Explicating Cues: A Typology for Understanding Emerging Media Technologies

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Cues have long been an important concept in computer-mediated communication (CMC), as several core theories have utilized cues to explain how they get filtered and interpreted through technologies. As computing technologies evolved, other related fields have also adopted cues as a concept for understanding technological interaction. Given the pervasive nature of cues, this article first explicates the concept and creates a typology of cues based on how different fields have studied them. It then examines key differences in how existing theories approach cues and their assumptions behind cues, and further pulls apart the relationship between different cue categories and their potential effects on social presence. Lastly, we explain how researchers could draw on this typology to understand the increasingly multifaceted ways that emerging media technologies present cues and evoke social presence. A clear typology of cues is necessary both to clarify the term and help guide future evolutions of CMC.

Keywords: Cues, Computer-Mediated Communication (CMC), Human–Computer Interaction (HCI), Social Presence, Human–Robot Interaction, Computers are Social Actors (CASA), Human–Machine Communication (HMC)

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Computer-mediated communication (CMC) research has grown dramatically as a field since the seminal contributions that launched the area into prominence (Kiesler, Siegel, & McGuire, 1984; Newhagen & Rafaeli, 1996; Short, Williams, & Christie, 1976; Walther, 1996). As the "computer" part of CMC has become more mobile, compact, ubiquitous, and developed new visual and auditory capabilities beyond text, there have been multiple evolutions of CMC that aimed to understand new forms of social practices

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and processes that they enable (Baym, 2000; Herring, 2004; Toma, Hancock, & Ellison, 2008; Weiser, 1991). Amidst these changes, the central question continually facing CMC scholars is "how and whether new technologies affect the utility of theories that were developed in the context of somewhat older technological contexts" (Walther, 2011, p. 470).

At the same time, these developments brought CMC theory more into contact with researchers in related fields such as human–computer interaction (HCI) and human–machine communication (HMC), who have been studying users' relationship with computing devices and the creation of meanings among humans and machines (Harrison, Sengers, & Tatar, 2011; Rogers, 2012; Guzman, 2018). While this merger of interdisciplinary traditions and theories speak to the importance and relevance of CMC amidst the growing complexity of the computing environment, it has also broadened applications of core CMC concepts and made them more complicated. In particular, this article focuses on explicating the concept of cues, as a shared and commonly utilized construct across various fields.

While cues have long been a central concept in CMC theory, it has often been adopted across fields without explication. Scholars now use the term cues in a variety of ways, even though they ascribe different meanings to the term. While early CMC scholars first thought of cues as social context information (Kiesler et al., 1984), these were later adapted to accommodate embodied avatars, facial expressions, verbal messages, and kinesics. HCI scholars, on the other hand, have conceptualized cues more as material physical attributes, modalities, perceptual bandwidth, reflections of affection, and visual design elements (Norman, 1988; Picard, 1995; Reeves & Nass, 2000). Cues can be indicators of human or group activity (Reicher, Spears, & Postmes, 1995), or built into the computing technology to simulate human activity (Fogg, 2002). Some fields have further used cues to describe elements and frames in news stories (Dvir-Gvirsman, 2019) or as triggers of cognitive route processing in persuasion research (Fransen & Fennis, 2014). Because cues are oftentimes used as an umbrella term that stands for various implications, this can lead to confusion within and across fields.

Scholars across disciplines have also focused on different aspects of cues, as studies have utilized cues as independent variables, dependent variables, and mediating variables. Cues were first studied as indicators of how technologies mediate communication between senders and receivers (Licklider & Taylor, 1968). HCI researchers also utilized cues, but placed more emphases on the effects of cues on user interaction and perception. Research has examined cues as physical attractiveness (Antheunis & Schouten, 2011), or as evidence of interactivity, agency, and display factors in virtual environments (Oh, Bailenson, & Welch, 2018). Given the multifaceted nature of cues, a clear typology of cues is needed to clarify the term and help guide future evolutions of CMC.

