanges have highlighted how intersubjectivity (finding common ground) can be a complex give-and-take in which meanings are negotiated through a variety of semiotic resources, drawing from multiple languages and finding verbal and nonverbal means to cooperate and communicate (see Canagarajah, 2007 and in this issue, Chen & Sevilla-Pavón, 2023). From that perspective, language is not something located in the speaker's mind, but rather "a social process constantly reconstructed in sensitivity to environmental factors" (Canagarajah, 2007, p. 94). Canagarajah (2007, 2013) stresses the idea of mobility in language use, bringing to mind the description in Blommaert (2010) of language as "a set of mobile symbiotic resources" (p. 43), drawn on by speakers to use as the context requires. That dynamic is illustrated in the bilingual game *Bizhuwanshang* in which players use Chinese or English interchangeably depending on game actions and in response to other players' input (Cui et al., 2023).

Tech-mediated Spaces: Linguistic Landscapes, Digital Maps, Extended Reality

Technology tools and platforms both give evidence of the reality of multilingualism in today's world and supply the means to document and analyze its manifestations. Studies of *Facebook* have shown its pervasive multilingualism, as is true for other social media as well (Sockett, 2014; Warner & Chen, 2017). The tools built into mobile devices—GPS, sensors, cameras—provide opportunities to explore multilingualism in public spaces. That has taken the form of examining "linguistic landscapes" in urban spaces, that is, analyzing linguistic and cultural dimensions of signs, advertising, street names, and neighborhood identities (Shohamy & Gorter, 2008). Rather than considering signs as static artifacts, practitioners of linguistic landscapes explore the use of language in light of its embodiment in local geographic and historical realities, thus using a spatial orientation. Virtual exploration of sites is possible through extended reality technologies, as in the use of the Wander application, which converts Google Street View into 360-degree images and recreates them in VR (Chun et al., 2022). An open-source app, Siftr, has been used to add geolocated data to maps, which can also be annotated with photos and texts (see Guerrero-Rodríguez et al., 2022).

In the introduction to a collection of articles on the topic, Malinowski et al. (2020) write that linguistic landscape "has captured the imaginations of language teachers and SLA theorists for the encounters it offers with the authentic, complex, and often contested languages and ideologies of everyday life" (p. 2). The added benefit evoked here is that students gain insight into the inequities in the representation of languages in social contexts, contributing potentially to explorations of social justice (Malinowski et al., 2020). The hyperlocal characteristics of linguistic landscape projects demonstrates as well that contrary to the image conveyed by textbooks (and in much of second language teaching), languages do not represent monolithic, unified cultures (see Klimanova & Hellmich, 2021b). Researching and documenting neighborhoods from linguistic and cultural perspectives can provide greater depth for L2 learners experiencing another culture, for example through study abroad (Lomicka & Ducate, 2021).

Digital maps offer the potential for "deep mapping," investigating historical and cultural developments in local areas of interest. Apgar (2018) uses that approach to demonstrate the complexity of sites in Berlin as a predeparture activity prior to a short-term visit to the city, followed by onsite uses. Free and Ingram (2018) describe a project in several cities in France using collaborative mapping involving both students and local inhabitants to gain insight into historical and current practices in local theaters. In addition to study abroad, location-aware projects using mobile devices can profitably leverage neighborhood environments for L2 language and culture study. Technologies using GIS mapping (Geographic Information Systems), for example, can be used to create digital semiotic artifacts of local culture for use in virtual exchange. The

MAPS model for exploring local cultures involves participants on each side of a virtual exchange creating a variety of local artifacts—photos, videos, graphics, voiceover narrations, multimodal mashups—together with captions. Those media are added to a GIS mapping platform and shared, serving as a basis for critical explorations of connections between physical location and cultural-historical contexts (Klimanova & Hellmich, 2021a, 2021b).

