

# Cultural gaze behavior to improve the appearance of virtual agents

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## ABSTRACT

Finding cultural dependencies on eye gaze behavior in conversations to derive general rules that are valid beyond culture would be crucial. In this way we like to build a gaze awareness model to provide visual feedback to users interacting with virtual agents. This work aims to give an overview of literature dealing with eye gaze and culture. In addition to that we claim that an eye gaze behavior for virtual agents is important. And further, we describe methods for measuring users' eye gaze.

## Author Keywords

eye gaze, culture, human-machine interaction, methods for measurement

## ACM Classification Keywords

H.5.2 User Interfaces: *Theory and Methods*; H.1.2 User/Machine Systems: *Human factors*

## INTRODUCTION

When you communicate with someone, you do not only exchange words. Every single word we speak or perceive is accompanied by movements of feet, hands, body or face – nonverbal behavior. An important part of nonverbal behavior is eye gaze. By comparing eye gaze behavior within different cultures we hope to derive general rules and parameters for eye gaze behavior in human-machine interaction. To build a gaze awareness model for virtual characters, we must understand the different functions eye gaze has.

Kleinke [17] summarizes many functions of eye gaze and its factors. He applies Patterson's [21] sequential model for nonverbal behavior to group functions of eye gaze and defines antecedent factors of eye gaze behavior. He groups the functions of eye gaze into five groups: *providing information* (e.g. liking and attraction, attentiveness, competence, dominance), *regulating interaction* (synchronization and regulation), *expressing intimacy*, *exercising social control* (e.g. persuasion and deception, ingratiation, threat and dominance), and *facilitating service or task goals* (information seeking, learning, cooperation and bargaining). This structure helps to analyze eye gaze but does not consider individual and environmental dependencies of eye gazing. Therefore Patterson introduces

three stages for nonverbal behavior (antecedents, preinteraction mediators, and interaction phase). Antecedent factors are *personal* (age, gender, personality and culture), *experiential* (e.g. behavioral consequences, anxiety, moods), *relational* (e.g. love and friendship, dependency, approval and status), and *situational* (interactive setting, seating distance, distraction and speaking order) factors.

## EYE GAZE IN HUMAN-COMPUTER INTERACTION

Most of research in human interaction with virtual agents has been conducted in two areas. First, the influence of virtual agents' eye gaze behavior on humans has been studied to show the importance of it. Some studies simply focus on the influence of eye gaze behavior without virtual agents and thus use only virtual eyes. Second, eye gaze behavior models for virtual agents have been developed to improve natural interaction with it.

## Influences of virtual eye gaze

To show what effect duration of virtual eye gaze on has, Bente et al. [3] varied eye gaze duration in avatar-based human-human conversation. They captured nonverbal behavior from users in a net conversation where the counterpart was substituted by a virtual agent. This study focused on the influence of variations of eye gaze duration. They found that longer durations of directed gaze results in a more positive evaluation and co-presence compared to shorter gazes. These results go along with studies about gaze duration variations within human-human conversations. Another study from Garau et al. [11] shows how important it is to equip virtual avatars with natural eye gaze behavior. They conducted an experiment to investigate the importance of eye gaze behavior by virtual agents. They compared conversations with audio-only, an avatar with random gaze behavior, an avatar with inferred gaze behavior and video transmission. Their findings were that the avatar with inferred gaze behavior outperformed the avatar with random gaze behavior and audio-only but not the conversation based on video transmission. The aim of this study was to find essential parameters to regulate eye gaze behavior in human-computer interaction. Nevertheless we can easily see that humans are aware of virtual eye gaze. Important for gazing in human-machine interaction is also

the timing of eye gazes. Heylen et al. [13] found that subjects easily get disturbed by a wrong gazing behavior. A look in the other direction took Rehm and André [23]. They found that users interacting with virtual agents look more at them when they are talking as they would look at humans.

### **Eye gaze models for virtual agents**

Two approaches can be found in research about developing eye gaze behavior models for virtual agents. One approach is dealing with the 'how to look'. This is mainly based on the physiological structure of eyes. Lee et al. [20] used an eye tracker for recording users eye gaze and used this data directly to reproduce a virtual eye movement model. This model includes statistically derived saccadic eye movements and they compared it with random saccadic movements and static eyes. Most chose the statistical model as most natural. The other approach handles the 'when to look'. Pelachaud and Bilvi [22] proposed a statistical model based on the annotation of conversations in dyads. Fukayama et al. [10] developed a gaze behavior model that is parameterizable by the amount of gaze, mean duration of gaze and gaze points while averted and found that varying these features have similar effect than in human-human conversations. A model with hierarchical state machines was developed by Colburn et al. [6]. The numbers used in their model for state transitions was for the main part derived from psychological literature.

