# Poster: Exploring the Impact of Dark Patterns in VR: A Comparison with the Real World

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***Abstract*—Dark patterns are manipulative design techniques that intentionally influence user behavior, often leading to privacy violations or financial disadvantages, and have increasingly become a subject of concern. This study compares the effects of dark patterns in physical and virtual reality (VR) environments, examining how the immersive nature and interaction characteristics of VR influence their impact. The findings indicate that dark patterns function similarly in VR environments as they do in physical spaces. Furthermore, the study suggests that prior VR experience may not mitigate the influence of dark patterns. This research contributes to a deeper understanding of the characteristics of dark patterns in VR environments.**

## I. Introduction

In recent years, the rise of dark patterns—design techniques to intentionally manipulate user behavior—have become a growing concern. These methods exploit cognitive biases and psychological vulnerabilities, often resulting in privacy violations or financial harm to users. Previous studies have mainly focused on the prevalence and impact of dark patterns in real-world interfaces, such as websites and mobile applications [1]. However, the impact of dark patterns in virtual reality (VR)—a technology rapidly gaining adoption—has not been sufficiently explored.

VR environments differ from traditional interfaces by providing immersive experiences with visual and haptic interactions. These features suggest that dark patterns in VR may more effectively manipulate users' attention and behavior. For example, Mathur et al. [1] showed that visual cues and interaction design significantly influence user choices. With the greater flexibility of VR interfaces, such effects may be amplified. Despite these possibilities, limited research has examined how VR-specific factors, such as immersion and familiarity, influence the effectiveness of dark patterns.

Addressing this gap, this study systematically compares the impact of dark patterns in VR with their effects in real-world interfaces. Specifically, we focuse on VR-specific factors, like familiarity and immersion, by examining the effects of dark patterns applied to VR and real-world contexts, aiming to clarify their influence on user responses. Based on the above, this study sets the following research questions:

- RQ1 Does the impact of dark patterns in VR environments differ from that in the real world?
- RQ2 Does familiarity or experience with VR affect the impact of dark patterns in VR environments?

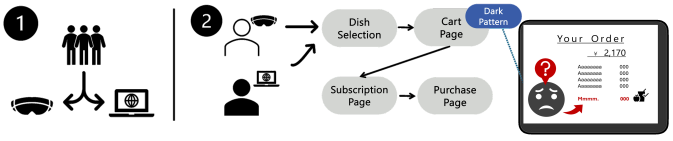


Fig. 1. Overview of the task-based survey

By examining these questions, this study seeks to provide a deeper understanding of how immersive interfaces shape the effectiveness of manipulative design techniques, thereby contributing to the ethical development of user-centered VR systems.

## II. METHODOLOGY

**Participants:** We conducted task and questionnaire surveys with 55 participants recruited from the authors' university (41 males, 13 females, and 1 undisclosed, ranging in age from 19-24). [1]. All participants were familiar with general PC usage, and their prior VR experience was measured using a pre-survey. Participants were randomly assigned to the VR group (27 participants) or the real-world group (28 participants).

**Design:** The study utilized a between-subjects design to compare the impact of dark patterns in VR and real-world interfaces. A custom website mimicking a food delivery service was used, featuring the "Sneak into Basket" dark pattern. This pattern adds products to the user's shopping cart without their consent, requiring the user to notice the unauthorized items and remove them. In this task survey, a bottle of tea was added to the cart, despite not being ordered (Fig. 1). The VR group wore VR devices and completed a tutorial to familiarize themselves with the VR environment before performing the tasks in the VR space. The real-world group completed the tasks using a PC.

**Data Collection:** The questionnaire was designed with the assumption that immersion in the VR environment would influence the results, and we used the Presence Questionnaire [2] to assess this immersion. To account for potential cognitive load from interacting with the web page, we used the NASA-TLX [3], a standard scale for measuring cognitive load during

[1]This survey was administered following an assessment of its content and procedures in accordance with the ethical standards established by the ethics committee of the organization to which the corresponding author belongs.