AR programs similarly add depth to our knowledge of and experience in specific locations, adding a layer of virtual data (annotation, video, animation, etc.) to our view of real-world surroundings. Several landmark projects have used AR on handheld devices to create scenarios which foster collaborative L2 learning through explorations of local communities (Godwin-Jones, 2016). *Mentira*, a place-based game, takes students learning Spanish into a neighborhood of predominantly Spanish speakers (Holden & Sykes, 2012). There they engage with local residents as well as with non-human players in the game. They need to use appropriate pragmatics in Spanish to gather clues to solve a mystery. *Chrono-ops* takes mixed groups of learners and proficient speakers to sites on campus where they interact with each other and local artifacts to gather information for assigned reports (Thorne, 2013; Thorne et al., 2021). *Guardians of the Mo'o* similarly leverages visits to culturally significant sites on the campus of the University of Hawaii at Manoa to foster collaborative, place-based learning experiences (Zheng et al., 2018). An interesting aspect of those AR games is that they involve physical displacement of the learners, as they walk about in response to game actions and directions. While the physical exercise may in itself be beneficial, the integration of L2 use in real-world settings can reinforce form-meaning connections. Carvalho and Freeman (2022) describes a project involving student creation of "walking trajectories" around a university campus and in surrounding neighborhoods. Participants created digital postcards that captured both digital images and audio descriptions, which were combined with GPS waypoints to create mapped walks. Those trajectories were then subsequently walked by other students, while listening to the narrations.

Benson (2021) sees "walking methods" (conversations in motion) as having the potential to enhance narrative research, "as a means of capturing how language environments are assembled in both space and time" (p. 7). Engman & Hermes (2021) chronicle how a walk in the woods contributes to Ojibwe language learning; in that lesson, a tree becomes a "public semiotic resource" (Thorne et al., 2021; see also in this issue Lee & Hampel, 2023). From the perspective of a spatial orientation, such encounters represent *emplacement*, which, according to Canagarajah (2018), "gives more importance to the body in drawing from the ecological affordances for meaning-making processes" (p. 50). Interestingly, Van Leeuwen (2005) in his study of social semiotics points to walking as an activity that would not seem to have semiotic significance, but where the different gaits and body movements can in themselves hold meaning. Walking tours play a role in linguistic landscapes (see chapters in Malinowski et al., 2021), while campus tours have begun to be incorporated into virtual exchanges, sometimes shared through extended reality technologies (Godwin-Jones, 2019c). Hadjistassou et al. (2021) reports on a project using AR between groups of students in Cyprus and the UK, in which augmented views of artifacts functioned as a basis for identifying and discussing cultural landmarks.

While AR adds layers of meaning to the world around us, VR takes us into new realities. This can come in a variety of forms, from desktop VR to "caves" (VR cubicles) to immersive VR through head-mounted displays (Blyth, 2018; Chun et al., 2022; Lin & Lan, 2015). VR can take the viewer through a real-world environment—a neighborhood in Paris, for example, or a tour of paintings in the Louvre Museum—but also into an imaginary reality, as in 3D gaming. Despite its potential for teaching and learning in many domains, the widespread use of VR in educational settings has been slow due to a variety of factors, namely expense, technical requirements, and the potential for physical discomfort (Cowie & Alizadeh, 2022). Nevertheless, exploratory studies have shown the potential benefits of VR for L2 learning (Chun et al., 2022; Lin & Lan, 2015). *Virtual Reykjavik* immerses learners of Icelandic in a generated version of the Icelandic capital in which they need to use that language to ask for directions and to find their way around the city (Bédi et al., 2017). *Virtual Tabadul* is a multi-institution Arabic and English language exchange project which combines VR with virtual exchange (Baralt et al., 2022), a promising combination. Global simulations integrating VR (such as Michelson & Dupuy, 2014) offer a compelling model for both

intercultural and language learning, as they provide individualized role play, collaboration, and multiple cultural/pragmatic interactions. Unfortunately, most VR implementations are less imaginative and experiential in terms of user interface and assigned tasks, relying often on mundane, closed multi-choice interactions (see Berns & Reyes-Sánchez, 2021).

Recent studies have claimed that the use of immersive VR in L2 learning may offer a means to map new lexical items more effectively to meanings (Ma & Yan, 2022). Using recently developed noninvasive neuroimaging techniques, Li and Jeong (2020) detected brain patterns through VR use that foster long-term memory. The writers theorize that the real-world simulation possible in immersive VR can overcome the "parasitic" L2 to L1 lexical mapping. The idea is that while an L1 is learned in natural settings at home, an L2 typically is learned in artificial surroundings (the classroom) which removes the organic connection between an item learned and its real-world representation. Another benefit of VR use that has been demonstrated in recent studies is the potential both to increase motivation and decrease anxiety among L2 learners (see in this issue Guo & Lan, 2023; Tai et al., 2020; Thrasher, 2022).

AI-based Spaces: Chatbots Today, the Metaverse Tomorrow?