This article first advances a typology of cues to bridge how different fields conceptualize cues. Then, using social presence as a representative example, we illustrate how each conceptualization of cues can evoke and correspond to different understandings of social presence across fields (e.g., CMC and HCI). The typology of cues and its relationship with social presence can contribute to future CMC research in several ways. First, it is one of the first to explicate cues as a concept and how they are deployed across disciplines. Second, it demonstrates how the typology can help clarify existing research on cues and their relationship to other concepts and outcomes. Lastly, it will be an important tool for guiding future research, as it can help scholars be more precise about the usage of cues and better understand the next evolution of computing tools. Particularly as emerging computing technologies are designed to be increasingly persuasive, physical, affective, and social, they are beginning to blend multiple conceptualizations of cues and engendering different social presence experiences simultaneously. We close this piece with examples of how a more advanced typology of cues will be especially relevant when applied to understanding emerging technologies such as chatbots, telepresence robots, computer agents, and augmented and virtual reality (VR) technologies.

Cues explicated

The concept of cues was first developed in interpersonal communication settings, as an indicator of a particular social meaning that gets decoded by an observer (Burgoon, 1991). Cues were analyzed as verbal or nonverbal distal cues (e.g., eye contact, body lean), which taken in combination can produce certain communication percepts (Burgoon et al., 1984). With the advent of personal computing technologies, CMC scholars began considering how people might ground their communication around the capabilities of technologies (Clark & Brennan, 1991), particularly as people began adopting certain practices around web browsing and online posting (Baym, 2000; Herring, 2004; Newhagen & Rafaeli, 1996). It was in this text-based environment that many of the core CMC theories about cues were developed, with scholars thinking of cues as being filtered out by technology and as a reflection of the richness of the media (Culnan & Markus, 1987; Daft & Lengel, 1984). Other theories such as the Social Information Processing (SIP) theory, Social Identity Model of Deindividuation Effects (SIDE), and the hyper-personal model of communication took a less deterministic view of technologies, but also explained how cues can be interpreted and utilized to develop interpersonal relations within CMC contexts (Walther & Parks, 2002).

Researchers in HCI who focused on communication questions have also drawn on cues as an important concept. One key facet of HCI research, known as user experience research, seeks to parse the relationship between human psychology and mental models for understanding technological artifacts (Dourish, 2006; Gibson, 1979; Norman, 1988). A second thread within HCI centers on artificial intelligence and whether users are able to distinguish computing technologies from humans (Turing, 1950; Searle, 1980). In both traditions, the question of cues became how computer interfaces present cues, either to facilitate human–computer collaboration or to demonstrate the computers' mastery of the scope and nuances of human linguistics to be perceived as human agents (Agre, 1997; Suchman, 2007; Winograd & Flores, 1986). More recently, communication scholars have looked into HMC and evaluate the philosophical and methodological approaches within the field (Guzman, 2018; Spence, 2019). From these different theoretical perspectives, there have been a multitude of ways that scholars conceptualize cues.

Cues as social signals

Scholars in the 1970s began to notice the differences between media technology forms such as videos, monaural speakers, and telephones. Short et al. (1976) were among the first scholars to systematically compare the warmth and intimacy delivered in mediated communication contexts. They referred to cues as non-verbal communication "signals" that include tone of voice, touch, proximity, and eye contact (p. 74). They posited in social presence theory that when cues were reduced due to the bandwidth of the media technologies, the efficiency of interaction would be diminished. As more technologies such as short message services, emails, and videoconferencing developed in the 1980s, scholars developed media richness theory (Daft & Lengel, 1984; Rice, 1992), where the correspondence between the ambiguity of a task and the richness of a medium determines communication effectiveness. Cues in media richness theory are also regarded as social signals such as facial expressions, gaze, physical distance, and tones (Rice, 1992).

These cues have also been studied in HCI contexts, but they are not delivered from other human communicators through media channels. Rather they are designed into media interfaces. Fiore et al. (2013) defined these cues as biological and physical dimensions that potentially serve as channels of useful information. They suggested that these cues could be interpreted as "social signals" based on environmental and cultural differences (p. 2). Such cues have been tested in the Computers are Social Actors (CASA) paradigm, media equation research, and human–robot interaction studies (Lee, Peng,

Jin, & Yan, 2006; Nass & Moon, 2000; Reeves & Nass, 1996). Examples of these cues include voice, eye gaze, and movements.

