Deceptive Patterns and Perceptual Risks in an Eye-Tracked Virtual Reality

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ABSTRACT

In the context of targeted advertisements and design, the line between nudging and manipulation is difficult to define, measure, and enforce. The discussion of what crosses the line between nudging users towards content they may find more enjoyable and what could manipulate them towards specific behaviors is common when defining deceptive or dark patterns. Dark patterns are increasingly present in both web and mobile contexts: producing interface designs that make it difficult to cancel subscriptions or make informed decisions that differ from default settings. In this position paper, we discuss behavior manipulation via eye tracking and the ethical implications of attention guidance in the context of virtual reality (VR) to highlight key challenges for an emerging technology in immersive spaces.

1 INTRODUCTION

The manipulation of user behavior is an emerging topic in ethics discussions for both new and old technologies. Commonly referred to as deceptive or dark patterns [2], the terms refer to a design pattern that influences how a user navigates an interface, selects items from an interface, and makes decisions on settings; such as accepting tracking cookies when you first visit a website. A design pattern becomes "dark" by making it significantly harder to find certain features—such as opt-out or unsubscribe options—and creating friction through the interface to force users away from their original intentions or from making informed decisions. From a U.S. policy perspective, discussion about the regulation of deceptive and manipulative design has centered around (1) the use of "dark patterns" to influence user consent regarding data collection or use; (2) broader consumer protection questions (e.g., steering users—particularly children—towards making purchases); and (3) specific sectors or practices (e.g., features such as auto-play that could encourage addictive behavior or loot boxes that could encourage gambling-like behavior) [20]. The unethical use of deceptive patterns has real-world implications, evidenced by a recent FTC lawsuit against Amazon regarding their subscription service [6]. In the context of gaming, the FTC ordered Epic Games to pay a $245 million settlement for allegedly using "dark patterns" to trick users into making purchases and then penalizing or threatening to penalize them when they contested the charges [5]. The FTC also ordered Epic to pay $275 million for allegedly collecting children's data within Fortnite without parental consent, in violation of the Children's Online Privacy Protection Act, and making it difficult to delete this data when requested, as well as using "unfair" privacy-invasive default settings [4]. Our work is concerned with the emergence of deceptive patterns in virtual reality (VR) and other immersive spaces that differentiate themselves from prior interfaces due to additional sensors, affordances, and standards for input methods [11].[1]

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[1]Within the scope of this paper, we will use deceptive patterns as a blanket term to cover dark, deceptive, and manipulative design patterns.

One particular sensor of note for VR is eye tracking for gaze estimation. Eye tracking has seen increasing integration in VR devices to support social VR [24], optimize rendering performance [16], and for enhancing interaction [17, 3]. Eye tracking taps into human vision to provide non-invasive insight into the perceptual and cognitive behavior of the user. We explore the intersection of deceptive patterns with current methods of perceptual manipulations using eye tracking in VR. Insights from prior literature inform the types of manipulations possible in VR based on eye-tracking data and expose the potential to guide attention for the purpose of manipulating decision-making.

The use of deceptive patterns can be seen as manipulating where a user's attention is allocated during interface navigation and what actions they perform [7]. We observe a parallel with research methods related to gaze or attention guidance, which are increasingly common within cinematic VR experiences in which the observer can freely rotate their head and diverge from the director's intended narrative sequence [18]. Beyond VR, gaze guidance methods based on eye tracking have been explored for various applications within traditional displays [1]. Guidance methods make use of eye tracking to either actively track if the user has reached the intended target or to subtly guide them without their awareness. Applications of subtle gaze direction (SGD) have been demonstrated to improve spatial recall [22] of objects and to train novices in analyzing mammogram images [23]. Such methods provide promise for positively influencing behavior to create effective training and learning procedures in both standard viewing and VR environments [8]. However, now that eye tracking is becoming a standard sensor in VR, the risk of gaze tracking and manipulation creates possibilities for new deceptive patterns in VR design.

The main contribution of our work is a discussion of existing methods to manipulate user perception and attention in VR based on gaze data, and a discussion on how these methods could create risks for deception if they are able to manipulate user decision-making in VR interfaces. The following sections clarify what component of deceptive patterns we target, provide background on existing gaze-based manipulations, and discuss the resulting ethical implications for the field.

2 PERCEPTION IN DECEPTIVE PATTERNS

Deceptive patterns have an evolving and adaptive definition depending on the context in which they are used. A simple example is tied to the concept of friction: when it is difficult or time-consuming to perform an action and the interface is able to deter the user from performing the desired action. For example, forcing a subscriber to call a customer service line to cancel a service when the functionality could easily be included on a digital form [2]. Instead, we focus on the manipulative component of deceptive patterns that could use eye tracking to subtly influence future behavior or decisions of a user without transparency to the user. Thus, we do not attempt to measure the difficulty or time consumed in performing actions within a VR interface, but attempt to understand how to map existing perceptual manipulations within nudging and manipulation when eye-tracking data is made available.