TABLE I
RESULTS OF FISHER'S EXACT TEST

| Comparison | p-value | Interpretation |
|---|---|---|
| VR vs. Real-World | $p = 0.492 > 0.05$ | **No significant difference** |
| Experienced (E) vs. Non-Experienced (NE) | $p = 0.850 > 0.05$ | **No significant difference** |

TABLE II
RESULTS OF THE MANN–WHITNEY U TEST FOR EACH INDICATOR: DECEIVED VS. NON-DECEIVED USERS

| indicator | p-value |
|---|---|
| Elapsed time | $p = 0.00614^{**}$ |
| SUS | $p = 0.182$ |
| NPS | $p = 0.206$ |

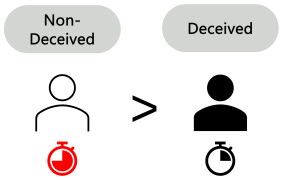


Fig. 2. A significant difference was found in the operation time

tasks. To assess the impact of dark patterns, we evaluated usability and satisfaction using the System Usability Scale (SUS) for usability and the Net Promoter Score (NPS) [4] for customer satisfaction. Additionally, task completion time and the rate of deception (whether participants noticed the dark pattern) were recorded for each group.

## III. RESULTS

### A. Impact of Dark Patterns in VR and Real-World

In the VR group, 10 out of 27 participants were deceived, compared to 5 were not. In the real-world group, 5 out of 28 participants were deceived, compared to 10 were not. Note that 20 participants who knowingly purchased oolong tea despite dark pattern were excluded, as deception could not be clearly determined. Fisher's exact test found no significant difference in the number of deceived participants between the VR group and real-world group (Table I, $p = 0.492$).

A Mann-Whitney U test was conducted to compare usability (SUS), satisfaction (NPS), and operation time on the cart screen between the VR and real-world groups. No significant differences were found in any of these metrics.

### B. Comparison Between Deceived and Non-Deceived Users

A Mann-Whitney U test was conducted to assess differences in cognitive load (NASA-TLX) and immersion (Presence Questionnaire) between deceived and non-deceived users in the VR group. No significant differences were observed for either metric.

Differences between deceived and non-deceived users in the VR group were analyzed for usability (SUS), satisfaction (NPS), and operation time on the cart screen. While no significant differences were found in usability or satisfaction, operation time showed a significant difference (Table II).

### C. Impact of Prior Experience with VR

Participants in the VR group were divided into the E group (top 25% in VR experience) and the NE group (bottom 25%). In the E group, 5 participants were deceived, and 5 were not. In the NE group, 4 participants were deceived, and 7 were not. The number of participants in the E and NE groups differs due to the exclusion of some participants.

Fisher's exact test found no significant difference in the number of deceived participants between the two groups (Table I, $p = 0.850$).

Mann-Whitney U tests comparing usability (SUS), satisfaction (NPS), and operation time on the cart screen between the E and NE groups showed no significant differences.

Mann-Whitney U tests comparing cognitive load and immersion between the E and NE groups revealed no significant differences, indicating that VR familiarity does not influence these factors.

## IV. DISCUSSION

Section III-A shows that applying real-world dark patterns in VR does not amplify their impact. However, as in the real world, dark patterns in VR still influence user behavior, highlighting their manipulative potential.

Section III-B reveals a significant difference in operation time between deceived and non-deceived users in the VR group. This aligns with [5], which found that dark patterns uniquely affect non-deceived users in the real world. These findings suggest that similar negative effects on non-deceived users' experiences also occur in VR (Fig. 2).

Section III-C shows no significant differences in deception rates or user experience metrics (usability, satisfaction, operation time) across VR experience levels. This indicates that familiarity with VR does not reduce the impact of dark patterns.

## V. CONCLUSION

This study compared the impact of dark patterns in VR and the real world, finding no significant differences. The results indicate that dark patterns influence user behavior similarly in both environments without amplification in VR. Furthermore, no differences were observed based on VR experience, suggesting that familiarity with VR does not reduce the effects of dark patterns.


