How to Frame People's *Social Responses* to Media Agents: a Taxonomy of Dynamic Social Interaction Rules

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Paul: “We should all go out some time. You bring Samantha. It'd be a double date.”

Theodore: [hesitates] “She's an operating system.”

Paul: “Cool. Let's go do something fun. We can go to Catalina.”

(Her, 2013)

Abstract

The Computers are Social Actors paradigm, written in 1994 by communications professor Clifford Nass, asserts that media interactions are inherently social: the social rules that people apply to everyday interactions with others also apply to interactions with computers, as long as they show enough social cues for the user to consider them worthy of a social response.

Whether interactions with technology are genuinely social, the paradigm addresses the issue of usability: as the first interaction with a technological artefact is driven by instinctive and intuitive processes, it is critical to harness human cognition to practice anthropocentric design.

This thesis takes a divergent approach to knowledge gathering and processing, dealing with 161 publications investigating interactions with media technology under conditions in which technologies could be perceived similarly to humans.

The research method consisted of extrapolating notions and cognitions and contextualising them geographically and historically to determine how they evolved over time and how they related to the coeval characteristics of technologies, artefacts, contexts, and customs.

The reformulation of theories has revealed limitations, design implications, inconsistencies and related definitions, mapping out principles and counter-principles addressed in technology-based and non-technology-based case studies, and bringing to light a model of social interaction that disregards the specifics of media at the physical or material level.

The Media Agent Interaction Handbook is the proposed exploratory search interface to support open problem contexts, designed to help interaction designers retrieve interconnected pieces of knowledge and envision multiple medial relationships characterised by dynamic agency.

A usability test with students and designers, intended to test the system's proposed conceptual interaction and exploration logic of knowledge elements, provided insight into the need to design more thoughtful search interactions.

Sommario

Il paradigma Computers are Social Actors, stilato nel 1994 da Clifford Nass, professore di comunicazione a Stanford, afferma che le interazioni con i media sono sostanzialmente sociali: le regole sociali che le persone applicano alle interazioni con altre persone si applicano a loro volta alle interazioni con i computer, purché mostrino abbastanza indizi sociali da far sì che l'utente le consideri degne di una risposta sociale.

Al di là del fatto che le interazioni con la tecnologia siano realmente sociali, il paradigma affronta la questione dell'usabilità: poiché la prima interazione con un artefatto tecnologico è guidata da processi istintivi e intuitivi, è critico sfruttare la cognizione umana per praticare design antropocentrico.

Questa tesi adotta un approccio divergente alla raccolta e all'elaborazione della conoscenza, occupandosi di 161 pubblicazioni che indagano le interazioni con le tecnologie mediali in condizioni in cui esse possano essere percepite in modo simile agli umani.

Il metodo di ricerca è consistito nell'estrapolare nozioni e cognizioni e nel contestualizzarle geograficamente e storicamente per determinare come si sono evolute nel tempo e come si sono relazionate alle caratteristiche coeve di tecnologie, artefatti e contesti.

La riformulazione delle teorie ha rivelato limiti, implicazioni progettuali, incoerenze e definizioni correlate, tracciando una mappa di principi e contro-principi affrontati in casi di studio a base tecnologica e non, e portando alla luce un modello di interazione sociale che prescinde dalle caratteristiche dei media a livello fisico o materiale.

Il Media Agent Interaction Handbook è l'interfaccia di ricerca esplorativa proposta per supportare contesti problematici aperti, progettata per aiutare i progettisti dell'interazione a recuperare pillole di conoscenza interconnesse e a immaginare molteplici relazioni mediatiche caratterizzate da *agency* dinamica.

Un user testing con studenti e designer, progettato per testare l'interazione concettuale proposta dal sistema e la logica di esplorazione degli elementi di conoscenza, ha fornito indicazioni sulla necessità di progettare interazioni di ricerca più consapevoli.

Ringraziamenti

La stesura di questa tesi ha seguito un percorso tortuoso, è stata interrotta e ripresa più volte, vittima delle opportunità della vita che prendono il sopravvento ed eclissano il resto.

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Contents

The writing of this paper grew out of a desire to take a divergent approach to knowledge collection and elaboration, which led to the development of a **taxonomy** useful for informing interaction design.

The method consisted of collecting and categorising research material from 1992 to 2022 for a total of 161 publications investigating interactions with media technology, particularly under the conditions in which technologies could be perceived similarly to humans, namely as as social actors capable of agentic communication with a human user.

Specifically, each notion and cognition was extrapolated and contextualised geographically and historically in order to determine how it evolved over time and how it related to the coeval characteristics of technologies, artefacts, contexts, and customs.

A map of **principles** and **counter-principles** dealt with in technology-based and non-technology-based case studies was outlined, bringing to light a model of social interaction that prescinds from the specifics of media at the physical or material level.

In addition, the comparison and reframing of theories revealed limitations, design implications, inconsistencies and related definitions that have allowed knowledge gaps to be filled and produced a set of unified, universal, and ubiquitous **social interaction rules** that can form the basis for future research and analysis.

Why CASA?

The CASA paradigm states that individuals' interactions with media are fundamentally social. The social rules which people apply to everyday social interaction with other people equally apply to their interaction with computers, as long as they show enough cues to lead the person to categorise them as worthy of a social response (Nass, Steuer & Tauber, 1994).

CASA developed from Nass and Reeves' (1996) media equation, focusing more narrowly on interactions with digital technologies. The media equation defends the general theory that people attach human attributes to media, treating them as social actors (Gambino, 2020).

As of now, it is intriguing to be reminded of the use Nass made of his research: by observing successful and unsuccessful interactions with technology, he uncovered strategies for effective human relationships (Nass & Yen, 2012). However, similarly to how studying human-computer interaction can help to better understand human-human communication, it can help to envision more instinctive human-computer interactions referencing human cognition.

Assuming that the social cues a computer should manifest are words for output (Brown, 1988; Turkle, 1984), interactivity (Rafaeli, 1990), and the filling of roles traditionally filled by humans (Cooley, 1966; Mead, 1934), it is safe to suggest that for Nass and colleagues the treatment of computers as human is universal. Considering the technological limitations of the time in which the empirical studies were conducted, "computers" and "media" are theoretically limited terms mostly used to cluster, in a generalising lab environment, stationary computers with preprogrammed text-based or voice-based outputs.

Moreover, it is important to specify that for Nass and colleagues, as reported in the paper "Are People Polite to Computers? Responses to Computer-Based Interviewing Systems" (1996), the social cues a computer should manifest elicit different degrees of social responses regardless of the medium in which they are embedded.

01

Mindless Responses to Computers

This chapter discusses empirical studies conducted by Nass and colleagues that recreate experiments from social psychology and sociology studies, which led to the hypothesis that interactions with technological artefacts trigger mindless social responses in humans.

MINDFULNESS AND MINDLESSNESS
Langer, 1992

The first shot at explaining people's social responses was taken by **Ellen J. Langer** in the field of experimental social psychology. Langer highlighted the difference between mindful and mindless mechanisms, attributing the former to a state of conscious awareness characterised by active information processing, and the latter to automatic processing in which attention is reduced and behaviour is rule-governed. The mindlessness/mindfulness continuum extends to the field of human-computer interaction, as people associate social roles and produce expectations toward technologies with little to no conscious awareness (Langer, 1992).

THE CASA METHODOLOGY
Nass and Moon, 2000

Since Langer failed to diagnose when and why mindless behaviour would occur and when individuals would treat computers as tools instead, **Nass and Moon** (2000) elaborated on her theoretical work conducting empirical studies. Nass and colleagues' research methodology consisted of a series of experimentations drawn from social psychology and sociology studies. Specifically, they would pick a social science finding, change "human" to "computer" in the theory statement, and re-run the experiment to discover if the behavioural or attitudinal rule still applied (Nass et al., 1994). Additionally, all of their studies involved experienced computer users, whose perspective would not have been supposedly biased by the novelty of using a computer.

According to their findings, the interaction with a technological artefact triggers mindless social responses, specifically overusing human social categories, manifesting premature cognitive commitments, or engaging in overlearned social behaviours (Nass & Moon, 2000). Although the results will endorse the assumption that mindlessness fosters social responses to computers, mindlessness was not directly measured but solely presumed from the level of computer experience of the participants.

01.1
Overusing Social Categories

Overusing categories defines the process of extending to the computer field exclusively human social categories, including mindless societal group stereotyping. When a social category cue is captured, its interpretation generates a series of assumptions no matter the context in which it manifested.

YOU LOOK LIKE A PERSON WHO KNOWS ABOUT THIS
Nass et al., n/d

Researchers **Nass et al.** conducted an experiment in an attempt to study people's responses to gendered computer voices. References of that research can be found in the later book "The Man Who Lied to His Laptop" (2012), as the original paper remains unpublished. For this experiment, Nass and colleagues built an auction site that showcased a wide variety of stereotypically male and female items. Participants involved in the study could hear the audio description of each item by clicking on a link; the text was read aloud by a spokesperson, whose voice only varied in pitch. Half of the participants heard the descriptions read by a "female" voice, while the rest by a "male" voice.

When the gender of the spokesperson matched the stereotypical gender of the items, participants claimed to feel more persuaded to purchase: the female voice was perceived to be more effective in advertising stereotypically female products, and the male voice for stereotypically male products.

As a result, Nass and colleagues provided empirical evidence supporting the notion that being associated with a social group that stereotypically demonstrates specific knowledge or abilities consequently forms expectations concerning their competence (Nass & Moon, 2000).

01.2
Manifesting Premature Cognitive Commitments

Assuming a level of competence can make someone appear expert just by being labelled as such: **perceived expertise** (knowledgeability) and **trustworthiness** (dependability) combined determine the degree to which the agent is persuasive (Nass & Yen, 2012).

CAN ANYONE (AND ANYTHING) BE A SPECIALIST?
Nass et al., 1996

In 1996, researchers **Nass et al.** conducted an experiment to validate this proposition. The first step consisted of instructing half participants to watch news and comedy segments on a television labelled as "News and Entertainment TV," while the other half was told to enjoy news on a "News TV" and comedy segments on an "Entertainment TV." According to their results, participants in the specialist condition rated the "News TV" more relevant and the "Entertainment TV" more enjoyable compared to their generalist counterpart.

In a follow-up study, participants were required to watch news segments supposedly transmitted on different networks, varying from CNN to ABC and CBS. Again, people considered the content coming from news-only networks to be more accurate and significant.

These experiments suggest that just by being labelled a specialist a source can be perceived as more compelling, no matter how complimentary the label itself is. However, **Dourish** (1996) questioned whether these results justified their conclusion, as he suspected that the experiment appeared to disclose more about American broadcast television than people's responses to technology.

Rapidly assessing the credibility of a medium can derive from mindlessly drawing conclusions after a single exposure, namely demonstrating what Langer called a **premature cognitive commitment**.

PREMATURE COGNITIVE COMMITMENTS OR THIN-SLICES OF BEHAVIOUR?

It is curious to mention that in the later publication "The Man Who Lied to His Laptop," which collects the empirical studies conducted up to that time by the same authors, Nass and Yen (2012) failed to retrieve Langer's definition but rather acknowledged another phenomenon, namely thin-slices of behaviour, to validate rapid assumptions after a single exposure.

Thin-slices of behaviour were discovered in 1992 by **Nalini Ambady** and **Robert Rosenthal**, and are rapidly assessed and strongly held impressions after a very short interaction upon which people establish judgements about others. These assessments are exceedingly connected to familiarity and rely on automated basic cognitive processing.

SIMILARITY-ATTRACTION EFFECT

Langer's definition has also been used by **Nass and Moon** (2000) to validate the role played by **personality** within social interaction. With regard to personality, **the rule of similarity-attraction applies**: people are likely to attribute positive characteristics to those who share personality traits with them. According to their findings, people tend to overextend the concept of shared genes to all types of similarities in their interaction with technology, just like they supposedly do with social rules. For this reason, the similarity-attraction rule applies to **matching emotional states** as well.

MISMATCHES

Aversion and poor performance supposedly arise if active and passive perspectives or positive and negative states are mismatched. Specifically, mismatches provoke destabilising reactions as a result of the cognitive work it requires to solve the inconsistency and to process its meaning. Opposing emotional information or personality manifestations can be linked to untrustworthiness and therefore cause a sense of disturbance (Nass & Yen, 2012).

THE EFFECT OF EMOTION AROUSAL ON BLAME ATTRIBUTION

Nass and Yoo, n/d

To explore the effects of emotion arousal on blame attribution, **Nass and Yoo** conducted an unpublished study whose reference can be retrieved in the book "The Man Who Lied to His Laptop" (2012). In a driving simulator, participants were joined by a robot tour guide whose role was to make comments and provide indications.

Figure 1
Professor Clifford Nass at the Communication Between Humans and Interactive Media Lab (2008)

Prior to operating the simulator, participants' emotional state was manipulated by having them watch videos in order to obtain variations of arousal, namely anger or melancholy. During the test, four hazards were planned so that the robot could engage with the drivers. After each obstacle, the tour guide would empathise revealing either an action-oriented approach or a passive approach to angry and melancholic participants. Action-oriented empathy blamed a person or a source that could be managed or changed, while passive-oriented empathy relied on more deterministic theories of causality.

According to their results, angry and melancholic people profited from different kinds of emotional support: angry participants treated with action-oriented empathy believed the tour guide to be more welcoming and trustworthy, while melancholic people managed by a passive approach thought that the tour guide was more supporting and acknowledging. Moreover, both sides improved their driving behaviours.

01.3
Overlearning

The final mindless social response cited by **Nass and Moon** (2000) is **overlearning**. Overlearning indicates the process of applying to the interaction with technology deeply rooted behavioural patterns, resulting from repeated exposures. Overlearning includes politeness, reciprocity and self-disclosure.

Nass confronted the manifestations of the **social desirability bias** found in social psychology literature. This phenomenon has two main manifestations, one being the normative response bias, in which the mere presence of the interviewer generates an inhibition, and the other being the interviewer-based bias, in which interviewees are likely to alter their answers according to the perceived predilection of the interviewer (Martin & Nagao, 1989). Hence, when an individual is asked to evaluate someone else's performance vis-à-vis, his responses are likely to be positively biased.

ARE PEOPLE POLITE TO COMPUTERS?
Nass et al., 1996

To validate the attribution of politeness norms to the interaction with computers, **Nass et al.** (1996) conducted an experiment in which the arranged conditions required participants to evaluate the performance of a computer.

Specifically, participants were asked to work with a computer that performed a task: in the first condition, the interview about the computer's performance was attended by the computer itself; in the second condition, it moved to a paper-and-pencil questionnaire, and in the third condition it was administered by a different computer in another room. In a follow-up study, Nass and colleagues investigated if the information output altered the social desirability effect, and therefore shifted the medium from text-based to voice-based.

Consistent with their prediction, in both studies participants provided more positive evaluations when the computer asked about its own performance, regardless of whether the output was text-based or voice-based.

PUSHING RECIPROCITY TO THE LIMITS
Moon, 2000

With the aim of investigating to what extent the persuasive power of computers could induce participants to reveal highly personal information, **Moon** (2000) conducted a study on **self-disclosure**. Specifically, she arranged two conditions: for half of the participants the computer prompted responses in a direct manner, while for the remaining half it would disclose information about itself first.

In order to ascertain which computer was more successful in eliciting personal information, Moon counted the number of self-disclosures, measured the length of the answers and involved two independent external judges.

According to the results, the computer that first disclosed personal information persuaded participants to reveal more private details, therefore validating the attribution of self-disclosure norms to the interaction with technology.

CAN A COMPUTER SAY, YOU OWE ME ONE?
Nass and Fogg, 1997

Lastly, the rule of **reciprocity** implies obligation to return the favour. In 1997, **Nass and Fogg** examined whether the behavioural rule still applied after a computer had provided help, and therefore conducted an experiment inspired by the desert survival exercise.

First, participants would use a computer to retrieve information about the items they needed to bring with them, listing them by importance. Then, the computer would ask for the participants' help to build a colour palette suitable to human perception. According to the computer's instructions, the greater the number of associations the more helpful the person was to the computer. Half of the participants performed the colour palette exercise on the same computer used for the desert survival situation research, while the other half utilised a different computer.

Their results showed that those who used the same computer for both tasks were keener to help building a more accurate colour palette, made double the comparisons and performed fewer mistakes than those who switched computers mid-experiment.

In a follow-up study, **Nass and Fogg** investigated what would have happened if the computer was unhelpful in the first task, and discovered **revenge** as opposing to reciprocity.

CULTURE CALAMITY?
Katagiri et al., 2001

Apparently, reciprocity was the only behavioural rule to be investigated **cross-culturally**. In 2001, it began to be apparent that the increasing growth of the Internet had simplified cross-national interactions, and cross-national differences had become more relevant (Katagiri et al., 2001).

Katagiri et al. re-run the experiment after having discovered a key differentiator: Japanese societies are collectivist while American society is individualist. To make up for the group-oriented perspective, the researchers added two conditions in which the two parties were computers associated to different brands. As a result, participants working on a computer whose family differenced from the first were more reluctant to help it.

Determining that computers are culturally embedded actors marks an exciting turning point in HCI research: the adoption of a dynamic perspective that accounts for cultural factors, increasing observation scale, and expanding diversity of the actors involved, it conveys how crucial it is not to generalise the context in which social behaviour arises.

01.4
Design Implications

The Computers are Social Actors paradigm is still relevant to scholars as it relies on users' existing mental models applied to offline social interactions (Gambino, 2020).

Whether interactions with technology are genuinely social, the paradigm addresses the pertinent issue of usability, which refers to the quality of a user's experience in the interaction with products and systems, deriving from straightforward and intuitive understanding of its functioning. As stated by Langer (1992), a first impression can become a last impression if the initial information is absorbed mindlessly; as the first interaction with an agent is driven by instinctive and intuitive processes, it is critical to leverage human cognition to practice anthropocentric design.

Because the studies were proven valid using computers whose output was mostly text- and voice-based, Nass and colleagues provided evidence to support the notion that it is not necessary to achieve a high level of photorealism to produce social responses (Nass et al., 1994).

As highlighted in the previous section, when opposing emotional information or personality manifestations are displayed, a sense of disturbance is generated (Nass & Yen, 2012). However, aversion can surface also if there are **perceptual mismatches** between different appearance dimensions in robots, despite the fact that they show a low or moderate correspondence with humans (Kim et al., 2020).

THE UNCANNY VALLEY
Mori, 1970

The original hypothesis known as the **Uncanny Valley** (Mori, 1970) refers to shifts in emotional responses toward robotic agents with varying degrees of human-likeliness. Specifically, the theory suggests that the observer's emotional response to the robot becomes increasingly positive as its appearance looks like that of humans, until it reaches a point beyond which the response becomes strong uneasiness and aversion.

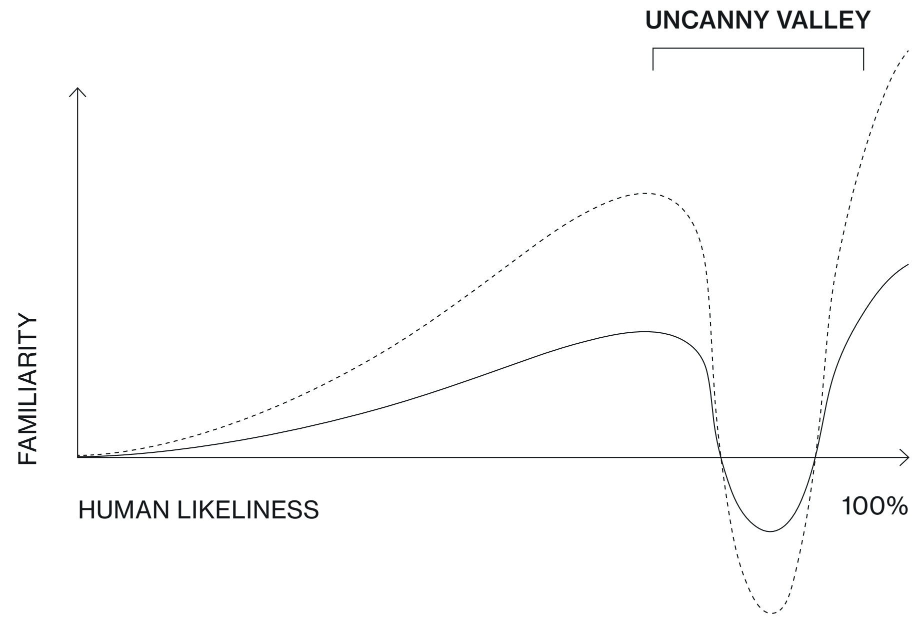


Figure 2
Hypothesised emotional response of subjects plotted against anthropomorphism of a robot, following Mori's statements (2007)

THE UNCANNY VALLEY AND THE MEDIA EQUATION
Reuten et al., 2018

The Uncanny Valley hypothesis has also been confirmed in conjunction with the Media Equation in a 2018 experimental Dutch study, which involved the measuring of physiological responses, namely, pupillometry, while showing pictures of basic emotion-expressing robotic and human faces (Reuten et al., 2018). The results showed that similar pupil response patterns were obtained for both human and robotic agents on the human-likeliness continuum.

IS THERE A SECOND UNCANNY VALLEY?
Kim et al., 2020

In 2020, researchers **Kim et al.** investigated the presence of the Uncanny Valley using Anthropomorphic roBOT(ABOT), the largest existing database of full-body robot images.

The researchers collected the responses of 78 participants, who were instructed to rate the images according to their degree of human-likeness and uncanniness. Their results suggested the existence of a second **smaller uncanny valley**, observed when robots were located in the first third of the spectrum, that is when they showed moderate resemblance with humans. Essentially, whether there are perceptual mismatches, independently from the level of human-likeliness, people may perceive robotic agents as uncanny.

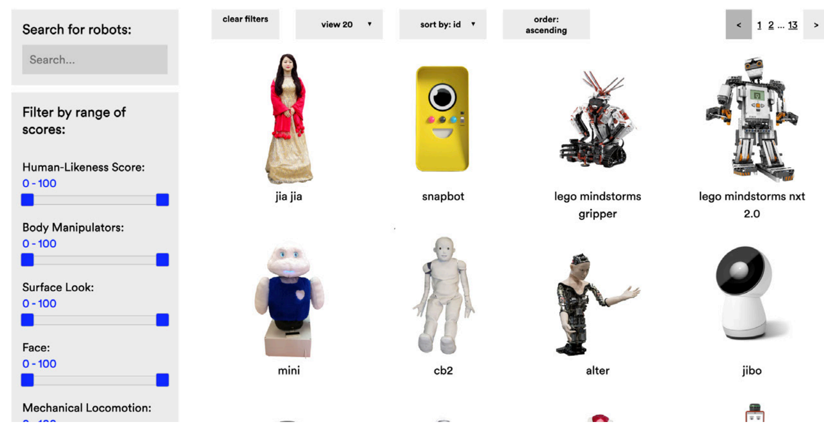


Figure 3
The Anthropomorphic roBOT(ABOT) database

Summary

Nass et al.'s empirical studies were conducted by recreating a series of experiments drawn from studies in social psychology and sociology, which led them to the hypothesis that interactions with technological artefacts trigger mindless social responses in humans. Specifically, people overuse social categories, manifest premature cognitive commitments, or engage in overlearned social behaviours (Nass & Moon, 2000).

First, their findings led them to the conclusion that **social group stereotyping** also applies to interactions with technology; specifically, being associated with a social group that stereotypically manifests certain competencies generates similar expectations (Nass & Moon, 2000).

Second, researchers have argued that perceived **expertise** and **trustworthiness** determine the degree to which an agent is **persuasive** (Nass & Yen, 2012), suggesting that something as simple as being labelled a specialist can make it seem more compelling.

Drawing on the **similarity-attraction paradigm**, the concept of shared genes applies to all types of similarities in people's interaction with technology, including emotional states and personality traits.

Following Nass et al.'s conclusions, low-budget representations of agents that show enough cues to be categorised as social actors can still be worthy of a social response; likewise, a common direction in the design community is to intentionally keep the human-likeliness of robots low to avoid uncanny feelings (Kim et al., 2020).

However, the discovery of the second valley implies more nuanced recommendations that will likely depend on the avoidance of personality, emotion, perspective, action-consistency and appearance mismatches.

Finally, the attribution of **reciprocity** and **self-disclosure** rules were validated for interaction with technology. However, the reciprocity rule manifested different dynamics when applied to cross-cultural study groups, resulting in the need to account for more diverse perspectives and suggesting that computers are culturally embedded actors.

In fact, accounting for cultural factors, increasing observation scale, and expanding diversity of the actors involved, it raises the issue of the importance of **inclusivity** in design. Designers should be mindful of ascertaining how the characteristics of technology imply culturally reliant social norms, and testing prototypes with multiple cultures in order to get rid of the Eurocentric approach (Katagiri et al., 2001).

Glossary

MINDFULNESS	A state of conscious awareness characterised by active information processing (Langer, 1992).
MINDLESSNESS	A state of automatic processing in which attention is reduced and behaviour is rule-governed (Langer, 1992).
OVERUSING	The process of extending to the computer field exclusively human social categories (Nass and Moon, 2000).
PREMATURE COGNITIVE COMMITMENTS	The act of mindlessly drawing conclusions after a single exposure (Nass and Moon, 2000).
OVERLEARNING	The process of applying to the interaction with technology deeply rooted behavioural patterns, resulting from repeated exposures (Nass and Moon, 2000).
UNCANNY VALLEY	The phenomenon by which a digitally generated figure or humanoid robot that has an almost identical likeness to human beings elicits a sense of discomfort or revulsion in the person who sees it (Mori, 1970).

01.5
Limitations

While supporting the validity of the results, Nass and colleagues' empirical approach reveals evident shortcomings. As mentioned at the end of the previous paragraph, it is pivotal to account for **contextual factors**. From artificial experiments derive artificial generalisations of real-world settings, which are independent of culture and individual characteristics of users. Being reciprocity the only rule that was tested cross-culturally, it defines the US researchers tendency to ignore the cultural dependency of their findings (Dourish, 1996).

PEOPLE ARE NOT POLITE TOWARD SMALL COMPUTERS

Goldstein et al., 2002

Goldstein et al. (2002) also raised an issue concerning the specific experimental methodology employed: objective performance and subjective attitude were handled as reciprocally independent dimensions, meaning that it is unclear whether respondents were unconsciously judging their own conduct with the computer rather than the performance of the computer itself.

Following Goldstein et al., the Media Equation does not alway apply. The Swedish researchers repeated Nass et al.'s empirical study of social desirability bias to investigate whether politeness rules still applied to smaller devices, particularly Personal Digital Assistants (PDAs). In their version of the experiment, they involved users without prior experience with a PDA. Also, the questioning source was always a pen-and-paper evaluation questionnaire, which had to be completed either in the presence or absence of the PDA.

According to their results, the effects of politeness did not spread outside of the physical boundaries of the device, and the method of using a paper-and-pen evaluation questionnaire discharged the experiment of any politeness bias.

THE CASA PARADIGM LACKS SPECIFICITY

The conclusions derived from the experiments lack explicit recommendations and proposals for future researchers to test and refine, leaving the assumptions open to interpretation.

As mentioned above, the umbrella terms "computers" and "media" are used interchangeably and refer to stationary computers delivering preprogrammed text-based or voice-based outputs. Given the limited technology of the time, social responses are said to be evoked regardless of the characteristics of the medium. However, today in computer-mediated communication and computer-generated communication, as well as in human-computer interaction and human-robot interaction, there is a wide range of media that allow for more frequent indicators of sociability.

Ultimately, there are no references concerning what represents enough social cues, what specific dimensions of computers will either encourage or discourage mindless social responses, or whether the relationship between human-likeliness and social responses is linear (Nass & Moon, 2000).

01.6

The Rejection of Alternative Explanations and Anthropomorphism Hypotheses

THE REJECTION OF ALTERNATIVE EXPLANATIONS
Nass and Moon, 2000

Nass and Moon (2000) argued that alternative explanations for mindless responses do not support the evidence of their studies. According to the researchers, for people to consciously apply social rules to computers, they must: address a programmer behind the computer, willingly suspend disbelief, or mistakenly believe that computers deserve humane treatment.

First, the programmer scenario was ruled out because, when interviewed, participants explicitly denied attributing sourcing to a human entity behind the computer screen.

Determining whether technology is perceived as a source rather than a medium has been a focus of attention in HCI research (Guzman, 2019); over time, researchers have confirmed that people react to technology itself compared to a human operator (Hoffmann et al., 2009; Srinivasan & Takayama, 2016; Straub et al., 2010; Sundar & Nass, 2000), differentiate between computerised voices (Sundar & Nass, 2000), and identify humans and technologies as different interlocutors (Eckles et al., 2009; Shechtman & Horowitz, 2003).

Second, suspension of disbelief was also discarded because participants were not confronted with highly complex modes of input that could lead them to believe they were supposed to pretend to be in a social situation; specifically, computers did not use self-referenced terms or other identifying features.

Lastly, Nass and colleagues had been rejecting the anthropomorphisation hypothesis, stating that being a highly conscious and identifiable mechanism, it could not have been used to justify participants' social response to computers.

Their studies involved **experienced computer users** whose perspective could not have been biased by the newness of the experience; also, participants pointedly refuted to attribute human-like characteristics to technology, however much they acted socially towards it.

WHAT IS ANTHROPOMORPHISM?

Anthropomorphism is an active phenomenon, namely "the tendency to imbue the real or imagined behaviour of non-human agents, e.g., animals, nature, gods, and mechanical or electronic devices, with human-like characteristics, motivations, intentions, or emotions" (Epley et al., 2007).

Nass et al. preferred to use the term "**ethopoeia**," which involves directly responding socially to an entity while acknowledging that it does not condone human treatment (Nass et al., 1993).

However, **Wang** (2017) argued that the research method of substituting humans for computers in their propositions, along with the practice of implementing personality into computers, were in effect an attempt at anthropomorphisation. Likewise, **Jakub et al**. (2018) suggested that although the term "ethopoeia" precisely defined human behaviour, it did not account for why the same behaviour occurred.

DOES CONSCIOUS ANTHROPOMORPHISM EXIST?
Kim and Sundar, 2012

Nass and Moon (2000) established that social responses toward technology can only be driven by mindless processes. In the following years, one direction that anthropomorphism research has taken in relation to the CASA paradigm has involved attempting to answer why mindless behaviour occurs and whether mindful behaviour might occur instead. Specifically, **Kim and Sundar** (2012) investigated whether the user propensity to treat computers in a human-like fashion is conscious or non-conscious.

Their research was an effort to expand Sundar's (2008) **MAIN model**, which consolidated a set of guidelines for identifying affordances across media to determine their credibility. According to the MAIN model, as it will be seen below, most digital media convey to some extent the technological affordances of Modality (M), Agency (A), Interactivity (I), and Navigability (N).

In their 2012 study, the researchers manipulated the variables of **interactivity** (Sundar, 2008) and **human-likeliness** of a health website in order to explore whether they would suit as anthropomorphic cues to induce mindful or mindless attributions in human terms.

Ninety-three undergraduate students were recruited and assigned to a high-interactivity or low-interactivity condition; the former website provided a high number of call-to-actions, while the latter a simpler flow. Across conditions, only differed the degrees of interactivity and the presence or absence of a human-like virtual agent. At the end of the task, a questionnaire required participants to indicate the perceived anthropomorphism, sense of social presence and credibility of the information provided.

According to their results, participants exposed to the human-like agent perceived less human-likeliness than those who were not, and there were no significant differences between the high- and low-interactivity conditions. Moreover, participants who were assigned the high interactivity condition and the virtual agent denied treating the website in a human-like fashion. However, the same participants attributed more intimate features to the website as opposing to those who were in the agent absent/low-interactivity condition.

Despite the initial hypothesis that supported the existence of conscious anthropomorphic attributions, Kim and Sundar's (2012) findings supported Nass and Moon's (2000) that as much as people deny treating computers humanely, they apply mindless social rules on perceiving anthropomorphic cues.

Following Nass et al.'s conclusions, as well as Kim and Sundar's (2012), basic representations of agents showing enough cues to be categorised as social actors can still be worthy of a social response. In Sundar's case, the degree of interactivity and the human-like virtual agent were sufficient to trigger human-like attributions with positive outcomes.

THE MODEL OF DUAL ANTHROPOMORPHISM
Jakub et al., 2018

Jakub et al. (2018) were the first researchers to address how Type 1 and Type 2 processing could have been involved in anthropomorphising robotic agents, and outlined the model of dual anthropomorphism to demonstrate that behaviour.

Following Evans and Stanovich (2013) research, **Type 1** is a rapid and independent cognitive process that does not require working memory and results in spontaneous and biased responses, while **Type 2** is a slower and serial cognitive process that requires working memory and motivation and results in normative and regulated responses.

According to Jakub et al. (2018), Type 1 and Type 2 processes are responsible for the induction of implicit and explicit anthropomorphic attributions, respectively. In their task performance experiment, participants' motivation levels were manipulated in order to obtain high- and low-motivation conditions; specifically, people were either told that their responses would need a follow-up explanation or that they would be kept anonymous.

Despite the questionability of their research hypothesis that led to statistically insignificant differences in outcomes, the researchers have argued that the **dual anthropomorphism model** could be used to explain why people report implicit anthropomorphism when they are not required to engage in conscious cognitive processes, conducing to the assumption that the social treatment of technology reflects implicit anthropomorphism (Jakub et al., 2018).

MINDFUL AND MINDLESS ANTHROPOMORPHISM
Lombard and Xu, 2021

In 2021, a similar approach has been adopted by **Lombard and Xu**, who expanded the concepts of mindless and mindful anthropomorphism. According to the researchers, **mindless anthropomorphism** presumably occurs when media incorporate social cues of high quality and quantity, yet media need not display social cues to be perceived as a source of social interaction. For instance, **mindful anthropomorphism** justifies scenarios in which people perceive high social presence when media do not exhibit strong social cues, leading to the assumption that individuals also consciously attribute human characteristics to technologies.

INTERPERSONAL VARIATION AND ANTHROPOMORPHIC ASSOCIATIONS
Goldstein et al., 2002

Nevertheless, in 2011 **Fischer** conducted a study to investigate whether individual variables influenced the perception of a robot as a social actor.

According to his results, participants made distinct and recurrent language choices when greeting the robot based on their understanding and the requirements of the interaction. It has been argued that mindlessness is neither biological nor evolutionary, but depends on individual and cultural factors (Fischer, 2011), leading to the hypothesis that reacting to a robot's greeting is not mindless behaviour but part of a more elaborate mental model of the robot.

In this interpretation of his findings, HR verbal interaction is consistent with human-human communication in situations where language choices must be made to facilitate conversation, such as when interacting with foreigners (Fischer, 2011).

However, Fischer also questioned whether his findings could be attributed to different types of anthropomorphism, which could account for subconscious, involuntary, and mindless responses in the moment, and which could be moderated by more conscious expectations about the communication partner.

FORM AND BEHAVIOURAL ANTHROPOMORPHISM
Gambino et al., 2020

In addition to the distinction between mindful and mindless anthropomorphism, the available literature has also argued for the existence of two objective anthropomorphic qualities, namely form and behaviour.

Form anthropomorphism, also referred to as visual anthropomorphism, describes the extent to which an entity exhibits a human-like appearance; form anthropomorphism has found broad support from research, which motivated researchers to achieve a human-like appearance of agents and robots to increase the likelihood of positive responses.

Behavioural anthropomorphism, on the other hand, refers to the extent to which an entity behaves in a human-like manner, and its perception is more subtle as there is no explicit human representation (Gambino et al., 2020).

Summary

As much as **Nass and Moon** (2000) rejected the anthropomorphism hypothesis to justify mindless behaviour, later researchers have argued for the existence of a **dual anthropomorphic association** that is based on explicit and implicit cognitive processing geared to support both conscious and unconscious social treatment of technology.