VR figures prominently in the idea of the metaverse (Hwang & Chien, 2022). The term, introduced in Neal Stephenson's *Snow Crash* (1992), has been in the news following Facebook's rebranding as "Meta" in 2022. The concept of a metaverse is a continually available digital space in which business transactions occur and in which entertainment, socializing, and communication venues are readily available to unlimited numbers of participants. Entry into the metaverse space is through multiple interconnected devices and platforms, with different degrees of access and interaction depending on the capabilities of the system used. Fully immersive access necessitates some type of augmented or virtual display system. It is a space in which the boundaries between digital and physical spaces have become blurred. The "real" in the metaverse will be based on data collected by the many digital, connected devices around us that incorporate cameras and sensors. The remainder of this virtual world will be created by sophisticated AI systems, which have access to all kinds of collected data. That will include incorporation of language technologies, allowing for access to resources and activities in multiple languages. While L2 speakers may not enter the metaverse with an express intent to practice language skills, incidental learning can accompany activities centered around entertainment, socialization, or commerce.

The current wave of "generative AI" is being used to create digital resources of all kinds (images from services such as DALL·E 2 and texts from ChatGPT), through minimal prompts or training (Roose, 2022). It seems likely that a coming metaverse will feature prominently pictures, texts, and videos created by such systems (Hu, 2022). The fuzziness that today's smart technologies enables between what is real and what is not is often seen as problematic, as in the creation of "deepfakes," digitally created images or videos that are uncannily similar to faces and bodies of real humans (Hsu, 2022). Such materials can be created through training an AI system on many hours of real audio or video footage. Deep machine learning applied to immense sets of collected data has led to breakthroughs in the capabilities of AI systems. In the concept of the metaverse, those systems are mutually compatible and linked together in a persistent network. In contrast to current VR software, the metaverse is permanently "on," allowing for continuity and recall of interactions. In Stevenson's metaverse, individual human consciousness itself may live on, presented in the novel as dystopian. A similar unsettling vision of our projected human-machine symbiosis is painted in Bridle's *New Dark Age: Technology and the End of the Future* (2018).

On the more optimistic side, it is easy to imagine a scenario in which language learners in a metaversal environment have access to both other L2 speakers—virtually present—and to nonhuman actors with whom they are able to converse. As in gaming environments, the non-human players will be represented by avatars (as will be the human participants). These are likely to be "smart avatars," modelled on human faces and bodies and capable of displaying subtle facial expressions and body movements; their conversational abilities are not scripted but are AI-based and open (Barfield & Williams, 2018). That potentially opens up a limitless number of subject domains as conversation topics. In the metaverse everything is recorded, so

that the artificial partners will have access to prior conversations and will have knowledge of individual characteristics of the human interlocutors. That could include L1/L2 background/abilities, hobbies/interests, as well as potentially highly personal information such as daily routine, work environment, family situation, and even financial status. While clearly issues of personal disclosure and privacy are at play in this scenario, the potential for L2 learning of having a highly knowledgeable, infinitely patient, and always available L2 partner is considerable.

Despite the marketing hype from Facebook/Meta, the metaverse hardly seems to be on the near horizon (except for gaming use, see Chen, 2022). Some have speculated that gaming platforms such as Fortnite are evolving into social spaces akin to the metaverse (Park, 2020). While awaiting the metaverse, L2 speakers can take advantage of the virtual conversation partners that already exist through chatbots (Huang et al., 2022). Chatbots—chatterbots or bots—are software programs with which one can engage in conversation, via text or voice. Such spoken dialogue systems have a long history, going back to the *Eliza* system of the 1960s (see Bibauw et al., 2019, 2022). Most chatbots used in language learning historically and currently are scripted and function in a question-and-answer or similarly constrained format. Responses are largely predetermined, based on parsing user input for keywords and using decision trees to build output. Such systems are designed to function only within particular domains of human experience. They have been incorporated into tutorial CALL systems (Heift & Schulze, 2015) as well as being available as standalone bots or incorporated into commercial language learning systems such as Babel or Duolingo (for an overview, see Fryer et al., 2020). Successful models have been built with HALEF, an open source, web-based framework for creating spoken dialogue systems (see Timpe-Laughlin & Dombi, 2020). Similar systems to HALEF have been used as well (Sydorenko et al., 2018). Such rule-based systems are designed for task-based language learning and function well in addressing targeted areas of SLA, particularly vocabulary and grammar (see Bibauw et al., 2019; Yang et al., 2022). They can provide guided practice in basic conversational exchanges (Timpe-Laughlin et al., 2022). Studies also have demonstrated that scripted dialog systems can be used effectively in setting up role plays for pragmatic language learning (Dombi et al., 2022; Timpe-Laughlin & Dombi, 2020).