### **EYE GAZE IN CULTURES**

To understand how culture influences eye gaze behavior, we give a comprehensive overview on literature that concentrates on cultural differences in eye gaze behavior among human-human interactions or conversations (see Table 1 for a summary).

Wrong gaze behavior can cause misunderstandings between people of different cultures as eye gaze is a highly "overlearned" behavior pattern [8]. Argyle and Cook report, for example, that Greeks look much more at people than it is common in Western Europe or US. Traveling there makes them feel rejected as people in Western Europe or US do not tend to stare the same way they are used to [1, 12]. Arabs think it is impolite to walk side by side while talking and not being able to look the counterpart into the eyes. Therefore they may start to "dance" ahead for being able to keep eye contact [15].

Argyle and Cook [1] reference to Ingham who compared Englishmen and Swedes during conversations. They describe that Ingham found that Swedes look longer while talking, whereas Englishmen glance more often although shorter. Watson [25] compared gazing from contact with gazing from non-contact cultures. Contact cultures have significant greater levels of eye gaze than non-contact cultures. Further, he also found that gaze behavior patterns are seen different among cultural groups. Gazing too much can be seen as superior, disrespectful, threatening, or

insulting by Africans, Asians and Indians. While gazing too little among Arabs and South Americans is seen as not paying attention or being impolite. Other cultures regard too little gaze as insincere, dishonest or as a sign of shyness. Watson analyzed 126 male students from 31 countries in conversations. He grouped these countries in six regional areas: Arabs, Latin Americans and Southern Europeans, Asians, Indians-Pakistanis and Northern Europeans (including Australia and USA). And further, he aggregated them for a more general analysis in contact and non-contact cultures (see footnotes 2 and 3 on this page).

Collett [7] shows that adaptation of cultural nonverbal behavior increases sympathy in the trained culture. In a study he trained Englishmen to interact with Arab people. He showed that Englishmen trained with typical nonverbal behavior for Arabs are more liked and accepted than Englishmen with their normal, untrained behavior. Part of the training was how to sit (direction and distance), to look always at the Arabian counterpart directly into the eyes while talking, shake hands and allow him to leave the room first.

Isbister [14] references to Leathers [19], who describes differences between direct eye gaze behavior among Arabs and Japanese. In Arab worlds steady eye contact shows engagement and sincerity. Such steady eye contact while interacting with Japanese should be avoided as it is not seen as polite to stare at somebody. Bond and Komai [5] looked at the influence of eye gazing in a two-person conversational situation on nonverbal behavior. The subjects, Japanese male college students, and interviewers had to either stare the counterparts for the whole time of a conversation into the eye (uninterrupted of one conversation's half) or look at their knees (uninterrupted the other half). The subjects responded to direct eye gaze with increased self-manipulations of hands, decreased response time and torso movements. Bond and Goodman [4] varied gaze duration within conversations. They found that persons using shorter and more frequent gazes while listening meant to be more socially active and more powerful. Argyle et al. [2] conducted a cross-cultural study among English, Japanese, Italian and Hong Kong. He asked to rate certain predefined relationship-specific rules in a questionnaire. The rule "Should look the other person in the eye during conversation" was highly endorsed by English and Italian but not by Japanese and Hong Kong. Although this study relies on questionnaires, it shows a very clear evidence for differences (expectations) in eye gaze behavior within different cultures.

Eye gaze behavior not only differs within cultures. LaFrance and Mayo [18] found that African Americans tend to keep eye contact while speaking and that they avoid eye contact while listening. Quite contrary to European Americans, who keep eye contact while listening and avoid eye contact while speaking. Erickson and Shultz [9] found

exactly the same among African and European Americans in counseling interviews.

Summarizing these studies, we cannot easily derive single values for specific cultural eye gaze behavior to use in human-machine interaction. But as Watson [25] showed, it could be sufficient to group cultural behavior in e.g. contact and non-contact to develop an gaze awareness model for believable eye gaze behavior.

### MEASURE USERS' EYE GAZE

To use users' eye gaze in human-computer interaction, we must find a way to automatically measure where someone is looking at. Another important thing is to define the resolution of the gaze areas of interest. Hall describes a system for notation of nonverbal behavior [12]. He defines four areas of visual perception based on the three areas of eye's retina (1) *foveal* (clear), (2) *macular* (clear), and (3) *peripheral* and furthermore (4) *no visual contact*. Applied on human-human interaction we can derive three areas of interest, as there is no clear distinction between macular and peripheral. Thus we get (1) direct eye contact, (2) looking in someone's direction, and (3) no visual contact. Kendon describes gazing with q- and a-gaze. If the subject of interest is looking at its counterpart, he names it q-gaze and a-gaze if not [16]. Compared to Hall this resolution is less accurate and thus needs less effort and technical equipment for setting up a recording scenario. This method also can easily be applied to scenarios where you do not exactly know where the counterpart's head is.

