# Dynamically Exposing Gaze to Foster Playful Experiences in Multiplayer Gameplay

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## Abstract
In this paper, we propose the use of 'visible gaze' for multiplayer gameplay to foster new playful experiences. Our eyes convey rich non-verbal communication, such as social cues, intention and emotions. In co-located gameplay, players monitor each other's gaze in search for clues through from non-verbal cues. By making the invisible visible, we can uncover new game dynamics that leads to new kinds of emotions experience beyond the dichotomy of positive/negative. The results from this project will allow us to design new kinds of emotional experiences for augmented traditional games as well as conventional multiplayer video games.

## Author Keywords
Eye tracking; gaze tracking; co-located play; Multiplayer; Tabletop games; Board games, Video games; Cognitive strategies;

## ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous; See http://acm.org/about/class/1998 for the full list of ACM classifiers. This section is required.

**Figure 1**: Gaze visualisation can be used to show the uncertainty through gaze with size. When the player looks at one area for longer, the confidence increases and the gaze point become smaller. Alternatively, the size of the gaze point can be directly reflected with the pupil diameter.

**Figure 2**: When two gaze points meet on the interface, their overlapped areas can be shown. In competitive games, gaze aversion may follow but can be used as deception if the second player continues to follow.

## Introduction

The eyes play a powerful role in our daily social interaction, conveying rich non-verbal communication cues that provide a window into complex mental states, such as emotions, beliefs, and desires [1]. In face-to-face gameplay, players tend to monitor each other's gaze in search of non-verbal cues to gain an upper hand in the game. An extreme case is how poker players often cover their eyes with sunglasses to hide any "tells". The eyes alone can signal emotion in different ways: the direction of the gaze, eye shape, pupil size and blink rate—all convey rich non-verbal cues to a trained eye [4]. Through opportunities afforded by advances in eye tracking technology for games, we can detect where players are gazing upon on an interface in real-time. This data can be utilised by displaying gaze visualisations, each with its own strengths. In this project, we are investigating the consequences of displaying gaze tracking data on a game board, both in terms of new game mechanics and in terms of new dynamics for existing games.

As our gaze behaviours are reflective of our thought processes, giving players the ability to "reading the minds" of their opponents can create exciting opportunities for game design. For example, gaze often precedes action, signalling *intention* [5] and therefore possible strategies. The player being read may feel discomfort or use it to his advantage by using deception, guiding his opponent to look elsewhere. This often happens in real world gaming situations, as humans have a profound ability to determine whether they are being looked at [3]. A player can misdirect their opponent using their gaze direction when noticed they are being observed. This awareness becomes more explicit to both players when gaze is made visible on the same surface i.e. "I know that you know that I know". This inevitably changes the way both players play the game i.e. the dynamics of gameplay. We propose that gaze when made visible in multiplayer gameplay can be used in numerous ways to generate new experiences beyond positive/negative dichotomies. Therefore, we aim to explore the various aspects of explicit gaze: How can explicit gaze be implemented as a game mechanic? How does mutual gaze awareness affect gameplay? Does the exposure of gaze lead to complex emotional responses?

## Background

Researchers have explored the use of gaze in many ways to enable new gameplay experiences [7]. These works in the literature focuses on using eye trackers as gaming input devices to enhance the player's experience. Designers typically aim to provide a positive experience by increasing both immersion and presence as the game becomes aware of the player's gaze. Wetzel et al. demonstrated how an adaptive AI can change the parameters of a game implicitly to reduce frustration, possibly to keep the player interested longer [10]. From psychology, we know that our gaze alone plays a major role in non-verbal communication, providing signals such as attraction, shared attention, filiation and intention. Vidal et al. demonstrated the use of these social gaze signals as game mechanics to enhance the interaction with virtual characters [8]. Most immersive games leverage gaze information alone, and not leveraging the use of subtle information from the eyes. Our eye behaviours and movements are able to show whether one is being truthful or deceitful [9], one's level of confidence [2, 6]. By fundamentally combining both eye behaviours and gaze, players can potentially obtain richer interactions.

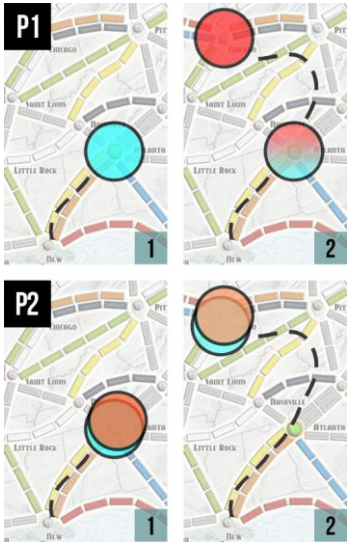


**Figure 3**: When a player follows the gaze of another player, the followed player can turn the tables by deceiving the opponent to look elsewhere, away from her point of interest. P1 gaze colour can change to notify the player that her gaze is being followed, affording the player to misdirect elsewhere. P2 is unaware of this and continues to follow.