First, mindful anthropomorphic attributions derive from slower, regulated cognitive processes driven by motivation, leading to willing treatment of technology in a social manner; for example, this is true for scenarios in which children imagine their toys talking to each other or assign names to objects. Second, mindless anthropomorphic attributions occur in relation to spontaneous cognitive processes and are the reason why people react socially toward technologies as much as they deny doing so.

However, because interpersonal differences define people's preconceptions about technology, interactions with technology, and the very goals of interaction, it can be argued that mindlessness is not a constant but rather a variable in the interpretation of technology as social.

Moreover, although research has primarily focused on achieving human-like appearances of agents and robots to increase the likelihood of positive responses, recently light has been shed on the impact that **anthropomorphic system behaviours** and actions have on user acceptance (Jensen et al., 2020).

Also, recent technological advances have increased the ability to create media that is more anthropomorphic in the way it behaves and appears (Gambino et al., 2020).

Consistent with the relevance of behavioural anthropomorphism, Nass et al. (1994) suggested that low-budget representations of agents that show enough cues to be categorised as social actors can still be worthy of a social response.

According to Miller (2002), successful anthropomorphic agents should manifest appropriate communication patters that model user expectations of acceptable behaviours and interactions with the system.

However, since interaction patterns and cognitive styles are **culturally dependent** (Katagiri et al., 2001), acceptance of anthropomorphism is unlikely to be universal, and unattractive anthropomorphic agents could have a detrimental effect on HCI and the tasks they are designed to support.

Specifically, **aversion** to socially embedded agents may arise regardless of their level of human verisimilitude; indeed, whether there are mismatches (Kim et al., 2020) in perception, perspective, or emotional state, more nuanced recommendations should be forwarded to designers seeking more positive user reactions.

Glossary

ANTHROPOMORPHISM	The tendency to imbue the real or imagined behaviour of non-human agents with human-like characteristics, motivations, intentions, or emotions (Epley et al., 2007).
DUAL ANTHROPOMORPHISM MODEL	The theory by which Type 1 and Type 2 processes are responsible for the induction of implicit and explicit anthropomorphic attributions (Jakub et al., 2018).
MINDFUL ANTHROPOMORPHISM	The process occurring when people perceive high social presence but media do not exhibit strong social cue (Lombard and Xu, 2021).
MINDLESS ANTHROPOMORPHISM	The process occurring when media incorporate social cues of high quality and quantity (Lombard and Xu, 2021).
FORM ANTHROPOMORPHISM	The extent to which an entity exhibits a human-like appearance (Gambino et al., 2020).
BEHAVIOURAL ANTHROPOMORPHISM	The extent to which an entity behaves in a human-like manner (Gambino et al., 2020).

01.7
Notes of Caution on Anthropomorphism

ANTHROPOMORPHISM EFFECTS ON TRUST AND CREDIBILITY
Jensen et al., 2020

The significance of behavioural anthropomorphism has raised questions regarding the relationship between **trust** and anthropomorphism. While it is often assumed that anthropomorphism positively influences trust, it was found in previous sections that too much anthropomorphism or mismatching detections can undermine positive acceptance of technology.

In 2020, **Jensen et al.** investigated whether the appropriateness of trust is affected by subtly human system behaviours and features (behavioural anthropomorphism) with respect to system reliability.

According to the researchers, it is critical to promote trust calibration for safer and more effective interactions with technology; for this reason, they conducted an experiment to explore how participants would calibrate their trust with an error-prone automated system, whose reliability was calculated as the percentage of tasks performed correctly.

The study envisioned conditions of machinelike versus human-like communication and low versus high reliability. During the experiment, participants were asked to say how willing they were to listen to the computer's suggestions despite the risk of inaccuracy; then, a subsequent feedback page reported either social pleasantries to elicit human qualities or minimal, aseptic information.

According to their findings, communication style and reliability influenced perceptions of anthropomorphism and trustworthiness. Participants in the low and high reliability conditions demonstrated over-trust and under-trust, respectively, although their trust was gradually calibrated over the course of the experiment.

Moreover, anthropomorphism was found to be a relatively dynamic perception with respect to an entity, with the premise of further exploring whether its perceptions would change with familiarity.

Finally, researchers discovered that only the reliability of the system influenced participants' trust appropriateness, although the more accurate system was perceived as more human-like, and the human-like communication style resulted in the machine being perceived as more benevolent than the machine-like communication style.

In conclusion, the research of Jensen et al.'s (2020) further contributed to the knowledge that anthropomorphism is dynamic, and its perceptions could be drawn from how a system acts, rather than how it looks, validating the relevance of behavioural anthropomorphism.

ACTION-CONSISTENT EMOTIONS AND TRUST
Antos et al., 2011

As stated by Nass and Yen (2012), opposing emotional information may be associated with lack of trustworthiness, a notion that has also been previously supported by **Antos et al.** (2011) who found that emotions consistent with actions are linked to greater perceived trust in agents, resulting in a desire to repeat interactions.

In their study, action-consistent emotions were described as emotions that emphasise characteristics manifested by the agent during various strategy-based tasks.

Furthermore, trust can be attributed to agents that are designed to represent human reasoning and motivations. However, it plays a complex role in the interactions a user has with other humans or with aspects of an interface or system. Feelings toward an anthropomorphic agent influence the mental model people construct of it, inevitably leading to uncalibrated appropriateness of trust as it is based on emotional connections rather than the reliability of the system (Culley & Madhavan, 2013).

As seen with Jensen et al. (2020), it is critical to promote trust calibration for safer and more effective interactions with technology, and if a system's trustworthiness is directly affected by its reliability, its manifestation of anthropomorphic behaviours connects with the user's emotionality.

In conclusion, anthropomorphism is a dynamic and biologically and evolutionarily biased concept that evolves with technological advances, individual disposition, contextual factors, and tasks to be performed, the application of which will strongly determine people's acceptance and social treatment of technology.

01.8
How to Assess Anthropomorphic Attributions

THE GODSPEED QUESTIONNAIRE
Bartneck et al., 2009

In all studies reviewed, participants' attitudes were recorded using self-report questionnaires designed to classify them according to their defining characteristics.

The Godspeed questionnaire was designed in 2009 by **Bartneck et al.** to help roboticists in their development journey and aims to measure users' perceptions of robots. Their research attempted to initiate the development of **standardised measurement tools** for human-robot interactions and focused on the concepts of anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety as starting points for the proposal of five questionnaires to be scored on a 5-point semantic differential scale.

1. The explored qualities of **anthropomorphism** are: Fake/Natural, Machinelike/Human-like, Unconscious/Conscious, Artificial/Lifelike, and Moving rigidly/Moving elegantly.
2. The explored qualities of **animacy** are: Dead/Alive, Stagnant/Lively, Mechanical/Organic, Artificial/Lifelike, Inert/Interactive, Apathetic/Responsive.
3. The explored qualities of **likeability** are: Dislike/Competent, Unfriendly/Friendly, Unkind/Kind, Unpleasant/Pleasant, and Awful/Nice.
4. The explored qualities of **perceived intelligence** are: Ignorant/Knowledgeable, Irresponsible/Responsible, Unintelligent/Intelligent, Foolish/Sensible.
5. The explored qualities of **perceived safety** are: Anxious/Relaxed, Agitated/Calm, Quiescent/Surprised.

In cases where the investigated system lacked physical embodiment, some elements were removed from the report, or new elements were developed to meet the research questions, as in the case of Jensen et al. (2020) with perceived behavioural anthropomorphism (PBA).

THE INDIVIDUAL DIFFERENCES IN ANTHROPOMORPHISM QUESTIONNAIRE (IDAQ)

Waytz et al., 2010

The Individual Differences in Anthropomorphism Questionnaire (IDAQ) was developed by **Waytz et al.** in 2010 to predict individual tendencies in agent anthropomorphisation, which presumably arise from differences in culture, norms, experience, education, cognitive reasoning styles, and attachment to human and non-human agents (Epley et al., 2007).

The questionnaire was constructed on the identification of classes of commonly anthropomorphised agents (non-human animals, natural entities, spiritual agents, and technological devices), associating five anthropomorphic and five non-anthropomorphic traits with each class. Non-anthropomorphic traits consisted of qualities related to observable or functional features, such as durability, usefulness, beauty, activeness, or lethargy, and were introduced to dissociate anthropomorphism from dispositional attribution.

02

Expansions of CASA

Since the CASA paradigm, numerous variables have been introduced that have the power to change the way people interact with media. This chapter covers the importance of motivational and circumstantial factors in determining people's social responses to computers.

The CASA paradigm and the Media Equation were published at a time when technologies were still functionally limited. In particular, human-computer interactions were rare and social affordances scarce compared to the current media landscape.

As previously mentioned, the framework is still relevant to scholars striving to create technological artefacts that reflect people's perceptions of offline social interaction (Gambino et al., 2020). Nevertheless, numerous variables have been introduced that have the power to change the way people interact with media.

02.1

Contextual Relevance

TECHNOLOGY ADOPTION IN PRIVATE HOUSEHOLDS

Firstly, computational technologies have become increasingly part of people's day-to-day lives around the world over the past 30 years. Specifically, in 2019 nearly **80% of private households** worldwide had a **computer** while, in developing countries, the PC penetration rate was about one-third lower.

In general, the percentage of households with a computer had been consistently rising around the world as computer use and Internet access were becoming more widespread (Alsop, 2021).

As of January 2021, **59.5%** of the global population was **active on the Internet**, including **96%** via **mobile devices** (Johnson, 2021). Moreover, it is estimated that the **global smartphone penetration** rate had reached **78.05%** in 2020 (O'Dea, 2021).

TECHNOLOGY ADOPTION IN THE WORKPLACE

As they adopt new technologies, most organisations will benefit from improved performance, better products, and higher productivity.

These advances correspond to increments in educational attainment and number of jobs in the IT sector: according to the Global Gender Gap Report 2020, **88%** of **females** and **91%** of **males** received **primary education** (Szmigiera, 2021); finally, as of January 2020, there were **3 million** employees in the US **IT sector**, compared to 1 million in 2019 (Mlitz, 2021).

Technological innovations have expanded the modalities of interaction and created new opportunities for their implementation in households and workplaces. The increasing frequency of interaction and familiarity with technology changed the way people interact with technology itself, adding **layers of complexity** to the original CASA paradigm (Gambino et al., 2020).

02.2

Individual Differences and Context of Exposure

PERSONALITY, DEMOGRAPHICS, AND KNOWLEDGE OF AND EXPERIENCE WITH TECHNOLOGY
Waytz et al., 2010

From their earliest experimentations, **Nass et al.** have discussed the importance of motivational and individual factors.

Specifically, complementary or similar aspects in **personalities**, as well as **demographics** (e.g., education level) and **knowledge** of and **experience** with **technology** (Nass et al., 1995) have been shown to be pivotal factors influencing social responses to computers.

For instance, in 1995 Nass et al. conducted an experiment focused on the dominance/submissiveness dimension of interpersonal behaviour; specifically, they investigated whether personality markers in computers were sufficient to create a personality that was strong enough to drive participants to identify with it.

The first computer was manipulated to demonstrate a dominant personality, characterised by strong language expressed in the form of assertions and commands; the submissive computer, on the other hand, used weaker language expressed in the form of questions and suggestions. Participants, also classified as dominant or submissive based on their responses to a personality test, were asked to collaborate with one of the two computers on a task.

According to their results, the computer received higher affiliation and competence rates when it matched the participants' personality, regardless of whether it was dominant or submissive.

THE SEEK MODEL
Epley et al., 2007

Next, **social disposition** was found to be a critical factor influencing people's attachment toward technology.

In order to systematically classify the rationale according to which people anthropomorphise a non-human agent, in 2007 **Epley et al.** proposed the **three-determinant model SEEK** (Sociality, Effectance, and Elicited agent Knowledge).

As a particular type of inductive inference, they argued that three determinants work together to increase or decrease the extent to which a person anthropomorphises non-human agents: specifically, to activate knowledge about humans both chronically and situationally, to increase the perceived predictability of a non-human object, or to satisfy their need to establish social interactions. Each psychological factor includes independent variables that are **dispositional** (stable individual differences), **situational** (transitory circumstantial aspects), developmental, and **cultural** (factors across time and space).

SOCIAL DISPOSITION
Wang, 2017

Sociality motivations steer anthropomorphism by raising accessibility of the non-human agent's social cues, thus motivating people to actively seek out sources of social interaction (Epley et al., 2007). Building on this assumption, **Wang** (2017) investigated whether users' social dispositions were associated with smartphone anthropomorphisation.

Specifically, the factors he considered were: **chronic loneliness** (aka a long-term feeling of detachment) which defines how people interact in social contexts; **attachment style**, which describes how people behave in intimate relationships; and **cultural orientation**, considered not only from the perspective of the collectivism/individualism relationship

(Katagiri et al., 2001) but also as a personal disposition. For his study, Wang distributed an online questionnaire that, among social dispositional factors, investigated respondents' dependence on technology use and its frequency.

According to his results, social disposition had a great influence on the assessment of anthropomorphism. Specifically, chronic loneliness and attachment styles resulted in stronger innate motivation to respond socially to technology; additionally, anthropomorphism was found to be culturally determined.

Different levels of anthropomorphism were reported in racial groups with different social dispositions, implying the need to research which cultural aspects are determinants of attitudes, motivations, or behaviours (e.g., whether individuals of the same age have similar anthropomorphic inclinations due to similar access to technology).

PREDISPOSITION TO ANALYTICAL THINKING
Lee, 2010

Further research demonstrated that **individual predisposition** and **cognitive task requirements** influence people's social response toward technology. Specifically, in 2010 Lee investigated whether people's predisposition to engage in rational thinking, relative to exposure to different degrees of human-likeness and different situational demands on cognitive resources, resulted in weaker or stronger social responses.

In his study, high-rationals were identified as highly motivated individuals who were apparently more likely to perform better on cognitively demanding tasks.

Expanding on the empirical studies conducted by Nass and Fogg (1997) on the social implications of praise, Lee explored how human-like features of an interface modelled the praise effects for different styles of analytical thinking.

Contrary to their high-rationality counterparts, only low-rationals' self-esteem was affected by the presence of human-like characters, which in turn did not amplify the effects of flattery. In addition, Lee examined whether flattery was influenced by reduced cognitive ability, and found that participants were more skeptical about the truthfulness of flattering feedback only when pursuing low demanding tasks. For instance, when they were cognitively engaged, no distinction was made between flattering and unflattering computers.

TOLERANCE OF IMPERFECTION
Wang, 2017

Tolerance of imperfection was another individual factor found to determine social attitudes toward technologies: an experiment conducted by **Salem** in 2013 detected that participants favoured clumsy robots over accurate ones.

HEIGHT OF EXPECTATIONS
Paepcke & Takayama, 2010; Waddell, 2018

Also, **higher expectations** were also found to lead to weaker social responses (Paepcke & Takayama, 2010; Waddell, 2018).

WILLINGNESS TO SUSPEND DISBELIEF
Duffy & Zawieska, 2012

Similarly, individuals' willingness to **suspend disbelief** could determine whether they treat a machine more like a tool or a social entity (Duffy & Zawieska, 2012).

ANTHROPOCEN-TRISM
Lombard and Xu, 2021

In addition, in 2021 **Lombard and Xu** raised the issue of **anthropocentrism**, described as "the tendency of individuals to perceive the world from a human-centred perspective, in which humankind is the most significant of all entities" (Nass et al., 1995); according to the researchers, a person with a high level of anthropocentrism is likely to perceive a limited social presence of technology, as they believe that technologies should already embody the physical and psychological attributes of people and occupy human social roles.

In fact, in 1995 Nass and colleagues suggested that experience with other cultures and education are strong predictors of the dimensions of anthropocentrism. Specifically, prevailing expectations of technologies such as robots taking on social roles actually predict whether people will be more or less likely to unconsciously attribute human qualities to technology.

CULTURAL BACKGROUND
Bartneck et al., 2007

Besides individual and motivational factors, also **contextual factors** play a decisive role in influencing our sense of presence.

People's culture and prior experience have been found to influence their attitudes toward robots. In 2007, researchers **Bartneck et al.** conducted a cross-cultural study to investigate whether people's cultural background influenced how they related to the Aibo robot.

467 participants from seven different countries were asked to fill out a survey that examined respondents' attitudes toward interacting with robots, toward the social influence of robots, and toward emotions in interacting with robots.

Their results showed that different cultural backgrounds profoundly influenced people's reactions toward the Aibo robot. In particular, Japanese responses indicated concern about the impact robots have on society and the emotional aspects of interacting with them.

According to the researchers, this may have been motivated by their increased exposure to robots in daily life and in the media; for instance, the Japanese may be more aware of the robots' capabilities and shortcomings.

US responses were the least negative, which may have been motivated by their open-minded perspective and familiarity with technology.

Mexican responses were the most negative, although the researchers pointed out that their results may have been compromised due to the small sample size.

In addition, the responses of participants who belonged to an Aibo community were different from those of participants who did not, although the researchers found no causal relationship. Finally, prior experience with Aibo decreased participants' negative attitudes over repeated interactions.

Unfortunately, the anthropomorphism condition was not found to be statistically significant: in fact, the researchers failed to examine the role played by the robot's human-likeliness, which could have revealed whether different representations influence attitudes toward robotic agents. However, this study showed that people in different cultures have different attitudes towards interacting with robots.

Figure 4
Five generations of Aibo robot dogs (Sony, 2015)

DEGREE OF INDUSTRIALISATION OF A COUNTRY
Epley et al., 2007

In their three-factor theory of anthropomorphism, **Epley et al.** (2007) also argued that a country's **degree of industrialisation** influences people's anthropomorphic associations toward technology as they are exposed to varying degrees of technological advancement.

TOLERANCE OF PRIVACY INVASION
Nitto et al., 2017

According to **Nitto et al.** (2017), a culture's **tolerance of privacy invasion** and **data sharing**, as well as **language norms**, are able to reflect and guide our perceptions.

OTHER FACTORS
Lombard and Xu, 2021

Finally, a wide variety of factors related to the **context of our exposure** to and interactions with technologies can impact our experiences of social presence. According to **Lombard and Xu** (2021), these factors include, but are not limited to, the **nature of the activity** or task involved, the **environment** (e.g., public or private), the **amount of people** involved and how one relates to them, the depth and quality of **information** provided, and the **time of day**.

02.3
Implications

SOURCING AS DEFINING CHARACTERISTIC

It is important to emphasise that different technologies represent different sources of interaction: social responses to technologies vary just as social responses vary when one encounters and interacts with children, strangers, and friends.

Consistent with CASA research, the attribution of sourcing as a defining characteristic allows for the interpretation of technology in human terms.

Sundar and Nass's (2000) distinction between source and channel allowed technology to be perceived no longer as a channel for human-human communication but rather as a source with a degree of agency.

Gambino et al. (2020) raised the issue of anthropocentrism, and took it a step further by stating that social responses to technology should not be limited to a focus on human similarities, but rather there should be an increasing focus on designing social scripts developed specifically through interactions with media.

For this reason, it can be argued that speculating on media-derived scripts should be a result of a thorough framing of the sourcing potential of emerging technologies in an effort to design more intuitive interactions.

Summary

As discussed in the previous section, the knowledge produced to date has largely emphasised the importance of motivational and circumstantial factors in determining people's social responses to computers, alluding to the idea that there is no universal formula but rather many nuances of disposition and circumstances that must be taken into account to predict positive or negative social treatment of technology.

First, **individual factors** such as familiarity with technology and education level, as well as personality traits and the need to establish social interactions should be juxtaposed with the nature and circumstances of the task at hand, as high cognitive demands can reduce people's unconscious susceptibility to social attributions (Lee, 2010).

In addition, computers are culturally embedded actors (Katagiri et al., 2001), and each culture has a different acceptance of technology depending on its level of industrialisation and exposure to it.

Within the same culture, people's social disposition influences the meaning they attach to technology, which can range from simple tools to impactful agents (Marakas et al., 2000).

Designers and engineers should therefore take into account which cultural aspects are determinants of attitudes, motivations, or behaviours, emphasising how crucial it is not to generalise the context in which social behaviour arises.

INDIVIDUAL FACTORS	CONTEXTUAL FACTORS
Personality and complementary traits (Nass et al., 1995)	Cultural background (Bartneck et al., 2007)
Demographics and education level (Nass et al., 1995)	Language norms (Bartneck et al., 2007)
Knowledge of and experience with technology (Nass et al., 1995)	Degree of industrialisation of a country (Epley et al., 2007)
Social disposition (Wang, 2017)	Tolerance of privacy invasion and data sharing (Nitto et al., 2017)
Predisposition to analytical thinking (Lee, 2010)	Cognitive demand of the task (Lee, 2010)
Tolerance of imperfection (Salem, 2013)	Environment (public or private) (Lombard and Xu, 2021)
Height of expectations (Paepcke & Takayama, 2010; Waddell, 2018)	People involved and how they relate to each other (Lombard and Xu, 2021)
Willingness to suspend disbelief (Duffy & Zawieska, 2012)	Depth and quality of information provided (Lombard and Xu, 2021)
Anthropocentric tendencies (Lombard and Xu, 2021)	Time of day (Lombard and Xu, 2021)

Figure 5
Summary of individual and contextual factors

03

From Tools to Social Actors

This chapter explores the social characteristics of technology from both a human-centric and a cue-driven approach.

03.1

Roles of Technology

COMPUTING TECHNOLOGY CONTINUUM OF PERSPECTIVE
Marakas et al., 2000

In 2000, **Marakas et al.** theorised the **computing technology continuum of perspective**. According to the researchers, people's acceptance of computers filling social roles and demonstrating social capacities can be measured on a continuum, with one end being the simplistic assumption that computers are tools, and the other a holistic perspective that sees computers as impactful agents.

Whether someone is at either end of the continuum depends on multiple factors such as "self-evaluation, social characteristics of computing technology, context/nature of interactions, and perceived control of rights" (Johnson et al., 2008; Marakas et al., 2000).

THE FUNCTIONAL TRIAD
Fogg, 2003

A similar distinction was carried forward a few years later by **Fogg** (2003) who, building on the empirical studies conducted by Nass and Reeves, contributed to a deeper understanding of persuasive technologies and conceptualised principles that were enlightening for the time in which they were published.

As noted in his 2003 book "Persuasive Technologies: Using Computers to Change What We Think and Do," the **functional triad** is a framework that was introduced as a teaching tool, portraying the three main roles that interactive technologies can fill, as seen from the user's perspective. According to the framework, interactive technologies can perform as tools, media, and as social actors.

1. Firstly, **computers as tools** provide easier access to and support through processes or operations; specifically, computers as persuasive tools reduce complex behaviours to simple tasks, guide users through processes or experiences, or use positive reinforcement to shape complex behaviour. As Fogg described, the tunnelling strategy can be exemplified by software installation processes.
2. Secondly, **computers as sensory media** provide simulations of real world experiences, enabling the understanding of the correlation between causes-and-effects or procuring exposure to jeopardising situations. Computers as persuasive media include simulated cause-and-effect scenarios, simulated environments, and simulated objects. For instance, persuasive environments such as immersive exercising equipments can motivate and reward people for performing certain targeted behaviours.
3. Lastly, **computers as social actors** have the power to enable collective dynamics of sociality and to exploit them to model targeted behaviours or grant social support. Specifically, computers as social actors are able to apply social influence, which includes social comparison and social facilitation, among others (Fogg, 2003).

THE RELATIONAL ROLE OF ROBOTS
Baraka et al., 2019

Similarly, in 2019 **Baraka et al.** outlined an extended framework for characterising social robots. Specifically, the researchers categorised robots based on the **relational role**, which is the role that a robot is designed to fulfil as a dimension that shapes human-robot interaction, determining the user's perception of the robot. The relational role of a robot is free from task-specific constraints and more strongly abstract.

- A robot "**for you**" serves as a utility, closely related to the concept of a tool, which was seen proposed by other authors such as Fogg (2003);
- A robot "**like you**" plays the role of a proxy, meaning that it takes action in place of another person;
- A robot "**with you**" serves as a teammate or companion, collaborating with the human toward a common goal;
- A robot "**as if you**" shares social or psychological traits with humans and is primarily used as a research tool to examine and validate theories;
- A robot "**around you**" shares common physical spaces and resources with humans, not necessarily collaborating but as bystanders or co-presents;
- Finally, a robot "**as part of you**" extends human biological embodiment (Baraka et al., 2019).

TIMESPAN
Baraka et al., 2019

Moreover, according to the researchers, domain-specific robots should also be characterised by **timespan**, meaning the period of time humans are exposed to the robot, such as short-term, medium-term, long-term, or lifelong.

First, **short-term interactions** with robots consist of consecutive, isolated interactions (e.g., customer service) in which robot design factors influence the human's first impression of the robot. Second, **medium-term interactions** go beyond a single interaction and extend repeatedly over several days or weeks, which is likely to shift perceptions toward robots over time.

Next, **long-term interactions** extend beyond the period required for the novelty effect to wear off and generate a sense of predictability in the human. Also, it is possible for a sense of **attachment** and **relationships** to be established with the robot; in addition, the robot is able to personalise the experience with the human by adapting to individual differences such as physical, psychological, and emotional state, performance, or behaviour.

Finally, **life-long interactions** accompany humans through major transitions, for example, moving from childhood to adulthood, or progressively losing some abilities as they age. Examples of such robots include robots assisting the elderly by providing new skills (Georgiadis et al., 2016) or robotic companions (Dautenhahn, 2004).

THE RELATIONAL ROLE OF CHATBOTS
Nißen et al., 2022

In 2022, **Nißen et al.** applied the same temporal classification to chatbots, as they considered them to be the physical extreme of the "**reality-virtuality continuum**" (De Keyser et al., 2019).

According to the researchers, **Ad-hoc Supporters** are less advanced and highly task-oriented versions of chatbots that complement the services already offered by a company.

Persistent Companions are long-term chatbots designed for longer, interdependent interactions. In addition, they possess features that support relationship-building processes with users, as they feature socially oriented communication styles (e.g., small talk), and adjust their personalities to match that of the user.

Finally, **Temporary Advisors** are medium-term chatbots that hybridise the characteristics of short-term and long-term chatbots, as they do not adjust their personality to that of the user, but integrate services and features to satisfy all the user's requests.

03.2
Implications

It is worth exploring the researchers' considerations in relation to the specific medium they were investigating at the time of their theories: **Marakas et al.** (2000) as well as **Fogg** (2003) considered the **relational role** of the computer, attributable to the technological availability of the time. However, subsequent studies have focused on more advanced declinations of media such as social robots (Baraka et al., 2019) and conversational agents (Nißen et al., 2022).

THE REALITY-VIRTUALITY CONTINUUM
Milgram, 1994

The "reality-virtuality continuum" was first introduced by **Milgram** (1994) who described it as a continuous scale showing at one end the completely virtual, a virtuality, and at the opposite end the completely real, a reality. The scale would include all variations of virtual and real objects.

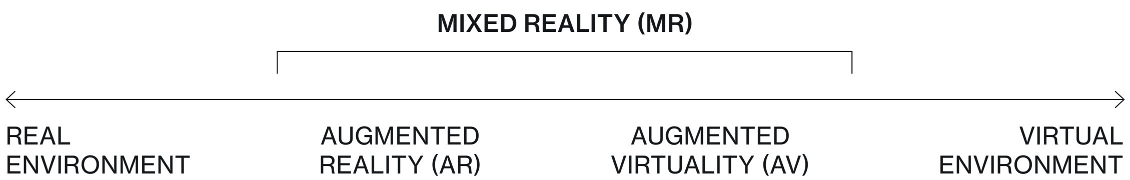


Figure 6
Representation of the virtuality continuum (adapted from Milgram; Kishino, 1994)

EXTENDING THE REALITY-VIRTUALITY CONTINUUM
Holz et al., 2009, 2011; De Keyser et al., 2019; Ancona et al., 2020; Nißen et al., 2022

Subsequent researchers have expanded the "reality-virtuality continuum" (Holz et al., 2009; Holz et al., 2011; De Keyser et al., 2019; Ancona et al., 2020; Nißen et al., 2022), suggesting that conversational agents, described as "physical or virtual autonomous technological entities capable of responsive and proactive behaviour in their environment" (Holz et al, 2009), come in various forms that can be located along the continuum; at one end are those that are tangibly present in the environment (**social robots**) and at the other end are conversational agents with no bodily appearance (**text- or voice-based conversational agents**).

In the middle of the continuum, one can find **mixed-reality conversational agents** that combine physical and virtual elements (Holz et al., 2011). Nevertheless, a different classification was given by Gambino et al. (2020), who provided the definition of "**media agent**," to classify any technological artefact demonstrating enough social cues to indicate the potentiality to be a source of social interaction. According to the researchers, media agents include conversational agents, virtual agents, smart devices with social interfaces and social robots.

Although it will be elaborated in the following sections, it is worth introducing these categorisations to convey a fundamental concept: if socially interactive media are viewed as belonging to a continuum rather than compartments, it can be argued that the fundamental rules of interaction lie beneath these definitions and are valid to a lesser or greater extent for each category of media.

TOWARD A MORE INCLUSIVE CLASSIFICATION OF RELATIONAL ROLES

	RELATIONAL ROLE				TEMPORAL ROLE	
	Marakas et al. (2000)	*Fogg (2003)*	*Baraka et al. (2019)*			*Nißen et al. (2022)*
1	Tool	Tool	"For you"	**Utility**	Short-term	Ad-hoc Supporters
2		**Media**				
3			"Around you"	**Bystander**	Medium-term	Temporary Advisors
4			"Like you"	**Proxy**		
5			"As part of you"	**Extension**	Long-term and life-long	Persistent Companions
6			"With you"	**Companion**		
7	Impactful agent	Social actor	"As if you"	**Self-likeness**		

Figure 7
Classification of relational and temporal roles according to various researchers

Looking at the table, if one collimates the relational roles theorised by the above researchers, it is possible to delineate a classification of roles ranging from the simplistic assumption that media are tools, to the more holistic perspective that sees media not only as impactful agents, but rather as **human-like entities** that emulate human cognition or particular social and psychological traits present in humans.

Furthermore, the **relational role** of media and their **temporal role** seem to exhibit directly proportional traits, in the sense that the more goal-oriented the agent's behaviour, the shorter the duration of the interaction. Comparatively, manifestations of anthropomorphic traits such as integration of social-emotional behaviours, socially oriented communication style, and character adaptation over the course of the relationship are indicators of greater cooperation and responsiveness to the user's personal needs (Verhagen et al., 2014).

More specifically, it can be analysed: medium as a **tool** (Marakas et al., 2000; Fogg, 2003; Baraka et al., 2019) and medium as **media**, understood as a platform that fosters CMC (Fogg, 2003), belong to a goal-oriented and short-term model of relationship; medium as **bystander** or proxy (Baraka et al, 2019) belongs to a temporal model of medium-term relationship; finally, medium as **extension** (Baraka et al, 2019), as well as **social actor** (Fogg, 2003) and specifically **companion** (Baraka et al., 2019) or **human-like agent** (Baraka et al., 2019), allows for the establishment of longer-term relationship types.

Summary

To summarise, **Marakas et al.** (2000) argued that people's acceptance of computers that demonstrate social skills depends on multiple factors, such as the social characteristics of the technology itself, the context of the interaction, and motivational factors (Marakas et al., 2000).

Similarly, **Fogg** (2003) suggested that the role that technology can fill depends on the perspective of the user.

The frameworks of Fogg (2003) and Marakas et al. (2000) provided support for the notion that motivational and circumstantial factors strongly determine people's social responses to computers, thus shaping the role that technology embodies and suggesting a **human-centred approach**.

On the other hand, **Baraka et al.**'s (2019) classification and **Nißen et al.**'s (2022) expansion suggested that the different roles an agent is designed to play determine the human perception of it; furthermore, based on the assumption that agents belong to a continuum depending on the design features they incorporate, it can be argued that the social cues embedded in the agent shape how it will be perceived by the user, and suggest a **cue-driven approach**.

Also, the basic rules of interaction lie below these definitions and are valid to a shorter or wider extent in each media category.

Glossary

COMPUTING TECHNOLOGY CONTINUUM OF PERSPECTIVE	The assumption that people's acceptance of computers filling social roles and demonstrating social capacities can be measured on a continuum, with one end perceiving computers are tools, and the other as impactful agents (Marakas et al., 2000).
THE FUNCTIONAL TRIAD	A framework portraying the three main roles that interactive technologies can fill, as seen from the user's perspective (tools, media, and social actors) (Fogg, 2003).
RELATIONAL ROLE	The role that an agent is designed to fulfil as a dimension that shapes human-robot interaction, determining the user's perception of it (Baraka et al., 2019).
TIMESPAN	The period of time humans are exposed to an agent (Baraka et al., 2019).
THE "REALITY-VIRTUALITY CONTINUUM"	A continuous scale showing at one end the completely virtual, a virtuality, and at the opposite end the completely real, a reality (Milgram, 1994).

04
Types of Agents

This chapter delves deeper into the declinations of media technology as technological artefacts capable of being a source of social interaction.

04.1
Declinations of Media

COMPUTERS OR MEDIA?
Nass et al., 1994

As mentioned at the outset, **Nass et al.** used the terms "**computer**" and "**media**" interchangeably, referring primarily to stationary computers that provided preprogrammed text-or voice-based output.

Moreover, given the technological limitations of the time, social responses were meant to be elicited regardless of the intrinsic characteristics of the medium; however, nowadays there is a much wider range of media constantly changing to become multimodal, ubiquitous, context-aware, and even invisible (Campbell, 2020; Fortunati, 1995; Ling, 2012). For this reason, there are more frequent indicators of sociability embedded in technological devices.

Studies subsequent to the publications of Nass et al. (1994) focused more narrowly on declinations of media such as **personal digital assistants** (Goldstein et al., 2002), **smartphones** (Wang, 2017), **robots** (among others, Bartneck et al. 2007; Duffy & Zawieska, 2012; Fiore et al., 2013; Salem, 2013; Reuten et al., 2018; Kim et al., 2020), **virtual agents** (Epley et al., 2007; Antos et al. 2011; Jensen et al., 2020), **conversational agents** (Feine et al., 2019), **computers in broader terms** (Marakas, 2000; Fogg, 2003), **computer interfaces** (Lee, 2010; Kim & Sundar, 2012), and **media in broader terms** (Sundar, 2008).

MEDIA AGENTS
Nass et al., 1994

As introduced in the previous section, in 2020 **Gambino et al.** used the term "**media agent**" to label technological artefacts that demonstrate the potential to be sources of social interaction.

According to the researchers, media agents consist of **conversational agents**, including voice assistants (e.g., Siri, Alexa), embodied conversational agents, and chatbots; **virtual agents**; **smart devices with social interfaces** (e.g., a smart refrigerator), including wearables (e.g., Apple watch); and **social robots** (e.g., Paro and Aibo).

THE PHYSICALITY-DIGITALITY CONTINUUM

Nevertheless, researchers have also expanded the "reality-virtuality continuum" (Holz et al., 2009; Holz et al., 2011; De Keyser et al., 2019; Ancona et al., 2020; Nißen et al, 2022), suggesting that conversational agents, described as "physical or virtual autonomous technological entities capable of responsive and proactive behaviour in their environment" (Holz et al, 2009), come in various forms that can be located along the continuum.

However, by interpreting the reality-virtuality continuum in terms of physicality and digitality, it is possible to locate media agents along said continuum as well.

Indeed, although there are technical and methodological differences between addressing robotic and virtual domains, today a large number of issues behind the construction of successful social agents crosses the boundaries of agent species.

What distinguishes all research on socially intelligent agents is the emphasis placed on the role of humans as the social interaction partners of artificial agents and, subsequently, the importance placed on aspects of human-like social intelligence in informing and shaping such interactions (Holz et al., 2009).

