

Virtual Spillover of preferences and behavior from extended reality

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ABSTRACT

This article aims to describe *Virtual Spillover* – a term that captures the influence extended reality (XR) has on people’s preferences and behavior, as well as the new preferences and behaviors that people adopt long-term outside of XR as a result of that influence. It does not argue that people should aim to reduce or stop virtual spillover (or that it is possible to do so), but that virtual spillover presents a new safety and security issue for XR reality. The article argues that XR will be uniquely pervasive because it contains the multimodal social and physical elements of physical environments, while also having the adaptability and variability of digital environments. It outlines the mechanisms through which influenced behavior can result in behavioral spillovers and preference change.

CCS CONCEPTS

• **Computing methodologies** → **Cognitive science**; • **Security and privacy** → *Human and societal aspects of security and privacy*; • **Social and professional topics** → *Government technology policy*.

KEYWORDS

Influence, Manipulation, Preference Change, Virtual Spillover

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1 INTRODUCTION

This article aims to describe *Virtual Spillover* – a term that captures the influence extended reality (XR) has on people’s preferences and behavior, and specifically the new preferences and behaviors that people adopt outside of XR as a result of that influence. It will argue that irrespective of whether such influence occurs spontaneously, or due to an intended attempt to influence, the virtual spillover of preferences and behavior from XR into the physical world can be significant and substantive. The term can be applied to other aspects of people’s lives that change due to activity in XR (e.g., development of new skills or ideas). The article however focuses on preference and behavior as they are highly susceptible to influence and thus a novel challenge for safety and security in XR.

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From the perspective of a person’s goals (or ends), virtual spillover can be both positive, if it brings people closer to their ends (e.g., a preference for being healthier due to an augmented reality assistant), or negative, if it takes them away from them (e.g., taking up smoking because it looked cool in virtual reality). Thus, this article doesn’t argue for any attempts to stop or reduce virtual spillover - it will become evident that it is impossible to do so - but rather seeks to provide a framework for understanding instances of virtual spillovers and its consequences.

This article will first outline the primary mechanism of influence in XR - *choice architecture*. It will then focus on how influenced behavior in XR can influence future behavior via *behavioral spillovers*. It will also describe the mechanisms of preference change. In line with adjacent scholarship, this article argues the virtual embodiment experienced in XR can lead to potentially dangerous emotional, cognitive, and behavioral changes [16, 26]. These changes can lead to "after-effects" with long-lasting consequences [21].

2 THE CHOICE ARCHITECTURE OF EXTENDED REALITY

Choice architecture is the environment in which people behave [24]. The concept captures the presence of physical (e.g., location) and social (e.g., group size) resources that are necessary for a behavior to occur. It also captures the influence exerted by the physical and social environment (See Figure 1). Some aspects of the environment are more influential than others. The influential aspects of the physical environment have been extensively researched and documented [20]. Social influence can be broadly categorised into influence from observing other people’s behavior (i.e., descriptive social norms) and from what most people publicly claim to prefer and value (i.e., injunctive social norm) [4]. All environments influence behavior to some extent, even when people are not aware of it [22].

I argue that the choice architecture of XR is uniquely pervasive in that it contains the multimodal social and immersive elements of physical environments, while also having the adaptability and variability of digital environments. Multimodal interaction techniques employ several human senses (i.e., modalities) simultaneously, such as speech, gesture, and gaze [13]. XR will deliver a more multimodal experience compared to more traditional user interfaces (UI) [19]. The multimodal experience of extended reality is proven to be immersive and persuasive [28] - "that is the whole point and that is how it exerts its benefits" [21]. Furthermore, compared to non-XR experiences, research has found that XR users feel more physically present, socially present, and involved [14].

XR will be highly variable and adaptable. Not only will methods such as *infinite photogrammetry*¹ allow one to map the physical world onto virtual experience, but the creative application of XR for developing new environments is practically infinite [8]. Creating virtual environments will be both cheaper and faster than creating physical environments, thus democratizing people's ability to influence each other through developing choice architectures. Further, there is evidence that recommender systems for adaptive user XR interfaces are highly influential [15].