With the limited scope built into dedicated language learning bots, they do not offer the free conversation on multiple topics that would benefit intermediate or advanced L2 speakers. However, different kinds of bots do offer that option. Social bots, for example, are designed to provide companionship to humans; examples are XiaoIce or Ruuh, developed by Microsoft, and widely used respectively in China and in India (Schlesinger et al., 2018). They are intended to operate as general chatbots, offering a safe space for casual conversation and socializing. As they are not scripted but rather built on top of AI systems, they are able to interact within a wide spectrum of information domains. While designed primarily for companionship, social bots offer opportunities for language practice and learning through informal conversations. They maintain a persistent profile of registered users, which allows the systems to learn about personal backgrounds and interests. They also incorporate advanced conversation maintenance mechanisms, enabling multi-turn conversations. Studies of XiaoIce have documented conversations lasting up to half an hour (Dokukina and Gumanova 2020; Zhou et al., 2020). Social bots are designed to be proactive, not just reactive to users. They can function as first movers in conversation, initiating talk on topics the system has learned are of interest to the individual user.

The language abilities of the AI systems behind social bots are based on a set of powerful processors analyzing speech data for statistical regularities, creating an artificial neural network with weighted, frequency-based connections linking nodes together (Godwin-Jones, 2021). That enables such systems to predict speech sequencing, based on regularly occurring constructions of words and phrases. This results in remarkably natural sounding language output. That is the case as well for voice systems more widely available than social bots, namely intelligent personal assistants (IPA's), such as Apple's Siri, Google Assistant, or Amazon's Alexa. These are AI-based voice dialog systems designed for general use, not for language learning. They function primarily as transactional agents, supplying responses to specific queries, and are not intended to engage in extended conversation. They maintain only select information about users, such as subscribed services. As with all chatbots, interactions with IPAs can be frustrating, with vague or

inappropriate responses, repetitions, or simply readings from a web page. Moreover, voice recognition is based on standard speakers of the language, so that IPA systems may struggle with nonstandard input (learner language, dialects). Nevertheless, a number of studies have demonstrated their usefulness for language learning, particularly for those at a novice level with no access to regular conversation partners (Alm & Nkomo, 2020; Dizon, 2020; Petrović and Jovanović, 2021). The default language can be changed, which offers the opportunity for learners to try out their oral skills. While pronunciation and question formulation are obvious linguistic areas for trial and error, the systems have been used for areas such as writing and storytelling as well (see Godwin-Jones, 2022a, in press).

IPAs are seeing constant improvement in all areas: voice recognition, quality of voice synthesis, and pragmatic skills (politeness, conversation management). Most significantly, they are gaining the ability to chat believably on a wide variety of topics and to do so from different identity positions. This has been enabled through the growth of *large language models* (LLM), AI systems that mine huge datasets with deep machine learning techniques to create artificial neural networks capable of generating texts in a great variety of forms and voices (Godwin-Jones, 2021). Systems such as GPT-3 and LaMDA have been shown to generate language that in many instances is indistinguishable from human output (Vincent, 2020). Chatbots are being built on top of LLMs, increasing exponentially their knowledge and conversational abilities. Indeed, a Google engineer conversing with LaMDA (Google's LLM) found the output of his conversation partner so authentic that he concluded a conscious entity must be responsible (Grant & Metz, 2022). While the claim that LaMDA had become "sentient" was widely debunked (and the engineer fired), the episode is a dramatic demonstration of how convincingly an LLM-based chatbot could function as a virtual conversation partner. With the public release of ChatGPT from OpenAI in late 2022 (based on the GPT-3.5 LLM), there has been widespread experimentation with generating texts of all kinds, as well as engaging in dialogue on a wide variety of subjects. Many media reports and blog posts have remarked on its astounding ability to produce believably human-like language. Experimentation with using ChatGPT in language learning has begun as well (Poole, 2022).