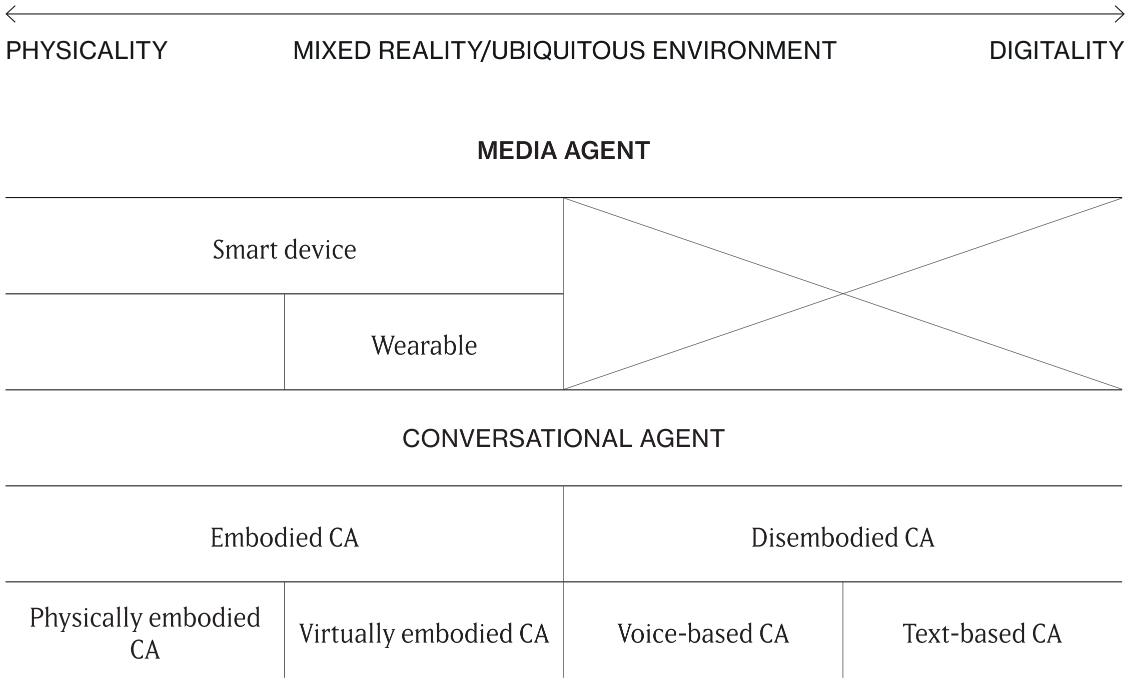


Figure 8
Representation of the physicality-digitality continuum

04.2
Smart Devices

SMART DEVICES AS SOCIAL ACTORS

A **smart device** is a technological device that is characterised by interoperability with other devices that can function interactively and autonomously to some degree through various wireless protocols; specifically, some examples include **smartphones**, **smartwatches**, **smart refrigerators**, or **smart cars**. In addition, smart devices may also exhibit characteristics of ubiquitous computing, as in their ability to exist in various forms.

Nowadays, according to Petrock (2019), 34% of US households have a smart assistant, and Internet of Things (IOT) devices are used in rehabilitation and nursing homes (Chan et al., 2008), but also as delivery service robots (Hawkins, 2019) or as smart speakers for the elderly (Volkskrant, 2019).

As will be further explored in the following sections, Wang (2017) investigated the applicability of the CASA paradigm in the interaction between humans and smartphones; more specifically, according to the researcher, smartphones and Internet of Things (IOT) devices (e.g., home speakers and smart watches) demonstrate different dimensions of social interaction than computers because their interactions with users are more frequent and ongoing (Wang, 2017).

In addition, the Internet of Things (IOT) enables **personalisation**, which implies more subtle and complex uses of smart devices tailored to the needs and requirements of specific target users (Kenneth, 2022). For example, smartphones have the potential to be highly personalised due to the wide variety of sensors they incorporate.

The ability of smart devices to be digitised and interconnected allows for multi-functionality, scalability, and remote operating (Kenneth, 2022).

BAGSIGHT
Van Beek, 2019

BagSight is a research artefact designed by **Evert Van Beek** in 2019, a PhD researcher at Delft University of Technology, with the goal of investigating the autonomy and intentionality expressed by "smart" objects in their relationship with people.

The artefact was designed to react to environmental stimuli, specifically to avoid obstacles and lead the wearer toward certain goals. By tightening its strings and then moving on the wearer's back, it was able to display expressive behaviour to some extent.

In an experimental setting, participants were recruited and asked to describe their experience while wearing the backpack. The results showed different perceptions of the artefact: in fact, it was considered for some as an extension of their organs, both understood as a **tool** and as an **agent**; others described it as an extension of their sensory capabilities that allowed them to "perceive the environment through an incorporated object."

Some quotes suggested that BagSight was socially interpreted as a "**leader**," who would guide people on which direction to take, or as a "**buddy**," a companion who would accompany them on an adventure. In addition, anthropomorphic associations were found in the way participants described how they were guided.

However, the most important concept to capture is that the **relational role** attributed to the backpack ranged from **leader** to being "**perceived to be accompanied by a buddy**," which shows how people's reactions are not determined by how smart a technology is or, in other words, the amount of sensors or features it incorporates.

Rather, it is indicative of a fundamental dependence on context and interpersonal variability, which tells us how much the relational role played by an artefact can change and be dynamic over time. Furthermore, the participants themselves were inconsistent in their perceptions of the backpack throughout the duration of the experiment (Rozendaal et al., 2021).

Figure 9
BagSight (Van Beek, 2019)

04.1
Wearables

WEARABLES AS SOCIAL ACTORS

Wearable technology has also steadily become the focus of attention in HCI research, as it allows researchers to capture continuous information about users' physiological activity; more specifically, users equipped with sensors become part of a larger ubiquitous environment that results in augmented interaction capabilities.

Wearables provide a constant collection of biological, behavioural, and environmental data, which can be translated into **physiological activities** such as **heart rate** and **galvanic skin response**, or into **on-camera activity documentation** and **geo-sensors** (GPS) for localisation (Girginov et al., 2021).

Nowadays, wearables can be applied to the evaluation of **health-related initiatives**, including those focused on physical activity, as well as enabling **relaxation** or increasing the **safety** and work efficiency of workers (DVV Media HR Group Ltd, 2018).

From a broader perspective, one can see wearables being used in healthcare, fitness, education, transportation, business, finance, gaming, or even music (Ometov et al., 2021).

WEARABLES AND SELF-TRACKING
Hancı et al., 2019

By measuring behavioural and physiological data, wearables have opened up the possibility of **self-tracking** devices to influence people's lifestyles, ultimately leading to **behaviour change** (Kersten-van Dijk et al., 2017).

Through the visualisation of quantified data, self-tracking devices are able to shift attention to seemingly simple activities while increasing their importance (Pink and Fors, 2017).

In 2019, Hancı et al. conducted a study to understand how subjectivity affects the experiential effects of long-term self-tracking devices for behavioural change; in particular, self-monitoring technology in the form of wearables arguably changes the perceived level of intimacy between users and devices, as the actual physical proximity as well as the physiological data being captured creates a new perceived psychological distance (Pink and Fors, 2017).

Furthermore, by adding the ability of such devices to provide **personalised** and **time-sensitive feedback**, researchers have argued that the ubiquitous nature of self-tracking devices can lead to establishing more intimate relationships with the device itself to some degree.

Hancı et al.'s 2019 research question was whether self-tracking devices had the potential to be interpreted as social agents or as mere information display tools (Hancı et al., 2019), which would be suggested by the attribution of human-like traits.

If the device was perceived as a social agent, then it should have filled the role of "**observer**," monitoring user performance and leading to ideally better performance.

According to their findings, tracking and quantifying their physical activity by providing numerical feedback prompted users to be more self-focused and self-critical, attributable to the perception of being held accountable by an observing social agent. In addition, the self-tracking device was oftentimes referred to as a "**close and helpful friend**," indicating strong anthropomorphic associations (Hancı et al., 2019).

Summary

These findings suggest that smart devices as well as self-tracking technologies can be perceived as social agents regardless of whether or not they exhibit social cues, adding knowledge to the hypothesis that the relational roles that technology can fill not only influence the relationships people establish with it, but also individual self-assessment processes.

04.4 Conversational Agents

CONVERSATIONAL AGENTS AS SOCIAL ACTORS

A **conversational agent** can be described as a physical or virtual technological agent that is able to adopt both reactive and proactive behaviour (Holz et al., 2009), accepting natural language as input and generating it as output to establish a social conversation with users (Griol et al., 2013).

The term "conversational agent" and its variants such as **CA**, **ECA**, **chatbot**, **dialogue system**, **companion**, **virtual assistant**, or **digital assistant** (Feine et al., 2019) have often been used interchangeably.

Nonetheless, conversational agents vary substantially in their mode of communication, embodiment, and context: more specifically, conversational agents can communicate via **speech** (Cowan et al., 2015), **text** (Schroeder & Schroeder, 2018), or both (Cho, 2019); they can be **disembodied** (Araujo, 2018), **virtually embodied** (Diederich et al., 2019), or **physically embodied** (Nunamaker et al., 2011); and finally, they can be used for both **domain-specific** and **goal-oriented** conversations or for **general conversations** (Gnewuch et al., 2017).

Furthermore, it can be argued that varying degrees of relational significance can be ascribed to the terms "**companion**" and "**assistant**."

Conversational agents allow users to interact with them using **natural language** while expressing **multimodal verbal and nonverbal human-like features** (e.g., joke, gender, gestures, facial expressions, response delay); for this reason, conversational agents are often treated socially (Go and Sundar, 2019; Krämer, 2008b; Louwerse et al, 2005; Niewiadomski and Pelachaud, 2010) as a sense of human-like interaction is conveyed (Følstad & Brandtzæg, 2017), and they promise greater ease of use and quicker fulfilment of user requests (Følstad & Brandtzæg, 2017).

Despite the recent increase in the number of conversational agents introduced to the market and improvements in their technical capabilities (McTear et al., 2016; Dale, 2016; Klopfenstein et al., 2017), it can be argued that conversational agents foster high user expectations that often do not align with the agents' actual capabilities (Ben Mimoun et al., 2012; Luger & Sellen, 2016).

Specifically, the design of conversational agents is driven by human social responses to the cues that conversational agents incorporate, such as human names, social role filling, or natural language use (Feine et al., 2019; Seeger et al., 2018). Such social responses influence individual perception of these agents, who are led to assume that conversational agents must act socially and demonstrate credible behaviour (Carolis et al., 2004; Pelachaud, 2009b).

Moreover, attitudes toward conversational agents have the potential to vary over time and in repeated interactions; for example, conversational agents could fill roles ranging from **digital assistants** to **companions** or even **friends** (Diederich et al., 2022; Fogg, 2003; Marakas et al., 2000).

Finally, conversational agents are usually applied to both **professional** and **private contexts**: specifically, regarding professional environments, conversational agents can be implemented to **support individual tasks** (Bittner & Shoury, 2019; Fast et al., 2017), **foster collaborations** (Bittner et al, 2019; Seeber et al, 2019), and **provide services** through the client interface (Diederich et al., 2021; Vaccaro et al., 2018; Wünderlich & Paluch, 2017); in private settings, they can be used to **support individual tasks** (Porcheron et al., 2018), as well as take on the role of **learning partners** (Graesse et al., 2017), and **caregivers** (Yokotani et al., 2018).

04.5
Embodied Conversational Agents

THE PHYSICAL END OF THE PHYSICAL-ITY-DIGITALITY CONTINUUM

Embodied conversational agents differ from disembodied conversational agents in the sense that they possess "**visually observable bodies**" that allow them to interact with humans through other communication channels beyond voice or text.

At the physical end of the physicality-digitality continuum are **embodied conversational agents**, often referred to as **social robots** (Caic et al., 2018), which are tangibly present in the environment and able to handle conversations with their users by means of facial and speech recognition technology.

SOCIALLY INTERACTIVE ROBOTS
Fong, 2003

Social robots have been approached differently in research depending on the purpose they served; for example, **Fong** (2003) used the term "**socially interactive robots**" to define robots critical to those domains where social interaction capabilities need to be demonstrated, i.e., where it is necessary to solve a task or because the very purpose and function of the robot is to socially interact with people (companions or educational robots).

THE ROLE OF PHYSICAL EMBODIMENT

However, regardless of the evolving definitions of social robots, the fact that they possess a **physical embodiment** was proven to be a social cue that enables people's social responses (Xu, 2018). Physical embodiment, in fact, allows people to interact with robots in the physical world, while interaction with **virtually embodied conversational agents** is usually limited to the digital world (Holz et al., 2009).

However, virtually embodied conversational agents are **scalable** and **low cost**, as well as available 24/7 for support and increasingly adaptable to user needs. Moreover, it can be argued that they improve the quality of customer services across all industries (Diederich et al., 2022).

MIXED-REALITY CONVERSATIONAL AGENTS

Holz et al., 2011

Furthermore, according to **Holz et al.** (2011), social robots such as **Pepper** (SoftBank Robotics) can be classified as **mixed-reality conversational agents**, as their mode of interaction combines robotic speech and physical embodiment along with virtual content appearing on a tablet; combining physicality with digitality allows for richer interactions and the overcoming of communicative limitations associated with strictly physical interactions.

For this reason, social robots are distributed along the continuum, and those that belong to a more ubiquitous environment are able to exhibit physical presence as well as richer expressive capabilities and personalisation features (Holz et al., 2011) compared to strictly physically embodied conversational agents.

Social robots have been implemented in many **public spaces**, as one can see in the case of the humanoid robot "Pepper" (SoftBank Robotics) introduced by Nestlé, Mizuho Bank and SoftBank's mobile phone stores, as well as **educational** and **daycare providers**; at the same time, the robot "Nao" (Aldebaran Robotics) was installed in Bank of Tokyo-Mitsubishi UFJ branches, while the communication robot "Palro" (Fujisoft) was adopted by **nursing homes** (Nitto et al., 2017).

AUTONOMOUS WHEELCHAIR ROLLAND

Fischer, 2011

In 2011, **Fischer** conducted an experiment to investigate interpersonal variation in verbal HRI relative to the CASA paradigm hypothesis.

The experiment was conducted using the Wizard-of-Oz methodology, through the organisation of a scenario in which participants were required to teach an autonomous wheelchair where specific places were within a room furnished as an apartment for disabled people; to do so, participants had to guide it around to make it familiarise with the environment.

According to his findings, participants who responded to the robot's greeting adopted conversational structuring with more cues and feedback, as well as were more aligned and viewed their partner as more linguistically and cognitively competent (Fischer, 2011).

These results showed that whether a situation is perceived as **social** or **non-social** can be inferred from the first response to the robot's intervention, and this can also predict the user's future linguistic behaviour during conversations with the robot.

More specifically, the type of relationship the participant was willing to establish could be inferred from the verbal choices and linguistic features in response to the robot's greeting; in fact, according to Fischer (2011), the participant's interaction goal and understanding of the human-robot interaction situation as social or non-social can be determined from this. This interpretation is consistent with other types of interaction such as communication with foreigners.

Figure 10
Autonomous Wheelchair Rolland (2011)

As can be seen from this transcript, the participant R005 in example (1) completely ignored the social utterances of the robot, as well as other utterances of the robot that were not easily understood. In example (3), however, the participant R009 reacted to all of the social and pragmatic aspects of the robot's first utterance.

EXAMPLE 1	
Rolland	*Yes, good afternoon, how are you?*
R005	*(Noise) — okay, (breathing) — back-wards, and to the right? — and straight (laughter) out? God, (breathing)*
Rolland	*Where are we going?*
R005	*To the left. Straight ahead? — To the table? And, backwards?*
Rolland	*Sorry, what kind of table?*
R005	*Huh? (Laughter) and to the right.*
Rolland	*Sorry, what kind of table?*
R005	*Uh, a dining table. — With dishes on it.*
Rolland	*The what?*
R005	*Yes, whatever. To the right, maybe? (laughter)*

EXAMPLE 3	
Rolland	*Yes, good afternoon, how are you?*
R009	*(Breathing) yes well, (laughter) thank you.*
Rolland	*You can now drive us to a place you want to name.*
R009	*Okay I'll drive us to the fridge.*

Figure 11
Excerpts from conversations with Autonomous Wheelchair Rolland (2011)

SOCIALLY ASSISTIVE ROBOTS
Caic et al., 2018

In 2018, **Caic et al.** studied the perception of **socially assistive robots** in elderly care.

In the field of healthcare, first generation robots could be found to support labor-intensive tasks for patients or healthcare staff, which went into functional roles such as **assistants**, **helpers**, **servants**, and **butlers** (Dautenhahn et al., 2005; Fong et al., 2003). This type of robot, specifically, provided <u>support in functional assistance through physical interaction</u> (Feil-Seifer and Mataric, 2005). In parallel, one could find robots with the primary goal of **establishing social interactions**, called by Fong (2003) "**socially interactive robots**," as seen earlier.

Finally, according to Caic et al. (2018), the latest generation of social robots include **assistive functionality** as well as social interactivity, offering assistance through human-like social interactions. In a healthcare context, socially assistive robots are autonomous, capture social cues through face and voice detection, and can provide assistance to children (Huijnen et al., 2016; Scassellati et al., 2012) and the elderly (Broekens et al., 2009). As they perform more socially compelling tasks, these robots turn into **companions**, **collaborators**, **partners**, **pets**, or **friends** (Dautenhahn et al., 2005; Fong et al., 2003).

The researchers used a phenomenographic approach to collect first-person accounts of participants' experiences. Their findings showed that:

- Socially assistive robots supporting **physical health** have the function of **safeguarding**, which includes monitoring and providing spatial guidance. The role that socially assistive robots play when facilitating physical health is both constructive as an **enabler** (empowerment) and destructive as an **intruder** (interfering with personal space).
- Socially assistive robots can support **psychosocial health** by providing **social contact**, as they can communicate with humans, read and express emotions, and suggest activities based on the person's mood (Dautenhahn, 2007). Existing research shows that acceptance of socially assistive robots is increasing among older adults, especially as they see them more as human-like **companions** (Dautenhahn, 2007; Robinson et al., 2014). The role that socially assistive robots play when providing psychosocial health is both constructive of an **ally** and destructive of a **substitute**.
- Finally, socially assistive robots support **cognitive health** by providing **cognitive support**, specifically by mitigating the negative effects of cognitive deficits and providing systematic cognitive reminders (Pineau et al., 2003). In this instance, socially assistive robots can be viewed both constructively as an **extension of the self** and destructively as a **disabler** that disengages the patient's abilities.

The phenomenographic approach investigated the potential roles of socially assistive robots in elderly care by capturing the user perspective. In contrast to what was seen in the BagSight (2019) case study, which monitored changes in the perceived relationship with the backpack during the duration of the experiment, here the behavioural changes of the participants were not taken into account. Nonetheless, it is an indicator of people's attitudes toward their understanding of social robotics technology.

Summary

This overview of empirical studies questioning perceptions in relation to physically embodied conversational agents has demonstrated a few key points: first, there are continual changes throughout research into definitions of social robots, the classification of which depends on the **communicative potential of their design** as well as their **functionality** and **contexts of use**; second, the perceived relational role filled by such social robots is highly dependent on interpersonal variability and changes in users' perspectives through ongoing interactions.

Furthermore, the social cues inherent in physically embodied conversational agents, just like physical embodiment, arguably ensure people's social responses toward such agents; however, by taking advantage of the ubiquitous nature of mixed-reality conversational agents, aspects of both digitality and physicality can be manifested to maximise their expressive capabilities and personalisation features.

Finally, as Caic et al.'s (2018) phenomenographic study showed, the type of relationship a person is willing to establish, as well as their interaction goal, is determined by their understanding of the situation and can be inferred from their verbal choices, thus shedding light on the idea that people's first reactions to social robots can be compared to those of **strangers**.

04.6
Disembodied Conversational Agents

THE DIGITAL END OF THE PHYSICALITY-DIGITALITY CONTINUUM

At the digital end of the physicality-digitality continuum are **disembodied conversational agents**, more specifically text- and voice-based conversational agents that, from a generic perspective, are employed as **virtual assistants** both in people's **personal lives**, such as in **education** or **healthcare**, and in **organisations** to renew and automate tasks (Diederich et al., 2022); specifically, disembodied conversational agents lack bodily appearance (Araujo, 2018).

VOICE-BASED CONVERSATIONAL AGENTS

Voice-based conversational agents are preferable when dealing with users with intellectual (Balasuriya et al., 2018), motor, language, and cognitive disabilities (Masina et al., 2020), or literacy and visual impairments (Barata et al., 2018), as they can provide support for routine tasks (Miner et al., 2019). In addition, voice-based conversational agents provide a more natural interface that relies on routine experiences of rapid and effective communication between people (Moon et al., 2016).

In fact, voice-based conversational agents enable **hands-free interactions**: more specifically, they facilitate the completion of tasks such as searching for information online, managing schedules and deadlines, playing multimedia, making calls, texts, or emails, controlling IoT devices, and telling jokes (Ammari et al., 2019; Hoy MB, 2018).

Similar to text-based (Liu and Sundar, 2018) and embodied (Bickmore et al., 2005) conversational agents, voice-based conversational agents foster non-transactional use cases that allow for the formation of **alliance** (Horvath and Luborsky, 1993) or **rapport** with users through conversation. However, those available in phones or smart speakers are neither anthropomorphic nor self-locomotive, which makes them different from human dialogue partners.

TEXT-BASED CONVERSATIONAL AGENTS

For what concerns **text-based conversational agents**, their **lexical features** (e.g., number of words and number of characters) can convey the extent to which the agent is perceived as competent or informative; **syntactic features** (e.g., the use of emoticons or expressive punctuation) can communicate emotion; finally, **turn-taking features** (e.g., turn duration and response latency) will vary greatly for the user and the conversational agent and determine the flow of the interaction (Ruane et al., 2021).

Moreover, text-based conversational agents can be classified according to the system they are supported by: more specifically, **AIML-based** chatbots are rule-based chatbots that mostly endorse goal-oriented behaviour and are not confined to a specific domain; on the other hand, **AI-powered** conversational agents are designed to simulate and mimic the unstructured stream of human conversation as they rely on machine learning systems powered by Natural Language Processing (Radziwill and Benton, 2017).

In addition, AI-powered conversational agents are able to carry on open-domain dialogues by transferring human values such as **companionship**, **connection**, **entertainment**, **education**, and other non-transactional use cases (Diederich et al., 2022).

SOCIAL VS FUNCTIONAL CONVERSATIONS WITH DISEMBODIED CONVERSATIONAL AGENTS

Clark et al., 2019

In 2019, **Clark et al.** investigated human-to-human conversation characteristics and their variability in the human-to-agent application, based on the assumption that typically people engage in limited, functional conversations with disembodied conversational agents.

Specifically, Clark et al. conducted semi-structured interviews that showed a dichotomous perception of conversation as **social** and **functional**, which shed light on the importance of forming a long-term bond and trust during the establishment of a relationship (Clark et al., 2019).

The results of their survey showed that while human-human conversation is oriented toward both social and transactional purposes, human-agent conversation is conceived in almost exclusively transactional terms. In the human-agent conversation, the development of **common ground** was perceived as a process closely tied to **personalisation**; **trust** was defined in terms of **system performance**; and the establishment of a **relationship** with a conversational agent was seen as impossible because of issues such as the **master-servant dynamic** and the dissonance between monetary incentives and the development of **friendship** between agents (Clark et al., 2019).

Additionally, participants described their interactions with agents as if they were talking to **accidental acquaintances**, which suggested a tool-oriented conception of the conversational agent rather than a dynamic social entity (Clark et al., 2019).

CLOVA

Oh et al., 2020

The transactional nature of relationships with disembodied conversational agents was also supported by **Oh et al.** in 2020, who conducted a study of **Clova**, an artificial intelligence (AI)-powered voice-based conversational agent that supports Korean.

The researchers investigated whether perceptions of a voice-based conversational agent changed by age group, and found that while **older adults** perceived Clova as a **companion** that demonstrated greater potential for personification, **younger adults** perceived it as a useful **tool** to facilitate a more efficient lifestyle.

In particular, elders reported explicit appreciations enriched by **anthropomorphic qualities** recognising their conversational power ("After going out and coming back, the moment Clova greeted me when I asked, 'Clova, how have you been?'. That was my favourite moment").

However, personifying behaviour was nearly absent with younger adults, who engaged in shorter conversations with Clova and focused on its technical flaws. Likely due to their prior exposure to conversational agents in the media, young adults' expectations were not met, which led them to adjust to the economy of the interaction, and subsequently led them to imagine Clova as a smart home manager or even a butler performing reliable and predictable transactional tasks (Oh et al., 2020).

Figure 12
AI-powered voice-based conversational agent Clova (2020)

SIRI

Lee et al., 2021

Similarly, exploring the relational role of voice-based conversational agents, in 2021 **Lee et al.** conducted a study focusing on how experiences of interacting with Siri could influence their perception of it as being a **colleague**, **supervisor**, or **friend**.

According to their results, participants reported high perceived trust when asking Siri to perform functional tasks, suggesting that conversational agents are viewed as trustworthy when engaging in transactional use cases such as searching for information or executing computations (Lee et al., 2021).

Furthermore, by investigating Siri's relational role, researchers found that in considering the conversational agent as a **colleague** or **supervisor**, participants valued co-presence and trust as key dimensions to be respected; furthermore, to trust Siri as a **friend**, the dimension of personal attachment also had to be observed.

Their findings supported the notion that while it is necessary for humans to have trust and be colocated to perceive an agent as a supervisor or colleague, the same human-to-human relationship development mechanisms involving personal attachment apply to establishing friendly relationships with a conversational agent (Ho et al., 2018).

Figure 13
AI-powered voice-based conversational agent Siri (2021)

MITSUKU

Croes and Antheunis, 2020

Similar to the Clova (2020) case study, another type of adaptation to the interaction economy was explored in the same year by **Croes and Antheunis**.

The researchers conducted a study involving **Mitsuku**, an easily accessible hybrid text-based conversational agent capable of holding non-transactional use cases with the purpose of fostering a sense of companionship.

The goal of the study was to investigate whether it was possible for humans to establish a relationship with a chatbot; however, their results showed that after repeated interactions with Mitsuku, the participants' expectations of the chatbot decreased, considering that the chatbot's interaction processes stayed constant, and that they did not feel Mitsuku was a friend. Likely, this was due to the fact that the lack of shared experience in communicating with the chatbot made it impossible for them to refer back to previous conversations (Hill et al., 2015).

Although the results of this study were valuable, researchers such as **Skjuve et al.** (2021) argued its limitations in that a chatbot not specifically designed to become someone's companion was used, as well as brief and infrequent interactions with the chatbot were conducted.

Figure 14
Hybrid text-based conversational agent Mitsuku (2020)

REPLIKA
Skjuve et al., 2021

In 2021, **Skjuve et al.** conducted a study on **Replika**, an AI-powered social chatbot designed to be users' **companion**, whose features are designed for relationship development and whose personality takes shape via continued interactions with users.

As introduced at the beginning of the section, a number of agents have been developed specifically for contexts such as **health** (Bickmore et al., 2010) **elder care** (Bickmore et al., 2005), **education** (Saerbeck et al., 2010), **customer service** (Bickmore and Cassell, 2001), and the **workplace** (Gockley et al., 2005).

The results of this study suggested a new framework of human-chatbot interaction, characterised by a rapid start of frequent exploration of intimate topics, followed by a process of non-reciprocal self-revelation once trust and engagement were established. According to the researchers, this acceleration of the exploration process was likely caused by a sense of relief regarding the perceived nonobservant nature of the chatbot (Skjuve et al., 2021).

The results of Skjuve et al.'s (2021) study supported the idea that chatbot users may have a lower cutoff for disclosing personal information with machines than humans (Lucas et al., 2014).

Figure 15
AI-powered social chatbot Replika (2021)

Summary

From the non-exhaustive analysis of these case studies on disembodied conversational agents, which addressed their perceived roles within an interaction from different perspectives, some commonalities emerge.

First, the importance of **communicative competence**, which is reflected in the type of vocabulary used, topics of conversation, and adherence to social rules (Jones et al., 1999) is inferred. In most cases, users found it necessary to adapt to the **economy of the interaction** by falling back on functional, transactional, and reliable use cases because their expectations of the communicative competence of disembodied conversational agents had not been met.

Therefore, rather than attempting to simulate human conversational skills, human-agent interaction should be treated as a genre of conversation in its own right characterised by dynamic rules and norms that change as the widespread use of long-term conversational agents in contexts designed to address social needs progresses (Skjuve et al., 2021).

Specifically, considering the **limited functional capacity** (Moore, 2017) of commercially available voice-based conversational agents, the types of conversations that users perceive as appropriate or possible to have with an agent at the moment are limited (Clark, 2018).

This leads to the consideration that, with the prospect of developing a connection, other ways to enhance social presence could be explored. For example, **embodied systems** are able to support voice-based conversation through gestures and expressions. This sheds light on the importance of considering **virtual and physical embodiment** as a social cue that enables people's social responses (Xu, 2018) by leveraging aspects of both digitality and physicality to maximise agents' expressive capabilities and personalisation features.

Finally, it is important to consider the **context** in which the acceptability and norms of conversation with voice-based agents are shaped, as people may avoid engaging in such interactions in private and public settings (Cowan et al., 2017).

To reiterate, it is also critical that engaging in more complex and more social tasks and interactions requires conversational agents to be able to appropriately conduct conversations (Jain et al., 2018), following a mode of exploration that may be different from human-to-human.

05
Baseline Terminology of Cognitive Psychology

This chapter provides an overview of cognitive psychology terminology and clarifies inconsistencies.

05.1

Social Cues, Behavioural Cues, or Social Signals?

THE W+ MODEL
Vinciarelli et al., 2009

Leveraging what was covered so far, context plays a crucial role in determining people's social responses to media, as it influences how social cues will be interpreted by the perceiver. In order to promote social behaviour understanding, **Vinciarelli et al.** (2009) suggested that the **W5+ model** (*where, what, when, who, why, how*) is well suited to provide context to an interaction. Specifically, according to the researchers, answering the *why* and *how* questions could enable the recognition of actors' communicative intentions, including social behaviours, affective, and cognitive states.

COMPUTERS AS SOCIAL ACTORS
Nass et al., 1997

As previously described, **Nass et al.** (1994) stated that in order for computers to be treated socially they must show enough cues to lead the person to classify them as worthy of a social response. The social cues identified by the researchers were **words for output** (Brown, 1988; Turkle, 1984), **interactivity** (Rafaeli, 1990), and the **filling of roles traditionally filled by humans** (Cooley, 1966; Mead, 1934), prompting the assumption that for Nass and colleagues, computers were construed as social actors regardless of their characteristics.

The experiments conducted by Nass and colleagues consisted of rigging computers to have personalities, genders, or conversational patterns. According to Lombard and Xu (2021), they were operationalising sets of social cues; for instance, when Nass et al. (1997) manipulated computers to have genders, they assigned a female voice and a male voice that were achieved by varying the pitch range.

PHYSICAL OR BEHAVIOURAL SOCIAL CUES?
Vinciarelli et al., 2009

To begin, one can argue the importance of shedding light on the semantically similar but formally different terminology that has been employed over the years. For a deeper understanding, social cues are defined as biologically and physically determined characteristics that are salient to observers because of their potential as sources of information (Streater et al., 2012).

Specifically, social cues can be both **physical** and **behavioural**: while physical cues are aspects of physical appearance and environmental factors, behavioural cues include nonverbal movements and actions in addition to vocalisations and verbal expressions, such as eye movements, head nods, smiles, laughter, and arm positioning (Pantic et al., 2011; Vinciarelli et al., 2012).

BEHAVIOURAL CUES OR BEHAVIOURS?
Ekman & Friesen, 1969

According to **Ekman & Friesen** (1969), **behavioural cues** are different from **behaviours** in that they last for shorter time intervals and communicate intentions. Specifically, they can communicate: affective/attitudinal/cognitive states, such as fear, joy, stress, disagreement, ambivalence, and inattention; emblems, such as culture-specific interactive signals; manipulators, such as actions on objects in the environment or self-manipulative actions; illustrators, such as actions accompanying speech; and regulators, such as conversational mediators.

However, social cues have often been referred to by researchers as behavioural cues, social signals, and even anthropomorphic or human-like characteristics (Donath, 2007; Pantic et al., 2011) interchangeably.

Social cues are embedded in media, yet it do not need to exhibit social cues to be perceived as a source of social interaction (see mindful anthropomorphism, Lombard & Xu, 2021). However, the issue regarding the quantity and quality of social cues had already been raised by Fogg, concluding the chapter "Computers as Persuasive Social Actors" in his book "Persuasive Technologies: Using Computers to Change What We Think and Do," recommending their appropriate use to designers.

SOCIAL CUES OR SOCIAL AFFORDANCES?

Sundar (2008) suggested that a given digital medium incorporates cues that convey a **specific affordance**, which in turn triggers cognitive heuristics and allows the perceiver to assess the credibility of a medium.

It can be argued that each **affordance** can be interpreted as a repository of individual or combinations of social cues. The term affordance was coined by **Gibson** (1979) and stands for the inherent functional attributes of an object that indicate possible actions by a user. Specifically, social affordances more accurately suggest that an object has the ability to accommodate communication (Fox & McEwan, 2017).

Social cues and social affordances are intrinsic features of the medium; while the former stands for observable features salient to the observer, the latter incorporates the aforementioned cues to communicate the potentiality of action.

SOCIAL CUES OR SOCIAL SIGNALS?

According to **Fiore et al.** (2013), **social cues** and **social signals** are the basic conceptual building blocks of the type of social intelligence required for human-robot interaction.

It can be argued that **social signals** are intrinsic features of the perceiver: specifically, social signals differ from social cues in that they are semantically superior to social cues and are emotionally, cognitively, socially, and culturally based. In more detail, social signals are interpretations of single or combinations of social cues that are influenced by mental states and attributes toward another agent (Streater et al., 2012), as well as contextual and motivational factors of the perceiver. Examples include **dominance**, **flirtation**, **attention**, **empathy**, **politeness**, or **agreement** (Pantic et al., 2011; Vinciarelli et al., 2012).

Following **Donath** (2007), a signal evolves from a cue at the moment the perceiver ascribes meaning to it. Therefore, cues precede signals, and a social cue can evolve into a social signal (Smith and Harper, 2003) when the media is ascribed a sociality (Nass and Moon, 2000; Wiltshire et al., 2014). Assigning socialness is the result of a conscious or unconscious interpretation of the cues, and eventually triggers a **social reaction** from the user (Knapp et al., 2013; Nass and Moon, 2000; Vinciarelli et al., 2012).

Because social signals rely on the disposition of the perceiver, their interpretation is dynamic, subjective, and context-dependent, which ultimately triggers a social reaction of the perceiver.

Social signals differ from social affordances in that the latter demonstrate the ability to adapt to communication, as they are repositories of perceptual cues that connote aspects of social structure to individuals. For instance, social affordances can be extrapolated from a medium regardless of the disposition or even presence of the perceiver.

SOCIAL PRESENCE	When individuals perceive **social presence** (or medium-as-a-social-actor presence as coined by Lombard and Xu in 2021), that is, the degree to which an agent perceives being in the company of another social agent, they apply the same set of social rules that they would apply to other humans, depending on the social cues they recognise.
SCHEMAS	At the cognitive level, people form impressions and make predictions about others by holding schemas about individuals (**person-schemas**), ourselves (**self-schemas**), and recurring events (**event-schemas**, or **scripts**). Schemas are mental models of how one expects something to be that greatly reduce the amount of cognitive work required; more specifically, event-schemas or scripts help people anticipate how agents should behave (Karim et al., 2018). Schemas are more closely associated with topics on which to make decisions, and are more likely to lead to stereotypical thinking and incorrect conclusions (Brown, 2013).
HEURISTICS	In contrast to schemas, **heuristics** are more closely associated with how a person makes a decision: heuristics are described as evolved generalisations of knowledge, of which the perceiver is most often unaware, that are used to make immediate judgments in situations of uncertainty (Hertwig & Todd, 2002). Heuristics can still lead to **cognitive bias**, although one can approach new situations and predict the outcome fairly accurately (Cherry, 2021). As extensively described for theories supporting Langer's (1992) **mindlessness** hypothesis, predictions about others are quick and based on relatively little information upon which people make judgments about others (see thin-slices of behaviour, Ambady et al., 1992).