Cues as social categories

In the 1990s, online chat rooms and discussion groups became more common for everyday interaction. Research on the SIDE model has examined the power of group identity within these communication environments (Reicher et al., 1995). SIDE posits that anonymity can interact with group norms in facilitating the social influence in a mediated environment (Spears & Postmes, 2015). Scholars theorized that anonymity would lead individuals to switch attention from individuated information to cues about group characteristics (Spears & Postmes, 2015). Rogers and Lea (2005) used "the membership of social categories" to refer to such group cues (p. 153). These cues include group avatars, color labels, aliases, interests, genders, and even IP addresses (Kim & Park, 2011; Lee, 2006). They could also simply be the knowledge about the group and the settings of the mediated environment.

HCI researchers have also studied the cues as social categories. Past work has suggested that individuals can form team relationships with computers and identify humanoid robots as group members through cues like assigned colors, nationality, and names (Kuchenbrandt et al., 2013).

Cues as message elements

Amidst the growing environment of text-based live chat systems, scholars formulated the SIP theory. The SIP theory suggests that over time, individuals will achieve similar levels of information exchange and impression formation in face-to-face and CMC settings, as users in mediated environments interpret the message cues available to them. Walther (1996) further argued that interpersonal relations could be inflated both positively and negatively. This hyper-personal model of communication was developed as online users were given the ability to customize their profiles on various social platforms. The model suggests that information senders can take advantage of the asynchronous nature of CMC for selective self-presentation, while receivers will take these message elements and form stereotyped impression of the message senders.

In these message exchange processes, individuals observe and interpret cues such as language styles, conversational contingency, emoticons and emojis, pauses, editing status, timing, and delay in response (Walther & Parks, 2002; Walther et al., 2015). Message senders could manipulate the cues of their avatars, nicknames, and basic profile information. Even the minimal availability of information (e.g., indications that responder is "typing") could be perceived as part of the messages processed by the information receivers.

These cues exist in HCI as well. Some of the earliest HCI studies attempted to simulate human intelligence and focused on creating machines that could respond with appropriate language and content (Agre, 1997; Turing, 1950; Weizenbaum, 1976; Winograd & Flores, 1986). More recent studies have examined the content of messages and how computer programs can interact with users in natural languages (Miner et al., 2016; Moon, 2000). These studies explain why some voice assistants or social robots may need to incorporate cues such as response time, pauses, or even emojis to more effectively respond to human inquiries.

Cues as technological affordances

As one key focus of HCI is on the interaction between users' perception, actions, and technological properties (Gaver, 1991; Gibson, 1979), Sundar et al. (2015) argued in the Theory of Interactive Media Effects (TIME) that cues can be understood as reflections of technology affordances. These design

elements of technology can serve as modality affordance, agency affordance, interactivity affordance, or navigability affordance. These technological cues (e.g., bandwagon cues, navigation buttons) can influence users' engagement with the media, determine their attitudes toward the content, and leverage the credibility of the interfaces (Sundar et al., 2015).

The source of cues

Within this typology, we found that scholars from different fields have conceptualized "cues" in similar categories. For example, both CMC and HCI scholars have noticed the role of interpersonal communication cues in the human–computer relationship such as facial expressions, voice, gestures, and proxemics. They have also studied how cues can highlight membership categories in the digital contexts. In addition, CMC and HCI scholars have noticed the role of message cues in developing relationships with either human communication partners or computer technologies.

The difference, however, lies in their assessments of the source of cues. While early CMC theories generally viewed cues as human-generated information that gets filtered through technologies, some HCI scholars were studying cues as a product of technological design, and how those facilitate human–computer relationships. Specifically, when referring to cues as social signals, Short et al. (1976) focused on how media bandwidth limits the transmission of social signals. In the context of group discussion, CMC scholars have examined anonymity effects and how users form group relations with others when they focus on group identity (Spears & Postmes, 2015). Additionally, scholars aim to understand how reading cues as message elements could enable communicators to form impression of others, maintain relationships, and rely on stereotyped knowledge to predict others' mental and physical states (Walther et al., 2015).