Bibauw et al. (2019) argue that "free dialogue should not be seen as the ultimate target of dialogue-based CALL" (p. 856), a point of view echoed in most studies of voice systems in CALL (Bibauw et al., 2022; Fryer et al., 2020). However, given recent advances in AI discussed above, open-ended conversations with a spoken dialogue system should not be quickly dismissed as a viable alternative to rule-based systems. As IPAs gain more capabilities through integration into LLM systems, they hold the potential to offer language practice through open-ended conversation with an artificial companion capable of taking on a variety of roles beyond that of tutor, as is now possible with ChatGPT. A particularly promising development is the possibility of creating a hybrid system, adding capabilities to an existing AI system. That could involve incorporating a learner corpus or other databases geared to language learning (Höhn, 2019). Stasaski and Ramanarayanan (2020) developed an English language learning system built upon extending an LLM (in this case, XLNet) and fine-tuned it to generate feedback on pragmatic appropriateness. A technique that has been shown to be successful in AI systems being able to parse learner language, which is nonstandard and unpredictable, is to pass the output through a spellcheck process to normalize language before processing (Zhou et al., 2019). Schlesinger et al. (2018) advocate for spoken dialogue AI to combine multiple backend systems, allowing a primary controller system to pass on to sub-systems user input that is ambiguous or not understood, potentially through algorithms specifically intended to address learner language. Additionally, one should consider that AI today incorporates advanced machine learning; in contrast to scripted systems, AI improves through usage.

Ambient Intelligence and Sociomaterialism

Chatbots are typically made available through widely used electronic messaging systems, such as Facebook Messenger, WeChat, or Weibo. That generally occurs through apps on mobile devices, most commonly today on smartphones. That phenomenon is, in fact, one of the main arguments in favor of IPAs, namely that their access on personalized mobile devices shifts the dynamics of L2 exchanges from an academic

setting to an experience integrated into everyday life. That is likely to make the service more easily available, more connected to L2 speakers' lived lives, and therefore more likely to enhance motivation and to lead to more frequent use. Additionally, AI-based tools including IPAs, search, and machine translation, are also becoming available on other devices, as wearables (watches, glasses), car installations (Apple CarPlay), or home appliances (speakers, wall mounts). This Internet of Things extends considerably the reach of AI tools, particularly in combination with faster cellular networks (5G) and more wide-ranging Wi-Fi. This holds the potential of ubiquitous access to digital services (most often voice-activated) wherever one might be, on the way to work (car), out for a run (smart earbuds), relaxing at home (smart speakers), or cooking a meal (networked appliances).

In the future, the access to the online world through multiple devices may be incorporated into a version of the metaverse. For now, it may be more appropriate to characterize the development of a digital world all around us as *ambient intelligence*, a term that has been used for some time (Sadri, 2011), including in language learning (Yang, 2013). It is made possible by ubiquitous cloud computing services, miniaturization, and the integration of multiple sensors and cameras. Advances in machine learning in areas such as image recognition and edge detection allow AI systems to capture and interpret physical actions in the environment. Analyses of facial expressions and body movements (from wearables) may even provide clues to human thoughts and emotions. Smart wristbands, such as Amazon's Halo, detect moods from listening to the wearer's speech, taking body temperature measurements, and monitoring other vital signs. On the one hand, this may raise visions of the surveillance state invading the bedroom. On the other hand, with sufficient privacy limitations and safeguards, such assistance promises the kind of seamless, invisible smart environment invoked in (utopian) science fiction. After all, Apple watches have been shown to have saved lives through emergency health alerts automatically triggered from built-in wrist sensors (Whitehead, 2022).

In a world of ambient intelligence, human beings take on a quite different relationship to their surroundings. This has interesting ramifications for language use and language learning. One of the avenues that appears to be promising for understanding the dynamics of a shifting relationship between humans and the material world is *sociomaterialism* (also labeled "new materialism"; Toohey, 2019). This is an approach used widely in the social sciences and more recently, in studies in applied linguistics (Guerrettaz et al., 2021; Thorne et al., 2021). It offers a different perspective on the relationship of humans to the material world. Reflecting theories in the biological sciences, sociomaterialism posits a more complex and close relationship between an organism and its surroundings. Biosemiotician Jakob von Uexküll distinguished the physical environment in which an organism lives (*Umgebung*) from its *Umwelt* (both German terms translate as environment; Kull, 2001). The *Umwelt* references parts of the surrounding space with which an organism directly relates and for which the organism has built in receptivity to stimuli. The *Umwelt* affects the actions of the organism (a snail eats a leaf) and in turn is changed by the actions of the organism (the leaf is eaten). Interestingly, Uexküll's idea of *qualitative organicism* embedded in the concept of the *Umwelt* has been used to describe AI-driven robots in their interactions with the environment (Emmeche, 2001). The deeper connection and ever-changing interrelationship that characterizes an organism and its *Umwelt* can be described using a term borrowed from quantum physics, *entanglement*. In quantum mechanics, this refers to the tight connection between subatomic particles that is maintained even when the particles are widely separated. In sociomaterialism, entanglement describes the distributed agency shared by humans and non-humans. Rather than viewing humans as autonomous agents, sociomaterialism "illuminates the significance of the myriad polysemiotic resources in the sociomaterial world" (Guerrettaz et al., 2021, p.9).