The choice architecture of XR will feel more immersive and multimodal than non-XR UI and more adaptable than physical environments, thus making it uniquely influential to human preference and behavior. The mechanisms of how these changed preferences and behaviors virtually spillover from XR to the physical world will now be explored (See Figure 1)

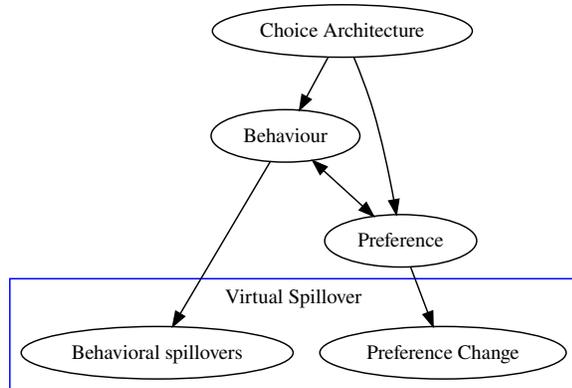


Figure 1: A Causal diagram showing the relationship between Choice Architecture, Preferences, and behavior, and how they cause Virtual Spillover.

3 BEHAVIORAL SPILLOVERS

I argue that the behavior change occurring in XR can influence future behavior outside of XR. The phenomena of one behavior in context A greatly affecting the probability of another behavior occurring in context B is known as a *behavioral spillover* [5]. The two behaviors are linked by an underlying motive that a person can hold explicitly or implicitly. The first behavior can either lead to another behavior that works in the same direction, known as a *promoting spillover* or go against it, which is known as a *permitting spillover*. For example, findings suggest that pro-environmental behaviors will spillover from one context to another if the person has an underlying pro-environmental motivation [11]. Permitting spillovers often occur in a phenomenon known as *moral licensing* – if people initially behave in a moral way they are more likely to later behave in an immoral [3].

Existing evidence suggests that people's online or digital behavior has both permitting and promoting spillover effects. Behavior in video games can spillover into an increase of both aggressive and

cooperative behavior outside of the game [17]. Meeting and socializing with someone in-game increases out-of-game socializing [7]. Online work behavior has an impact on offline work behavior [25]. Further, Online activist behavior often decreases offline activist behavior [10]. Finally, substantive evidence indicates that people's online consumer behavior influences their offline consumer behavior, and vice versa [6, 12, 18, 27]. Although more research is needed, given the persuasive potential of XR, XR is likely to cause behavior change that will result in significant and substantive behavioral spillover.

4 PREFERENCE CHANGE

XR changing behavior will in turn change people's preferences. Preferences are any explicit or implicit mental process that brings about a sense of liking or disliking for something. Preferences are not static; they can change and get influenced by choice architecture (See Figure 1) [9]. Further, behavior and preference have a bidirectional causal relationship. Although preference does influence behavior, behavior can predate and lead to the formation of new preferences [1]. Research in AI Safety has outlined the problem of behavior and preference manipulation by AI systems [2]. Specifically, an iterative ML system tasked with learning a user's preference will change their interactions with a user in line with those preferences. This change in interaction will influence human behavior, which in turn will influence human preference. Thus, by learning preferences over time, the AI is changing preferences.

Given the use of recommender systems in XR, interacting with XR will also lead to preference change [15]. This changed preference can virtually spillover outside of XR. Safety and security research in XR must address which preference change is ethically appropriate and which is highly manipulative. For example, preference change that leads to outcomes that are beneficial to the influencer and strictly detrimental to the influencee may be considered as manipulative [23].

5 CONCLUSION

This article introduced the term virtual spillover in order to outline how XR can result in a change of behavior and preference outside of XR. Not all forms of virtual spillover are a concern, but some certainly are. This may include an increase in behavior that could be considered as dangerous or illegal, as well as highly manipulative preference change. Auditing systems can be put in place, identifying the presence of mechanisms that change behavior and preference, and identifying and removing those which can be considered as a threat.

The XR environments we are in might have new norms surrounding behavior and identity. The norms of one XR environment may be different from another. The virtual spillover of this social norm heterogeneity may challenge the social norms of the environments we live in. As Slater et al. (2020) put it "The combination of immersion and personalization could lead to a fracturing of what social and political thought calls 'the public sphere' [21]". As it is now evident, stopping the occurrence of virtual spillover is impossible. It naturally occurs from people's everyday interactions with XR.

¹Procedurally generating an infinite version of a scanned physical environment.

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