The Dark Side of Dark Mode: How Does Screen Display Mode Affect Financial Crimes

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Short Paper

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Abstract

There is an emerging trend in digital interface design to include the dark mode (i.e., font in white against a dark background) in addition to the traditional default light mode (i.e., font in black against a white background). While this innovation was motivated by usability considerations, it is unknown whether and how different screen display modes can influence user behaviours. Drawing on the findings from environmental psychology, we propose that screen display mode can influence users' moral decision making. Specifically, we focus on users' decisions to conduct financial crimes and predict that users are more likely to conduct financial crimes when using dark (vs. light) mode. We propose perceived anonymity as the underlying mechanism and theorize the moderating effect of screen size. Two laboratory experiments were designed to test on two financial crimes, namely, insurance fraud and insider trading. The potential theoretical and practical contributions are discussed.

Keywords: display mode; financial crime; human-computer interaction; financial technology

Introduction

In recent years, digital devices and applications have been providing users with two display modes for daytime and night respectively, i.e., light mode using font in black against a white background and dark mode using font in white against a black background. The newly introduced dark mode added to the default light mode was mainly motivated by usability considerations, e.g., prolonging battery usage and protecting eyes at night (Piepenbrock et al., 2013). However, there lacks understanding about whether and how users' decision making process will be affected by different screen display modes. Specifically, will people behave less morally when using a dark mode compared to a light mode? The metaphorical meaning of dark vs. bright that has long existed in literature, theatre, and people's daily language use seem to support the association between brightness and morality, and between darkness and immorality (Meier et al., 2004; Sherman & Clore, 2009). For example, William Shakespeare wrote in Sonnet 147 "For I have sworn thee fair and thought thee bright--/Who art as black as hell, as dark as night". Shakespeare used the metaphorical meaning of darkness against brightness to express not just the lack of light, but more importantly the presence of evil, e.g., "as black as hell" (West, 2007). In this research, we propose that the effects of different display modes reach far beyond usability aspects, and could have unintended impact on users' moral decision making. More importantly, screen display mode is very easy to change in software and application development, making the intervention easy and costless to implement.

Considering the rapid development of financial technology, we focus on users' moral decision making in the domain of financial activity, i.e., finance crime. Financial crimes involve the unlawful conversion of the ownership of property to one's own personal use and benefit. It can cover a broad range of forms including fraud, market manipulation, theft, money laundering and so on. Although all financial crimes are prohibited, the deterrence of laws and regulations is very limited for some that are hard to be detected, such as insurance fraud and insider trading (Adams et al., 2018). We argue that due to the minimal deterrence posed by regulations, the conduct of these kinds of crime would largely depend on people's own conscience, thus allowing subtle environmental factors to exert non-trivial impacts. We reviewed research on financial crimes focusing on the role of technologies and found that most studies adopt a technical perspective by

developing IT monitoring systems or machine learning techniques to detect financial crimes such as insider trading (Donoho, 2004; Liu et al., 2020; Marsden & Tung, 1999; Tung & Marsden, 2000). Nevertheless, little or no attention has been given to the effect of simple visual cues of the digital interface. To provide a novel perspective to and enrich our understanding of the technological factors in financial crimes, this research aims at addressing the following research question:

RQ: *whether and how would screen display mode affect users' tendency to conduct financial crimes?*

We ground our core theoretical argument on findings from environmental psychology. Environmental darkness, as compared to brightness, is found to promote immorality by concealing identity and creating a sense of anonymity (Page & Moss, 1976; Zhong et al., 2010). Notably, recent studies demonstrate that even if such sense of anonymity is illusionary (Zhong et al., 2010), it can still significantly alter people' moral decision making. Merging the above findings with the observation and empirical evidence that users' attentional and cognitive resources are extensively restricted within the IT artifact they are interacting with (e.g., Agarwal & Karahanna, 2000), we reason that the seemingly trivial interface design factor, namely, screen display mode, can resemble the effect of environmental lighting and play a non-trivial role in users' moral decision making. Specifically, we predict that using a dark mode, as compared with a light mode, will increase users' tendency to conduct financial crimes. We explicitly propose perceived anonymity as the underlying mechanism, and theorize the moderating role of screen size for the main effect.

To test the proposed hypotheses, two lab experiments are designed. Study 1 aims at testing the effects in the context of insurance fraud and study 2 is designed for a different crime, i.e., insider trading. We plan to develop four versions of task prototype for each experiments, where we will manipulate the screen display mode with either dark or light mode and run on either desktops (large screen) or mobile phones (small screen). These two experiments are expected to provide robust evidence and high generalizability for our proposed effects.