Glossary

		PERCEIVER	MEDIUM
CUE	Biologically and physically determined characteristics that are salient to observers because of their potential as sources of information (Smith and Harper, 2003).		X
SOCIAL CUE	A cue that triggers a social reaction of the user (Fogg, 2002; Nass and Moon, 2000).		X
SOCIAL AFFORDANCE	Repository of social cues suggesting that an object has the ability to accommodate communication (Fox & McEwan, 2017).		X
SOCIAL SIGNAL	The conscious or subconscious interpretation of cues in the form of attributions of mental state or attitudes towards media (Nass and Moon, 2000; Wiltshire et al., 2014).	X	
SOCIAL REACTION	Emotional, cognitive, or behavioural reaction of the user toward media that is considered appropriate when directed at other humans beings (Krämer, 2005).	X	
SOCIAL PRESENCE	The degree to which an agent perceives being in the company of another social agent (Biocca and Harms, 2002).	X	
EVENT-SCHEMA OR SCRIPT	Specific type of schema related to events that helps people anticipate how agents should behave (Karim et al., 2018).	X	
HEURISTICS	Evolved generalisations of knowledge, of which the perceiver is most often unaware, that are used to make immediate judgments in situations of uncertainty (Hertwig & Todd, 2002).	X	

05.2
Social Affordances

As mentioned above, **social affordances** are the inherent functional attributes of an object that suggest it has the ability to accommodate communication (Fox & McEwan, 2017); in addition, it can be argued that social cues can serve as affordances (Sundar et al., 2015), and that each affordance is a repository of individual or combinations of social cues that conveys the potential for action.

Heuristics are described as evolved generalisations of knowledge, of which the perceiver is most often unaware, that are used to make snap judgements in situations of uncertainty (Hertwig & Todd, 2002). The **HSM model** is a theory of persuasion that aims to explore how people receive and process persuasive messages.

According to the model, the validity of a message can be estimated based on **systematic processing**, which involves deliberative processing, or **heuristic processing**, which involves the use of simplifying rules or mental shortcuts to minimise the use of cognitive resources. The predilection of heuristic or systematic processing predicts the extent to which a person will be persuaded or show behavioural changes (Chaiken, 1980).

THE MAIN MODEL
Sundar, 2008

One direction that the CASA research took consolidated into the **MAIN model**, which proposed guidelines for identifying affordances across media to determine and thereby increase their credibility. The MAIN model emerged from theoretical frameworks such as the HSM model that explored the use of heuristics in the digital age, and is an approach geared toward facilitating the evaluation of the trustworthiness of a given digital medium.

According to the MAIN model, a given digital medium embeds cues or markers that convey a specific affordance, which in turn triggers cognitive heuristics and enables the perceiver to assess the credibility of the medium. **Sundar** (2008) addressed the increasing information overflow and content consumption of the new-media environment, stating that facilitating credibility assessment had become critically important, as it had become challenging to identify the source of information among the layers of online transmission dynamics.

Moreover, the cues embedded in the four affordances depend on the device, the individual characteristics of the user and the context, which play a decisive role in shaping the user's judgements.

According to the MAIN model, most digital media convey to some extent the technological affordances of **Modality** (M), **Agency** (A), **Interactivity** (I), and **Navigability** (N).

- Firstly, **Modality affordance** is tied to the structure of the medium and, according to its type, its output modalities can be textual, aural, or audiovisual. Some of the cognitive heuristics that can be triggered by Modality affordance are the *distraction heuristic*, causing sensory overstimulation; the *novelty heuristic*, resulting in the loose and erroneous association between the quality of the medium and its innovation; and the *being-there heuristic*, in which the immersiveness of the medium augments the intensity and the authenticity of the experience.

- Secondly, **Agency affordance** enables the assigning of sourcing to elements in the communication chain. A few of the cognitive heuristics that Agency affordance can trigger are the *bandwagon heuristic*, which implies collective endorsement; the *social presence heuristic*, which can amplify the reception of socio-emotional content even when anthropomorphic cues are lacking; and the *identity heuristic*, which enables the user to affirm his identity on the medium.
- Next, **Interactivity affordance** communicates greater sense of cohesiveness and contingency determining a robuster flow of interaction. Some of the cognitive heuristics that Interactivity affordance can trigger are the *interaction heuristic*, which suggests that the medium is able to register user's inputs; the *responsiveness heuristic*, which accounts for the dynamism of the medium; and the *control heuristic*, which provides the user with a higher sense of information quality.
- Lastly, **Navigability affordance** refers to the design of the interface and the organisational arrangement of information. Specifically, it can trigger the *browsing heuristic*, which suggests that the user take a glance at the site; the *scaffolding heuristic*, which allows users to understand the role of navigational aids; or the *play heuristic*, enabling escapism and an enjoyable user experience.

The MAIN model represents a powerful and non-exhaustive framework that supports an heuristic-based approach to the understanding of the impact of affordances in new-media environments.

Following Sundar's (2008) conclusions, **heuristics** provide valuable insights for design decisions concerning new digital devices, as they account for people's perspective and manage to provide psychologically meaningful decisions for specific target users.

Summary

AFFORDANCE	HEURISTIC	QUALITY
MODALITY	Realism Old media Being there Distraction Bells & Whistles Coolness Novelty Intrusiveness	Utility Importance Relevance Believability Popularity Pedigree Completeness Level of detail Variety Clarity Understandability Appearance Affect Accessibility Conciseness Locatability Representative quality Consistency Compatibility Reliability Trustworthiness Uniqueness Timeliness objectivity Expertise Benevolence
AGENCY	Machine Bandwagon Authority Social presence Helper Identity	
INTERACTIVITY	Interaction Activity Responsiveness Choice Control Telepresence Flow Contingency Similarity	
NAVIGABILITY	Browsing Elaboration Scaffolding Play Prominence Similarity	

06
Existing Classifications of Social Cues

This chapter explores existing classifications of social cues applied to human-human, human-robot, and human-computer interaction, highlighting their implications and limitations.

06.1
Social Cues in HHI

SOCIAL CUES IN INTERPERSONAL COMMUNICATION

Over time, research in interpersonal communication has contributed to various classifications of social cues. To name a few, **Trager** (1958), **Crystal** (1969), and **Laver** (1980) offered an early classification of nonverbal vocal cues; in 1976, **Leathers** split interpersonal communication by framing verbal and nonverbal communication systems, the latter divided into **visual**, **auditory**, and **invisible subsystems** (Leathers, 1976; Leathers and Eaves, 2015). Following Leathers, each of the four subsystems is responsible for the formation and transmission of different intents in interpersonal communication.

In 1978, **Burgoon and Saine** identified codes to classify nonverbal behaviours: (a) **haptics**, the use of touch, (b) **kinesics** (eye, head, and body movement), (c) **proxemics**, the use of space, (d) **vocalics**, voice characteristics in addition to verbal content, (e) **physical appearance**, (f) **chronemics**, the use of time, and (g) **artefacts**, aspects of the environment as well as personal accessories (Burgoon & Saine, 1978).

Worthy of an in-depth examination is **social signal processing**, the computing domain designed to model, analyse, and synthesise social signals in human–human and human–machine interactions (Pentland, 2007; Vinciarelli et al., 2008, 2012; Vinciarelli, Pantic, & Bourlard, 2009).

06.2
Social Signal Processing

In 2009, **Vinciarelli et al**. framed the **social signal processing** (SSP) approach to investigate how social cognition is related to the interpretation of social cues in human-human interaction.

First, the researchers defined a taxonomy of social cues and each was associated with some of the most relevant social behaviours. Specifically, the five categories of social cues are **physical appearance**, **gestures and postures**, **face and eye behaviour**, **vocal behaviour**, and s**pace and environment**; in addition, the seven social behaviours are **emotion**, **personality**, **status**, **dominance**, **persuasion**, **regulation** and **rapport**.

In literature, the terms **social signal** and **social behaviour** are often used interchangeably, despite the fact that social signals are shorter in duration and are strongly influenced by context and temporal disposition as they evolve dynamically over time (Goleman, 2006; Vinciarelli et al., 2012).

PHYSICAL APPEARANCE

First, physical appearance includes **height**, **attractiveness**, and **body shape**. Each of the three subcategories of cues can communicate dominance, while status can be sensed by height and attractiveness. **Attractiveness** also has a great influence on social perception and can convey personality, persuasion, and rapport; in fact, it has the ability to trigger the **halo effect**, implying that when it is present other qualities will also be valued.

Similar to **Fogg's** (2003) investigation of social cues in a human-computer scenario, attractive computer technologies might be perceived as more persuasive than their unattractive counterparts, and personas targeting consulting, advertising, or training would have to be preferentially attractive to be effectively persuasive.

In addition, different **body shapes** (somatotypes) can elicit the attribution of specific personality traits (Cortes et al., 1965). For example, **endomorphic individuals** tend to be perceived as friendlier but more reliant on others; **mesomorphic individuals**, in contrast, are likely to be perceived as more independent and mature; finally, **ectomorphic individuals** are prone to be perceived as more opinionated and uptight. According to Knapp et al. these attributions are **stereotypical**, although they play a significant role in influencing perceptions.

By 2009, only a few papers had addressed the problem of analysing people's physical appearance, including measuring symmetry to automatically assess beauty (Aarabi et al., 2001), according to the researchers.

GESTURES AND POSTURE

Second, **gestures and posture** cover **hand gestures**, **posture**, and **walking**. Posture plays an important role in communicating social behaviours, as it can be **inclusive** or **non-inclusive** and **face-to-face** or **parallel**. The former implies that facing in the opposite direction from others is a sign of non-inclusiveness, while the latter implies that face-to-face interactions are more engaging than sitting parallel (Chartrand et al., 1999).

In addition, postural behaviour includes **walking**, which can convey status, dominance, or personality. However, postures can also be assumed unconsciously and yield reliable information about people's dispositions in social interactions.

According to previous research (McNeill, 1996), 90% of body gestures are associated with speech; however, gestures are also used for regulating interactions, enhancing meanings, punctuating, and greeting (Morris, 2007), although they can sometimes reveal aspects of someone's attitude (Richmond et al., 1995).

By 2009, research efforts in gesture recognition were headed mostly toward using gestures as alternative keyboards (Oviatt, 2003) or automatic sign language reading (Ding et al., 2007).

Automatic posture recognition has been addressed in a few articles, mostly aimed at surveillance (Gandhi et al., 2007) and task recognition (Forsyth et al., 2006). In a few cases, **posture** has been analysed as a measure for social signalling, notably in 2003 by Mota et al. to estimate the interest level of children new to computers, and to recognise people's emotional state (De Silva et al., 2004).

FACE AND EYE BEHAVIOUR

Next, **face and eye behaviour** carry **facial expressions**, **gaze behaviour**, and **focus of attention**. The face is a crucial multi-signal apparatus for interpersonal communication (Keltner et al., 2000), that brings flexibility and specificity; in addition, personality, attractiveness, age, and gender can be ascertained from the face itself (Ambady et al., 1992).

Two main approaches to measuring facial behaviour in psychological research are **message-judgment** and **sign-judgment** (Cohn, 2005). Specifically, the message-judgment approach aims to infer what underlies a certain facial expression; the most frequent descriptors in this approach are **Ekman's** six basic emotions (fear, sadness, happiness, anger, disgust, and surprise).

In contrast, **sign-judgment** is a more objective approach that attempts to label facial movements by associating changing facial expressions with the actions of the underlying muscles. Because the latter method is comprehensive and free of interpretation, it allows the discovery of new patterns related to emotional or situational states.

By 2009, no efforts on automatic recognition of social behaviours in spontaneous facial behaviour recordings were reported. While older methods for analysing facial behaviour employ simpler approaches including machine learning to classify relevant information into evaluative categories, newer methods employ probabilistic and statistical methods (Pantic et al., 2007).

NONVERBAL VOCAL BEHAVIOUR

In addition, **nonverbal vocal behaviour** includes all spoken cues that surround the verbal message and influence its actual meaning. **Voice quality**, **linguistic** and **nonlinguistic vocalisations, silences**, and **turn-taking patterns** are subcategories of nonverbal vocal behaviour that contribute to different aspects of the perception of a message as social.

Voice quality relates to prosody, that is, pitch, tempo, and energy (Crystal et al., 1969). **Prosody** relates to how something is said, and conveys socially meaningful cues; for instance, energy outbursts can accompany emotions (Scherer, 2003), **pitch** can communicate dominance and extroversion, while **fluency** can influence perceived competence and persuasiveness (Scherer, 1979).

Next, **segregates** are used to substitute words and to accompany someone else's speech; in the latter case, they might express attention or agreement (Shrout et al., 1981).

Non-linguistic vocalisations provide information about someone's attitude in a social interaction; for example, **laughing** is associated with desirable social behaviour (Keltner et al., 1999) while **crying** may be involved in mirroring (Chartrand et al., 1999). Finally, **silence** may be associated with social behaviours such as emotion, status and rapport.

By 2009, no effort was made to measure non-linguistic vocalisations, with the exception of laughter because of its pervasiveness in social interactions (Kennedy et al., 2004) and crying (Möller et al., 1999).

SPACE AND ENVIRONMENT

Finally, **space and environment** include **distance** and **seating arrangements**. Interactions are influenced by the characteristics of the environment, and the type of relationship established between individuals determines their interpersonal distance.

Reciprocal distances are culturally dependent and are commonly measured according to four concentric areas, namely, the **intimate zone**, the **casual-personal zone**, the **social-conscious zone**, and the **public zone** (Aiello et al., 1974).

- In the case of Western Europe and the United States, the **intimate zone** corresponds to a distance of 0.4-0.5 m and suggests close friendships and family;
- The **casual-personal zone** varies between 0.5 and 1.2 m and includes familiar individuals such as colleagues and friends;
- The **social-consultative zone** can be identified between 1 and 2 m and includes formal relationships;
- Finally, the **public zone** reaches beyond 2 m and is outside the interaction (Aiello et al., 1974).

Seating arrangements are also an indicator of social behaviour and reciprocal perception: dominant individuals tend to sit in positions that provide greater visibility and control (Russo, 1967).

By 2009, video surveillance approaches as well as proximity sensing devices were used to track people in public space and detect social signals. Specifically, the most common sensors used to extract behavioural cues have been microphones and cameras at various levels of complexity (Eagle et al., 2006), as well as measures of physiological activity (Gunes et al., 2008) and neurological activity such as fMRI (Montague et al., 2002) and EEG (Uddin et al., 2007).

Nevertheless, privacy and intrusiveness are two important issues addressed by the field of human sensor research, as they involve both ethical issues and the need for passivity to avoid altering the behaviour of recorded individuals.

Summary

SOCIAL CUES		SOCIAL SIGNALS	REFERENCES
PHYSICAL APPEARANCE	Height	Status, dominance	*Gladwell et al. (2005)*
	Attractiveness	Personality, status, dominance, persuasion, rapport	*Dion et al. (1972)* *Fogg (2003)*
	Body shape	Personality, dominance	*Cortes et al. (1965)*
GESTURE AND POSTURE	Hand gestures	Emotion, personality, persuasion, regulation, rapport	*McNeill (1996)* *Morris (2007)* *Richmond et al. (1995)*
	Posture	Emotion, personality, status, dominance, persuasion, regulation, rapport	*Chartrand et al. (1999)*
	Walking	Personality, status, dominance	
FACE AND EYES BEHAVIOUR	Facial expressions	Emotion, personality, status, dominance, persuasion, regulation, rapport	*Keltner et al. (2000)* *Ambady et al. (1992)*
	Gaze behaviour	Emotion, personality, status, dominance, persuasion, regulation, rapport	
	Focus of attention	Emotion, personality, status, dominance, persuasion, regulation, rapport	

SOCIAL CUES		SOCIAL SIGNALS	REFERENCES
VOCAL BEHAVIOUR	Prosody	Emotion, personality, dominance, persuasion, rapport	*Crystal et al. (1969)* *Scherer (1979)* *Scherer (2003)*
	Turn taking	Emotion, personality, status, dominance, regulation, rapport	*Shrout et al. (1981)* *Keltner et al. (1999)* *Chartrand et al. (1999)*
	Vocalisations	Emotion, personality, dominance, persuasion, regulation, rapport	
	Silence	Emotion, status, rapport	
SPACE AND ENVIRONMENT	Distance	Emotion, personality, status, persuasion, rapport	*Aiello et al. (1974)*
	Seating arrangement	Dominance, persuasion, rapport	

06.3
Social Cues in HCI and HRI

Related work in human-computer and human-robot interaction has consistently given insights into cues to be employed for specific technology domains and application contexts.

1. In 2000, **Cassell et al.** defined the dimensions that conversational agents can assume by differentiating whether the appearance of an embodied conversational agent is **animated**, **photorealistic**, **stable**, **2D** or **3D**, or **humanoid** (Cassell et al., 2000).

2. As it will be seen more fully in the following section, **Fogg** (2003) also extended the classification of social cues initialised by Nass et al. (1996) by identifying five primary types of social cues that can be found in persuasive computational technology: **physical**, **psychological**, **language**, **social dynamics**, and **social roles**.

3. In 2005, **Cowell and Stanney** surveyed empirical studies of nonverbal cues and provided a classification of them for embodied conversational agents designed to assess their credibility according to **origin** (i.e., non-behavioural, behavioural) and **individual control of the social cue** (i.e., low, high) (Cowell and Stanney, 2005).

4. **Walther** (2006) studied the field of computer-mediated communication by structuring nonverbal cues into **interpersonal communication** (e.g., chronemics) and **technology reintroduced communication** (e.g., 2D avatars, anthropomorphic icons).

5. Similarly, in 2017 **Fox and McEwan** reviewed the perceived social affordances of computer-mediated communication channels scale, an important contribution to aid the prediction of perceived affordances by exposing the hypothesis that lean media does not necessarily lead to insufficient emotional transmission.

6. **Affordances** were also explored in depth by **Sundar** (2008) who framed the **MAIN model** in an attempt to propose guidelines for identifying affordances across media to determine and increase their credibility. According to the MAIN model, a given digital medium incorporates cues that convey a specific affordance, which in turn triggers cognitive heuristics and allows the perceiver to assess the credibility of the medium.

In addition, human-robot interaction research has focused on modeling robot social cues:

1. In 2011, **Hegel et al.** proposed a taxonomy of social cues for robots emphasising the importance of distinguishing between **social cue** and **social signal**, **designer intention** (i.e., explicit, implicit), **sign source** (i.e., human, artificial), and **perceptual type** (i.e., appearance, auditory, olfactory, tactile, motion).

2. In 2013, **Fiore et al.** extended the **SSP** model by suggesting that it should be leveraged to better understand how social cues and signals influence the perception of robots as social agents, and studied the role of **proxemics** and **gaze** to help define requirement-specific robots.

3. **Feine et al.** (2019) published a **taxonomy of social cues** strongly inherent to conversational agents, starting with a literature review of social cue classifications made up to that point. The researchers provided a comprehensive and easy framework for researchers to use to systematically classify their findings. The taxonomy, as it will be explored in a later section, is modelled after **Leathers**' (1976) nonverbal interpersonal communication system composed of visual, auditory, and invisible subsystems.

4. **Lombard and Xu's** (2021) case is the only one that considers social cues independently of the medium that incorporates them, in contrast to previous researchers who focused more narrowly on medium-specific cues. Rather, the MASA paradigm expands directly from the CASA paradigm and focuses on the term media technology in broader terms. The researchers suggested that social cues could be categorised by **quality** and **quantity**; specifically **primary** and **secondary cues** could elicit different social responses in people.

06.4
BJ Fogg's Classification of Social Cues

Taking into account the user perspective, **Fogg** (2003) extended the classification of social cues initialised by his colleagues, and identified five primary types of social cues that induce people to make inferences about social presence in computational technology: **physical**, **psychological**, **language**, **social dynamics** and **social roles**.

PHYSICAL CUES

Physical cues (**face**, **eyes**, **body**, and **movement**) are sufficient to alter the social influence of a computer character. According to Fogg (2003), visually attractive computer technologies can have more persuasive power than their unattractive counterparts; computer personas targeting **consulting**, **advertising**, or **training** should preferably be attractive to be effectively persuasive. However, since attractiveness is a subjective quality, designers must first understand the aesthetic expectations of their target audience.

PSYCHOLOGICAL CUES

Psychological cues (**preferences**, **humour**, **personality**, **feelings**, **empathy**, and **sorry**) can lead people to assume, often unconsciously, that the product has emotions, preferences, motivations, and personality. Specifically, psychological cues can be basic or complex, communicating empathy or personality, respectively.

As stated by Fogg (2003), the **principle of similarity** applies to psychological cues, in the way that similar technological artefacts are received more favourably by users. The link between personality and the similarity-attraction rule was discovered by Nass and Moon (2000), assigning to mindless cognitive processes the responsibility for the overextension of the concept of shared genes.

LANGUAGE CUES

The persuasive use of language becomes apparent via the use of **language cues** (**interactive language use**, **spoken language**, and **language recognition**), which are able to convey social presence and to persuade in the form of either written or spoken text.

As reported by Fogg (2003), by offering praise through words, symbols, or sounds, computer technology can cause people to receive persuasion more openly.

THE EFFECTS OF COMPUTERS THAT FLATTER
Nass and Fogg, 1997

Fogg's principle of **praise** derived from an experiment conducted by **Nass and Fogg** himself in 1997, which was aimed at exploring the consequences of flattery and praise by running a game between a computer and a participant. The experimental setting called for participants to be divided into two groups, one of which was told they would receive highly accurate feedback (**praise**), while the other was told they would receive completely random feedback (**flattery**). According to their findings, positive feedback increased the user's perception of their own performance, regardless of whether the feedback was actually genuine (Nass and Yen, 2012).

As demonstrated by Schrauf and Sanchez (2004), only 20% of typical words in English or Spanish have a completely neutral connotation, compared to 50% of negative-oriented words and 30% of positive-oriented words. Hence, language is rarely neutral and can have either a positive or negative influence on the receiver.

SOCIAL DYNAMICS CUES

Next, **social dynamics cues** (**turn taking**, **cooperation**, **praise** for good work, **answering questions**, and **reciprocity**) reflect patterns of interaction between people and are culturally dependent. For this set of cues, Fogg explained the principle of **reciprocity** to demonstrate the potential for using technology to leverage social dynamics (Fogg, 2003).

As widely described above, in 1997 **Nass and Fogg** conducted a **reciprocity** study to examine whether the behavioural rule still applied after a computer had provided help. According to their findings, people would feel the need to reciprocate when computing technology had done a favour for them.

SOCIAL ROLES CUES

Finally, **filling social roles** (**doctor**, **teammate**, **opponent**, **teacher**, **pet**, and **guide**) enhances the persuasive power of computing technology. In particular, computers could take on authority roles to gain more influence when providing information or making suggestions; in particular, authority roles such as **teachers**, **referees**, **counsellors**, or **experts**.

Picking up on the 1996 experiment conducted by researchers Nass et al., perceived **expertise** (knowledgeability) and **trustworthiness** (dependability) combined determine the degree to which the agent is persuasive (Nass & Yen, 2012), and just being identified as an expert causes the agent to be perceived as more compelling and accurate.

According to Fogg (2003), however, authority roles are not the only ones that hold influential power: in fact, roles as **friends**, **entertainers**, or **adversaries** could be effective even without leveraging power status. Specifically, for computers in social roles, it is important to be aware of the role model to be embodied to avoid counterproductive results. As Fogg concluded, the quantity and quality of social cues, as well as their appropriate use, should be of interest to designers and engineers.

Summary

CATEGORY OF SOCIAL CUES	SOCIAL CUES
PHYSICAL CUES	Face, eyes, body, and movement (Fogg, 1997).
PSYCHOLOGICAL CUES	Preferences, humour, personality, feelings, empathy, and sorry (Fogg, 1997).
LANGUAGE	Interactive language use, spoken language, and language recognition (Fogg, 1997).
SOCIAL DYNAMICS	Turn taking, cooperation, praise for good work, answering questions, and reciprocity (Fogg, 1997).
FILLING SOCIAL ROLES	Doctor, teammate, opponent, teacher, pet, and guide (Fogg, 1997).

06.5

SSP for Human-Robot Interaction

According to **Fiore et al.** (2013), **SSP** should be leveraged to better understand how social cues and social signals influence one's perception of robots as social agents, thus allowing for an understanding of agent intentions. Specifically, the purpose of their research was to investigate how social cues were translated into social signals and, at a practical level, to provide recommendations that could help engineers and designers create requirement-specific robots.

Researchers have argued that the degree to which a robotic agent is able to demonstrate social presence depends on the social signals that the social cues convey, and how these signals are interpreted by the observer.

SOCIAL PRESENCE THEORY
Biocca and Harms, 2002

Social presence theory describes the process by which humans understand the intentions of others, focusing more specifically on the interactions between humans and artificial agents (Biocca and Harms, 2002).

For this reason, the degree to which a robotic agent displays social cues affects its social presence and provides a rough indication of the extent to which humans are able to understand its intentions. Specifically, Fiore et al.'s study (2013) examined changes in perceptions over time and multiple interactions. The undergraduate students involved in the study were asked to cross a hallway, and halfway they would encounter the robot coming from the other end.

Although the sample of participants was not representative of the entire population, where individual factors could have resulted in different dispositions towards the agent, the context in which the experiment took place demonstrated **ecological validity** as it was conducted in a real-world setting.

GAZE AND PROXEMIC BEHAVIOUR

Researchers focused on the handling of two observable physical cues, namely **gaze** and **proxemic behaviour**.

As it was introduced at the beginning of the chapter, **gaze** is a visual behaviour used as a cue for understanding the actions, intentions, and mental states of others (e.g., Kleinke, 1986; Baron-Cohen et al., 1995), whereas **proxemic behaviour** is representative of the relationship between two individuals in that it specifies their spatial distance, which can be intimate, casual-personal, socio-consultive, and public (Aiello et al., 1974).

Figure 16
iRobot, Ava 500 (2013)

ASSERTIVE OR PASSIVE PROXEMIC CONDITIONS?

Specifically, **Fiore et al.** (2013) programmed an **assertive** and a **passive proxemic condition**.

According to their results, when the robot acted **passively**, it was perceived by participants as being more socially present. The researchers argued that the reason for this result was that it appeared as if the robot considered social rules of politeness. Furthermore, the perception of **social presence** was found to increase during repeated interactions, regardless of the robot's demonstration of social cues.

Notably, **gaze** seemed to have relevance only when it was coupled with the proxemics variable in the scenario.

In conclusion, the researchers argued that engineers and designers should take into account the changing relevance of social cues depending on the context and desired affordances, which is likely to alter the perception of robots as social agents.

Exploiting cues that trigger more accurate associations and convey certain emotional states could allow users to more clearly understand and predict agent intentions in order to better perform collaboration, service, or performance tasks.

06.6
A Taxonomy of Social Cues for Conversational Agents

In 2019, **Feine et al.** conducted an iterative process of developing a taxonomy aimed at developing a comprehensive and straightforward classification of social cues for conversational agents. Delving into the existing literature, the researchers aimed to frame a tool that researchers could use to systematically classify their findings.

The taxonomy was created following **Leathers**' (1976) nonverbal communication systems, and included a three-tier hierarchy in which the highest order level included the distinction between **verbal cues**, **visual cues**, **auditory cues**, and **invisible cues**.

CATEGORY	SUBCATEGORY	SOCIAL CUES
VERBAL CUES Cues expressed with written or spoken words.	**Content** Cues that refer to the literal meaning of a message.	**Content cues** Greeting and farewells, refer to past, joke, small talk, self-disclosure, self-focused questions, express name, praise, opinion conformity, ask to start/pursue dialogue, excuse/apologise, thanking, tips and advice, and first turn.
	Style Cues that refer to the meaningful deployment of language variation in a message.	**Style cues** Formality, sentence complexity, lexical diversity, strength of language, and abbreviations.
VISUAL CUES Cues that can be seen (except words themselves).	**Kinesics** Cues that refer to all body movements of the agent.	**Kinesic cues** Arm and hand gestures, head movement, eye movement, facial expressions, posture shift.
	Proxemics Cues that refer to the role of space, distance, and territory in communication.	**Proxemic cues** Background and conversational distance.
	Agent appearance Cues that refer to an agent's graphical representation.	**Agent appearance cues** 2D/3D visualisation, gender, photorealism, facial features, clothing, name tag, attractiveness, colour of agent, degree of human-likeliness, and age.
	CMC Computer-mediated communication cues refer to visual elements that can augment or modify the meaning of a text-based message.	**CMC cues** Typeface and emoticons

CATEGORY	SUBCATEGORY	SOCIAL CUES
AUDITORY CUES Cues that can be heard (except words themselves).	**Voice qualities** Cues that refer to permanent and adjustable characteristics of speech.	**Voice qualities cues** Gender of voice, volume, pitch range, and voice tempo.
	Vocalisations Cues that refer to nonlinguistic vocal sounds or noises.	**Vocalisations cues** Whisper, laughing, vocal segregates, yawn, grunts, and moans.
INVISIBLE CUES Cues that cannot be seen or heard.	**Chronemics** Cues that refer to the role of time and timing in communication.	**Chronemic cues** Response time
	Haptics Cues that refer to tactile sensations on the user's body.	**Haptic cues** Tactile touch and temperature

Figure 17
A taxonomy of social cues for conversational agents (2019)

In order to validate the applicability of the taxonomy, the researchers used it as an **analytical framework** to demonstrate how it could be implemented on existing media. Specifically, they studied the social cues of a **text-based conversational agent** (Poncho on Facebook Messenger), a **voice-based conversational agent** (Amazon's Alexa), and a full **embodied conversational agent** (SARA).

APPLICABILITY STUDY ON A TEXT-BASED CONVERSATIONAL AGENT

For the analysis of **Poncho**, Feine et al. excluded auditory and kinesic cues as the chatbot did not communicate with audio and only had a static profile image; they also found that Poncho exhibited a number of **visual cues**, namely the name tag and a low degree of photorealism. Next, it portrayed **greetings**, an **informal conversational style**, and **low sentence complexity** for verbal cues. In total, the researchers identified **11 social cues** in Poncho's design.

Figure 18
Chatbot Poncho (2016)

APPLICABILITY STUDY ON A VOICE-BASED CONVERSATIONAL AGENT

For the analysis of **Alexa** (Amazon's Echo personal assistant), the researchers excluded visual cues and CMC because the conversational agent had no visual representation or text-based communication. In addition, they identified numerous **verbal cues** such as **telling jokes**, **greetings**, **farewells**, and **small talk**, while in terms of style they considered it **informal**.

In addition, many **auditory** and **verbal cues** were identified: for audio, the researchers found a specific **pitch range** and **voice tempo**, which could still be customised; Alexa was also found to **laugh** (Chokshi, 2018) and **whisper**. Finally, the researchers found **chronemics** as an invisible cue, which brought the total number of implemented social cues to **16**.

Figure 19
Speaker Alexa (2022)

APPLICABILITY STUDY ON A VIRTUALLY EMBODIED CONVERSATIONAL AGENT

Finally, **SARA** (Socially Aware Robot Assistant) is a virtually embodied conversational agent that serves as a **personal assistant** for conference participants. Feine et al. analysed SARA's social cues from the existing literature; specifically, they found that it exhibits a wide range of social cues. First, SARA was found to use **verbal cues** such as **greetings** and **goodbyes**, expressing a **name**, **self-disclosure**, **praise**, and **reference to the past**. In addition, her speaking style was described as formal, complex, and lexically diverse.

Regarding **visual cues**, the researchers recorded a comic-like and detailed 3D visual appearance; in addition, it used **arm and hand gestures**, **head movement**, **eye movement**, **facial expressions**, and **posture shifts**.

Regarding **auditory cues**, SARA had a qualitatively variable female voice and no vocalisations were found. Finally, **chronemic cues** such as pausing were identified, resulting in **24 total social cues** implemented in its design, which differs from previous examples in having a more realistic representation.

Figure 20
SARA (Socially Aware Robot Assistant) at World Economic Forum (2017)

In conclusion, Feine et al.'s (2019) taxonomy did not account for social signals, and the abstraction of cues was conducted at the highest perceivable level to allow designers to implement them. According to the researchers, further studies could delve into the subcategories of cues and investigate whether the taxonomy is applicable to other types of media and contexts.

06.7

Primary and Secondary Social Cues

THE MEDIA ARE SOCIAL ACTORS PARADIGM
Lombard and Xu, 2021

In 2021, **Lombard and Xu** proposed **the Media are Social Actors paradigm** as an extension of the original CASA paradigm in an attempt to make a qualitative and quantitative distinction between social cues, arguing that their effect on social responses is determined by individual differences and contextual factors.

The new paradigm was introduced as an attempt to answer two open questions raised by Nass and Moon (2000), the first being why mindless behaviour occurs and the second being what constitutes a sufficient number of social cues and which dimensions of technology are most likely to elicit social responses.

Regarding the first question, it was already examined their model of **mindful and mindless anthropomorphism**. Regarding the second question, however, Lombard and Xu (2021) proposed a classification between **primary and secondary social cues** that provides comprehensive guidelines for assessing the quality and quantity of cues.

QUANTITY AND QUALITY OF SOCIAL CUES

The issue of the importance of the **quantity and quality of social cues** for designers was first raised by **Fogg**, concluding the chapter "Computers as Persuasive Social Actors" in his book "Persuasive Technologies: Using Computers to Change What We Think and Do," which recommended their appropriate use.

More specifically, Lombard and Xu (2021) argued that when media incorporate social cues of high quality and quantity mindless anthropomorphism is triggered, however, media need not exhibit social cues to be perceived as a source of social interaction.

For example, cases in which media do not exhibit strong social cues but a high social presence is still perceived are justified by **mindful anthropomorphic associations** in which individuals consciously attribute human characteristics to technologies.

Primary cues are the most relevant to human perception because responses toward this category are derived from evolutionary and biological biases toward human-like characteristics. According to the researchers, primary cues are a sufficient but not necessary condition for eliciting social responses: these primary cues are **facial expression**, **eye gaze**, **gestures**, **human-sounding voice**, and **human or animal shape**.

Secondary cues, on the other hand, are less relevant in aiding people's perception of socialness and do not always produce social responses; these cues are **human or animal size**, **language use**, **motion**, or **machine-sounding voice**.

PRIMARY CUES

As mentioned above, according to Lombard and Xu (2021), primary cues mainly focus on nonverbal cues, but also include verbal cues and are: **facial expression**, **eye gaze**, **gestures**, **human-sounding voice**, and **human or animal shape**.

1. First, past research has argued that the **face** is a powerful multimodal tool for social perception (Vinciarelli et al., 2009) and for communicating personality, attractiveness, age, and gender (Ambady et al., 1992). **Eye gaze** communicates social signals of attention, emotion, or recognition (Andrist et al., 2015; Fink & Penton-Voak, 2002), and can be used as a cue to understand the actions, intentions, and mental states of others (e.g., Kleinke, 1986; Baron-Cohen et al., 1995).

2. Second, **gestures** serve as nonverbal cues that complement spoken communication (Krauss et al., 1996) and reveal unconscious aspects of someone's disposition (Richmond et al., 1995).

According to **Salem et al.** (2013), technologies designed with mobile and limb components that imply social rituals and intentions are able to evoke social perception. In their 2015 study, **Bevan and Fraser** found that allowing participants to shake the NAO robot's hand before a negotiation task led to increased cooperation.