The study by Guerrettaz et al. (2021) explores the use of language learning materials from a sociomaterial perspective. While studies of classroom L2 instructional materials focus largely on textbooks, a rich array of semiotic resources are potentially present in that environment, from chalkboards and paper handouts to digital video and mobile apps. Those materials interact with the human actors—teachers and students—in various ways, creating *assemblages*, understood as "complex heterogeneous gatherings of polysemiotic resources" (Guerrettaz et al., 2021, p. 7). While some of the actions in the classroom are expected and predictable, Guerrettaz et al. (2021) point out that even a seemingly static resource such as a textbook can

be used in myriad, unexpected ways. That can even apply to a grammar worksheet (see Churchill et al., 2010). The emergent meaning of pedagogical materials depends not just on the materials themselves but on how the interaction develops in a particular space and in a particular time with a particular group of learners. This parallels every language teacher's likely experience that using the exact same materials in similar ways in different classes leads often to very different student learning outcomes. Intentions do not always align with outcomes. From this perspective, materials are not inert, but rather *enacted* (Fenwick, 2015, p. 5). Sociomaterialism "breaks down artificial boundaries between the material and the social, by foregrounding entangled interrelationships of the material world in relation to social processes, structures, and dynamics" (Guerrettaz et al., 2021, p. 4).

If a sociomaterial orientation helps break down the division between the material and the social, it also makes clear that other binaries are unsustainable, such as the distinction between incidental and planned second language learning. That is particularly evident in examining SLA in digital spaces, in which L2 users may be primarily intent on socializing or entertainment, but out of which L2 learning may emerge. Learners interacting with online communities and materials have a wide choice, leading to an even more complex and unpredictable situation than exists in the classroom. In the digital world, it is particularly evident that while the developmental trajectory is shaped by interactions with people and artifacts online, those entities are changed as well. In social media, for example, the user is shaped by posts, but changes that resource through new posts in turn. In discovering and using online materials and communities in accord with developmental stages and personal inclinations, the user aligns resources in a highly personalized way. That concept of *alignment* refers to the "the complex means by which human beings effect coordinated interaction, and maintain that interaction in dynamically adaptive ways'' (Atkinson et al., 2007, p. 169). That adaptation of resources to personal needs results in outcomes that are not preordained but rather emergent.

Variable development in SLA, based on a shifting mix of individuals with materials and people, evokes *complex dynamic systems* (Larsen-Freeman, 1997), an approach that has been found to be useful in exploring informal language learning (Godwin-Jones, 2018a; Kusyk, 2017; Sockett, 2014). The self-organization evident in many L2 learners' personal trajectories highlights the role of randomness and serendipity in SLA, particularly when it involves autonomous learning in online environments (Godwin-Jones, 2019b). That randomness accompanies decentralized control and is an important element in the process of emergence, understood to reference outcomes in complex systems that are new, unexpected, and not present in the constituent parts of the system (Murray & Lamb., 2018). In VR, for example, students exploring independently the virtual environment showed higher learning gains, as captured by statistical methods such as "roaming entropy" that quantifies the degree or variability of movement trajectories in self-directed exploration of space (Li & Jeong, 2020). Similarly in AR design research, there have been calls for developers to relinquish a level of control to users, who could be given the freedom to engage in exploration beyond the expected AR task completion (Parmaxi & Demetriou, 2020). Providing individual choice in using learning materials is an important step in developing learner autonomy (Godwin-Jones, 2019b; Murray & Lamb, 2018)