Conversely, HCI has centered on how cues as social signals may evoke anthropomorphism of computers and simulate interpersonal communication components. The CASA research focused more on how social signals like voice led users to respond to technologies as social actors (Nass & Moon, 2000). Those who focus on the agency affordance attempt to understand the credibility of online sources and the cognitive effects of webpages (Lee & Sundar, 2010). These central differences about the source of cues explains how scholars who address the same type of cues may be starting their inquiries with different ontological assumptions about cues and their contribution to the human–technology relationship.

Cues and social presence

Given these different conceptualizations of cues and the source of cues, existing literature about the outcome of cues is similarly mixed. To illustrate this, we take the example of a related concept, social presence, to examine how explicating cues can help scholars parse out its relationship with certain outcomes. Social presence is an important concept here as it is commonly studied alongside cues to understand perception of media channels and outcomes of media use across CMC and HCI.

While social presence has been conceptualized from a variety of perspectives, there is an overarching definition of social presence: "when part or all of a person's perception fails to accurately acknowledge the role of technology that makes it appear that s/he is communicating with one or more other people or entities" (ISPR, 2000, presence defined). However, as cues can be generated by individuals, groups, or computing technologies, the evoked social presence could be different. For instance, CMC researchers have conceptualized social presence as the sense of being with others (Biocca, Harms, & Burgoon, 2003) or the perceptual illusion that users respond to mediated social actors (Lombard & Ditton, 1997). In HCI contexts, social presence has been referred to as the illusion that media technologies become social entities (Lombard & Ditton, 1997), or as the mental state where synthetic social actors are experienced

as real social actors (Lee, 2004). CMC scholars broadly emphasize how the role of technologies has been overlooked in users' presence experiences while HCI research accentuates how technologies themselves are perceived less as machines but more as social beings.

More specifically, as an outcome of cues as social signals, Short et al. (1976) operationalized social presence as "the subjective quality of medium" (p. 66). When it comes to cues as social categories, Rogers and Lea (2005) argued that lack of cues might finally result in higher social presence in that the cues as social categories can generate a feeling of group affiliation and immersion, "enabling the medium to become a social entity and thus conveying social presence" (p. 153). As Rogers and Lea (2005) foregrounded the capacity of the medium to evoke immersion experience, their conceptualization of social presence still emphasized the quality of the communication channels. Comparatively, both the interpersonal and the hyper-personal perspectives discuss the process of developing interpersonal relationships through computer technologies rather than the media features per se (Toma et al., 2008). Therefore, users may experience social-actor-within-medium presence, which refers to the idea that users respond to the cues presented by the mediated communicators and partially overlook the role of media technologies (Lombard & Ditton, 1997). Other scholars' conceptualization of social presence or co-presence also mentions such psychological reactions to para-authentic characters in CMC (e.g., Lee, 2004; Zhao, 2003).

Although similar types of cues exist in HCI studies, their connection to social presence can be understood in a different vein. As users interact with non-mediated social signals that are designed into machines, or engage in team relations with chatbots or digital agents that are assigned membership cues, users may experience medium-as-social-actor presence, which refers to individuals' reactions to the cues presented by machines or computers themselves. Similarly, as machines demonstrate various language