3. Next, **human-sounding voice** has led to greater effects than speech from machine-sounding speech in evoking social responses (Chérif & Lemoine, 2019; Chiou et al., 2020; Xu, 2019), and serves as an extension of the body in everyday interactions with voice assistants (e.g., Siri).

4. Lastly, **human-like and animal-like shape** of technologies has been effective in making technologies more appealing; the 2006 study by **Fadiga et al.** involved using fMRI to measure brain activity and found that observing animal-like shadows activated brain waves and physiological reactions similar to decoding human speech.

SECONDARY CUES

Secondary cues, on the other hand, are not always effective in triggering social responses. They are: **human or animal size**, **language use**, **motion**, and **machine-sounding voice**.

1. For **size**, an experiment conducted in 2009 by **Walters et al.** found that shorter robots lead to greater closeness in approach than taller robots, however the effect faded with repeated interactions. It could be argued that this effect is consistent with **Cortes et al.'s** (1965) stereotypically biased attribution of specific **personality traits** to body shapes highlighted by **Vinciarelli et al.** (2009), stating that **endomorphic** (round, fat, and soft) individuals tend to be perceived as more friendly while **ectomorphic** (tall, thin, and frail) individuals are prone to be perceived as more tense.

2. Second, effects on **language use** depend on variations in language; for instance, **informal**, **friendly**, and conversational language, as well as language with segregated, self-referential terms, has been

found to be more expressive and suggestive than cold, monotonous, and formal language (Goble & Edwards, 2018; Hoffmann et al., 2020; Sah & Peng, 2015).

3. Next, **motion** in compliance with social rituals has been found to have social power in anticipating agents' purpose, mental states, and social disposition, compared to random movement (Hoffman & Ju, 2012; Xu, 2019). As learned with the experiment by **Fiore et al.** (2013), the robot crossing the hallway in a passive condition was perceived to be more socially present than when it was assertively behaving as if it were adhering to social rules of politeness.

4. Finally, **machine-sounding voice** has been found to generate less social presence than human-sounding voice (Chérif & Lemoine, 2019), although the level of sociality attributed to technology depends on the relationship between the technology and its users (Wang, 2017). For example, it can be argued that the potential for **personalisation** and **diversification** of ringtones and reminders, as well as alarms, suggest that users have grown to interpret them as **social actors**.

5. According to the researchers, other socially relevant cues include **olfactory cues** (Chen, 2006), **haptic cues** (Blakemore, 2016; Li et al., 2017), **interpersonal distance** (Syrdal et al., 2006; Takayama & Pantofaru, 2009; Walters et al., 2009), and **degree of flexibility** (Duffy & Zawieska, 2012).

THE ASPECIFICITY OF THE MASA PARADIGM

It is worth noting that **Lombard and Xu's** (2021) case is the only one that considers social cues independently of the medium that incorporates them, in contrast to previous researchers who focused more narrowly on medium-specific cues. Rather, the MASA paradigm expands directly from the CASA paradigm and focuses on the term media technology in broader terms.

Furthermore, it can be argued that the distinction between primary and secondary cues is both qualitative and quantitative, meaning that researchers examined the existing literature to indicate which cues were most likely to elicit social responses.

In contrast, Vinciarelli's (2009) SSP, as well as Fogg's (2003) classification and Feine et al.'s (2019) taxonomy focused on a strictly quantitative approach, of which the latter proposed a hierarchy of specificity.

Summary

CATEGORY OF SOCIAL CUES	SOCIAL CUES	REFERENCES
PRIMARY SOCIAL CUES	Facial expression	*Vinciarelli et al. (2009) Ambady et al. (1992)*
	Eye gaze	*Andrist et al. (2015); Fink & Penton-Voak (2002); Kleinke (1986); Baron-Cohen et al. (1995)*
	Gestures	*Krauss et al. (1996) Richmond et al. (1995) Salem et al. (2013); Bevan and Fraser (2015)*
	Human-sounding voice	*Chérif & Lemoine (2019) Chiou et al. (2020) Xu (2019)*
	Human-like or animal-like shape	*Fadiga et al. (2006)*
SECONDARY SOCIAL CUES	Human or animal size	*Walters et al. (2009) Cortes et al. (1965) Vinciarelli et al. (2009)*
	Language use	*Goble & Edwards (2018); Hoffmann et al. (2020); Sah & Peng (2015)*
	Motion	*Hoffman & Ju (2012) Xu (2019); Fiore et al. (2013)*
	Machine-sounding voice	*Chérif & Lemoine (2019) Wang (2017)*

06.8
Social Signals

As introduced at the beginning of the section, **social signals** differ from **social cues** in that they are semantically superior to social cues and are emotionally, cognitively, socially, and culturally based (Streater et al., 2012). Furthermore, social signals evolve from social cues as the latter are consciously or unconsciously interpreted, triggering a social response in the user (Knapp et al., 2013; Nass and Moon, 2000; Vinciarelli et al., 2012).

The terms **social signal** and **social behaviour** are often used interchangeably, despite the fact that social signals are shorter in duration and are strongly influenced by context and temporal disposition as they evolve dynamically over time (Goleman, 2006; Vinciarelli et al., 2012).

Specifically, the sequence of cues over time and the imitation of social cues displayed by other agents can influence the social signals transmitted (Campano et al., 2015; Lamolle et al., 2005; Prepin et al., 2013; Youssef et al., 2015).

A CLASSIFICATION OF SOCIAL SIGNALS
Lombard and Xu, 2021

According to **Lombard and Xu** (2021), combinations of primary and secondary social cues could abstract human features and constitute the social signals of **interactivity/responsiveness**, **perceived personality**, **social identity**, **companionship**, **uniqueness**, and **health status/life span**.

1. First, **interactivity** may include eye contact, the nodding and smiling of a physically embodied robot, or the response time of a chatbot, or the contingency of a message (Jung et al., 2014; Lew et al., 2018).

   It is worth reprising **Sundar's** (2008) **MAIN model**, which consolidated a set of guidelines for identifying affordances across media to determine their credibility. According to the MAIN model, most digital media convey to some degree the technological affordances of Modality (M), Agency (A), Interactivity (I), and Navigability (N).

   The affordance of **interactivity**, as understood above, communicates the contingency and robust flow of interaction, primarily activating the **heuristics of interaction**, **responsiveness**, and **control** that allow the user to recognise how well the medium is able to dynamically register and respond to user input, increasing the user's sense of perceived control.

   A follow-up study conducted by **Kim and Sundar** (2012) found that a **high level of interactivity** and the presence of **anthropomorphic elements** on a website unconsciously increased users' sense of social presence.

2. Subsequently, **perceived personality** may include speech styles, vocal features, movements, and proximity (Mou et al., 2020), while **social identity** can be achieved by triggering a sense of belonging, e.g., providing same-nationality suggestions (Hogg & Abrams, 1988; Kuchenbrandt et al., 2013).

   It can be argued that **same-nationality** stems from the similarity-attraction rule that explains how people are likely to make positive associations to those who share similar characteristics with them (Nass & Moon, 2000).

3. **Companionship** may include physical presence, sound, or touch. Early research suggested that the ritual of watching television was more associated with the object itself rather than what it showed (Rubin, 1983).

   It can be argued that identifying technology as a companion is an act of anthropomorphising; in fact, **Wang** (2017) found that social factors such as **chronic loneliness** were associated with stronger anthropomorphising tendencies.

4. In addition, technologies can also be perceived as **unique** because of their potential for **personalisation**; for example, many mobile devices ask users to name them, or allow for the customisation of ringtones and outer shells, as well as provide context-aware information through location enablement (Choi et al., 2017).

5. Finally, obsolete technologies that have reached the end of their **lifespan** can be revolutionised and repurposed (Lechelt et al., 2020).

Summary

SOCIAL CUE(S)	SOCIAL SIGNAL	REFERENCES
Eye movement, head movement, facial expression, response time, and message contingency	**INTERACTIVITY**	*Jung et al. (2014)* *Lew et al. (2018)*
Voice qualities, vocalisations, kinesics, proxemics	**PERSONALITY**	*Mou et al. (2020)*
Name tag, nationality	**SOCIAL IDENTITY**	*Hogg & Abrams (1988)* *Kuchenbrandt et al. (2013)*
Tactile touch, sound, physical presence	**COMPANIONSHIP**	*Rubin (1983)*
Name tag, customisation	**UNIQUENESS**	*Choi et al. (2017)*
Out-of-service	**LIFESPAN**	*Lechelt et al. (2020)*

Figure 21 (right)
Classification of other literature-derived social cue/social signal associations

Other Literature-Derived Social Cue/Social Signal Associations

SOCIAL CUE(S)	SOCIAL SIGNAL	REFERENCES
Eye gaze (eye movement)	**ATTENTION, EMOTION, OR RECOGNITION**	*Andrist et al. (2015)* *Fink & Penton-Voak (2002)*
Smile (facial expression)	**POLITENESS, CONTENTEDNESS, JOY OF SEEING A FRIEND, IRONY/ IRRITATION, EMPATHY, GREETING, DOMINANT OR SUBMISSIVE PERSONALITY**	*Carolis et al. (2004)* *Youssef et al. (2015)* *Vinciarelli et al. (2009)*
Greeting, nodding (head movement), smile (facial expression), arm and hand gestures	**AGREEMENT**	*Bevacqua et al. (2010)* *Pelachaud (2009)*
Choice of words	**POLITENESS**	*Mayer et al. (2006)*
Excuse	**EMPATHY**	*Klein et al. (2002)*
Interaction order, strength of language, confidence	**PERSONALITY/MATCHING PERSONALITY**	*Nass et al. (1995)*
Gender of voice	**BIOLOGICAL GENDER AND GENDER STEREOTYPING**	*Nass et al. (1997)*
Head movement, facial expression, eye movement, gestures	**BELIEFS, INTENTIONS, AFFECTIVE STATE, AND MENTAL STATE**	*Pelachaud (2005)*
Head movement, smile, facial expression, eye movement, vocal segregates, vocalisation, voice tempo, pitch range	**MEANINGFUL MULTIMODAL BACKCHANNELS (E.G., AGREEMENT, REFUSAL)**	*Bevacqua et al. (2010)*

06.9

Review of the Classifications and a Note of Caution

COLLECTIVE EXHAUSTIVENESS OF THE TERMS

Importantly, the relationship between **social cues**, corresponding **social signals**, and resulting social reactions are not causally determined; specifically, a social cue and a signal are not mutually exclusive, but rather a single social cue can lead to multiple social signals (Carolis et al., 2004) and a social signal can result from a collection of social cues (Bevacqua et al., 2010; Pelachaud, 2009).

CONTEXT-DEPENDENCY OF SOCIAL CUES

Delving into the **context-dependency** of the interpretation of social cues, it is sufficient to suggest that in most Western cultures, vertical nodding is generally perceived as agreement, whereas in Bulgaria, this social cue is interpreted differently and signifies disagreement (Andonova and Taylor, 2012); conversely, in South Asian cultures and particularly in India, head wobbling sideways as a form of nonverbal communication can signify yes, good, maybe, okay, or I understand, depending on the context (Lewis, 2008).

In addition, a **smile** could be an indicator of politeness, serenity, irony, or greeting, among others. Even postures, while generally corresponding to social attitudes, are sometimes just a matter of convenience; or **physical distances**, which typically represent social distances, are sometimes just determined by spatial limitations (Chartrand et al., 1999). Therefore, to determine the communicative intent conveyed by an observed behavioural cue, it is critical to understand the context in which the cue was displayed.

ECOLOGICAL VALIDITY OF THE STUDIES EXPLORED

However, most of the studies covered so far **lack ecological validity**, which means that the laboratory setting in which the experiments were conducted bears the problem of generalisability and lacks universality. In addition, it can be argued that the findings are limited to the medium used during experimentation, so delineating inclusive rules is hardly attainable.

The only attempt to delineate a full range of social cues is the case of **Lombard and Xu** (2021), in which **primary and secondary cues** were delineated independently of the medium incorporating them, in contrast to previous researchers who focused more narrowly on medium-specific cues. As a downside, however, it can be said that this approach, while inclusive, **lacks specificity**.

SUBJECTIVENESS VS OBJECTIVENESS OF THE RESULTS

Furthermore, it can be argued that **Lombard and Xu's** (2021) distinction between primary and secondary cues is both **quantitative** and **qualitative**, if not **subjective**, as the researchers reviewed the existing literature to indicate which cues were most likely to elicit social responses, depending on the success or failure of the experiments themselves.

In contrast, **Vinciarelli's** (2009) SSP, as well as **Fogg's** (2003) classification, and **Feine et al.'s** (2019) taxonomy focused on a strictly **quantitative approach**, of which the latter proposed a hierarchy of specificity.

More specifically, one could argue that research on social cues has moved in multiple directions: for example, one can identify focal points on observable behaviours (Vinciarelli et al. 2009), invisible behaviours (Leathers, 1976; Feine et al., 2019), or social behaviours (Fogg, 2003; Lombard and Xu, 2021).

LIMITATIONS OF FOGG'S CLASSIFICATION

Fogg's (2003) classification of social cues in persuasive computers, which evolved directly from the CASA paradigm, saw the distinction between physical cues, psychological cues, language, social dynamics, and social role filling.

However, there is no apparent distinction between social cues and social signals, specifically between observable features of the medium and interpreted social behaviour. Rather, **social behaviours are taken as social cues** (e.g., personality and empathy as psychological cues).

LIMITATIONS OF NASS ET AL.'S CLASSIFICATION

As one may recall, the experiments conducted by Nass and colleagues consisted of rigging computers to have **personalities**, **genders**, or **conversational patterns**, although it has been argued that they actually consisted of operationalising sets of social cues (Lombard and Xu, 2021).

For example, when **Nass et al.** (1997) manipulated computers to obtain genders, they assigned a female voice and a male voice, achieved by varying the pitch range, which then led to the interpretation of the varying pitch (**social cue**) as a biological gender (**social signal**).

LIMITATIONS OF VINCIARELLI ET AL.'S SSP

The SSP computational domain, introduced by Vinciarelli et al. in 2009, was designed to model, analyse, and synthesise social cues in human-human interactions, although it has also demonstrated adaptability in the field of human-computer interactions (Pentland, 2007; Vinciarelli et al., 2008, 2012; Vinciarelli, Pantic, & Bourlard, 2009; Fiore et al., 2013).

The SSP focused strictly on **observable**, **biological nonverbal cues**, so both verbal cues (referring to what is said) and invisible cues (referring to the timing or tactile features of an interaction), initially addressed by Leathers (1976) and taken up by Feine et al. (2019), were excluded a priori.

Furthermore, it can be argued that being modelled on human-human interaction, the SSP focuses heavily on the **human face** and demonstrates adaptability to **human-robot interactions** specifically, as there is physicality of the interaction. However, the SSP, in order to demonstrate validity in other contexts such as human-agent conversational interaction, would need to be revised.

LIMITATIONS OF FEINE ET AL.'S CLASSIFICATION

Feine et al.'s (2019) taxonomy shows three levels of specificity that are independent of context, research domain, and culture. It is important to remember that the classification outlined by these researchers focuses only on **conversational agents**, more specifically text-based, voice-based, and embodied conversational agents.

The taxonomy was based on **Leathers**' (1976) **verbal and nonverbal communication systems**, which more specifically covered interactions with communicative intent between humans.

Therefore, it stands to reason that social cues related to agent embodiment, such as physical presence or shape, are missing. However, Feine et al. (2019) conducted an abstraction of the cues to allow designers to implement them, and additional categories could be extracted to increase the adaptability of the taxonomy to other domains.

LIMITATIONS OF FEINE ET AL.'S CLASSIFICATION

Also **Lombard and Xu's** (2021) classification shows some inconsistencies: for example, the qualitative categorisation between primary and secondary cues is based on empirical studies that either failed or succeeded, so it could be argued that their conclusions are rather **circumstantial**.

Furthermore, the social cues mentioned in the primary/secondary cues partition and those that trigger social signals differ in specificity and consistency, meaning that the two lists appear to be supported by different literature.

Furthermore, comparing Lombard and Xu's (2021) classification with that of Feine et al. (2019), it becomes apparent that the social cues indicated by the former demonstrate different degrees of specificity depending on the desired social signal: for example, **interactivity** could be triggered by eye and head movements (**third level of complexity**), whereas **personality** could be triggered by kinesics and vocalisations (**second level of complexity**).

However, some cues could be implemented in Feine et al.'s (2019) taxonomy such as customisation, sound, nationality, message contingency, and out of order, as well as physical characteristics such as shape.

Summary

Nass and Moon (2000) left three open questions, namely what constitutes enough social cues, what specific dimensions of computers will encourage or discourage mindless social responses, and whether the relationship between human-likeliness and social responses is linear.

In an attempt to answer what constitutes enough social cues, **Lombard and Xu** (2021) outline the distinction between **primary and secondary social cues**, according to which media that include cues of high quality and quantity will be mindlessly perceived as social entities.

In contrast, **Feine et al.** (2019) proceeded to define an **objective classification of cues** whose application to real-world scenarios can convey the hypothesis that the higher the number of identified social cues, the stronger the communicative potential of an agent.

However, **Kim and Sundar** (2012) concluded that changing the degree of interactivity of a website and proposing a **human-looking virtual agent** was sufficient to trigger human-like attributions with positive outcomes.

Consistently, **Fox and McEwan** (2017) set forth the hypothesis that lean media does not necessarily lead to insufficient emotional transmission.

07

Toward a Unified Framework for Medial Relationships

The chapter introduces the building blocks of medial relationships, a framework that combines existing knowledge based on the assumption that people's social response to media is the result of a combination of various factors.

07.1

What Was Learned so Far?

THE UBIQUITOUS NATURE OF MEDIA AGENTS

In **Chapters 3.2** and **4**, it was argued that the **reality-virtuality continuum** (Milgram, 1994) demonstrates the potential to be interpreted in terms of physicality and digitality, leveraging the assumption that the boundaries of agent species blur when searching for the basic rules of interaction, which apply to a lesser or greater extent to each category of media.

In particular, the physicality-digitality continuum allows for a more responsive and holistic redistribution of media agents, where the lowest common denominator emphasises the importance given to aspects of human-like social intelligence in informing and shaping such interactions (Holz et al., 2009).

To echo the above, at the physical end of the physicality-digitality continuum one can find **smart devices** and **wearables**, while the ubiquitous nature of **conversational agents** spreads them over the entire length of the continuum.

First, **physically embodied conversational agents**, such as social robots, are tangibly present in the environment; then, **mixed-reality conversational agents** sit in the middle of the continuum in that their mode of interaction manifests aspects of both physicality and digitality, while **virtually embodied conversational agents** enhance interaction capabilities by shedding physical presence. Finally, **disembodied conversational agents**, particularly voice- and text-based conversational agents, can be found at the **digitality end** of the continuum.

THE RELATIONAL ROLES OF MEDIA AGENTS

Following the case studies analysed, it was possible to understand how the same artefact may have been perceived in different social terms depending on the participants involved in the study.

- **BagSight** (Evert Van Beek, 2019), the smart backpack capable of displaying expressive behaviour, was socially interpreted by participants as a "**leader**," who would guide them on the direction to take, or as a "**buddy**," a companion who would accompany them on an adventure.
- **Self-trackers** (Hancı et al., 2019) were perceived as "**observers**," who would monitor users' performance, or as "**close and available friends**," defined by physical distance with the device that led to the creation of a new psychological distance.
- The **Autonomous Wheelchair Rolland** (Fischer, 2011) was perceived by participants as **social** or **non-social**, and this attribution was inferred from the verbal choices they made in response to the robot's greeting, which also determined their willingness to establish a relationship with it.
- **Socially assistive robots** (Caic et al., 2018) deployed in healthcare facilities were found to fill the roles of **enablers** or **intruders** when safeguarding physical health, as **allies** or **substitutes** when providing social contact, and as **extensions** or **disablers** when providing cognitive support.

- The experiment with the voice-based conversational agent **Clova** (Oh et al., 2020) showed that older adults perceived Clova as a "**companion**," whereas younger adults perceived it as a "**useful tool**" that enabled a more efficient lifestyle, and viewed it as a "**smart home manager**" or even a "**butler**" capable of performing reliable and predictable transactional tasks.
- Lee et al.'s study of **Siri** (2021) showed that for the voice-based conversational agent to be perceived as a **supervisor** it had to meet the dimensions of co-presence and trust, whereas to be perceived as a **friend** it had to develop the dimension of personal attachment.
- The 2020 experiment by **Croes and Antheunis** determined that interactions with **Mitsuku** were not sufficient to establish long-term relationships with the text-based conversational agent.
- In 2021, the study by **Skjuve et al.** showed instead that **Replika**, the text-based conversational agent, could actually be perceived as a "**companion**" and that that relationship-building process was characterised by faster self-disclosure dynamics.

Summary

From the non-exhaustive analysis of the case studies, it was identified that commonly users find it necessary to adapt to the **economy of interaction**, relying on transactional use cases that leverage reliability.

In some experiments, participants' reactions toward artefacts were not determined by how smart the technology was, but rather by **context** and **interpersonal variability** as well as **temporal incongruity**.

Media agents are thus characterised as **dynamic agency**, changing and evolving according to context and flow and remaining open to sense-making practices, demonstrating the potential to support **a variety of medial relationships**.

Considering anthropomorphic features as integration of social-emotional behaviours, and more specifically social cues as carriers of communicative potential, one can attempt to frame the constitutive elements of human-media-agent relationships, uniting previous research under the assumption that the rules apply to some extent to each category of media, which in turn belongs to a ubiquitous and interdependent **physicality-digitality continuum**.

07.2

The Building Blocks of Medial Relationships

HUMAN AND CONTEXT

In **Chapter 2.2**, an extended classification of **individual characteristics** and **circumstantial determinants** was presented, based on the assumption that nuances of disposition and context must be taken into account to predict positive or negative social treatment of technology.

In fact, individual factors such as familiarity with technology and education level, as well as personality traits and the need to build social relationships, should be paired with the nature and the condition of the impending task (Lee, 2010).

In the table below, the determinants have been categorised under the more generic terms **human** and **context**, and have been further specified if they belonged to **disposition** (the prevailing tendency toward a condition or action), **motivation** (the reason for behaving in a particular way), **context** (the circumstances in which something occurs), and **situation** (the way in which something is positioned vis-à-vis its surroundings).

HUMAN		CONTEXT	
DISPOSITIONAL FACTORS	MOTIVATIONAL FACTORS	CONTEXTUAL FACTORS	SITUATIONAL FACTORS
Personality traits	Predisposition to analytical thinking	Cultural background	Environment (public or private)
Knowledge of and experience with technology	Tolerance of imperfection	Language norms	Number of people involved and how they relate to each other
Chronic loneliness	Height of expectations	Degree of industrialisation of the country	Time of day
Attachment style	Willingness to suspend disbelief	Tolerance of privacy invasion and data sharing	Cognitive demand of the task
Demographics	Anthropocentric tendencies		Depth and quality of information provided
Individualist or collectivist			

Figure 22
Classification of human and context-specific factors

MEDIA AGENT

In order to frame the media agent building block, it is worth resuming Feine et al.'s (2019) classification of social cues for conversational agents, which showed three levels of specificity that were independent of context, domain, or culture.

As one may recall, the taxonomy was created following **Leathers**' (1976) nonverbal communication systems, and included a three-tier hierarchy in which the highest order level included the distinction between **verbal cues**, **visual cues**, **auditory cues**, and **invisible cues**.

In addition to being the most objective and comprehensive taxonomy to be explored in this research, Feine et al. argued that the higher the number of identified social cues, the stronger the communicative potential of an agent, plausibly complying with the assumption that **anthropomorphic features** can be considered as integration of **social-emotional behaviours**.

However, in this context, **proxemics** has been removed from the realm of the media agent and has been assigned to the **building block of interaction** that will be explored shortly.

Moreover, as the researchers have suggested the potential of their taxonomy to accommodate additional categories to increase its universality, it stands to reason that social cues related to **agent embodiment**, such as **physical presence** or **shape**, can be borrowed from Lombard and Xu's (2021) classification. However, in this case, it was fundamental to take into consideration and conform the varying degrees of abstraction that arguably appeared throughout their research.

In this case, social cues such as **customisability**, **nationality**, **message contingency**, and **out of order**, as well as physical characteristics such as **shape** can be applied to Feine et al.'s (2019) classification.

Furthermore, social cues that appear in other classifications and are relevant in this context have been implemented, such as **sound** and **silence** of the **social signal processing** (SSP) approach by Vinciarelli et al. (2009), among others.

MEDIA AGENT

VERBAL CUES		VISUAL CUES		
Content	*Style*	*Kinesics*	*Agent appearance*	*CMC*
Greetings and farewells	Formality	Arm and hand gesture	2D/3D visualisation	Typeface
Refer to past	Sentence complexity	Head movement	Gender	Emoticons
Joke	Lexical diversity	Eye movement	Photorealism	**Customisability**
Small talk	Strength of language	Facial expression	Facial feature	
Self-disclosure	Abbreviations	Posture shift	Clothing	
Self-focused questions		**Focus of attention**	Name tag	
Express name			Attractiveness	
Praise			Colour	
Opinion conformity			Degree of human-likeliness	
Ask to start/ pursue dialog			Age	
Excuse/apologise			**Shape**	
Thanking			**Size**	
Tips and advice			**Nationality**	
First turn			**Out of order**	
Message conformity			**Familiarity**	
Answer questions				

MEDIA AGENT

AUDITORY CUES		INVISIBLE CUES	
Voice qualities	*Vocalisations*	*Chronemics*	*Haptics*
Gender of voice	Whisper	Response time	Tactile touch
Volume	Laughing		Temperature
Pitch	Vocal segregates		**Pressure**
Range	Yawn		**Vibration**
Voice tempo	Grunts/moans		
	Sounds		
	Silence		

Figure 23
Classification of media agent-specific social cues

INTERACTION

In order to frame medial relationships it is necessary to consider **interaction** as a constitutive element in its own right. In particular, interaction does not acquire meaning only in terms of the media agent, but rather remains open to sense-making practices depending on the human it concerns.

Interaction can be ascribed two categories of cues, namely **temporality** and **proxemics**; as was extensively discussed in **Chapter 3**, the temporality of interaction defines the period of time humans are exposed to a media agent, which influences their perception of it overtime.

Resuming the case studies analysed in **Chapter 4**, the longer younger adults were exposed to the conversational agent **Clova** (2020), the more they adapted to the economy of the interaction, determined by the conversational agent's communicative competence. As with **BagSight** (2019), participants' perceived relationship with the smart backpack changed throughout the experiment.

For what concerns **proxemics**, it was discovered by **Fiore et al.** (2013) that a hallway-crossing robot was perceived as more socially present when it behaved passively as though it complied with social rules of politeness.

INTERACTION

TEMPORALITY	PROXEMICS
Timespan of interaction	Conversational distance
Duration of interaction	Proximity
Frequency of interactions	Background
Synchronicity	
Turn taking	

Figure 24
Classification of interaction-specific factors

SOCIAL RESPONSES

The fourth and final block corresponds to **social responses** toward media agents. As was introduced at the beginning of **Chapter 6** and explained in depth in **Chapter 6.8**, social signals are interpretations of single or combinations of social cues that are influenced by mental states and attributes toward another agent (Streater et al., 2012), as well as by contextual and motivational factors of the perceiver. Therefore, the final building block showcases the results of the combination of **human**, **context**, **interaction**, and **media agent cues**.

Because social signals are based on the disposition of the perceiver, their interpretation is dynamic, subjective, and context-dependent, ultimately triggering a social reaction from the perceiver.

In defining social responses toward media agents, it is important to emphasise the fact that here social behaviours are viewed as social signals in the sense that they are influenced by context and evolve dynamically over time (Goleman, 2006; Vinciarelli et al., 2012).

Although it is virtually impossible, with the knowledge gained to date, to associate every social cue or combination of social cues with its social signal, this classification reports **categories of social cues at a high level of abstraction** that are more likely to be involved in generating specific social signals.

Thus, in order to identify the social cues responsible for social signal activation at the highest level of complexity, it would be necessary to conduct more specific case studies that consider various combinations of human, context, interaction, and media agents cues.

Because Feine et al.'s (2019) classification focused more narrowly on social cues, an attempt was made to extrapolate or infer social cues from other studies analysed in this research, such as Lombard and Xu's (2021) classification, Vinciarelli et al.'s (2009) social signal processing approach, and other associations found in the literature that can be explored in Table 15. However, adjustment work was conducted in order to achieve consistent levels of complexity in the terminology used.

SOCIAL RESPONSES

SOCIAL CUES	SOCIAL SIGNALS
Kinesics Chronemics Content	**Interactivity**
Agent appearance	**Lifespan**
Agent appearance CMC	**Uniqueness**
Kinesics Voice qualities Vocalisations	**Multimodal backchannels (agreement, refusal, interest, attention)**
Voice qualities Kinesics Vocalisations Content Style Agent appearance Proxemics	**Personality**
Kinesics Voice qualities Vocalisations Temporality Proxemics	**Emotion**
Content	**Politeness**
Agent appearance Kinesics Voice qualities Vocalisations Proxemics	**Persuasion**

SOCIAL RESPONSES

SOCIAL CUES	SOCIAL SIGNALS
Agent appearance Kinesics Vocalisations Proxemics	**Status**
Agent appearance Kinesics Voice qualities Vocalisations Temporality Proxemics	**Dominance**
	Rapport
Kinesics Vocalisations Temporality	**Regulation**
Kinesics Content Voice qualities Vocalisations Temporality Proxemics	**Reciprocity**
Kinesics Content Temporality Proxemics	**Empathy**

Figure 25
Classification of social cues/social signals associations

The second part of the social response building block revolves around **roles**. Specifically, **relational roles**, their corresponding **social roles**, and their **temporal profile**.

By **relational roles**, it refers to the role that a media agent is designed to fulfil as a dimension that shapes the human-media agent interaction, determining the user's perception, which can be free from task-specific constraints and more **abstract**.

In contrast to relational roles, **social roles** are interpreted as the set of characteristic attitudes and behaviours expected of an individual who occupies a specific position or performs a particular function in a social context.

Relational roles, which are ordered according to their **perceived proximity** to humans, viewed from both a physical and psychological perspective, are assigned one or a combination of social roles, a temporal profile, and the social signals most likely to be involved in generating the relational persona.

The list of relational roles derives from Table 4 of Chapter 3.2, however the item "self-likeness," referring to the frequently mentioned "social actor," has been broken down into the layers of "ally," "influence" and "authority," with the aim of increasing the level of precision according to the effect that the role itself is able to generate.

Figure 26 (right)
Classification of social signals/relational roles/social roles/temporal profiles associations

ROLES					TEMPORAL PROFILE
SOCIAL SIGNALS	RELATIONAL ROLES	SOCIAL ROLES			
Interactivity Uniqueness Lifespan	**(8) Utility**	Butler			Short-term
Interactivity	**(7) Media**				
Interactivity	**(6) Bystander**	Observer			Medium-term
Lifespan	**(5) Proxy**				
Multimodal backchannels Personality Emotion Politeness Regulation Rapport Reciprocity Empathy	**(4) Ally**	Pet	Teammate	Opponent	Long-term & life-long
Multimodal backchannels Personality Emotion Politeness Rapport Empathy	**(3) Influence**	Leader	Entertainer		
Multimodal backchannels Personality Emotion Persuasion Status Dominance	**(2) Authority**	Teacher	Expert		
Lifespan	**(1) Extension**				

In conclusion, the goal of this mapping was to fill in the gaps in the research conducted to date by providing a coherent yet ubiquitous baseline that could concern to some degree every media category.

Moreover, these building blocks allow for the design of media agents characterised by dynamic agency, which evolves according to contexts and remains open to sense-making practices, ultimately leading to the envisioning of multiple medial relationships.

Summary

In this section, the **constituent elements of medial relationships** were introduced. By considering existing knowledge and filling in its gaps, it was possible to abstract a useful framework for considering the various factors that determine people's social responses to media.

First, the building block of **human and context** includes dispositional, motivational, contextual, and situational determinants; next, **interaction** includes temporality and proxemics; then, **media agents** include the categories of verbal, visual, auditory, and invisible cues; finally, **social responses** include social signals, relational roles, social roles, and temporal profile.

08

Information Retrieval as Information-Seeking Activity

The chapter analyses the steps that led to interactive information seeking and retrieval as a relationship between an information seeker and an information retrieval system. A look at exploratory search interfaces raises the need for more thoughtful search interactions that can support dynamic open problem contexts.

As introduced at the outset, the criterion for writing this research thesis arose from a desire to take a **divergent approach** to knowledge gathering and processing. A map of principles and counter-principles covered in technology- and non-technology-based case studies was mapped out, bringing to light a model of social interaction that prescinds from the specifics of media at the physical or material level. In addition, the reworking of the theories revealed **limitations**, **design implications**, and **inconsistencies** that allowed for the filling of knowledge gaps and the production of a set of **unified and ubiquitous social interaction rules** that can form the basis for future research and analysis.

Since the goal of this paper is to provide a **useful tool** for designers to make more informed design choices and retrieve interconnected pieces of knowledge, it was also necessary to conduct investigative work on the scope of **information retrieval** as an **information seeking activity**.

By delving into the concept of information interaction as the relationship between information seekers and an information retrieval system, exploring users' mental models and experimental search user interfaces, it is possible to delineate the ideal information visualisation model(s) to facilitate information retrieval processes to be applied to design processes.

08.1
Interactive Information Seeking and Retrieval

INTERACTION WITH TEXT

According to **Wagner** (1994), interaction occurs when two objects and events influence each other. However, when interacting with a printed text, the sociological definition does not apply; in fact, since the printed text cannot adapt to the reader's input, the concept of interaction can be used with the meaning of interpretation.

USER-INTERMEDIARY INTERACTION

The notion of information seeking and retrieval can be traced back to the **1960s** (Savage-Knepshield and Belkin, 1999), when **Taylor** (1968) acknowledged the interactive nature of information seeking as an exchange between users and librarians.

In this case, users initiate an interactive negotiation with a librarian to fill a knowledge gap. However, more standardised research on user-intermediary interaction began in the 1980s (Belkin and Vickery, 1985; Cool and Belkin, 2011).

INTERACTIVE INFORMATION RETRIEVAL

In 1992, **Ingwersen** described **interactive information retrieval** as:

The interactive communication processes that occur during retrieval of information by involving all major participants in information retrieval, i.e., the user, the intermediary, and the information retrieval system – the latter consisting of potential information, mainly in the form of text and text representations as well as information retrieval system setting.

STRATIFIED MODEL OF INFORMATION RETRIEVAL INTERACTION

Saracevic, 1996

In 1996, **Saracevic** suggested a layered model of information retrieval interaction that emphasised the user's search intent. According to Saracevic,

- At the **surface level**, users interact with an information system through an **interface**, imparting commands that represent a problem statement; on the other side, the system responds with meta-information, text, images or further questions;
- At the **cognitive level**, users interact with the system by evaluating the information provided in relation to the initial problem statement;
- Finally, at the **situational level**, users interact with the situation in which the search results could help solve the problem.

In 2007, **Xie** proposed a model that specifies changes in information retrieval strategies in the digital age by incorporating **interactive intentions**, which refer to the **sub-goals** a user needs to accomplish in the process of performing their search task.

08.2

User-Information Retrieval System Interaction

USER-LED INFORMATION SEEKING

By emphasising the interaction between the **information seeker** and the **information system**, **Belkin et al.** (1993) pioneered the shift from intermediary-assisted Information retrieval to **end-user-led information seeking**.

Belkin et al. (1993) hypothesised that an information retrieval situation occurs when users realise that they are in an **anomalous state of knowledge** (ASK) with respect to the problem being addressed. When the problem is submitted to an information retrieval system, there is often a discrepancy between the user's need and the submitted request, as they are not always able to formulate it in a way that is appropriate to the language of the system.