3 Gaze-based Manipulation in VR

We categorize existing manipulations based on the ability to take advantage of perception, guide gaze position, and to influence decision making. Figure 1 demonstrates the flow from tracking gaze to exploit perception and guiding attention as it relates to tracking, nudging, and manipulation.

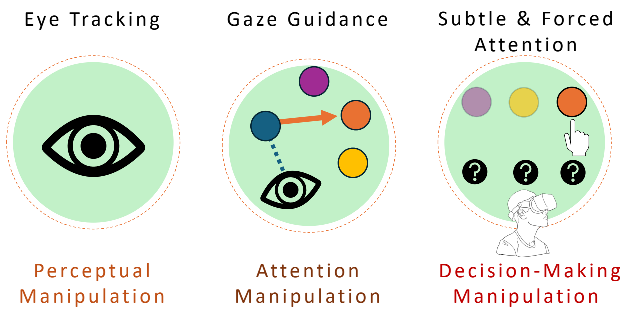

Figure 1: The flow from using eye tracking to enable perceptual manipulations, gaze guidance techniques to enable attention manipulation, and how subtle and forced attention guidance could lead to decision-making manipulations.

3.1 Perceptual Manipulation

We refer to perceptual manipulations as taking advantage of the allocation of attention, i.e. gaze fixations, to manipulate the environment or content in a manner that changes the user's perception. For example, Marwecki et al. demonstrated an eye-tracking environment that performed an array of manipulations to influence anticipation, observation, and recall within VR scenes [15]. One example included adaptive difficulty in a puzzle-solving game. While fixated on a particular region, only a small portion of the field of view is seen in high acuity. This small region is called the fovea and spans approximately two degrees of visual angle, roughly the size of a thumb at arm's length. Outside of this region is the periphery, which is sensitive to motion but does not have the visual acuity to read text or perceive small details. Thus, puzzle pieces can be modified or re-located when the user is fixating elsewhere to make the puzzle easier or harder without them noticing. Manipulation was directly demonstrated across several interfaces, including adaptive difficulty, re-location of virtual game objects to better align with a physical prop, shifting virtual objects in the scene to make use of a small physical space, reduction of motion sickness using periphery blur, an adaptive art gallery that replaced paintings to match the user's preferred style, and hiding low-fidelity visual effects that interrupted the VR experience. While all of these manipulations were designed to benefit the user, the same methods could easily be adapted to create negative consequences for the user. For example, Tseng et al. describe a series of perceptual manipulations possible in VR with a focus on physical harm, such as accidentally colliding with a bystander or running into furniture [25]. However, this work did not focus specifically on eye-tracked VR and the broader range of harms when perceptual manipulations go unnoticed.

Implications From the eye-tracking-based examples above, it is clear that tracking the fovea and periphery enables deceptive patterns. For example, a game could sharply increase difficulty after a certain period of time to influence users towards purchasing upgrades or different levels using real money. Relevant information, such as privacy notices, can also be minimized and buried within the periphery when the app loads based on initial gaze position to make it more difficult for the user to perceive them. Thus, the ability to model attention precisely from eye tracking allows designers significantly more insight into user perception, and provides a means for manipulating users within immersive environments.

3.2 Attention Manipulation

We refer to attention manipulation as using gaze guidance methods and stimuli, usually visual, to direct a user's current gaze position to a desired region or object. The guided gaze position and resulting fixations represent the manipulation of where a user is allocating their attention. Gaze guidance has always been a component of visual design, including narrative art pieces that are static in nature but use visual features such as horizons or cues such as pointing to draw attention. We focus on the manipulation of the current region of attention by triggering a series of gaze guidance mechanisms. Rothe et al. provide a full review of dimensions across guidance mechanisms and a practical taxonomy in the context of narrative VR [18]. In the context of deceptive patterns, the most relevant dimensions include autonomy (voluntary or forced), user awareness (subtle or overt), and user cognition (memory-free or memory-bound). We provide several examples of methods to further illustrate these dimensions.

3.2.1 Autonomy

Within autonomy, one method of gaze guidance is to apply a yellow-green color filter to the VR content that becomes more intense as the user looks away from the point of interest [21]. The user ultimately controls whether they look towards the intended region, treating the color cue as a suggestion the user can choose to follow. In contrast, a cue that requires the user to look at a specific region before progressing to the next scene would be considered forced, as the user cannot proceed without looking at the region [13]. Autonomy is heavily coupled with the subtle and overt nature of cues and whether a gaze shift is voluntary or not could influence whether the mechanism crosses the line from nudging to manipulation.