Cues	Examples	Source		Understanding of social presence	
		Human Communication	Computer Communication	Human Communication	Computer Communication
Cues as social signals	Voice, touch, facial expressions, gestures, physical distance, eye contact, etc.	Social presence theory (Short et al., 1976); Media richness theory (Rice, 1992)	The CASA paradigm (Nass et al., 1994); The Media Equation (Reeves & Nass, 1996)	Subjective quality of the medium (Short et al., 1976); Features of the media (Rice, 1992)	Medium-as-social-actor presence (Lombard & Ditton, 1997); Experiencing artificial social actors as real people (Lee, 2004); Copresence (Zhao, 2003)
Cues as social categories	Group names, avatars, color labels, ID gender, IP address, knowledge, social context	Social Identity Model of Deindividuation Effects (Spears & Postmes, 2015)	The CASA paradigm (Nass et al., 1996); The Media Equation (Reeves & Nass, 1996)	The capacity and the quality of medium (Rogers & Lea, 2005)	Medium-as-social-actor presence (Lombard & Ditton, 1997); Experiencing artificial social actors as real people (Lee, 2004)
Cues as message elements	Language style, pauses, editing status, response delay, emoticons, punctuations, etc.	Social information processing theory; Hyper-personal model of communication (Walther, 1996)	The CASA paradigm (Moon, 2000); The Media Equation (Reeves & Nass, 1996)	Presence as social actor within medium (Lombard & Ditton, 1997); Sense of being with others (Zhao, 2003); Experiencing para-authentic characters (Lee, 2004)	Medium-as-social-actor presence (Lombard & Ditton, 1997); Experiencing artificial social actors as real people (Lee, 2004); Copresence (Zhao, 2003)
Cues as affordances	Modality, agency, interactivity, navigability	-	TIME (Sundar et al., 2015); The MAIN model (Sundar, 2008)	-	Feel as if communicating with a social entity (Kim & Sundar, 2012)

Note: The categories of cues are not mutually exclusive. Some emerging media use phenomenon may contain multiple types simultaneously.

Figure 1 A typology of cues, the source of cues, and their relationship to social presence.

styles as message elements, individuals may have the misperception that computers can understand human language. Lee (2004) and Zhao (2003) also described such experiences of communicating with an intelligent being when suspending their disbelief in interactions with automated media technologies. Further, cues as affordances can activate social presence heuristics as well (Kim & Sundar, 2012; Sundar, 2008), especially when the agents present anthropomorphic features. A typology of cues and its relation to their sources, theoretical frameworks, and social presence is attached in Figure 1.

Cues and the future of CMC

This typology of cues reveals key differences in how different areas of scholarship has conceptualized cues, their origins, and their association with social presence. While CMC literature has tended to focus on how humans interact *through* computer technologies and how they rely on the cues available to them to develop, maintain, and end interpersonal relationships with others, HCI literature has mostly centered on how users interact *with* computer technologies, respond to them as social actors, and use cues to retrieve and evaluate online information (Lee & Sundar, 2010). This is not only an important mapping to explicate cues historically, but also points the way for future research, as emerging technologies are blurring the boundaries of CMC and HCI and enable users to interact both *with* a digital social actor and *through* a computer system. It is because of these changes that the field needs to update their concepts and integrate the CMC and HCI understandings of cues and social presence to inform future research.

Research on the growing ubiquity and sophistication of chatbots is one example for the necessity of integrating different perspectives of cues (Miner et al., 2016). Chatbots may be assigned different avatars, gender, or personality traits. Their introduction to the social media is such that chatbots and humans are coexisting on the same platform (Edwards et al., 2014), which requires a combination of theories that examine the perception of cues as both human- and computer-generated. For example, researchers interested in how users develop interpersonal relationship with these chatbots can refer to cues as message elements in the typology and combine both the hyper-personal model of communication and the media equation to examine how users form stereotyped impression of these chatbots based on designers' assigned cues. Recent work on chatbots' typos and capitalized words has corroborated the feasibility of such combination in explaining users' perception and attitudes towards chatbots (Westerman, Cross, & Lindmark, 2018).

Cues as social categories may also be applied to research on chatbots. As some online chatbot accounts can show avatars, assigned gender, and hobbies just like human accounts, users may fail to differentiate between chatbots and real humans in an anonymous online environment (Edwards et al., 2014). As users may be exposed to multiple chatbots' comments in such cases, it would be meaningful to examine how users understand chatbots in a group discussion context. Researchers can examine the effects of cues as social categories combining both SIDE and the CASA paradigm to understand how users form group relations with chatbots and how chatbots impose peer pressure on users' attitudinal and behavioral change.