Conclusion: Towards a Relational Pedagogy

Viewing SLA through the lens of ecological frameworks such as sociomaterialism and complex dynamic systems highlights the variety and unpredictability in the process, undermining metaphors of linear development and engineered learning (Godwin-Jones, 2019a). Those theories support a *relational pedagogy* (Kern, 2015, 2018) in which the roles of learners and objects are best understood in relation to the context of learning. A relational pedagogy encourages learners to go beyond simple definitions and items used in isolation to accept multilayered meanings as they emerge from use in different contexts (see also this issue Satar et al., 2023). This perspective has the potential "to reconfigure language as situated across time and space, at the interface of the material and non-material" (Gurney & Demuro, 2022, p. 14). Dynamic assemblages of language learners and materials create new and unique outcomes that can only be

understood by examining the entangled and situated relationships in this process of "Becoming" (Dépelteau, 2018, p. 10). This accords with the observation in Wei (2018) that "language learning is a process of embodied participation and resemiotization" (p. 17). That description fits particularly well in considering the potential language learning embedded in virtual and simulated environments into which L2 speakers physical being is projected and in which they respond verbally and physically to situations and to other participants.

Gurney and Demuro (2022) point out that the implication of adopting relational approaches to studying human phenomenon are radical for fields such as sociology, education, and applied linguistics "in which practitioners aim to predict, control, or recommend courses of action to determine situations and outcomes" (p. 9). Echoing that sentiment, Guerrettaz et al. (2021) express skepticism concerning universal "best practices" in instructed SLA, eschewing a one-size-fits-all pedagogy. They comment that teacher training should "emphasize recognition and responsiveness over controlled planning" (p. 17). If we accept the idea that humans are "open systems" (Thorne et al., 2021, p. 109) and that L2 learners are part of a personalized "language learning system" (Magno e Silva, 2018, p. 230), we are less likely to anticipate fixed learning trajectories or to analyze learning from a cause-and-effect perspective (Larsen-Freeman & Tedick, 2016). Our emphasis instead can be on the relationships among learning resources and learners. From that perspective, unexpected outcomes should be viewed as natural results, not failures (Guerrettaz et al., 2021). Traditionally, instructed SLA has been concerned with finding universally applicable methods, but a relational pedagogy emphasizes the need to adjust goals and methods to account for local and situational variables. That might mean accepting that for some learners in some situations, functional proficiency in all areas is not a needed or desired outcome.

Person-centered SLA stresses individual learning trajectories (Benson, 2019; Ortega, 2019). If we view L2 learning as highly situated, that should translate into examining those "situations" closely. A number of studies involving sociomaterialism and related frameworks use conversational analysis (CA) to follow the dynamic development in exchanges (Eskildsen & Majlesi, 2018). Particularly helpful is multimodal CA which takes into consideration non-verbal interactions (Atkinson et al., 2018; Eilola & Lilja, 2021; Messina Dahlberg & Bagga-Gupta, 2016; Thorne et al., 2021). The results in CA-based studies are often qualitative, showing how individual learning experiences occur in specific settings. While the outcomes of individual learning histories vary with individuals, making generalizations problematic, grouping similar learning experiences together through cluster analysis can be instructive in pointing to potentially successful learning pathways and strategies (Lee et al., 2019; Peng et al., 2020). Helpful as well in extracting informative trends from individual learning histories is qualitative research synthesis. Studies such as that of Chong and Reinders (2021), synthesizing qualitative studies in CALL, collect and distill vital aspects of those individual or small group experiences, adding to the depth and richness of qualitative studies by making those findings more transferrable and generalizable.

Using CA, ethnomethodology (or similar frameworks) provides emic insights into situated language use at the individual level. As Levine (2020) reminds us, that micro level is important, but L2 use and learning should also be viewed from meso (i.e., institutional) and macro (societal) levels (see also in this issue, Suvorov & Gruba, 2023). After all, if we consider language and SLA as embedded, the larger contexts are as important to understand and investigate as the local occurrences. Taking that larger perspective also entails looking at both informal and structured language learning as constituents of a common ecology. The use of "bridging activities," encouraging students to seek out L2 learning resources online, then bring them as resources for group use in the classroom, helps close the gaps between (local) structured and (online) incidental learning (Thorne & Reinhardt, 2008; see multiple examples in Sundqvist & Sylvén, 2016). Student exploration and curation of online L2 resources, subsequently developed into digital learning modules, moves in that same direction (Mathieu et al., 2019). The concepts of "rewilding" (Thorne et al., 2021) and "structured unpredictability" (Little & Thorne, 2017) invoke this dynamic. Bringing real-world language use into the classroom—most easily done with online materials—can be illuminating, creating possible "boundary clashes" (Whitehead, 2021) or "critical moments" (Messina Dahlberg & Bagga-Gupta, 2016) that demonstrate the artificiality of the classroom while raising awareness of the variability in

authentic language use.