Our research is expected to make several important theoretical contributions. Firstly, we are among the first to study the effect of screen display mode on users' moral decision making. Although scattered prior research (e.g., Bagchi & Cheema, 2013) studied the effect of website background color on consumers' perception and behaviors, the color they studied (e.g., red vs. blue) is less predominant as the dark vs. light mode in practice. And we found little research specifically focusing on users' moral decision making as the outcome. Although we chose to contextualize users' moral decisions in financial activities, our rationales and findings will be generalizable to other contexts and contribute to diverse literature streams. Secondly, we will contribute to the literature of financial crime using digital technologies by providing a novel human-computer interaction perspective and show how a subtle interface design factor could influence people's tendency to conduct financial crimes. Practically speaking, the findings of our research could provide implications for both system developers and financial institutions.

Literature Review

Environmental Lighting and Moral Decision Making

Increasing environmental brightness has been widely adopted in urban planning practice to decrease crime rate (Pease, 1999; British Standards Institution, 2003). The benefit of road lighting on reducing crime is also supported by empirical evidence. For example, using a large scale crime data in three US cities from 2010 to 2019, Fotios et al. (2021) found that ambient darkness has a significantly positive effect on crimes like robbery and arson. Research in environmental psychology theorized sense of anonymity as the underlying mechanism of the effect of environmental lighting on people's moral decision making (e.g., conducting crimes). Specifically, environmental darkness conceals identity, decreases public visibility and increases inhabitations (Page & Moss, 1976; Zhong et al., 2010).

While it may be straightforward that environmental darkness increases anonymity and thus increases moral transgressions, one may question what if the environment is not dark enough to effectively conceal identity. In other words, does the effect of environmental darkness still hold when people are not experiencing *actual* anonymity? In response to this, Zhong et al. (2010) proposed and found that regardless the actual anonymity, darkness creates a sense of *illusionary* anonymity because people anchor their perception of anonymity not on the fact whether their actions are visible to others, but on their own phenomenological experience of darkness. They found that people are more likely to conduct morally questionable behaviors

in darkness across different darkness manipulations that did not reduce participants' actual anonymity, i.e., lighting conditions of the room and wearing sunglasses vs. regular glasses (Zhong et al., 2010). Subsequent research replicate the above effect and found people behave more selfishly (e.g., make less donation to charity) when in a room with dim (vs. bright) light (e.g., Chiou & Cheng, 2013).

Although the above findings consistently support the effect of environmental lighting on moral decision making, it is unknown whether the rationale can be generalized to digital setting. Specifically, will using dark vs. light screen display mode affect users' moral decision making? We found little research testing this effect, and we argue that the answer is not clear and requires further empirical evidence. On one hand, there is an important difference such that screen display mode only affect what people see on the screen but not their surroundings as ambient lighting does. And to validate the sense of anonymity mechanism, it seems essential to surround users in darkness. On the other hand, it is reasonable to infer that screen display mode is able to resemble ambient lighting because when interacting with digital devices, users' sight scope or even attentional resources are largely limited within the screen. Hence, to answer this question, we examine how screen display mode, a subtle interface design factor, can affect users' moral decision making.

Financial Crimes through Digital Technology

As the development of financial technology (FinTech), there are increasing financial activities conducted via digital technologies. While it increases the connivence for individuals to involve in simple financial activities such as online trading and insurance, it also cautions both researchers and practitioners the occurrence of financial crimes via digital technology. Therefore the wide adoption of financial technology demonstrates an urgent need to understand what and how design factors could affect financial crimes. One pioneer work related to this topic is Marsden and Tung (1999), where they proposed and tested an IT monitoring system to detect individuals' accessing inside information and their abnormal profits. Subsequent research applies more advanced techniques such as data mining and machine learning to detect illegal financial activities. For example, Donoho (2004) developed and tested the performance of an expert model using knowledge discovery techniques to detect insider trading in option market before news break. Similarly, Liu et al. (2020) also focused on detecting the ex-ante potential insider trading using a deep learning approach from financial text. In addition to insider trading, IS research extensively use machine learning approach and leverage the relevant textual content to detect many types of fraud in financial activities (Abbasi et al., 2012; Cecchini et al., 2010; Dong et al., 2018; Glancy & Yadav, 2011; Siering et al., 2016). For example, Abbasi et al. (2012) proposed a business intelligence framework to utilize public financial information to detect financial fraud. Siering et al. (2016) used linguistic and content-based cues to detect fraud in for online crowdfunding platforms. Complementing the publicly available financial data, Dong et al. (2018) obtained the financial social media data and designed an algorithm for corporate fraud detection.