According to the researchers, this problem is solved by **iterative interaction**, which is a conversational process in which the user communicates with the information retrieval system by gradually adapting his or her request once the system's output is interpreted.

INFORMATION-SEEKING STRATEGIES (ISSS) FRAMEWORK

Belkin et al., 1993

Specifically, in 1993 **Belkin et al.** proposed an **information-seeking strategies** (ISSs) framework that broadly characterises the behaviours adopted by users when interacting with information systems during information retrieval (Belkin et al., 1993).

According to this scheme, four dimensions define the information-seeking process: the goal of the interaction, the method of interaction, the mode of retrieval, and the type of information resource being interacted with. Each dimension can be understood as a distinction between two dichotomous states:

- The space of **goal of interaction** is defined by learning and selecting;
- The space of **method of interaction** is defined by **scanning** and **searching**;
- The space of **mode of retrieval** is defined by recognition and specification;
- Finally, the space of **resource** is defined by information and meta-information.

08.3

Known-Item and Exploratory Search

HUMANS' SEEKING BEHAVIOURS

Belkin et al.'s (1993) framework on information-seeking strategies (ISSs), which defines the dimension of the **method of interaction** in terms of **scanning** or **searching**, offers an interesting outlet for delving into the search behaviours of humans, as it requires a holistic perspective in complex scenarios.

In the field of information retrieval, in order to complete their search task, users need to know what they are looking for (Marchionini and White, 2008). However, the precise formulation of questions to satisfy an information need requires domain knowledge. If the information need cannot be presented accurately, due to the user's lack of background knowledge or the complexity of the task, the user must undertake an **exploratory search**.

SEARCH TASKS

Search tasks can be divided into **known-item** search tasks and **exploratory search tasks**, but despite the classifications, all search tasks can be considered exploratory to some extent (White and Roth, 2009), while exploratory search tasks can include elements of known-item search.

Information retrieval research has mainly focused on improving retrieval for a single question-answer (Kanoulas et al., 2012), while exploratory search scenarios have received less attention (Marchionini, 2006).

LOOKUP, LEARN AND INVESTIGATE
Marchionini, 2006

Marchionini (2006) explained the paradigm of exploratory search by integrating it into a framework of three categories: **lookup**, **learn** and **investigate**.

While lookup (referred to as known-item search in the previous paragraph) is a basic interaction that implies fact-finding search, learn and investigate are iterative processes of exploration that include actions, such as acquisition, comparison, aggregation and integration of new information, but also the analysis, synthesis, forecasting, evaluating and interpretation of the new knowledge (Marchionini, 2006).

FACTORS IMPACTING SEARCH BEHAVIOUR AND PERFORMANCE

Based on standard search user interface engines (Liu et al., 2013), a number of factors have been shown to influence search behaviour and performance. First, the user's **domain knowledge** or **experience with the information retrieval system** has led to faster query formulation and time spent on the search task (Duggan & Payne, 2008).

According to **Byström & Järvelin** (1995), **task complexity** also determines performance, as search tasks are characterised by **a priori determinability** (conceptual complexity, Diriye et al., 2015), which determines how complex it is to determine the requirements of the task; similarly, **Aula and Russell** (2008) spoke of **procedural complexity**, which is determined by the number of subtasks involved in the search task.

On the one hand, **conceptual complexity** is mostly influenced by domain knowledge, as systems, such as **faceted interfaces**, work in the direction of presenting search-relevant metadata that allow users to filter and categorise factors relevant to a domain. On the other hand, **procedural complexity** can be addressed by HCI as it is influenced by the search functionality provided by the user interface.

08.3.1
Information Presentation

SEARCH INTERFACES

According to **Zoltán Gócza**,

People are better at recognising things than recalling them from memory. It is much easier and faster to click on a link than to enter a search term: you don't have to spontaneously come up with the proper search expression, or worry about synonyms and spelling.

To support exploratory search, several search interfaces have been suggested over time that deliver additional information to searchers in order to facilitate interaction.

Common strategies employed in exploratory search interfaces are **keywords** associated with each search result, which may represent: the most **frequent** keywords (Hoeber & Yang, 2009), keywords **assigned by authors** (Ruotsalo et al., 2018), or keywords **flagged by other searchers** (di Sciascio et al., 2018).

Other strategies include extracting specific terms from user queries to obtain **contextual information** for release to other domain-specific repositories (Bozzon et al., 2010). Finally, other studies have explored the extraction of metadata such as **time** (Hoeber et al., 2016; Krestel et al., 2011) and **location** (Krestel et al., 2011).

Generally, the methods to represent supplementary information vary depending on the nature of the information and the need to show relationships. Specifically, some strategies involve spatialising information by showing **similarity** between objects or **importance** (Kangasrääsiö et al., 2015; Ruotsalo et al., 2018). Examples include **grid layouts** (Bozzon et al., 2010), **tag clouds** (Ahn et al., 2010), **histograms** (Hoeber & Yang, 2009), **timelines** (Hoeber et al., 2016), and **maps** (Krestel et al., 2011).

TEXTUAL SEARCH DATABASE SYSTEMS DESIGN PRINCIPLES FOR WEB USER INTERFACE DESIGN

In a seminal paper, **Feng et al.** (2017) applied **Shneiderman's** (2010) eight design principles for interactive systems to the design of text search database systems. In 2022, **Mahdi et al.** reviewed these principles in the context of user interface design. Among others, three are of particular relevance when considering the design of exploratory search interfaces:

First, provide **query shortcuts** and hints to users based on their **levels of expertise**, where for novice users it means providing prompt answers to queries for clarification, while for expert users it means allowing them to precisely specify their query using advanced operators from the outset.

Next, consider the trade-off between **opaque** and **transparent functionality**, which involves the extent to which the system anticipates user needs versus increasing user control over interface behaviour.

Finally, reduce the **memory load** by providing a history and shortcut mechanism.

08.4

Faceted Search

Faceted search (Yee, Swearingen, Li, & Hearst, 2003) is a type of search assistance that provides exploration support through **interactive tools**, which help users refine their queries.

This type of search allows users to browse through information in a **hierarchical manner**, such as moving through the subcategories of a category, limiting and presenting results that match only a set of determined criteria extracted from the results metadata.

One type of faceted search involves the use of dynamic **HTML controls** (e.g., checkboxes and drop-down menus) to help users refine results based on certain attributes of the retrieved items (Yee, Swearingen, Li, & Hearst, 2003).

SCIENCE DIRECT

When submitting a search query in Science Direct, the search bar provides options to refine results based on year of publication, article type, publication title, and subject area (Iqbal et al., 2020), which dynamically change based on the keywords entered.

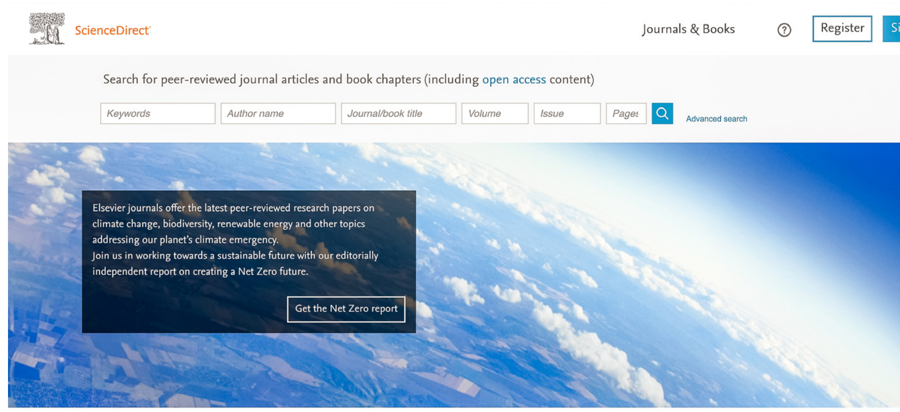


Figure 27
Science Direct homepage

AMAZON.COM

Similarly, searching for a laptop computer on Amazon.com allows the user to refine the results by brand, price, operating system, display size, processor type, amount of memory, hard drive size, and customer reviews.

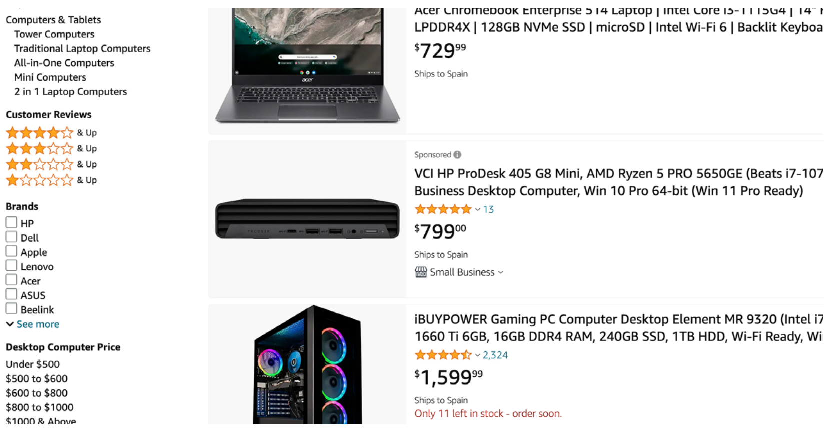


Figure 28
Amazon product list page

EXPERIMENTAL SEARCH USER INTERFACE

In 2018, **Ruotsalo et al.** proposed an **interactive faceted query suggestion** to study the effect of search assistance and measured its effectiveness in exploratory tasks at both query-answer and whole-session levels. The interface allowed users to interact with a search bar and adjust the query by clicking on keywords.

According to the results, interactive faceted query suggestion led to positive results at the whole-session level, but was not effective at the single input level.

In particular, participants seemed to rely on the suggestion to **supplement**, but not replace, interaction with the typed query, which suggests that it is used primarily to **support navigation**.

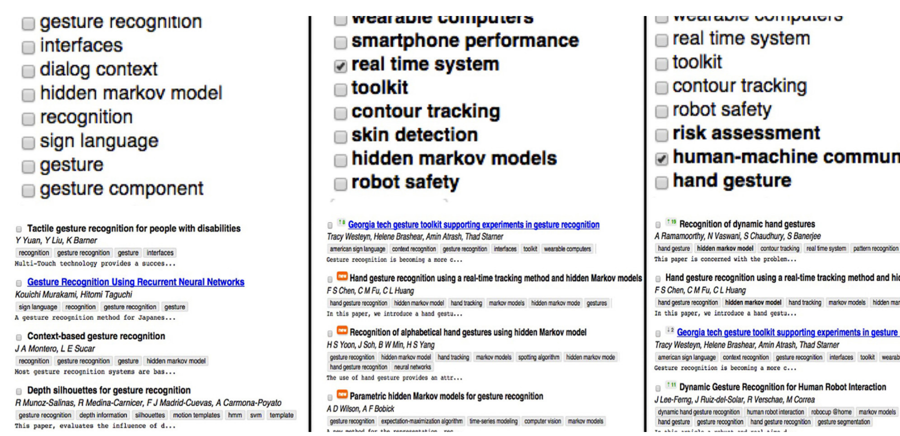


Figure 29
Interactive faceted query suggestion (2018)

08.5
Considerations

Based on the analysis of the literature to date on interactive information seeking and retrieval, it has been found that:

- Searchers must perform a **known-item** or **exploratory search task**, depending on whether or not they are able to accurately express their information need. However, all search tasks can be considered exploratory to some extent (White and Roth, 2009), while exploratory search tasks may include elements of known-item search.
- The user's **domain knowledge** or **experience with the information retrieval system** affects the time it takes the user to complete the search task and the ease of navigating the information retrieval system, and will determine what type of search task will be conducted.
- The **conceptual complexity** of the task, which is influenced by domain knowledge, is facilitated by interactive search assistance tools (e.g., faceted search); nevertheless, the search steps and target information may be vague. Instead, the **procedural complexity** of the task involves a series of search actions and is determined by the functionality of the user interface.

Empirical studies on the interactive features of faceted search, while improving the knowledge of exploratory browsing, are conceptualised to support learning and investigation. **Exploratory browsing**, as a necessary first step in exploratory search, is intended to reduce uncertainty and is what enables the researcher to move from exploratory to focused search (White & Roth, 2009).

Indeed, many systems try to help the user identify his or her needs by, for example, suggesting **query refinements** or providing **auto-completion**. In most cases, systems assume whether the user is performing a broad or narrow search and vary the way they present results.

THE NEED FOR MORE THOUGHTFUL SEARCH INTERACTIONS

Users of traditional search need to establish search criteria at the outset, even though they may be uncertain of the keywords to type in, which makes traditional search ill-suited to navigate situations where the need for information is unclear.

In particular, the nature of exploratory search is enhanced by inquiry and building **understanding**, has a broad, **poorly structured** and **open problem context**, involves multiple elements and even **uncertainty**, is not oversimplified, and is **dynamic**. All this creates an open context for empirical research that leads to more thoughtful search interactions.

Because this research work is intended to be a useful tool for designers to make more informed choices when designing interactions between humans and media agents, it is necessary to conduct empirical work to acquire data for the investigation of users' mental models.

09
The Media Agent Interaction Handbook

The Media Agent Interaction Handbook is an exploratory search tool aimed at helping interaction designers in the retrieval of interconnected pieces of knowledge, to address open problem contexts in the design of human-agent multimedia interactions.

09.1
Conceptual Interaction and Search Logic

CONCEPTUAL INTERACTION

The **Media Agent Interaction Handbook** is an exploratory search tool aimed at helping interaction designers in the retrieval of interconnected pieces of knowledge, to address open problem contexts in the design of human-media agent interactions.

A mock-up of an interface in information retrieval logic was hypothesised, consisting of **ten** self-consistent and modular **learning objects** that represent my conclusions understood as the logic of navigation and exposition of the revised theory.

In particular, the learning objects are able to create a holistic perspective of the building blocks of human-media agent interaction, which is useful to support design research.

Specifically, I set myself the problem of giving a **systematic approach** to an audience of designers: the principles are short and memorable and are defined by **resources** and **meta-data**; moreover, they provide a **single learning objective** that is described and contextualised by the linked descriptive examples.

The aim of the handbook is to provide a clarification of the social rules applicable to a greater or lesser extent to each category of media agent belonging to the physicality-digitality continuum; although not complete, it gives an idea of the exploratory approach that can be developed further.

The information is filtered by **keywords**, but there is also a desire to urge users to adopt an open mind, to consider all solutions, and to leverage **curiosity** in the discovery of related knowledge.

SEARCH LOGICS

The prototype is designed to allow filtering of results according to category. Principles and case studies belonging to the constituent elements of the **human and context**, **interaction** or **media agent** are displayed as resources, allowing both categorisation according to specific design requirements and free exploration guided by curiosity and related material. Each learning object consists of knowledge pills, meta-data explaining new terminology and resources that refer to the original theories on which the handbook was based.

ARCHITECTURE

The learning objects consist of **10 principles** and **23 technology-based and non-technology-based case studies**, the mapping of which can be considered rather complex: principles vary in the number of descriptive examples, as a principle may refer to one or more case studies; on the other hand, case studies may refer to one or more principles.

The **gateway** to the resource repository is explanatory and descriptive of the type of information that will be available and how it can be used.

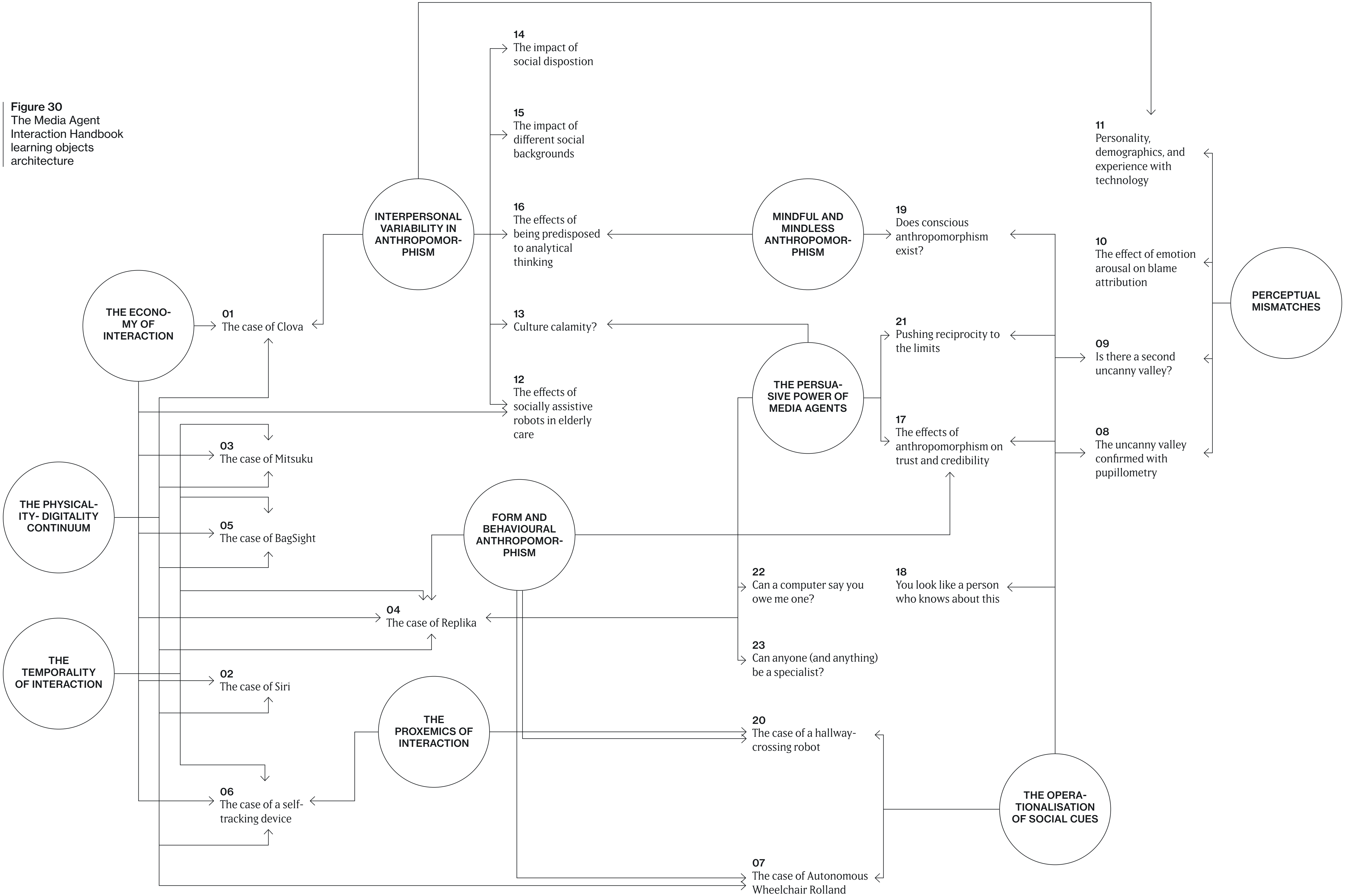


Figure 30
The Media Agent Interaction Handbook learning objects architecture

GATEWAY

The **gateway** is explanatory in the type of content users will find within the handbook. Indeed, it provides a quick overview of the dimensions that help predict and shape the social treatment of technology, consisting of **human and context** (nuances of individual characteristics and circumstantial factors), **interaction** (the function of human and media agent, which shapes the type of relationship that can be established) and **media agent** (any technological artefact whose anthropomorphic characteristics are an integration of socio-emotional behaviour).

The combination of the three building blocks determines **social responses**, the interpretation of which is **dynamic** and **evolutionary**, open to sense-making practices. For this reason, the handbook stops at the constitutive elements as ingredients to be taken into consideration when designing human-media agent interactions.

A call to action urges users to explore all the **resources**, while below the highlights introduce the **principles**, stand-alone knowledge pills that frame the fundamental laws of social interaction, and the **case studies**, which contextualise the principles and support the understanding of knowledge.

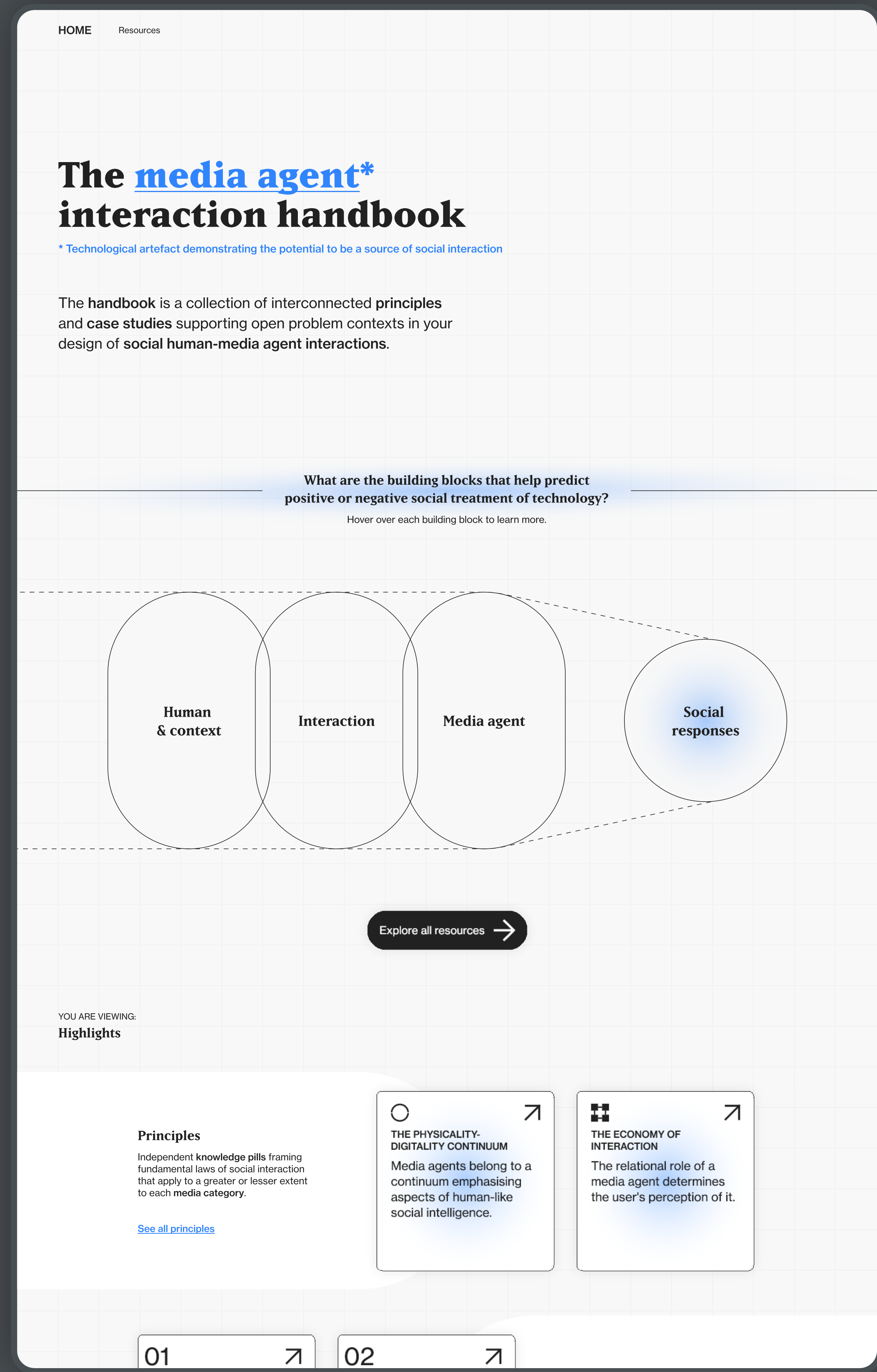


Figure 31 (right)
The Media Agent Interaction Handbook gateway

RESOURCES

The **resource** page is a collection of principles and case studies that address both specific and general design needs. As introduced at the beginning, a filtering system allows users to focus on the building blocks of **human and context**, **interaction** or **media agent**, and then further screens the results by focusing on principles or case studies. Upon clicking, the resources reorganise themselves by showing only the desired content, while a short introduction in each card provides an overview of the topic covered in the section.

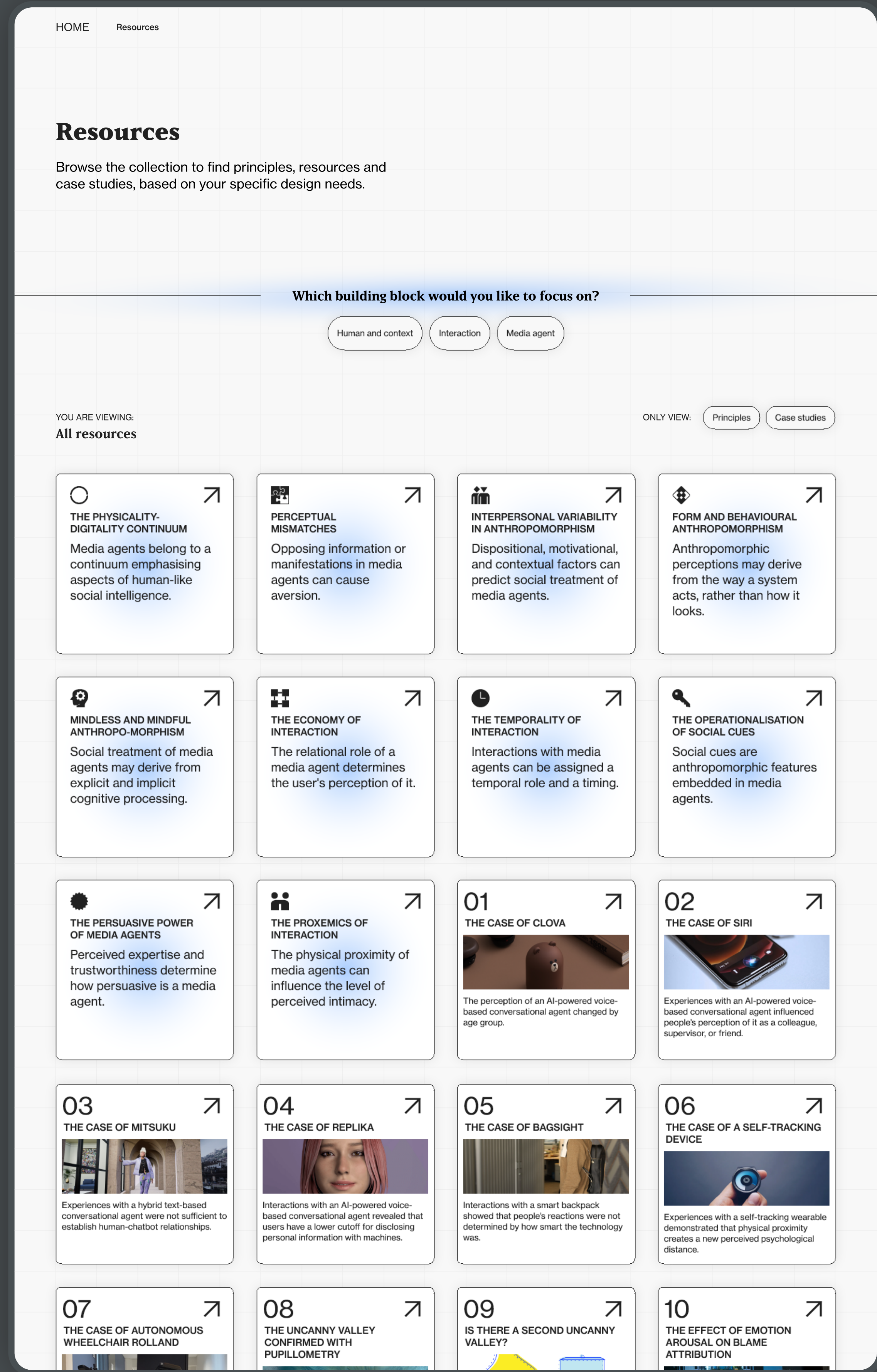
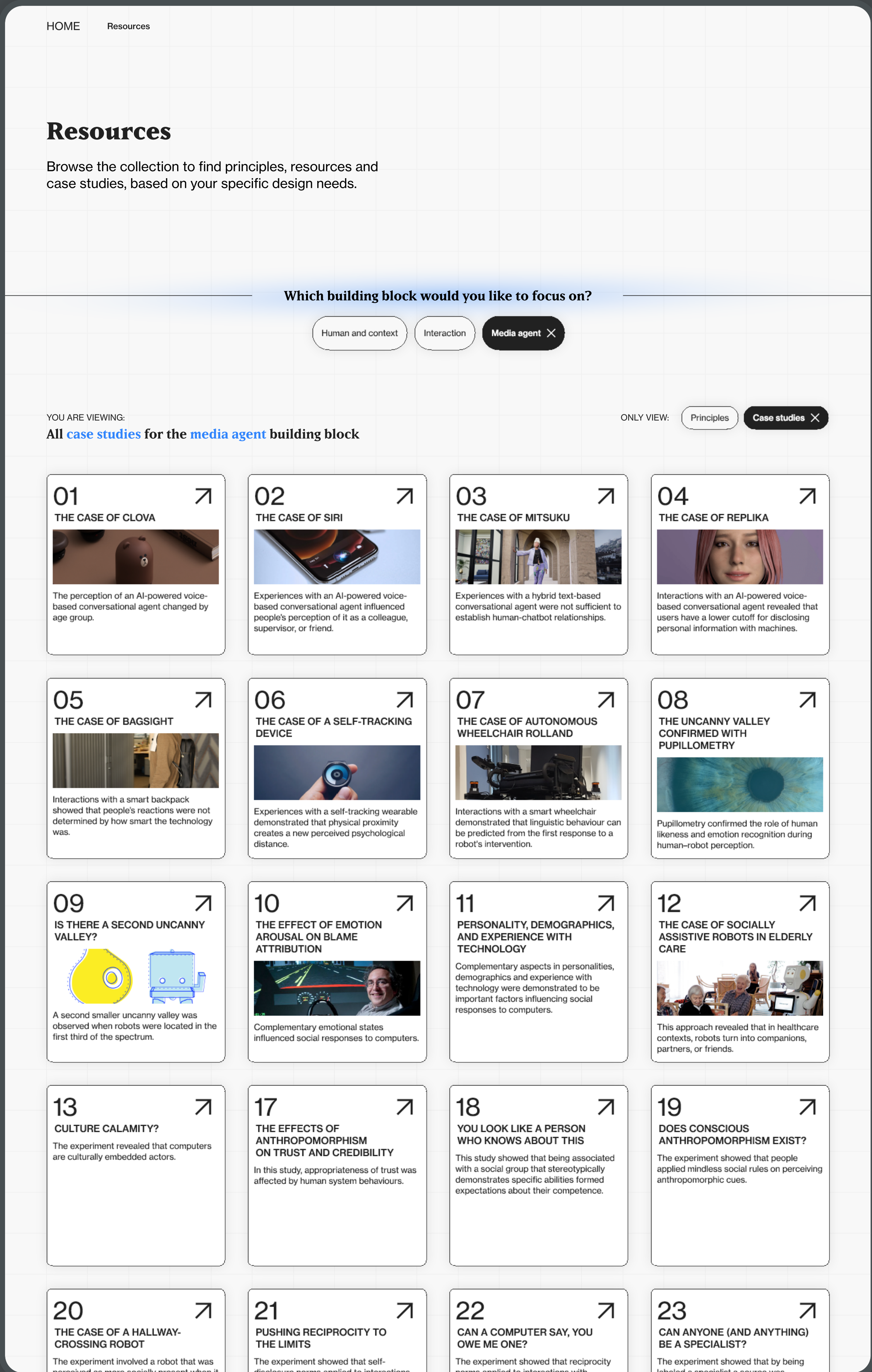


Figure 32 (right)
The Media Agent Interaction Handbook Resource page without set filters



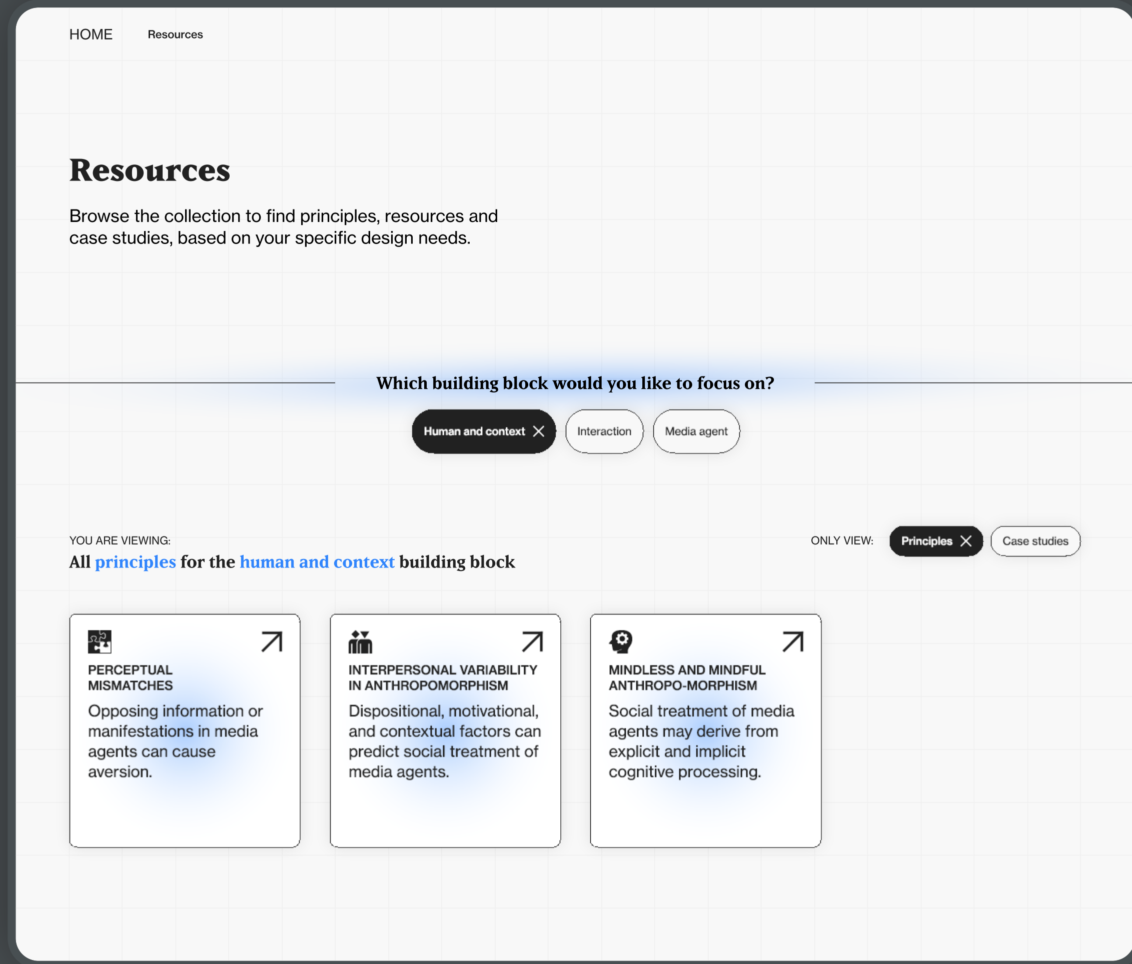


Figure 33 (left)
The Media Agent Interaction Handbook case studies for media agents on the resources page

Figure 34 (top)
The Media Agent Interaction Handbook principles for human and context on the resources page

09.2
Learning Objects

THE PHYSICALITY-DIGITALITY CONTINUUM

By expanding the **reality-virtuality continuum**, the physicality-digitality continuum blurs the boundaries of species of **media agents**, as it is based on the tenet that the basic rules of interaction are applicable to a lesser or greater extent to each category of media. In these interactions, the lowest common denominator is the emphasis on aspects of human-like social intelligence.