The literature about eye gaze in culture does not often provide detailed measurements of where exactly someone is looking. Kleinke [17] lists two different ways of looking at each other in synchronized point of view: (1) *mutual gaze* if two persons are looking at each other's face and (2) *eye contact* if they are looking at each others eyes. Latter is difficult to recognize without appropriate tools and setting and thus cannot often be found in cultural eye gaze literature.

The automatically measurement of eye gaze interaction between humans and computers nowadays does not require one-way mirrors or split screens for analysis. We plan to use an eye tracker to measure users' eye gaze. Currently resolution and handling, which includes calibration of users before usage, of remote (non-contact) eye trackers became sufficient for human-computer interaction. Accuracy even lets you analyze up to Hall's defined *foveal* area. Also speed gets close to real-time and therefore lets us interact with users with no delay.

### CONCLUSION AND FUTURE WORK

As there is no norm to study eye gaze behavior among different cultures and the studies followed different goals, they do not provide standardized results. This makes it difficult to re-use their findings for human-computer

interaction, i.e. implementing a computational model that is aware of regulating interaction with gaze. Further, as eye gaze behavior is not only influenced by culture, but also e.g. by distance, gender or personality [17], it makes it impossible to use these quantitative findings for a particular virtual character. But nevertheless, this overview gives a great pool of qualitative findings that helps to implement models that are aware of strong cultural distinctions; such as e.g. Japanese do not often look people directly into the eyes or Greek need visual feedback through eyes. Second, Watson's [25] findings offer a basis to develop a gaze awareness model for human-machine interaction. His significant results for eye gaze behavior in contact and non-contact cultures makes us aware that we cannot simply apply 'any' findings in literature for creating a gaze behavior model. Creating a model must make us think about what kind of virtual character we are using for what kind of interaction and what kind of people will be interacting. As we do not want to make new models for any single user or virtual character our challenge will be to find appropriate parameters to adjust our interaction model to individual functions such as culture.

Our focus will next be on cultural eye gaze differences between Germans and Japanese. Within CUBE-G [24] we collected a corpus in Germany and Japan with dyadic interactions in three settings: (1) first time meeting, (2) negotiation, and (3) conversation with different social status. We will annotate the eye gaze directions in both cultures and compare it with the findings in literature. Unfortunately there is not much about gazing in conversations about Germans, but we can use Watson's [25] findings about Northern Europeans, which include German subjects, to compare with. From our new findings we will develop a model for German and Japanese eye gaze behavior and awareness for virtual agents.

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Authors	Cultures and Gazing	Situation	Results
Argyle and Cook [1]	English and Swedes	Laboratory conversation in pairs	Swedes had longer glances and more mutual gazes than Englishmen. But Englishmen had a higher frequency of glances
	Greeks and Western Europeans	Reported from Greek people	Greece look at people much more than Western European do.
Argyle et al. [2]	English, Italian, Japanese, and people from Hong Kong	Questionnaires about rules in different relationships.	Mutual gaze during conversations is extremely important for Englishmen and Italian, but less important for Chinese from Hong Kong and Japanese.
Bond and Goodman [4]	Chinese from Hong Kong	Watching videos of two-person interactions where gaze duration was varied.	Chinese relate shorter and more frequent gazes while listening to more socially activity and more powerfulness.
Bond and Komai [5]	Japanese	Conversations in pairs. Staring and looking away at partner during an entire conversation.	Direct eye gaze increased self-manipulations of hands, decreased response time and torso movements.
Collett [7]	Arabs and English	Englishmen trained and not trained on Arab behavior interacting with Arabs.	Trained Englishmen were more liked and accepted than Englishmen with normal, untrained behavior.
Hall [12]	Greeks and Americans	Reported	Greeks look for answers in each other's eyes.
LaFrance and Mayo [18]	African Americans and European Americans	Dyadic interactions	African Americans keep eye contact while speaking and avoid eye contact while listening.
Erickson and Shultz [9]		Counseling interviews	European Americans keep eye contact while listening and avoid eye contact while speaking.
Watson [25]	Contact (Arabs, Latin Americans and Southern Europeans) and Non-Contact (Asians, Indians-Pakistanis and Northern Europeans including Australia and USA)	Common conversation in pairs.	Contact cultures have significant greater levels of eye gaze then non-contact cultures.

**Table 1. Overview about research literature focusing on gaze behavior and influence of gaze within different cultures.**