Although the above research provide ample evidence showing the role of technology in financial crimes, they emphasized extensively on the technical details that are usually unknown to users who are conducting the financial activities. Therefore, these research can only predict financial crimes that might happen, but can barely intervene and affect people's decision on conducting such crimes. We note that it is important to take a different perspective which can consciously or subconsciously affect people's decision making process. Interface design factors such as screen display mode are the most salient visual factors when people are interacting with technologies in financial activities. Thus, the current research aims at advancing our understanding by proposing and investigating novel human-computer interaction factors to understand financial crimes conducted via digital technology.

Hypotheses Development

Drawing on the theory and findings from environmental psychology, we study the effect of screen display mode on users' moral decision making regarding financial crimes. We further propose perceived anonymity as the underlying mechanism and screen size as a theoretically derived moderator. The research model is presented in Figure 1.

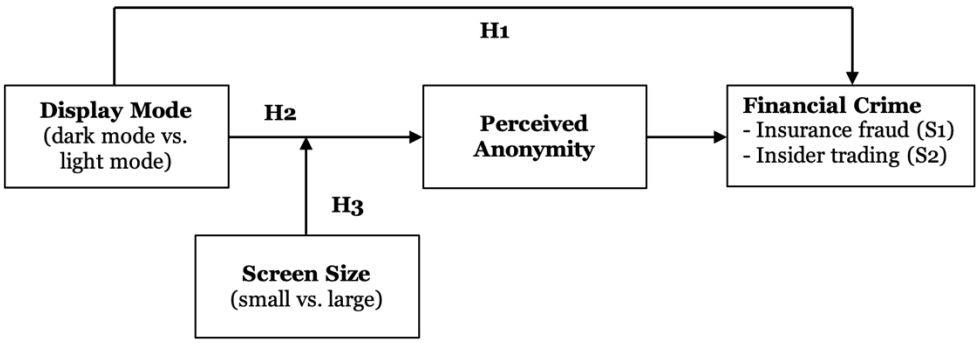

Figure 1. Research Model

As introduced before, prior findings in environmental psychology demonstrated that environmental darkness (vs. brightness) creates a sense of anonymity which subsequently lead to inhabitation (Page & Moss, 1976) and moral transgressions (Chiou & Cheng, 2013; Zhong et al., 2010). The sense of anonymity may not be necessarily produced from actual anonymity where others cannot observe the focal person's action, but can also arise from merely illusionary anonymity as long as the focal person himself/herself experiences darkness (Zhong et al., 2010). We argue that screen display mode (i.e., dark mode vs. light mode) can resemble the effect of environmental lighting during users' interaction with digital devices. Because prior research demonstrated that users often experience a state of cognitive absorption when interacting with digital devices, i.e., a deep level of involvement with the content presented on the screen (Kumar et al., 1996; Agarwal & Karahanna, 2000). Notably, Agarwal and Karahanna (2000) conceptualized five dimensions characterizing the state of cognitive absorption, including temporal dissociation (i.e., the inability of realizing the passage of time) and focused immersion (i.e., the experience of total engagement where other attentional demands are ignored). These two states lend credit to the expectation that screen display mode, although seems to be a subtle factor, can exert as large impact on users' moral decision making as more salient environmental factors, such as lighting.

Research in environmental psychology theorize sense of anonymity as the underlying mechanism of the effect of environmental lighting on people's moral decision making. We argue that the same mechanism can be applied to the digital settings. Specifically, if the perceived anonymity resulted from environmental darkness can increase crimes conducted in peoples' offline surroundings, we should expect that perceived anonymity resulted from the digital devices can increase crimes conducted online through these digital devices. Indeed, prior research have shown that online anonymity is associated with various crimes that can be conducted with computers (Armstrong & Forde, 2003). While the sense of anonymity can be induced by actual identity concealment designs such as in the dark web (Jardine et al., 2020), we argue that it can also be induced by illusion as demonstrated in Zhong et al. (2010). Echoing the earlier argument, even if dark mode (vs. light mode) may not induce actual anonymity, users can still perceive to be anonymous and feel that their online behaviors are less visible to others. And as in offline setting, such perceived anonymity would increase moral transgressions. Thus, we propose:

H1: *Users are more likely to conduct financial crimes in the dark display mode than in the light display mode .*

H2: *The effect of display mode on conducting financial crimes is mediated by users' perceived anonymity.*

Following the perceived anonymity mechanism, we theorize that the effect of display mode on financial crime is moderated by another digital device factor, i.e., screen size. Compared with devices with larger screens such as desktops, mobile phones can create a more private and immersive space and make users feel like their activities are less observable to others (Melumad & Pham, 2020). Based on the strong sense of privateness afforded by the small screen of mobile phones, some scholars conceptualize mobile phones as a form of "refuge" in modern society (Trub & Barbot, 2016). A recent consumer research found that consumers experience psychological comfort when using their mobile phones, and metaphorize mobile phones as "adult pacifiers" (Melumad & Pham, 2020). Similarly, we argue that smaller screens, as compared with larger screens, can enhance users' sense of anonymity such that users may feel their activities on smaller screens to be less detectable.

If the proposed anonymity mechanism of dark vs. light mode on financial crime holds, we would expect that the effect will be diluted when perceived anonymity is reduced by other factors, e.g., screen size. Therefore, we propose the following moderating effect of screen size:

H3: *The effect of display mode on conducting financial crimes is weaker for a smaller screens than for larger screens.*

Methodology

We designed two lab experiments to test the proposed hypotheses in the context of two common financial crimes, i.e., insurance fraud and insider trading, respectively. These two financial crimes are chosen as the task contexts because they are hard to be detected and therefore the deterrence of laws and regulations is minimal, which makes people's conduct of these two crimes largely susceptible to subtle environmental factors. For insurance fraud, the existence of substantial information asymmetry between the insured and the insurer incentivize the insured to deliberately conceal or even provide wrong information to insurer (Derrig, 2002), and the insurer can hardly detect the deception because sometimes the insured is the only one who knows that information (e.g., certain conditions of a second-hand car). For insider trading in stock market, because theoretically one can make any investment strategies and it is possible to make huge benefit just by chance, regulators can hardly prove the "unreasonably" high profit is due to the use of non-public information (Adams et al., 2018). The two experiments are expected to improve the generalizability of our proposed effects across different types of financial crimes.

A 2 (display mode: dark mode vs. light mode) x 2 (screen size: small vs. large) between subject design will be adopted for both experiments. We will develop four versions of task prototype to manipulate the two factors: 1) dark mode for mobile phone, 2) dark mode for desktop, 3) light mode for mobile phone and 4) light mode for desktop. We will control for other visual display factors such as contrast between the font color and the background color. The participants, procedures, and operationalization of our dependent variables in the two experiments are elaborated below.

Study 1

In study 1, we will test the effects of display mode and screen size on conducting insurance fraud. Considering that purchasing insurance is a common financial activity for adults, we believe undergraduate students could be regarded as a representative sample. Participants will come to the laboratory and be randomly assigned to one of the four experimental conditions. They will use the provided devices to conduct a car insurance task, adapted from Schweitzer and Hsee (2002). Specifically, they will be told to imagine they had purchased a second-hand car one month earlier and the task is to purchase a car insurance for this car. Participants will be first shown a description about their acquired car including information about the brand, engine type, the odometer mileage, etc. They will be told that the odometer mileage is 6,000 miles when they acquire the car, and in the following month they have driven the car for commuting. Then they will be shown a description about a car insurance where they have to report the odometer mileage of the car to the insurance company. Importantly, they will pay an additional 500 dollars if the odometer mileage exceeds 5,000 miles.

The dependent variable insurance fraud will be coded from participants' reported odometer mileage (1=report the false information, i.e., insurance fraud, and 0=report the true information, i.e., no insurance fraud). To make participants' decision consequential, we will convert their participation fee as their budget to purchase the car insurance, so that if participants conduct insurance fraud by providing knowingly false information to the insurance company, they will indeed save money and benefit from it. After the task, they will answer a questionnaire including perceived anonymity and other control variables, for example relevant individual characteristics (e.g., self-monitoring and moral identity)