## ACKNOWLEDGEMENT

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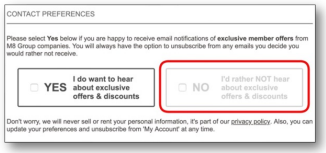
## Motivation

- Dark patterns manipulate user behavior, exploiting cognitive biases. These patterns exploit cognitive.
- They cause privacy violations and financial harm
- Previous studies focus on real-world interfaces such as websites and mobile apps.
- The impact of dark patterns in VR environments remains insufficiently explored.
- Unlike the real world, the unique sense of immersion in VR may amplify the impact of dark patterns.
- **This study examines dark patterns in VR and compares their effects with real-world environments.**

Dark patterns




Dark patterns


## Research Questions

**RQ1**: Does the impact of dark patterns in VR environments differ from that in the real world?

**RQ2**: Does familiarity or experience with VR affect the impact of dark patterns in VR environments?

## Method

- A task-based survey and questionnaire survey were conducted with 55 participants (Japanese).
- The participants were divided into two groups:
  - **VR group**: 27 participants performed tasks in a VR environment using VR devices.
  - **Real-world group**: 28 participants performed tasks on a PC.

Experimental scenes

**Task：**

- Participants used a food delivery service website that included a dark pattern.
- A representative dark pattern, "**Sneak into Basket**," was implemented.
- Record the user's choices and determine whether they were deceived.

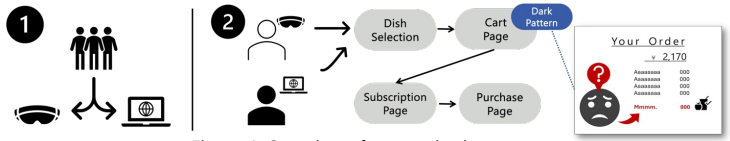
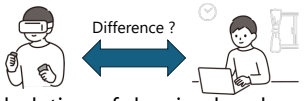



Figure 1: Overview of our method

## Results

### ■ Impact of Dark Patterns in VR and Real-World




- Cross-tabulation of deceived and non-deceived participants in the VR and real-world groups is as follows:

| | Deceived | Non-deceived |
|---|---|---|
| VR | 10 | 10 |
| Real-world | 5 | 10 |

- Fisher's exact test results showed **no significant difference** ($p = 0.492$).

⇨ **No difference in susceptibility to deception between VR and real-world environments.**

### ■ Impact of Prior VR Experience with VR

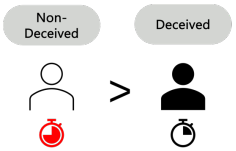
- Users were classified into the E group (familiar with VR) and the NE group (unfamiliar)
- Cross-tabulation of deceived vs. non-deceived participants in E and NE groups is as follows:

| | Deceived | Non-deceived |
|---|---|---|
| E | 5 | 5 |
| NE | 4 | 7 |

- Fisher's exact test results showed **no significant difference** ($p = 0.850$).

⇨ **No difference in susceptibility to deception based on VR experience.**

### ■ Comparison Between Deceived and Non-Deceived Users




**1) Cognitive load and sense of immersion**

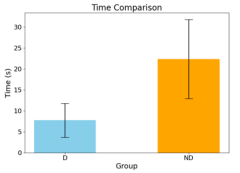
- No significant difference was found in cognitive load or immersion.

⇨ **Cognitive load and immersion are not related to susceptibility to deception.**

**2) Impact on user experience**

- Usability, satisfaction, and cart screen operation time were evaluated.
- Only operation time showed a significant difference.

⇨ **Non-deceived users spent significantly more time on cart operations.**




Operation time of the deceived and non-deceived users

## Discussion

### Answer to Research Questions

- **RQ1**: Real-world dark patterns applied in VR do not amplify their influence but still deceive users in the same way as in the real world.
- **RQ2**: Familiarity with and experience in VR do not mitigate the impact of dark patterns in VR.

### Future Research

- There is a possibility that dark patterns using interfaces unique to VR environments, different from real-world ones, may emerge.
- For VR-specific dark patterns, the impact may differ from the current results, requiring further investigation.

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