A spatial orientation to language use and language learning illuminates the complex intertwining of people and artifacts physically present with those digitally available. The wide use of videoconferencing in education, for example, complicates concepts of local and remote as well as online versus offline. Neat divisions are not tenable. That is demonstrated in studies such as that by Messina Dahlberg and Bagga-Gupta (2016), in which the simultaneous use of webcams and handwritten notes blurs the lines among modalities of access. Mobile devices as well represent the intersection of the local and the remote, of the personal and the social; they are equipped to support localized use, while making available all the resources of a global network. Smartphones are infinitely customizable, allowing individuals to decide on a great variety of device settings we well as on a personal mix of apps installed. At the same time, there are technical constraints on how mobile devices can be used, as well as usage options that may affect activities such as second language learning (see in this issue, Darvin, 2023). From a sociomaterial viewpoint, the phone and user form an entanglement of shared agency; smartphones supply "extensions of human cognition, senses, and memory" (Moreno & Traxler, 2016, p. 78). The sensors, proximity alerts, and camera feeds function as stimuli, extending cognition while acting as an intermediary between ourselves and the environment. For many users, smartphones have become part of their *Umwelt*, an indispensable "digital appendage" (Godwin-Jones, 2017, p. 4) with which they reach out to and interact with the outside world.

A sociomaterial perspective and 4E cognition theory problematize distinctions of mind versus body, as they also qualify the nature of human agency. The increasing role that AI plays in our lives (and in education) adds a further dimension to the complex human-material dynamic. AI systems built on LLMs produce language that mimics closely human-created texts in style and content. A radical development in writing-related technologies is the AI-enabled incorporation of auto-completion of phrases into text editors and online writing venues, as well as suggestions for alternative wording (Dale, 2021). Auto-completion features in tools such as Google Docs or Grammarly raise questions of originality and credit (Godwin-Jones, 2022b). That is all the more the case with tools such as ChatGPT which are capable of generating texts on virtually any topic and in a variety of languages. O'Gieblyn (2021) argues that due to the powerful advances in language technologies, we need new definitions of intelligence and consciousness, an argument bolstered by 4E cognition theory. In consideration of the language capabilities of AI tools today, particularly the text generation capabilities of services such as ChatGPT, we also need new understandings of authenticity and authorship (Godwin-Jones, 2022b).

O'Gieblyn (2021) points out that AI is able to replicate many functional processes of human cognition such as pattern recognition and predicting. That derives from the fact that language generation in such systems is based on statistical analysis of syntactic structures in immense collections of human-generated texts. That probabilistic approach to chaining together phrases, sentences, and paragraphs is capable of producing mostly cohesive and logically consistent texts. Yet these systems can also betray a surprising lack of knowledge about how objects and humans relate to one another. This results in statements that are occasionally incoherent from a social perspective. This is due to the fact that AI systems have no first-hand knowledge of real life. Unlike human brains, AI has no referential or relating experiences to draw on. Interestingly, the human-machine relationship is described in Dombi et al. (2022) as being akin to intercultural encounters, with common ground not initially present, as AI and humans exist in different realms, with the "smart" digital entity having only a limited knowledge of lived human experience. Schlesinger et al. (2018) point out the ramifications of this ignorance for the performance of AI-based chatbots. Since the bots have no real understanding of human social relationships, they assume universal cultural contexts apply to all situations, not making appropriate distinctions based on context. This can lead to unfortunate and unacceptable language production including the use of pejorative or racist language. While chatbots can filter out blacklisted terms, that does not really solve the problem, as the system cannot interpret usage patterns in which such terms could potentially be acceptable (Schlesinger et al., 2018).

The deep machine learning processes behind LLM-based chatbots do not allow for fine tuning or tweaking the algorithms. Today we have better insight into human neural networks through neuroimaging then we

do into the black box of artificial neural networks used in AI. That fact should make us cautious in using AI-based language technologies in an unreflective manner. At the same time, advanced AI tools offer considerable potential benefits for SLA, and their informed, judicious use—alongside additional semantic resources that are contextually appropriate—seems to lie ahead for both learners and teachers.

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