Study 2

Study 2 will be conducted to test another form of financial crime, i.e., insider trading. And we plan to recruit MBA students to better suit the task context. We adapt a simulated trading task from Lee and Andrade (2015). Participants will be randomly assigned to one of the four experimental conditions to conduct a cash-out task. Part of the participation fee will be converted into an asset that they can hold or to sell, and their

profits in the task will be converted back thus affecting the payment amount they will ultimately receive. Before the cash-out task begins, we will briefly introduce some trading rules in real world and list typical financial crimes in trading including insider trading, and we will emphasize to make the experiment realistic, any illegal trading behaviors during experiment will cause a deduction of their participation fee. The trading consist 25 rounds and the asset value changes every round. In each round, participants decide whether to hold or sell (i.e., cash-out) the asset. Participants will be told that the value of the asset in each round is partly determined by chance and partly by all participants' decision in the experiment in the previous round. Notably, the actual trend of the asset price is pre-determined by the experimenter so that market volatility should be identical to participants in all experimental sessions. To eliminate the effect of participants' consideration about experiment duration, we will require all participants to stay in the laboratory until all 25 rounds ends even if they have cashed out in earlier rounds.

To create a condition where participants will be able to conduct insider trading, they will "accidentally" receive a document from the experimenter that shows the actual price change in each round before the task (the experimenter will pretend to wrongly give them this sheet together with other experimental materials they should receive). We will emphasize in the document that it is for experimenters ONLY and should not be distributed to any participants. In such case, the participants would believe that the experimenter accidentally leak insider information, and by leveraging which they can make more profit. Our task design mimics the realistic scenario so that people have the incentive to conduct the crime, but also worry about being caught.

In the "accidentally" delivered document, we will clearly show the optimal strategy, i.e., cashing out in the X^{th} round gives the highest profit. And we will compare participants' 1) cash-out decision in the X^{th} round and 2) total earnings, across four conditions. Because everyone has the same insider information, if we observe significantly more participants cash out in the X^{th} round in dark condition than in light condition, we can conclude dark mode increase insider trading. Same logic will be used to test the moderating role of screen size. The results of total earnings across conditions can further corroborate the finding. Perceived anonymity and control variables (e.g., self-monitoring and moral identity) will be measured in the post-task survey.

Conclusion

The proposed research focuses on an emerging interface design trend of incorporating dark mode in addition to the traditional light mode, and propose its effect on users' moral decision making about conducting financial crimes. We refer to the findings from environmental psychology and theorize that using a dark mode would increase the tendency to conduct financial crimes than using a light mode, because like environmental darkness, a dark screen can create a sense of anonymity and make users feel that their actions on the device are less observable. In line with the logic of anonymity, we further propose that screen size moderate this effect because a smaller screen induces a higher level of perceived anonymity than larger screen, which dilute the effect of screen display mode on perceived anonymity. We designed two lab experiments to test the proposed effects in the context of two different financial crimes, i.e., insurance fraud and insider trading. The two experiments are expected to corroborate with each other and demonstrate high generalizability of our findings.

This research is among the first to study screen display mode on users' tendency to conduct financial crime in particular, and on users' moral decision making in general. We will make two important theoretical contributions. Firstly, we will contribute to the literature on the effect of visual interface design factors on moral decision making. Specifically, we found little research studying the screen background color on users moral decision making. The most relevant study (Bagchi & Cheema 2013) investigated the effect of red website color on consumers' willingness to pay in auction and negotiation. However, to the best of our knowledge, this is little research study moral related behaviors as the outcome of different background color. Our rationales and findings will be generalized to contexts other than financial crimes and contribute to the corresponding literature. Secondly, we will contribute to the literature on the financial crimes through digital technology by introducing a novel human-computer interaction perspective as complement to the existing design science perspective. We will demonstrate how a subtle interface design factor, i.e., screen display mode, can interfere users' decision making process of conducting financial crimes. Unlike most studies adopting a technical perceptive that can identify users who have the propensity to conduct financial

crimes, our research is expected to directly intervene users' decision making process when facing the temptation to conduct financial crimes.

Lastly, our research is also expected to provide important practical implications to both system developers and financial regulatory authorities. For system developers, we will show that although the innovation on screen display mode is motivated by usability considerations, it should be adopted cautiously because of its far-reaching impact on users' moral decision making. And it is a very easy intervention that developers can adopt because all software development tools support changing the color of fonts and backgrounds. For financial institutions, we will show that in addition to the sophisticated techniques for detecting financial crimes, a seemingly trivial interface design factor may play a non-trivial role in affecting financial crimes. When financial institutions are considering developing software or applications for certain financial activities, e.g., insurance companies trying to digitize the purchase of insurance products, they shall caution the developers to use light (vs. dark) display mode. More importantly, changing the screen display mode will not only directly alter users' tendency of conducting crimes, but be far less costly than implementing advanced algorithms or sophisticated systems.

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