Another emerging technology that requires a multifaceted understanding of cues is telepresence robot (Herring et al., 2016). When interacting with telepresence robots, users may not only respond to their communication partners through the video screen, but also to the gestures and the motions of the robots. Thus, telepresence robots can present both cues as non-mediated social signals and cues as mediated social signals. Based on these characteristics, researchers can compare the effects of a telepresence robot's simultaneous in-space motion and on-screen motion (Sirkin & Ju, 2012). Additionally, some telepresence robots can use their screen to present emojis (i.e., cues as message elements) and navigate their moving paths (i.e., cues as social signals), which may engender additive or

synergetic effects of disparate types of cues. Hence, researchers can examine how these different types of cues compete against or interact with each other in evoking users' social presence experiences.

Future research can also test how users experience both medium-as-social-actor presence and social-actor-within-medium presence at the same time or how one type of social presence may outweigh another during users' interaction with telepresence robots. These studies can help understand how the combination of cues can affect our psychological processing of these telepresence robots, especially the allocation of attention to two social actors within one single entity. Thus, this typology can facilitate research that builds on our understanding of a hierarchy of or interrelationship between cues, as the unique power of each single type of cue given off by either human operators or machines is still largely unknown.

A third growing area where the intersection of cues is necessary to understand are computer agents (e.g., web guides, personalized interface agents). These media technologies contain a multitude of cues as social signals, message elements, and social categories. When interacting with these computer agents, on one hand, individuals would experience medium-as-social-actor presence if they perceive the agent as a social entity. On the other hand, they would experience social-actor-within-medium presence if the computer is deemed as a mediator between the virtual agent and the users. Prior research has demonstrated the intricacy of multi-layered source orientation in users' interaction with computer agents (Solomon & Wash, 2014). As such interactive agents are often embedded into media interfaces, researchers could compare and potentially construct new analyses and measurement of presence experiences that were once separately rooted in CMC and HCI. The results would contribute to the understanding of users' perception of these non-human agents as human, computer interlocutors, or some combination therein and help discover the targets of users' social responses.

Lastly, VR and augmented reality (AR) technologies have raised additional levels of complexity regarding cues. New possibilities in collaborative VR environments and haptic interactive tools could benefit from bringing in HCI concepts. For example, the addition of force and touch feedback can improve users' communication effectiveness and open up a more productive public space (Bailenson, 2018). In this context, users' interactions with both haptics devices (i.e., cues as affordances) and avatars in VR (i.e., cues as mediated social signals) may determine their sense of being with those digital actors in virtual environments. Researchers could then integrate TIME and social presence theory to study the effects of the affordances, the sense of intimacy, and their behavioral change in VR.

In AR contexts, it is possible to display additional mediated social signals and message elements juxtaposed with physical interaction. Users may need to react to the cues from computer-generated social actors (e.g., Pokémon GO) or from human interactants (e.g., Augmented Tweets) and reconcile these cues with those from the physical space. As AR technologies continue to progress toward glasses and wearable devices, these interactions will become increasingly common and will require researchers to unpack multiple layers of cues, social presence experiences, and interactions with both content and forms of technology.

Conclusion

Cues have historically been and continue to be an integral and invaluable concept for understanding CMC. Given its importance, it is crucial that we be precise in our understanding of cues. By pulling apart the various conceptions and approaches that scholars have taken when utilizing cues, we argue that the typology will be an important theoretical and conceptual contribution for future research. First, it can help scholars make sense of the landscape of cues historically and elucidate what has to date been a complicated concept. Second, it offers future scholars a clear way of combining different types of

cues and social presence to better understand emerging technologies. Because these technologies merge cues and blur disciplinary perspectives, our typology can help scholars make sense of the complicated technology environment while also linking together theories, testing key relationships, and building more advanced frameworks that integrate CMC theories with those from other disciplines. As CMC continues to evolve, scholars have argued that CMC concepts need to be adaptive to technological features, while still being grounded in core communication processes that are relevant even if the technology recedes (Parks, 2009). It is through clarifying existing concepts such as cues and social presence with an eye toward the future that CMC theories can evolve and account for continual changes in technology.

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