**Figure 4**: Dynamic Heatmap illustration. The areas in red ('hot' areas) shows the area in which the player has a high number of fixations, showing a pattern.

## Opportunities for Gaze

Here, we propose how making gaze visible can be used both as a new game mechanic and as a way of changing the existing dynamics of a game. Further, we take a look at aspects of social gaze to determine how eye behaviours and movements in addition to gaze can be used in social gameplay.

### Gaze Visualisation as a Mechanic

The ability to view the gaze of the opponent can be used a *power-up*, providing an upper hand as the player can gain insights into another player's thought process. In order to use this, gaze must first be meaningfully displayed on the board, and the type of visualisation will influence what can be inferred by it. By using a *dynamic heatmap* (see Figure 4), a player is able to view what another player has looked at over a period of time. This time window can be adjusted to reveal patterns and insights to both long-term or short-term strategies. Regions with a high number of fixations points can be easily identified.

We can also visualise gaze using *real-time gaze point* by directly mapping the coordinate stream to an object such as a translucent lens on the interface. This provides insights into another player's immediate thought process i.e. what that player is thinking at that point in time. The player's gaze moves between points of interest on the interface, which can be inferred if a pattern emerges. This is similar to deducing using traditional gaze direction as a signal commonly seen in co-located gameplay. However, unlike using dynamic heatmap, there no historic trace of where the player looked. Further, the size of the gaze point on the interface can grow/shrink accordingly to the player's certainty (see Figure 1). The use of pupil dilation can be used in addition to the gaze point confidence. The size of the pupil is linked to the degree of uncertainty during decision-making i.e. when a player is unsure their pupils will dilate [6]. A larger gaze point signifies uncertainty and players may attempt to hide this.

In both examples of gaze visualisations, they can be replayed, providing an animated pattern over the board and used as a form of power up against the opponent.

### Gaze Changing the Game's Dynamics

By making gaze explicit, we can effectively change the dynamics of the game, creating new opportunities for inferring intent and deceiving opponents. The amount of time gazing at a point, the frequency of glances, and the patterns of fixation are all important non-verbal communication cues. When two visible gaze points meet on the interface, they indicate *shared attention*, opening opportunities for new game experiences (see Figure 2). For example, a potential increase levels of intimacy in cooperative games. But what happens when two players continue to stare at the same point in competitive games? Are players trying to deceive each other? Or is one player just distracting the other? Alternatively, gaze aversion can occur where one player immediate looks away. The avoidance of eye contact is often used as a predictor of deception but on the interface, it can signify other emotions such as self-consciousness ("Stop looking at where I am looking!").

On the other hand, we can look at eye movements which both involuntary and voluntary helps us process visual stimuli. In general, eye movements increase when we put more thought whereas a confident strategy in mind would show distinct areas [2]. Beyond the fixation-saccade-fixation cycle, we are able to

**Study Conditions**

We drew up four conditions to subject pairs of players to in order to determine the effects of gaze awareness:

1. Gaze is not visible to either player (baseline).
2. Both players can see each other's gaze, and both players know that the other player can see it (symmetrical aware).
3. Both players can see each other's gaze, but both believe that only they can see it (symmetrical unaware). In this condition, we are interested in whether players will be able to discover that the other player can see their own gaze simply by their gaze patterns and changes in game strategy.
4. Only one player sees the other player's gaze, but the other player does not know that the other player can see it (asymmetrical unaware). We are interested in what happens when the game is tipped in favour of a single player who can see the opponent's gaze point.

explore other known eye movements as a dynamic such as *smooth pursuits*. For example, one player can 'know' if his gaze has been followed if his opponent's gaze correlates to his visible gaze point on the surface (see Figure 3) but the following player may not necessarily know that the followed player knows.

## Conclusion & Future Work

In this paper, we suggested opportunities for new game mechanics and dynamics afforded simply by making gaze visible on the game board. We conclude that by visualising gaze, players still need to do some guess work to figure out what the other player is thinking, currently doing or about to do next but having gaze visible to players allows them to make an 'informed best-guess', but the emotional consequences of this process (e.g. deception, self-consciousness, bluffing, etc.) can substantially affect the gameplay.

To study the effects and demonstrate these dynamics, we selected a board game available in both digital and traditional versions for a study—*Ticket to Ride*. This will allow us to test the experience of the play setup (remote x co-located) and type of gaze visualisation (real-time x averaged over time). We will subject players to several conditions (see the Study Conditions side bar). The results from this project will allow us to design new kinds of emotional experiences for augmented traditional games as well as conventional multiplayer video games.

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# Presenting Author's Biography

Eduardo Velloso is a Research Fellow at the Microsoft Research Centre for Social Natural User Interfaces at the University of Melbourne in Australia. Eduardo holds a PhD in Computer Science from Lancaster University and a BSc in Computer Engineering from the Pontifical Catholic University of Rio de Janeiro. His research aims at creating future social user experiences combining novel input modalities such as gaze, body movement, touch gestures, etc. His latest work has investigated eye-based interaction with smart watches, multimodal combinations of gaze, and eye control of video games.