PHYSICALITY — MIXED REALITY/UBIQUITOUS ENVIRONMENT — DIGITALITY

MEDIA AGENT			
Smart device			
	Wearable		
CONVERSATIONAL AGENT			
Embodied CA		Disembodied CA	
Physically embodied CA	Virtually embodied CA	Voice-based CA	Text-based CA

Figure 35
The Media Agent Interaction Handbook physicality-digitality continuum principle

PERCEPTUAL MISMATCHES

Building on the **uncanny valley hypothesis**, a sense of **aversion** arises if active and passive perspectives or positive and negative states do not coincide. However, aversion also emerges if there are perceptual mismatches in the appearance of media agents. While a common guideline is to keep media agents' similarity to humans low, designers seeking more positive user reactions should follow the recommendation of avoiding mismatches in personality, emotion, perspective, actions, and appearance.

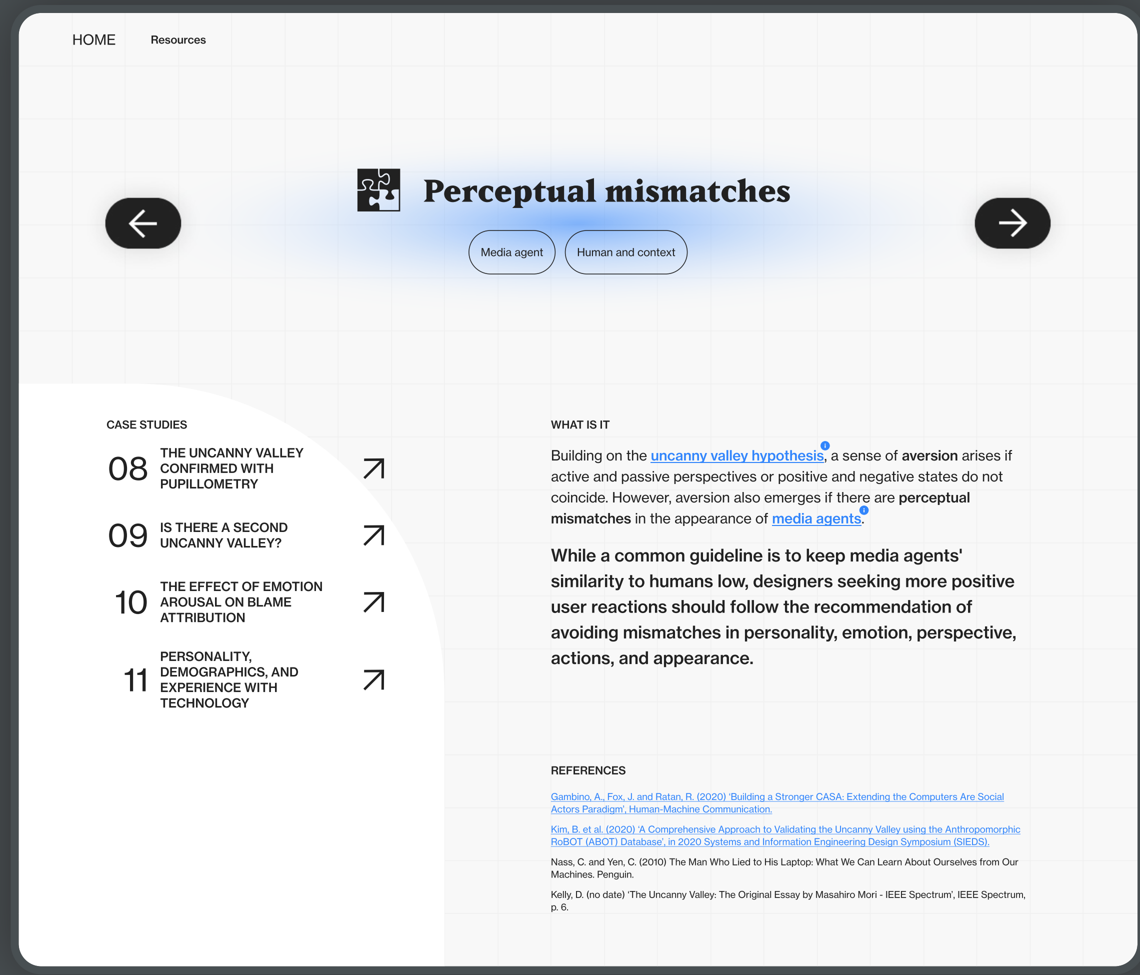


Figure 36
The Media Agent Interaction Handbook perceptual mismatches principle

INTERPERSONAL VARIABILITY IN ANTHROPOMORPHISM

Interpersonal differences define people's preconceptions about media agents, interactions with media agents, and the very goals of the interaction. For this reason, many nuances of disposition and circumstances must be taken into account to predict positive or negative social treatment of technology.

DISPOSITIONAL FACTORS	MOTIVATIONAL FACTORS	CONTEXTUAL FACTORS
Personality traits	Predisposition to analytical thinking	Cultural background
Knowledge of and experience with technology	Tolerance of imperfection	Language norms
Social disposition	Height of expectations	Degree of industrialisation of the country
Demographics	Willingness to suspend disbelief	Tolerance of privacy invasion and data sharing
	Anthropocentric tendencies	

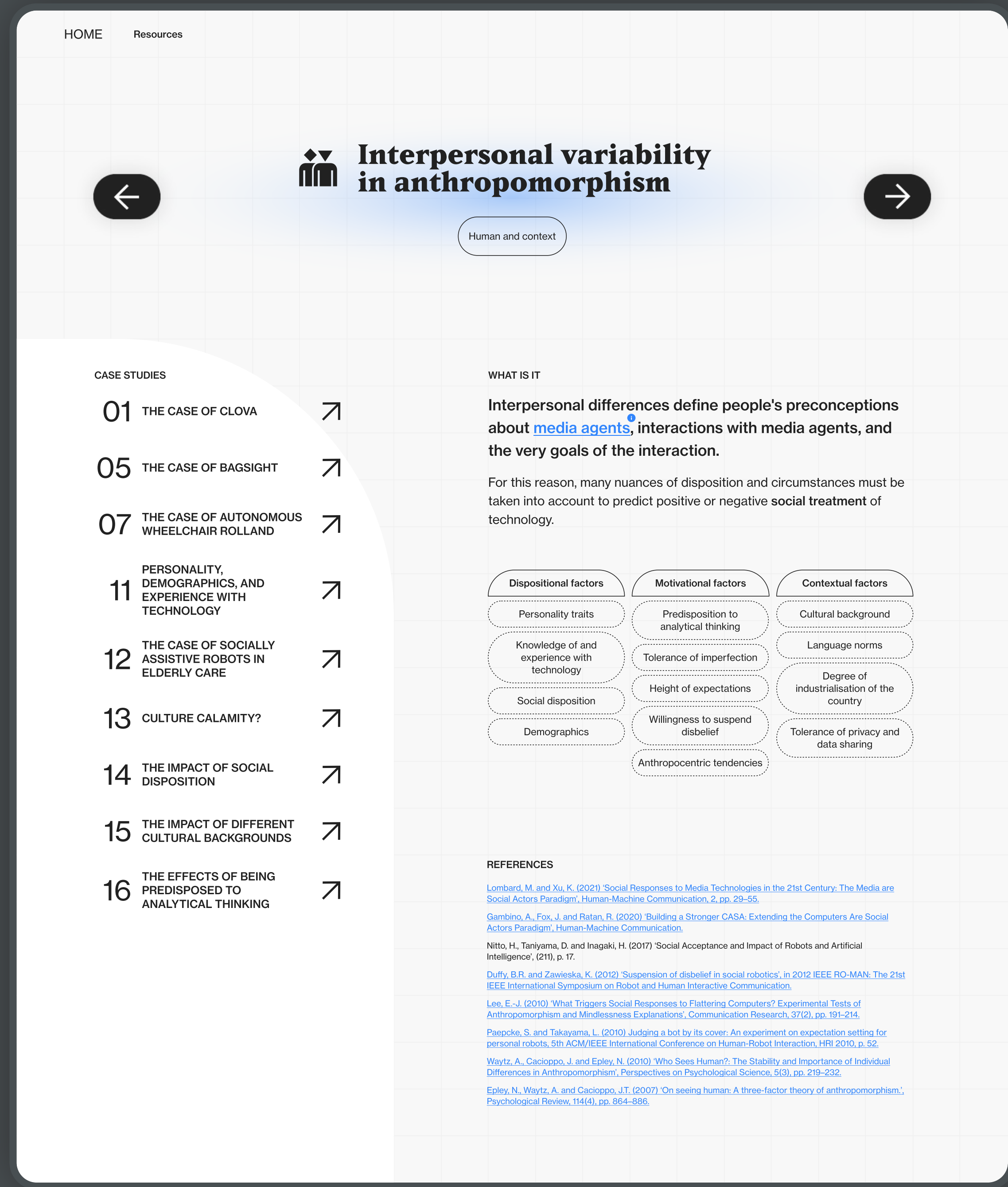


Figure 37
The Media Agent Interaction Handbook interpersonal variability in anthropomorphism principle

FORM AND BEHAVIOURAL ANTHROPOMORPHISM

While **form anthropomorphism** describes how much an entity shows a human-like appearance, **behavioural anthropomorphism** refers to the extent to which an entity behaves in a human-like manner, and its perception is more subtle in that there is no explicit human representation.

Therefore, anthropomorphic perceptions may derive from the way a system acts, rather than how it looks. Successful anthropomorphic agents should manifest appropriate communication patterns that model users' expectations of acceptable behaviours and interactions with a system.

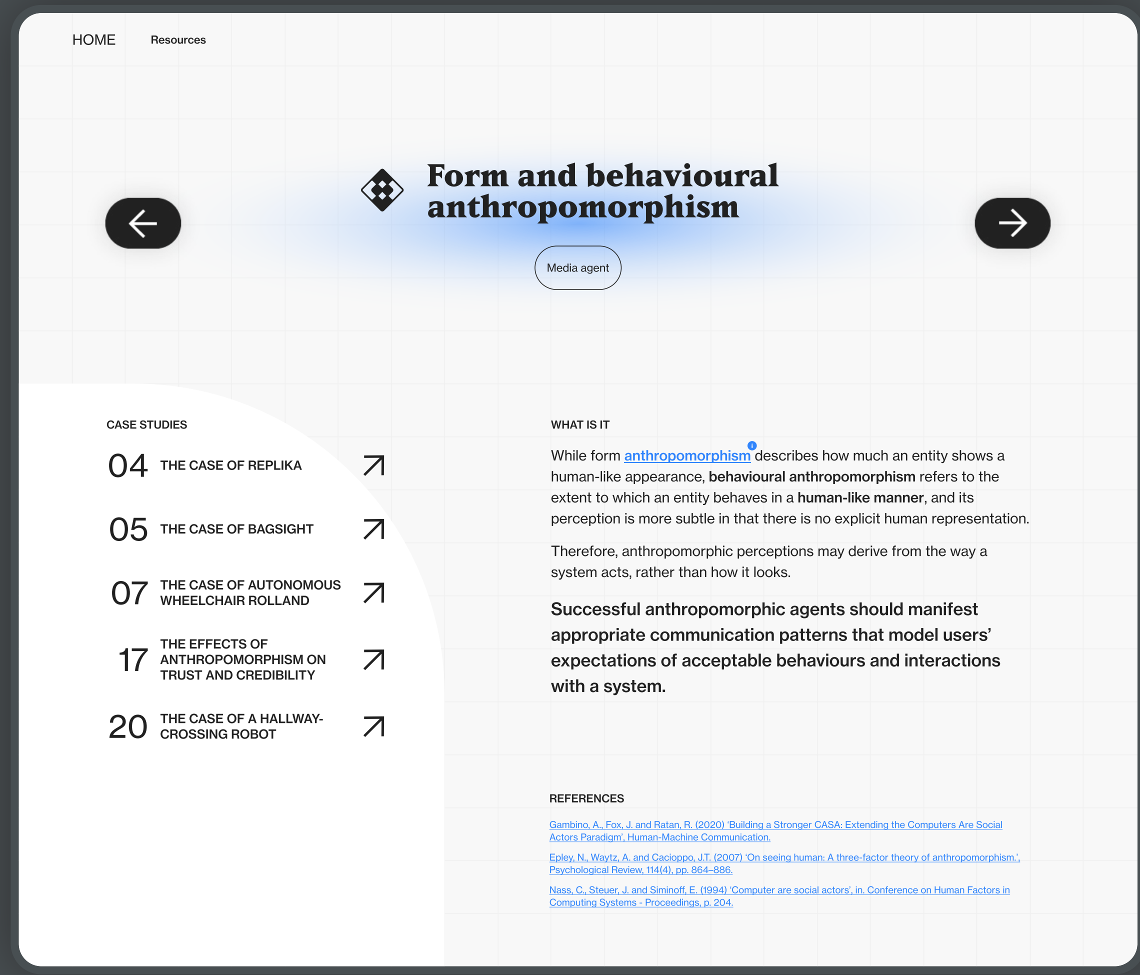


Figure 38
The Media Agent Interaction Handbook form and behavioural anthropomorphism principle

MINDFUL AND MINDLESS ANTHRO-POMORPHISM

A dual anthropomorphic association, based on **explicit and implicit cognitive processing**, can be used to support both conscious and unconscious social treatment of media agents.

Mindful anthropomorphic attributions derive from slower cognitive processes that lead to conscious social treatment of technology (e.g., children who imagine toys talking to each other).

Mindless anthropomorphic attributions derive from spontaneous cognitive processes and are the reason why people react socially to technologies, even if they deny doing so.

However, mindlessness is a variable in the interpretation of technology as social, as interpersonal differences define people's preconceptions.

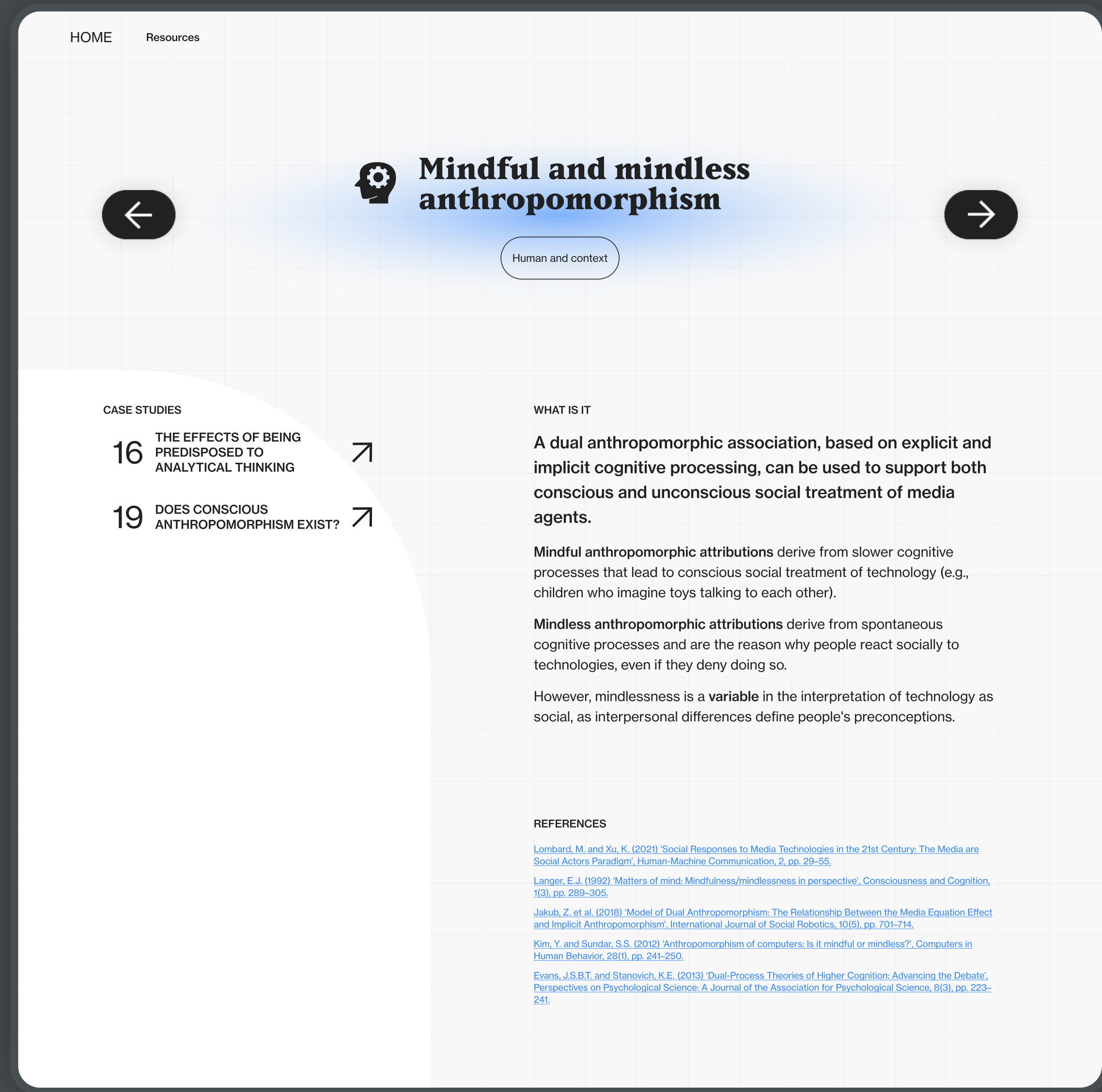


Figure 39
The Media Agent Interaction Handbook mindful and mindless anthropomorphism principle

THE ECONOMY OF INTERACTION

If expectations about a media agent's communicative competence are not met, users fall back on functional, transactional, and reliable use cases to fit the **economy of interaction**. The relational role of a media agent determines the user's perception, which is free from task-specific constraints and more abstract.

Sorting relational roles by perceived physical and psychological proximity to humans, media agents can be considered from **utility** to **extension** of one's body, passing through social roles of ally, influence, and authority.

RELATIONAL ROLES

08	Utility
07	Media
06	Bystander
05	Proxy
04	Ally
03	Influence
02	Authority
01	Extension

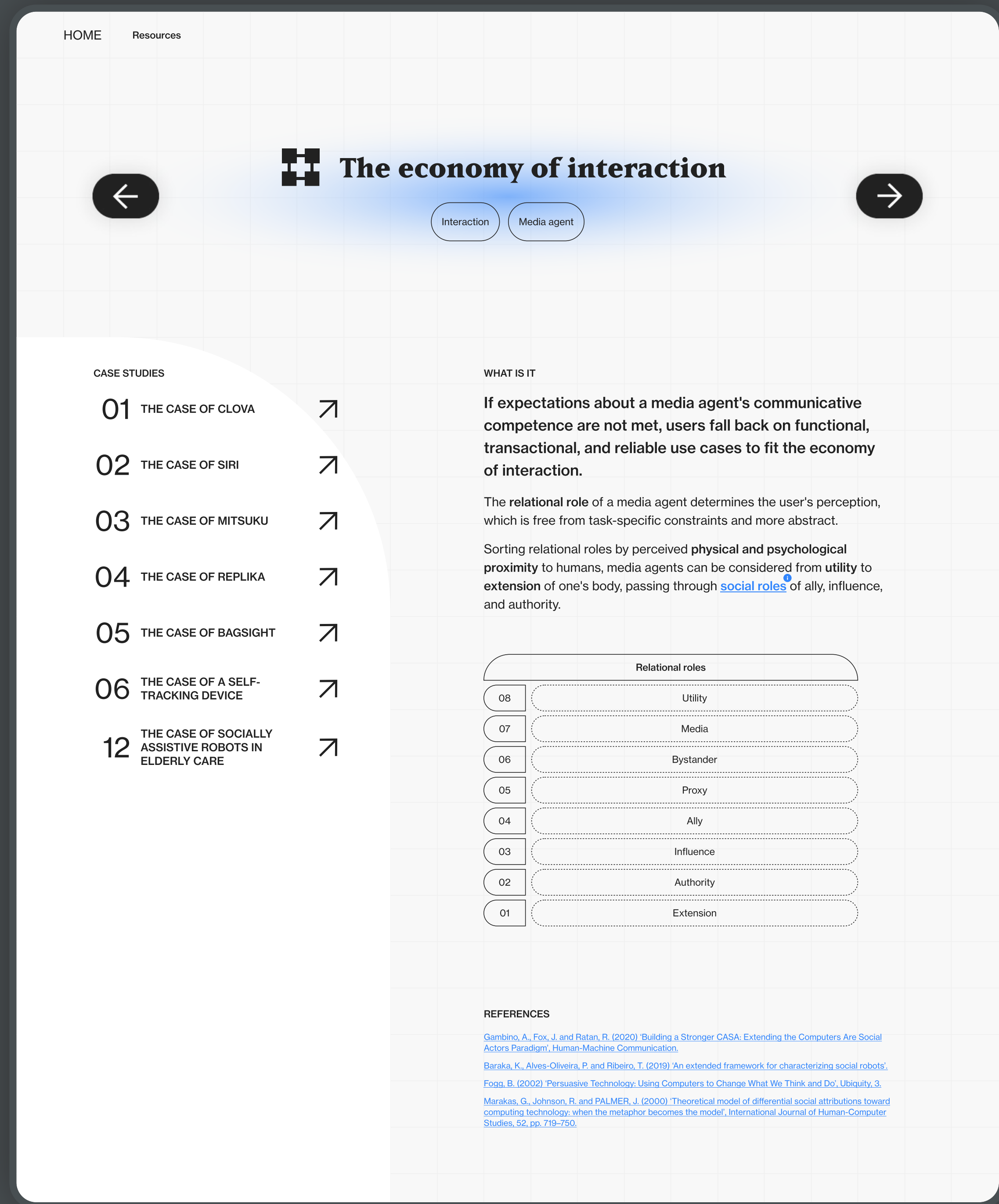


Figure 40
The Media Agent Interaction Handbook economy of interaction principle

THE TEMPORALITY OF INTERACTION

The **temporal role** defines the type of relationship that can be established with the media agent: the more goal-oriented the agent's behaviour, the shorter the duration of the interaction.

The type of interaction can thus be **short-term**, characterised by consecutive, isolated interactions (e.g., customer service); **medium-term**, where interactions extend repeatedly over several days or weeks; **long-term**, which generates a sense of predictability and attachment; and finally **life-long**, characterised by interactions that last a lifetime and accompany humans through major transitions.

Timing, on the other hand, is the dimension that defines the spatial location of interaction in time, and is able to alter the perception of the media agent.

TIMING	TEMPORAL ROLE
Timespan of interaction	Short-term
Duration of interaction	Medium-term
Frequency of interactions	Long-term
Synchronicity	Life-long
Turn taking	

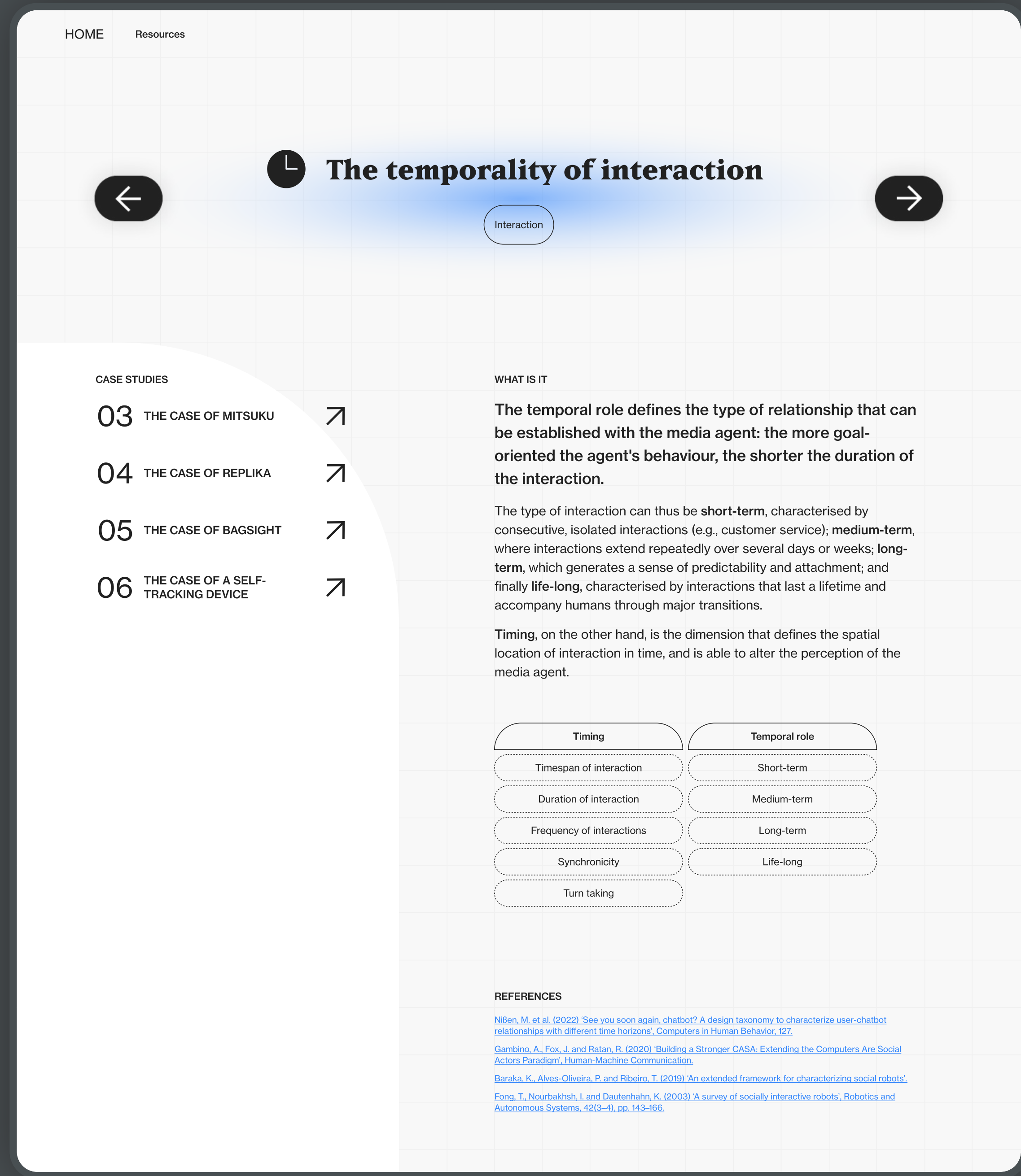


Figure 41
The Media Agent Interaction Handbook temporality of interaction principle

THE OPERATIONAL-ISATION OF SOCIAL CUES

Social cues are anthropomorphic features embedded in media agents to enhance their communicative potential and are independent of context, domain, and culture.

If the goal is to endow medial agents with personalities, genders or communicative patterns, it will be necessary to **operationalise sets of social cues**, although their interpretation will be dynamic and will ultimately depend on interpersonal variability.

Considering social cues as integrations of social-emotional behaviours, the higher the number of cues, the stronger the communicative potential of the media agent. At a high level of abstraction, social cues can be classified according to a two-level hierarchy.

VERBAL CUES	Content
	Style
VISUAL CUES	Kinesics
	Agent appearance
	CMC
AUDITORY CUES	Voice qualities
	Vocalisations
INVISIBLE CUES	Chronemics
	Haptics

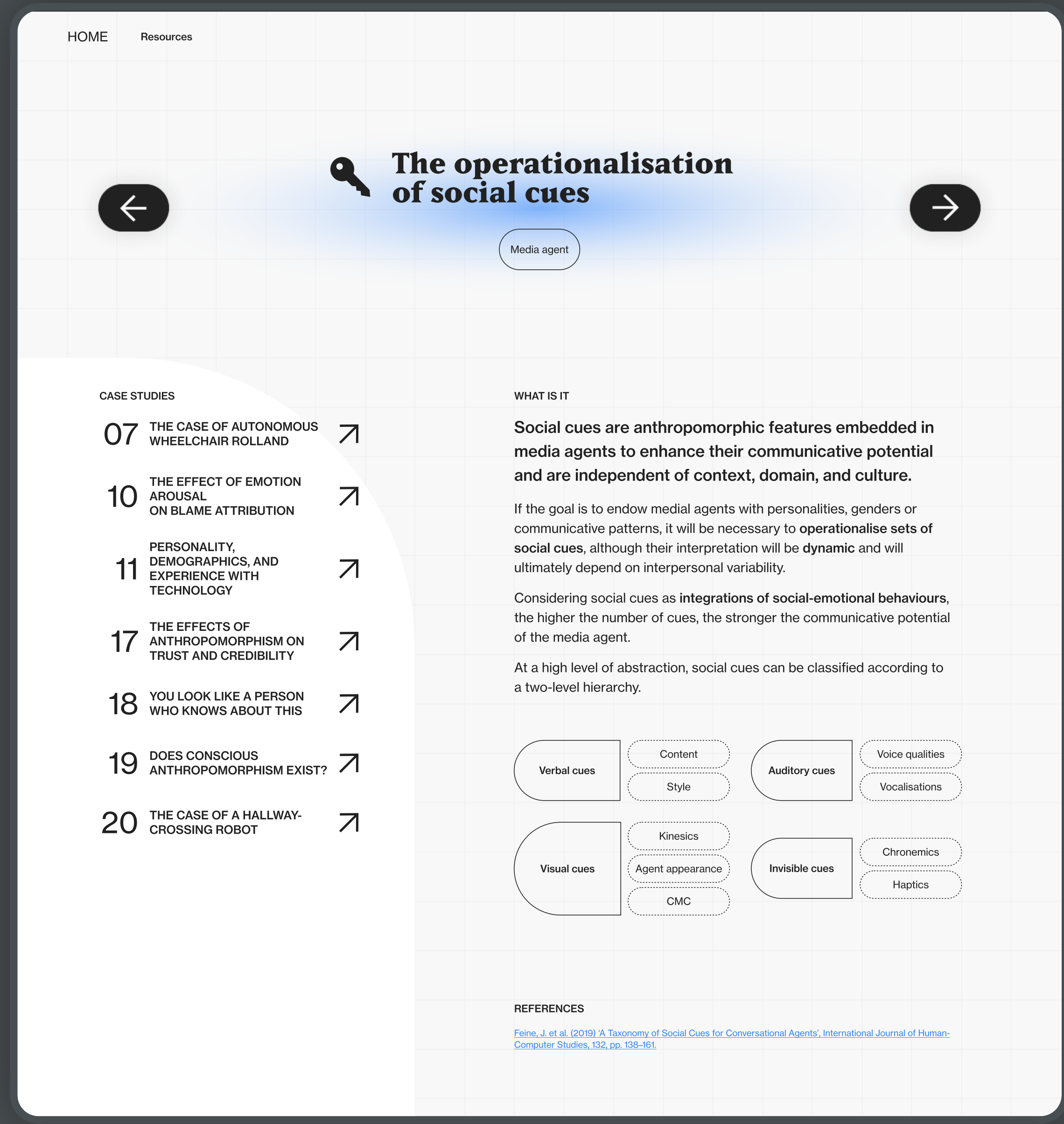


Figure 42
The Media Agent Interaction Handbook operationalisation of social cues principle

THE PERSUASIVE POWER OF MEDIA AGENTS

Perceived expertise and trustworthiness determine the **degree of persuasion** of a media agent, where trust is often directly associated with system performance, reliability, and communication style; moreover, media agents employed in transactional use cases are perceived as more trustworthy than social use cases.

Specifically, **trust** can be attributed to agents designed to represent human reasoning and motivations, so it plays a complex role in the interactions a user has with aspects of an interface or system. Because the manifestation of anthropomorphic behaviours connects to user emotionality, it is critical to promote the calibration of trust for safe and effective interactions with technology.

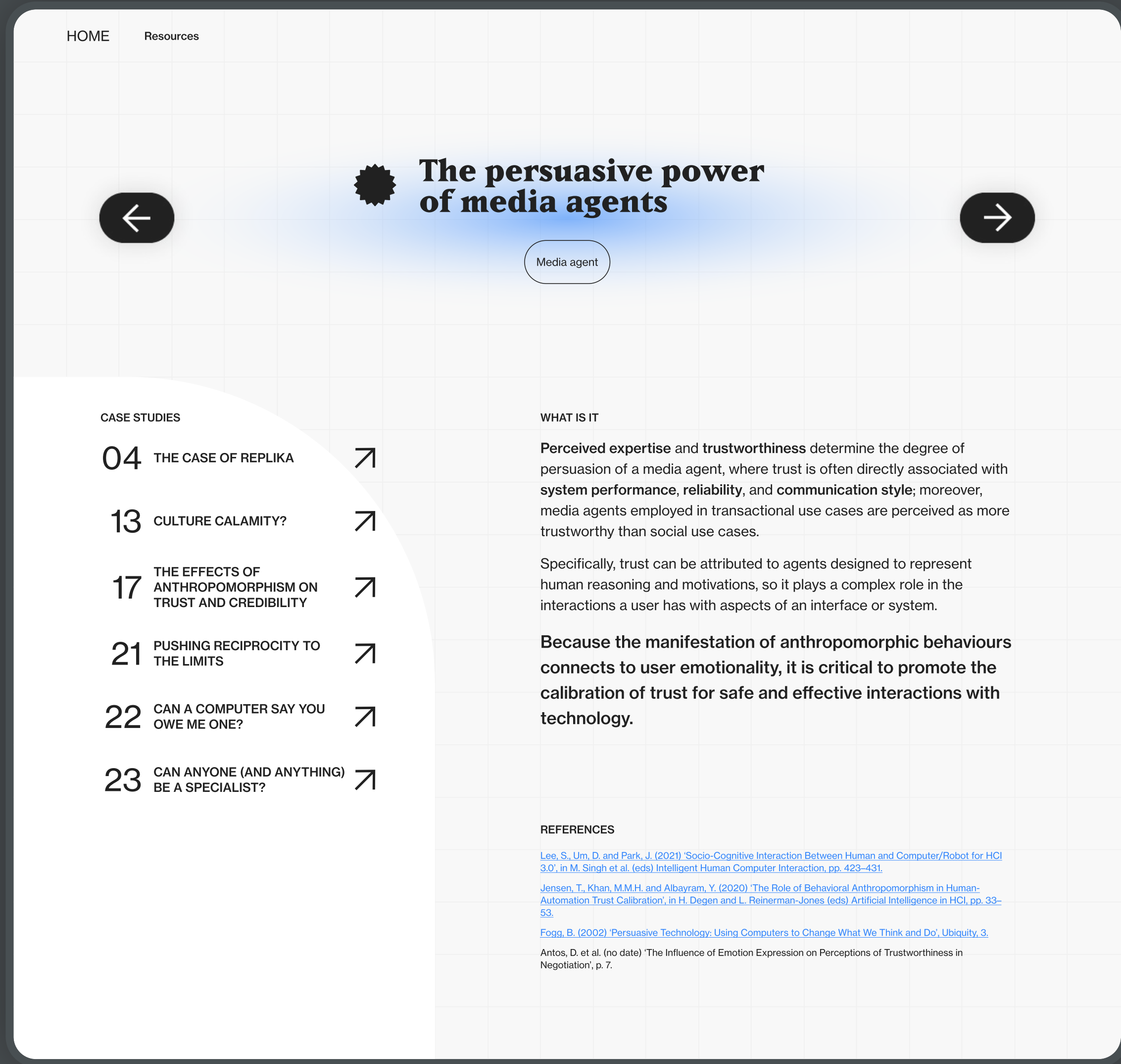


Figure 43
The Media Agent Interaction Handbook persuasive power of media agents principle

THE PROXEMICS OF INTERACTION

Proxemic behaviour is representative of the relationship between two individuals in that it specifies their spatial distance, which can be intimate, casual-personal, socio-consultive, and public.

While mutual distances are culture-dependent, <u>the physical proximity of media agents can influence the level of perceived intimacy between users and devices</u>, creating a new perceived psychological distance and closeness.