3.2.2 Awareness

Subtle cues also present an avenue for manipulation. For example, the aforementioned SGD technique can be imperceptible with high quality eye-tracking data in the right conditions [1]. The SGD method makes use of the current gaze position to track if the target of interest is within the periphery or not, and then uses a high-contrast flicker cue to draw attention. Since the periphery is sensitive to motion a user will reflexively look towards the flicker cue without conscious control of their behavior. Eye-tracking data is then used to remove the cue while the user makes a saccade, a rapid eye movement in which the user cannot process visual information, resulting in the manipulation of attention towards the target without the user noticing the visual cue. Extensions of SGD have explored which parameters create an imperceptible cue in VR and additional techniques such as left-right stereo mismatch to subtly guide attention [8, 14]. The ability to subtly guide users has great potential to enable skill learning in training applications and to create narratives that guide a user without taking them out of the experience. Subtle methods are ideal when a user needs to be guided while also providing room the user to learn or feel in control of their actions. While prior work has been evaluated with positive examples of subtle nudging, the same methods enable direct manipulation of a user without their knowledge.

3.2.3 Cognition

Rothe et al. refer to cognition as being memory-free or memory-bound [18]. Memory-free refers to whether the guidance is directly relayed via stimulus (i.e., a sign shaped like an arrow pointing in a particular direction) while memory-bound relies on the user to interpret the cue: a sign saying the next piece of the puzzle is located in a red chest that would trigger the user to look towards the last place they saw a red chest. The key difference is the user must determine the intention of a memory-bound guidance cue and then respond, which may be less effective at getting the user to the target than memory-free cues; but would also provide the user a sense of discovery or autonomy in their behavior. While less direct, memory-bound guidance is linked to interpretation and by requiring cognition may open the door to manipulation of what the user will decide to do in the future, as opposed to the more mechanical nature of memory-free cues. The classification of guidance cues is tied heavily to modeling attention behavior as driven by bottom-up (stimulus-driven) and top-down (goal-driven) processing, however, a deeper discussion on attention modeling and the full taxonomy of guidance cues is outside the scope of this paper.

Implications Attention manipulation includes a broad set of methods that aim to influence the attention allocation of a user. It is difficult to classify gaze guidance techniques as strictly nudging or manipulation, as even well-intentioned VR interfaces have the potential to manipulate users in an unethical way, as discussed by Krauss [11]. Specifically, guidance that is forced or subtle in nature introduces a slippery slope with the potential to deceive users.

3.3 Decision Making Manipulation

To our best knowledge, we have not found research studies or findings measuring the impact of gaze manipulation on decision-making or choices made within VR experiences. Thus, we consider the manipulation of decision-making for eye tracking as the use of gaze guidance in a manner that could change a future decision of the user. We imagine a broad range of decisions could be influenced by modulating what users pay attention to, how long they pay attention to them, and in what order. These techniques could have similar targets as existing deceptive patterns, such as guiding users towards certain data privacy settings, as well as novel targets such as manipulating social judgements of virtual characters or avatars based on which actions you observe.

We did identify prior works that have employed eye tracking to study decision-making and choice behavior. For example, Krajbich et al. demonstrated how fixation patterns were able to model which choice a user would make when presented with a set of options [9]. The ability to infer choice behavior provides a direct link between attention and decision-making, and it is not surprising similar results were found in the context of financial purchasing decisions [10]. Further analysis into the field of decision-making and psychology is necessary to understand the paths in which decision-making manipulation could be achieved when guiding gaze in VR. While there is an established relationship between gaze patterns and an eventual decision, the relationship between a forced fixation pattern and decisions or user preferences should be explored in future user studies. Additionally, design work is necessary to identify the manipulation risks most critical to VR and populations that may be more vulnerable or at risk than others, including children [12, 19].

Implications The ethical implications of manipulating decision-making are clear when the resulting decision benefits someone else or puts the individual at risk. However, there are instances where the manipulation of decision-making could benefit the user. For example, someone with an eating disorder who is guided away from looking at junk food during a social VR party may have positive impacts on the health of the user in the real-world. Likewise, within a VR shopping menu, such as games with micro-transactions, the use of attention manipulation to actively guide users towards an item on sale because it is frequently purchased by them, even though the user did not intend to purchase the item during the trip, can be seen as well-intentioned or benevolent; although the user could be working to reduce their spending due to addictive tendencies. Our goal with this paper is to motivate the field to explore the limits of gaze-based manipulation, and spark further discussions on the necessity and ability to regulate deceptive harms in the future of VR.

4 Conclusion

Our discussion highlights current gaze-based manipulation methods present in VR and posits gaze guidance techniques pose a potential ethical risk in the context of deceptive patterns. Risks emerge when the methods are applied outside of their current applications to improve user experience or narrative engagement. By considering the application of these techniques and their transparency to the user, we attempt to reason about when manipulations cross the line from nudging to manipulation. We highlight the ability to manipulate attention, especially in a forced and subtle manner, has the potential to affect the future decisions of a user. However, the current understanding of the extent to which decisions could be manipulated in VR scenarios is not yet established. The key challenges we identified include the need to design relevant VR scenarios for evaluating deceptive patterns, a gap in the understanding of how gaze guidance techniques could be exploited to effectively change decisions, and the need for a practical approach to classifying and regulating deceptive patterns in VR based on gaze manipulations.

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