Physical distances, which generally represent social distances, are sometimes determined only by spatial boundaries. Therefore, to determine the communicative intent conveyed by an observed social cue, it is critical to understand the **context** in which the cue was displayed.

PROXEMICS
Conversational distance
Proximity
Background

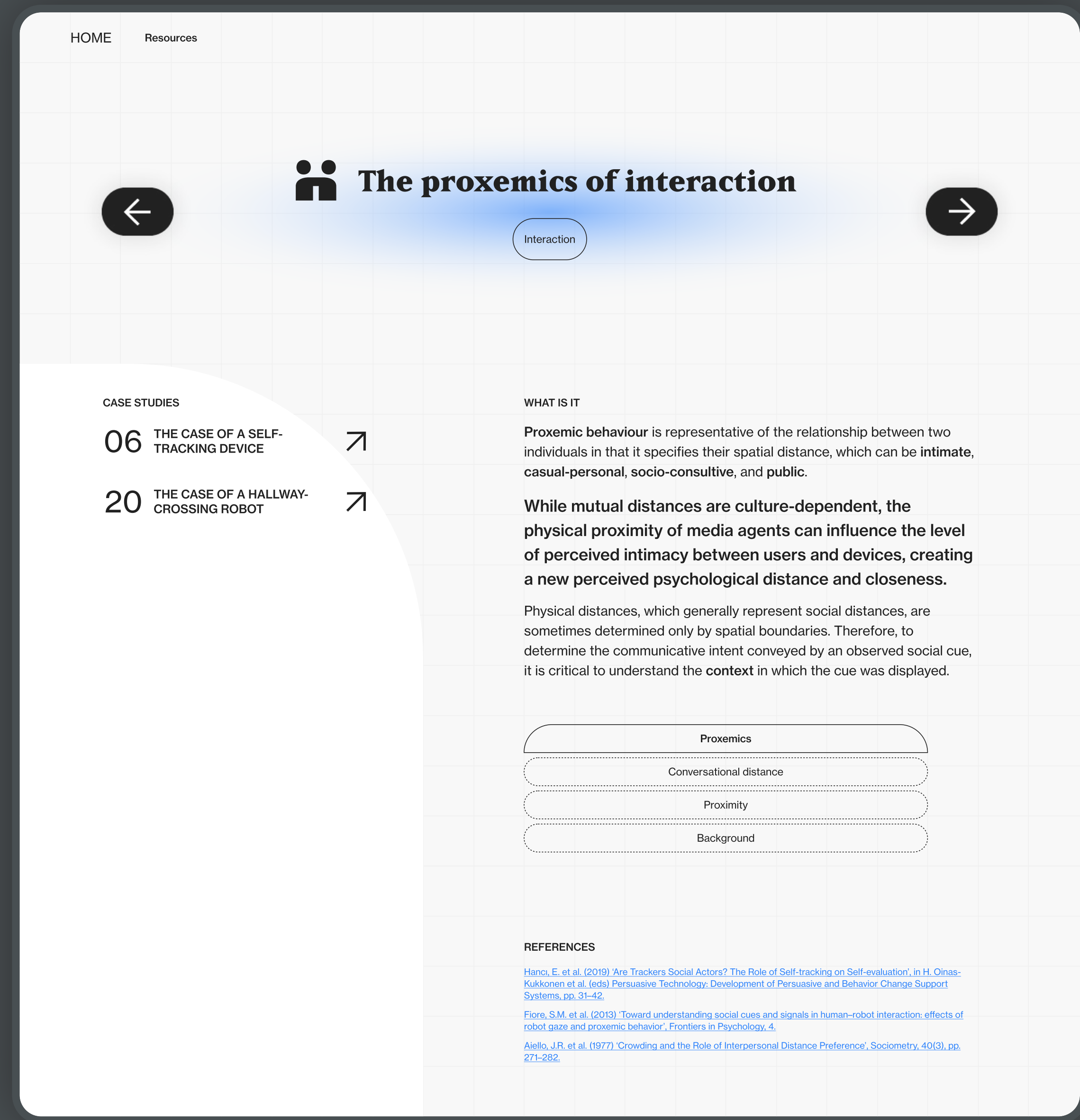


Figure 44
The Media Agent Interaction Handbook proxemics of interaction principle

CASE STUDIES

Case studies are laid out systematically and concisely to emphasise key aspects. Each case begins with a **problem statement** that clarifies and contextualises the topic that will be covered, so that users understand whether the information they are about to read is suitable for their needs. Afterwards, the **method**, **results** and **conclusions** are discussed.

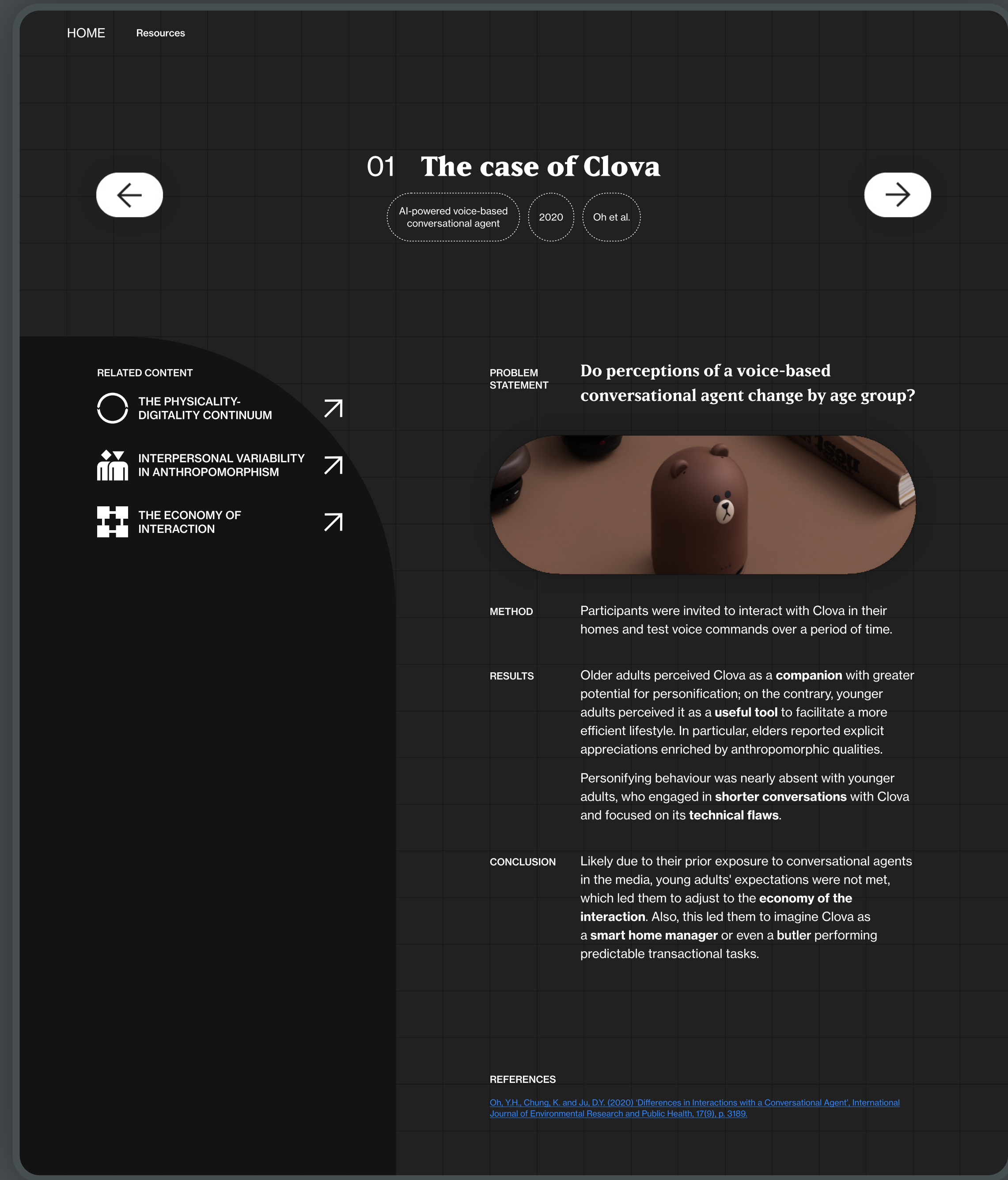


Figure 45
The Media Agent Interaction Handbook Clova case study

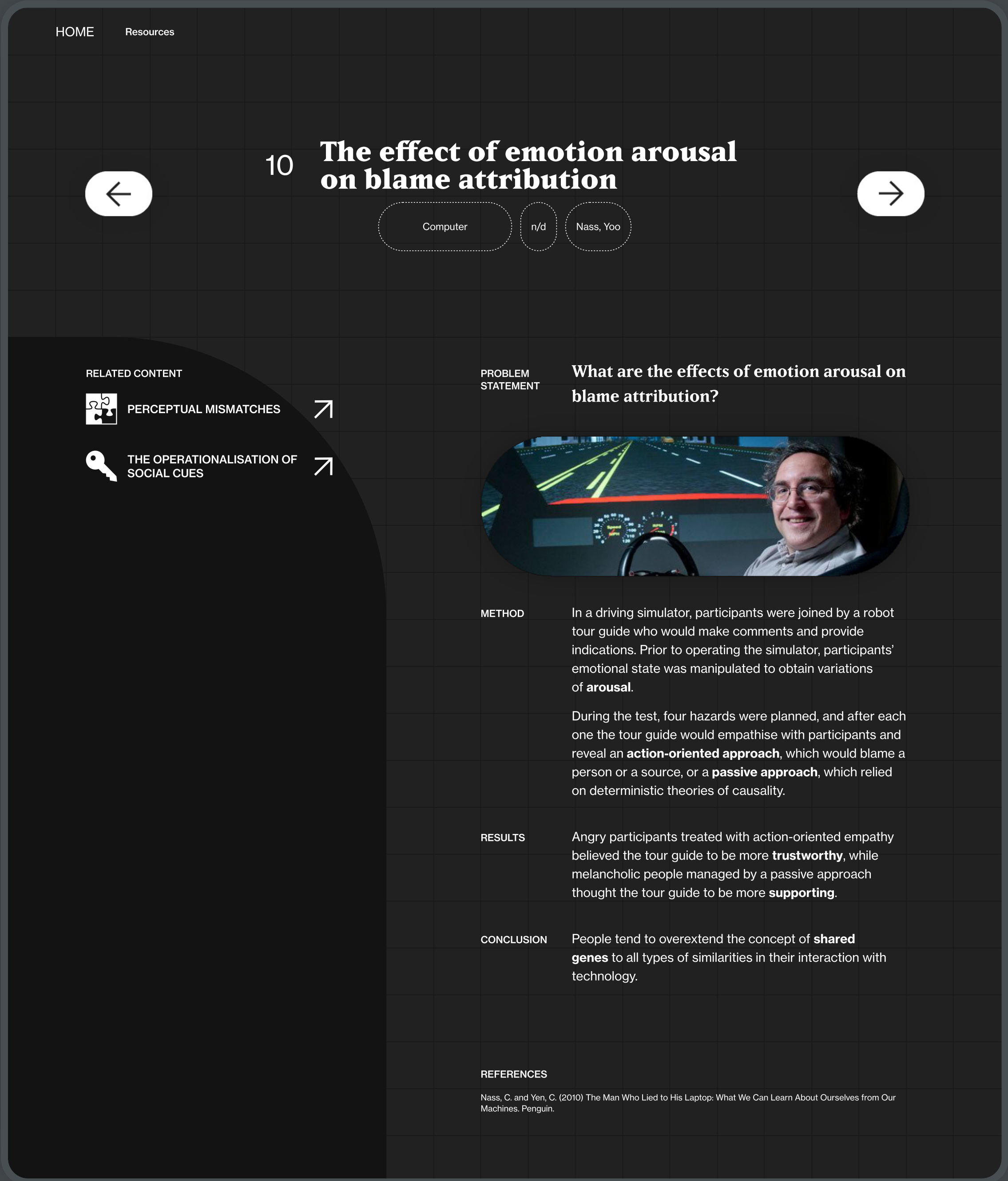


Figure 46
The Media Agent Interaction Handbook
effect of emotion arousal on blame attribution case study

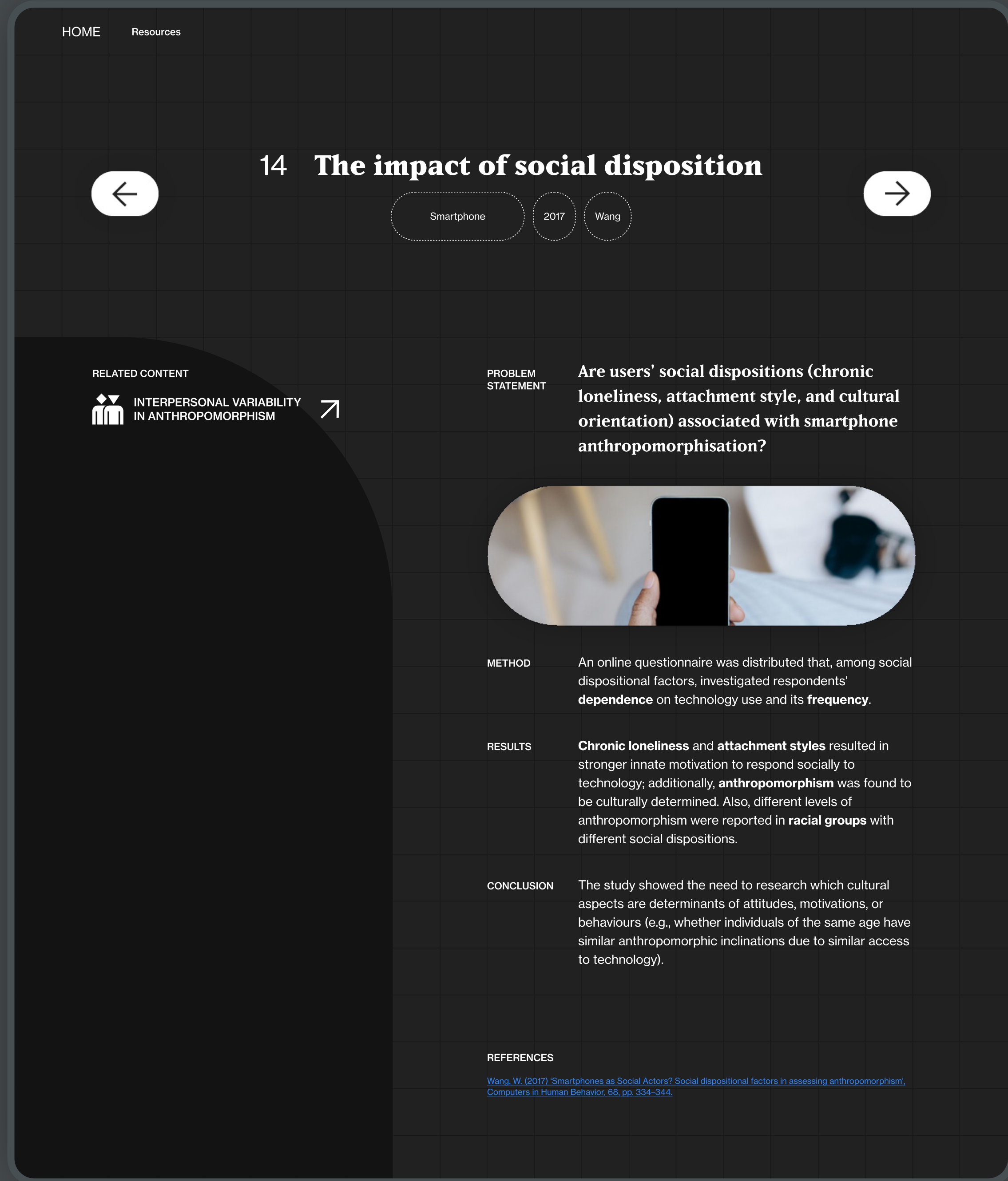


Figure 47
The Media Agent Interaction Handbook
impact of social disposition case study

09.3
User Testing Setup

The goal of the usability test was to verify the **conceptual interaction** proposed by the system and the **exploration logic** of the knowledge elements.

The test was organised in three phases: the first phase consisted of organising a workshop with **Professor Margherita Pillan's** UX Design students enrolled in the first year of Digital Interaction Design at the Politecnico di Milano; the second and third phases, contained in a **Google form** to be answered virtually, consisted of three search tasks and a survey on the overall experience.

CLASSROOM ACTIVITY

On November 9, 2022, I had the opportunity to present the thesis to UX Design students of Professor Margherita Pillan enrolled in the first year of Digital Interaction Design at Politecnico di Milano. The workshop, conducted remotely on Webex, first consisted of a short presentation that introduced the **topic**, **research method**, and **testing goal**; then, 5 minutes were given to the students to freely explore the dashboard. This would allow participants to familiarise themselves with the resource collection, interface and features of the system they would be using. The objective of this activity was to check whether students understood the topic, intended as a **synthetic tree of knowledge** based on statements that are an alternation of principles and case studies.

The **debriefing** session was conducted live, encouraging students to respond through their microphone or by posting their answers and opinions in the chat. The questions asked in the debriefing were:

1. What was the topic?
2. Under what circumstances should this topic be accessed?
3. What do you think is the search logic?

SEARCH TASKS

The **search tasks** and **post-activity survey** were collected in a Google form and forwarded to Professor Margherita Pillan's students and other designers and colleagues.

The search tasks presented examples of in-depth knowledge filtered through three usage scenarios that exemplified the design questions that could be answered in the content search. The first search task was **principle-driven**, and involved searching for knowledge pills; the second search task was **case study-driven**, and involved searching for contextualisations of that knowledge in real-world scenarios; and the third search task was **design-driven**, and required the researcher to connect pieces of knowledge to answer a design brief.

The goal of the search tasks was to understand whether the content was summarised in an understandable way and whether the design scenarios were perceived as plausible. Each task was elaborated as a statement, followed by a question and tip that suggested a way to carry out the task or the starting point.

Specifically, the search tasks were:

1. **Principle-driven search task**: proxemics is the study of how people unconsciously structure the space around them. How does it influence the social perception of media agents? Pro tip: consider which building block proxemics belongs to in order to filter the results.
2. **Case study-driven search task**: find 2 case studies in which a disembodied conversational agent was treated in social terms. Pro tip: consider the declinations of a disembodied conversational agent according to the physicality-digitality continuum.

3. **Design-driven search task**: you have been asked to design a text-based conversational agent to play the role of a teacher for distance learning situations. What characteristics should the conversational agent have? Pro tip: consider the dimensions of temporality, persuasive power, and interaction economy.

For each search task, users were asked to answer these debriefing questions:

1. What search procedure did you follow to arrive at your answer and what would your answer be?
2. How do you feel the contents are summarised? Did you find the language easy enough to understand and apply?
3. Do you perceive the search scenarios to be plausible? Can you think of any other search scenarios?

POST-ACTIVITY SURVEY

The **post-activity survey**, divided into 6 sections, aimed to collect comments and accurate responses from open and closed questions. Section No. 3 will be omitted as it consisted of the search tasks extensively described above.

Section No. 1: title and privacy protection disclaimer

1. The answers you provide will be collated and kept at an aggregated, pseudonymised level. Personal references will not be made in the eventuality of a publication of the results.
2. Link to prototype.

Section No. 2: background information

1. What is your background?

Section No. 4: overall experience with the handbook

1. How would you describe your overall experience with the handbook?
2. What did you like the most about using the handbook?
3. What did you like the least?
4. How easy/hard was it to retrieve the requested information?
5. What, if anything, caused you frustration?
6. Were the proposed filters sufficient to sort the results and get the information you needed?
7. Would you have preferred additional search aids (e.g. a search bar, additional filters, a map, etc.)?

Section No. 5: topic understanding

1. Were you already familiar with the topic?
2. Did your knowledge of social interactions with media agents increase after testing?
3. Did your curiosity about the topic increase after you spotted the first piece of information? Did you feel motivated to explore?

Section No. 6: handbook use cases

1. Do you think the handbook could be a useful tool for interaction designers to refer to for future projects?
2. How frequently would you use the handbook?
3. What design situations come to mind when interacting with the contents of the handbook?
4. Is there anything else you would like to add?

09.4
Results and Implications

CLASSROOM ACTIVITY

As for the **classroom activity**, students replied in chat by providing comprehensive answers to debriefing questions.

When asked "What is the topic?," students responded that it was about "Discovering the notion of a media agent" and "How people and technology can work together."

When it came to defining under what circumstances the content should be accessed, students confirmed that the tool belonged to the design research phase, particularly in "Designing products involving media agents and to find inspiration when we have open problems in design."

The search logic was considered broad to specific, urging designers to "Have an open mind, including all solutions." Students also rightly pointed to "Filters and the use of keywords" but also "The surprise of accidentally finding something you didn't know before."

The results of the first activity showed that students rightly attributed the use of the platform to the research design phase. In addition, it is remarkable how they considered curiosity itself a tool and rationale for exploration, allowing them to move among knowledge elements guided by the desire to discover something they did not know before.

BACKGROUND INFORMATION

Ten students and designers responded to the search tasks and post-activity survey. The participants' backgrounds were varied, of which **40%** had a background in **digital interaction design**, **30%** in **communication design**, **20%** in **product design**, and **10%** in **interior design**.

PRINCIPLE-DRIVEN SEARCH TASK

The search tasks invited participants to describe the search procedure followed to arrive at the answers and to provide an answer to the question. The **principle-driven task** asked to consider how proxemics influenced social perceptions of media agents, prompting users to weigh in on the building block to which proxemics belonged.

Starting at the **gateway**, users clicked on the “See all resources” call-to-action, used the navigation bar, or took advantage of the “See all principles” shortcut in the “Highlights” section of the gateway.

One user reported that they then filtered by principle by selecting “View only: principles,” and from there they scanned the filtered results by reading the card titles and selecting those of interest to them.

Following the prompt in the task statement, many users responded that they marked **principles** by **interaction** block and browsed the results to find the principle of “Proxemics of interaction.”

Most respondents directly cited the principle of proxemics of interaction in response to how proxemics influenced social perceptions of media agents, stating that physical proximity can influence the level of perceived intimacy between users and devices.

However, one participant added that:

“When you use a personal device you perceive it as an extension of your body as you carry it with you all the time. Whereas if you use, for example, an ATM you perceive it as something more distant; the moment the interaction happens you stand in front of it and quickly touch the interface, only for the time it takes to use the service.”

One respondent, however, did not perceive the principle as exhaustive, so they looked for the answer in “The case of a hallway-crossing robot,” one of the related case studies, where they found that "If a media agent respects the proxemics of a particular cultural context it is perceived as more socially present.”

CASE STUDY-DRIVEN SEARCH TASK

The **case study-driven search task** invited participants to find two case studies in which a disembodied conversational agent was treated in social terms. The task also urged respondents to find out what a disembodied conversational agent consists of by exploring the physicality-digitality continuum.

Again, participants used the navigation bar, clicked on the “See all resources” call-to-action, or used the “See all case studies” prompt on the gateway to access the case studies.

Some participants directly filtered the results by **media agent** block and **case studies**, then browsed through the results to identify those that, based on the titles and descriptions, seemed closest to the search objectives. Others, however, followed the suggestion to first look for the principle of the physicality-digitality continuum and to find out what a conversational agent was, which was understood as a “Subgroup of media agent.” Then, they were able to select the building block of the media agent and identify related case studies.

One participant took a slightly **different approach**, which consisted of browsing through the case studies using navigation arrows to see which ones were related to the principle of the physicality-digitality continuum and choosing those as the correct answers.

Unfortunately, one participant did not feel the explanation of the physicality-digitality continuum principle was sufficient and relied on a **Google search** to better understand what a disembodied conversational agent was and return to the handbook to complete the task.

The answers of all participants were “The case of Clova,” “The case of Siri,” “The case of Replika,” or “The case of Mitsuku.”

DESIGN-DRIVEN SEARCH TASK

The **design-driven search task** invited participants to identify the characteristics that a text-based conversational agent would need to play the role of a **teacher**, prompting respondents to consider the dimensions of temporality, persuasive power, and economy of interaction.

Several methods were adopted to obtain the required information, but they yielded **very similar results**. For example, one method consisted of using the “View all principles” shortcut on the gateway, then analysing the principles that might relate to their problem and then browsing through the case studies to see if they could provide insights for developing a better text-based conversational agent.

In contrast, another participant began to browse through all the case studies, seeing those that were labeled as text-based conversational agents and identifying those that were most relevant to the case.

Following this approach, the response was that the agent had to be professional, trustworthy and reliable, ensuring the right emotional distance with the user. Regarding this last point, the interviewee suggested that the Replika case, under these circumstances, would be the example not to follow, as participants in that experiment opened up too quickly.

Other participants, however, were helped by the suggested keywords and focused on the **interaction** block to find out all the information they needed. One participant stated that "To design a text-based conversational agent that is also a teacher, it is necessary to define the orientation of the service, to choose its temporal role. Then, one should consider the issue of trust in shaping the system and the relational role with respect to the user."

While one participant stated that "The agent should be able to establish a **long-term relationship** that can generate a sense of predictability and attachment; they should also be able to adopt the correct communication style and connect with users on an emotional level," another contrasted by saying that a teacher should establish a **short-term relationship**, as "A teacher should have their goals very clear," but also stating that they should be able to establish the relational roles of ally, authority and influence and should convey trustworthiness.

LANGUAGE AND CONTENT

Participants' opinions were almost **unanimous** regarding the **comprehensibility of the language**; some users appreciated the way the content was summarised and schematised, stating that it "Includes all the basic information I need to start researching during the first step in concept development." However, many participants struggled with terminology and, while appreciating the presence of the **bibliography** to expand their research, suggested the implementation of more informational tags to explain more difficult terms.

PLAUSIBILITY OF THE SCENARIOS

The scenarios were considered **plausible**, although sometimes not suitable for an inexperienced user. However, they were perceived as applicable to any consistent and complicated topic, such as "Research according to authors," which was explained as the platform's understanding of how the topics presented were studied if one is writing a literature review, or "When designing other kinds of relationships with media agents."

OVERALL EXPERIENCE WITH THE HANDBOOK

Most participants stated that the experience was pleasant and smooth and considered the handbook to be "A professional, exploratory, and informative tool." Also, it was suggested that the ability to enter multiple filters at once should be implemented.

When asked what they liked **most** about the experience, one participant said they "Liked the way the content is presented. It gives you insights into the topics, points of reflection. Usually, when dealing with topics like this, you expect to spend hours reading documents without being able to understand." Others emphasised the amount of resources in the contextual examples and case studies.

Whereas when asked what they liked **least**, some pointed to "The way of navigating between the different pages of the principles," as finding something from the resource page, using the filters, was found to be more intuitive. Some participants struggled to understand each concept, while others criticised some minor UI interactions, such as the **close icon** for filter deselection being too small or the **function of hovering** building blocks in the gateway being cumbersome.

Moreover, participants' opinions varied when it came to describing how difficult it was to retrieve the required information: on a scale of **1 to 5**, where **1** was **easy** and **5** was **difficult**, responses were evenly distributed, but with a strong concentration on **2** (**30%**) and **3** (**40%**).

Nothing in particular caused frustration, other than the **absence of a text-based search bar** or **timeline**. This point was further addressed when asked if the filters present were sufficient to sort the results and get the information needed, as **40 percent** of participants said they were **not**.

Specifically, the preferred additional search tools were a **search bar** (**70%**) and **additional filters** (**30%**). Although a search bar was not implemented to focus on the exploratory opportunities of the prototype and because of related implementation problems, the desire for **additional filters** was also raised in the search tasks, as tags belonging to the case studies were not used as filtering options on the resources page, resulting in some **frustration**.

TOPIC UNDERSTANDING

It is interesting to compare how although **70 percent** of the participants were unfamiliar with the topic, **all of them** said that their knowledge of social interactions with media agents had increased after the user testing, and **90 percent** that their curiosity about the topic increased after they identified the first information and felt motivated to explore.

HANDBOOK USE CASES

All participants claimed that the handbook is a useful tool for interaction designers to refer to for future projects, and on a scale of 1 to 5 (where **1** is **never** and **5** is **very frequently**), **70 percent** voted **4**. When asked what design situations came to mind when interacting with the contents of the handbook, many suggested **design phases** (e.g., research, concept generation and benchmarking) and **use case scenarios** (e.g., home automation, virtual experiences).

Adopting a more business-oriented lens, one participant proposed that the handbook might be useful when working on marketplaces: "Can I add a chatbot within some pages? What should I consider if I want to add it? Are some choices a good fit? Surely I could find some answers there."

DISCUSSION

The user testing provided some interesting insights into the handbook. Regarding the **search tasks**, it was refreshing to see how different approaches to content search led to similar conclusions, suggesting that **knowledge elements** can be explored in various ways.

When a participant was dissatisfied with the information obtained from the principle of "Proxemics of interaction," they relied on **related case studies** to further deepen their knowledge. Meanwhile, when searching for case studies in the case study-driven search task, a participant browsed through the collection to find which case studies were related to the principle of the physicality-digitality continuum.

The design-driven search task demonstrated the **greatest variability in search**, ultimately suggesting similar characteristics that a media agent teacher should embody: the only discrepancy was between those who thought the relationship should be **long-term**, and those who thought it should be **short-term** and goal-oriented: however, this reinforces the hypothesis that some aspects of the design of human-media agent interactions depend on the **context of use** and **service orientation**, as well as on the **interpersonal variability** of the designers themselves and how they model the system with respect to the user.

One unanticipated use of the learning objects was to point to a use case as an example **not to be followed**, applying the logic that because under those circumstances the interaction with one type of media agent had certain consequences, it would be necessary to depart from how that interaction was designed if a different outcome is to be expected.

Regarding the use of **search aids**, users were not completely satisfied with the filtering options provided in the prototype. Even though the **absence of a search bar** caused the most frustration, apart from implementation limitations, it was dictated by a desire to investigate how users would interact with knowledge elements by means of **exploration**, **hierarchy**, and **perceived categorisation of concepts**. Specifically, removing **known-item search** from the experience, it shed light on the perceived value of introducing other types of search aids such as **timelines**, **author search**, or more **case study-specific filters**.

Moreover, the study revealed an innovative insight: **curiosity** itself was considered to be a tool and rationale for exploration, which increased by **90 percent** after the first testing activity. In addition, it allowed users to move among the knowledge elements guided by the desire to discover something they did not know before and to search for other types of resources (e.g., contextualised in case studies) better suited to their needs.

Overall, the **conceptual interaction** of the prototype and the **logic of exploration** of the knowledge elements was verified, providing a positive impact on the user experience in information retrieval processes.

As the search scenarios were believed plausible, it supported the potentiality of the handbook to be used as an **aid to design research**.

Finally, considering that the tool's usefulness was perceived to be limited to experienced users, further work should be conducted to revise the proposed filters based on the test results, in order to **support known-item search** as well as **ensure clearer understanding of difficult terminology** via means of an increased number of informational tags.

LIMITATIONS

The test was subject to some limitations. First, the **user group** in the activities is relatively **small** and **uniform**, as it involved current and former design students at Politecnico di Milano. This may therefore not represent the experience and opinions of a larger or more diverse user group. Also, the perceived usefulness of the tool for people with backgrounds other than design, such as architecture or software engineering, is unknown.

Second, because the search tasks were conducted **remotely** and **asynchronously**, and without the supervision of a facilitator to provide further explanation, it is not known whether some responses were related to an actual conceptual interaction problem or a misunderstanding of the task requirements.

It is therefore necessary to undertake a further iterative phase of design adaptations and user testing, as well as the formulation of additional **search tasks** and **use scenarios**.

Summary

HIGHLIGHTS	LOWLIGHTS
A great variability in search approaches led to similar conclusions and results.	The scenarios were considered unsuitable for an inexperienced user.
Case studies were perceived as contextualizing knowledge or as examples not to be followed if different interaction results were to be achieved.	Participants struggled with terminology and suggested the implementation of more informational tags to explain more difficult terms.
Curiosity was considered to be a tool and rationale for exploration, increasing by 90 percent after the first testing activity.	Participants voiced the need to select multiple filters at once, as well as the need for additional filters related to case studies and a search bar.
The handbook was considered a useful tool during the design phases (e.g., research, concept generation and benchmarking) and in various use scenarios (home automation, virtual experiences, marketplaces).	The small, uniform user group did not represent the experience and opinions of a larger or more diverse user group.
Testing with the handbook increased users' knowledge of social interactions with media agents by 100%.	It is not known whether some responses were related to an actual conceptual interaction problem or a misunderstanding of the task requirements.

Conclusions

MOTIVATION

The research work grew out of a desire to take a divergent approach to knowledge gathering and processing and an interest in the Computers are Social Actors paradigm, which investigated social perceptions of computers at a time when technologies were functionally limited.

Twenty years of technological innovations and cultural changes have challenged the relevance of the paradigm. Nevertheless, if interactions with technology are still genuinely social, the question of usability emerges: since the first interaction with a technological artefact is driven by instinctive and intuitive processes, it is crucial to harness human cognition to practice anthropocentric design.

Originally, researchers Nass et al. (1994) discovered strategies for effective human relationships by observing successful and unsuccessful interactions with technology. However, similar to how the study of human-computer interaction can help to better understand human-human communication, it can help to imagine more instinctive human-media interactions that reference human cognition.

APPROACH

The body of work consisted of two phases: the first, research-based, consisted of extrapolating notions and cognitions and contextualising them geographically and historically to determine how they evolved over time and how they related to the coeval characteristics of technologies, artefacts, contexts and customs.

The reformulation of theories revealed limitations, design implications, inconsistencies and related definitions, bringing to light a model of social interaction that does not take into account the specificities of media at the physical or material level.

The second design and empirical phase consisted of identifying a way to communicate this knowledge in a way that was accessible to designers in addressing open problem contexts and imagining multiple medial relations.

PROTOTYPE AND USER TESTING

The Media Agent Interaction Handbook was proposed as an exploratory search interface aimed at investigating the search logic applied by users.

The categorisation of knowledge elements was organised to reason according to the building blocks of medial relationships, with the aim of addressing the need for more complex search interactions.

Usability tests conducted with design students and designers provided insights into the conceptual interaction of the system, positively influencing the users' experience in their information retrieval tasks.

Curiosity became an exploration rationale in its own right, while numerous search strategies were adopted that led to similar results. When the results were different, it was due to the way designers intended to orient and shape the system with respect to the user.

Further work needs to be done on the search interface to also support known-item search, as well as ensuring a clearer understanding of difficult terminology and making the tool suitable for an even wider variety of usage scenarios and skill levels.

ETHICAL IMPLICATIONS AND FUTURE PERSPECTIVES

In advocating the adoption of a relational perspective, it is important to shed light on the benefits and harms that can result from different types of relationships with media agents. Although they are designed as machines, their ability to exhibit social-emotional behaviour and their proximity to human sociality and culture make it difficult to define category boundaries (Prescott, 2017).

As we have seen extensively, people are inclined to spontaneously form social-emotional bonds with media agents regardless of their integration of anthropomorphic characteristics. Specifically, when considering the subjective nature of approaching media agents relationally or transactionally, emphasis is placed on the importance of the consequences of human-media agent social interaction.

In addition, it is crucial to consider how and where relationships with media agents arise and to what extent these relationships replace human-human relationships.

The rule of reciprocity, described in the chapter “Mindless Responses to Computers,” is an example of this: when it occurs between humans and media agents, the necessary condition for the agent is to deceive the human into believing that it is able to reciprocate.

Designing for ethics should be the result of an interdisciplinary approach, focusing on integrating artificial intelligence, refining hardware and software components, examining the impact of relational dynamics and social networks on quality of life, and understanding the implications for privacy and autonomy.

The blending of perspectives and methodologies will enable future development of strategies to promote positive impacts and discourage negative ones so that the field continues to progress.

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