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Embodied Gambling—Investigating the Influence of Level of Embodiment, Avatar Appearance, and Virtual Environment Design on an Online VR Slot Machine

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Slot machines are one of the most played games by players suffering from gambling disorder. New technologies like immersive Virtual Reality (VR) offer more possibilities to exploit erroneous beliefs in the context of gambling. Recent research indicates a higher risk potential when playing a slot machine in VR than on desktop. To continue this investigation, we evaluate the effects of providing different degrees of embodiment, i.e., minimal and full embodiment. The avatars used for the full embodiment further differ in their appearance, i.e., they elicit a high or a low socio-economic status. The virtual environment (VE) design can cause a potential influence on the overall gambling behavior. Thus, we also embed the slot machine in two different VEs that differ in their emotional design: a colorful underwater playground environment and a virtual counterpart of our lab. These design considerations resulted in four different versions of the same VR slot machine: 1) full embodiment with high socio-economic status, 2) full embodiment with low socio-economic status, 3) minimal embodiment playground VE, and 4) minimal embodiment laboratory VE. Both full embodiment versions also used the playground VE. We determine the risk potential by logging gambling frequency as well as stake size, and measuring harm-inducing factors, i.e., dissociation, urge to gamble, dark flow, and illusion of control, using questionnaires. Following a between groups experimental design, 82 participants played for 20 game rounds one of the four versions. We recruited our sample from the students enrolled at the University of Würzburg. Our safety protocol ensured that only participants without any recent gambling activity took part in the experiment. In this comparative user study, we found no effect of the embodiment nor VE design on neither the gambling frequency, stake sizes, nor risk potential. However, our results provide further support for the hypothesis of the higher visual angle on gambling stimuli and hence the increased emotional response being the true cause for the higher risk potential.

Keywords: virtual reality, virtual environments, immersion, gambling, risks, embodiment, avatars

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1 INTRODUCTION

The gambling industry continues to use new and more attractive gambling methods, such as online-gambling and gambling in immersive Virtual Reality (VR) (Griffiths, 2017). Using new technologies has the potential to increase the risk potential of gambling (Armstrong et al., 2017), such as the chance to evoke an addiction. It was shown that VR increases several harm-inducing factors, such as dissociation (Aardema et al., 2010) and urge to gamble (Park et al., 2014). Higher harm-inducing factors potentially indicate a higher risk potential of gambling. Recent research shows a higher risk potential of a slot machine when played in VR than on desktop (Heidrich et al., 2019). Also, research revealed a negatively influenced decision-making in a gambling context in VR (Oberdörfer et al., 2020) potentially caused by an increased visual angle on the stimulus (Oberdörfer et al., 2021). The visual angle refers to the size of a particular stimulus in the visual field of a person.

The effects found in these recent studies provide first indications of a higher risk potential of VR gambling. At the same time, these results raise the need for additional research to 1) determine the true cause for the higher risk potential and to 2) investigate the influence of prominent VR factors. While the former direction requires an investigation of immersion and the effects of a higher visual angle on the stimuli (Oberdörfer et al., 2021), the latter research direction requires the integration of VR-specific factors in virtual gambling environments, such as embodiment, social aspects, and emotional design of the virtual environment (VE).

The provision of an embodiment is a common approach to increase the user experience of a VR simulation. Depending on the style of the avatar, users can be influenced in their behavior (Yee and Bailenson, 2007). Hence, to advance the research of the dark sides of VR, it is important to investigate whether different degrees of embodiment affect the risk potential of gambling games. This requires a two-fold approach. Besides evaluating the risk potential of different degrees of embodiment, such as minimal and full embodiment, it is also important to vary the characteristics of the provided avatars. In addition, as the VE might influence the gambling behavior (Abbott et al., 2018), it is important to investigate whether different designs affect the overall risk.

Contribution

In the present study, we evaluate the effects of providing an embodiment on the risk potential of a VR slot machine as displayed in **Figure 1**. We use either a minimal embodiment or a full embodiment. In the full embodiment condition, the avatars either belong to a high or a low socio-economic status. As the surrounding VE can have an effect on the gambling behavior, we embedded the slot machine in two different VEs that differ in their emotional design. By logging gambling frequency as well as stake size, and measuring harm-inducing factors, i.e., dissociation, urge to gamble, dark flow, and illusion of control, we determine the risk potential. In a comparative user study, we found no effect of the embodiment nor VE design on the risk potential. This provides first indications that the risk potential is not increased by providing a full embodiment. However, our results substantiate the hypothesis of an increased visual angle and hence a higher emotional response to stimuli being the true cause for a higher risk potential. By transferring a gambling game from a desktop to an immersive VR version, the visual angle is typically increased while external distractors are shut out. This is an important insight as such a technology transfer could increase the overall risk potential despite the game remains unchanged.

2 THEORETICAL BACKGROUND

Millions of people worldwide suffer from gambling disorder (Calado and Griffiths, 2016). Depending on the country, the problem gambling rates are mostly between 0.12 and 5.8% (Calado and Griffiths, 2016). Gambling disorder can have severe effects on a patient's life as it leads to a deterioration of social, professional, material as well as family values, and

FIGURE 1 | We represent users with a full embodiment in a playground environment and allow them to gamble at a slot machine. They can observe themselves in a mirror to the left of the slot machine grid.

commitments (World Health Organization, 1993). Gambling disorder is classified as a disorder due to substance use or addictive behavior by the International Statistical Classification of Diseases and Related Health Problems and the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013; World Health Organization, 2018).

In general, one can categorize gambling games as soft or hard gambling games based on their risk potential (Meyer and Bachmann, 2005). For instance, lotteries belong to the soft gambling games and are one of the most played games in many countries (Calado and Griffiths, 2016). In contrast, slot machines pose a severe risk potential and are one of the most played games by players suffering from gambling disorder (Calado and Griffiths, 2016; Banz and Lang, 2017). Despite having only a small fraction of the number of players of lotteries, slot machines generate the highest revenue (Banz and Lang, 2017). Therefore, to advance the research of the dark sides of VR, we focus on slot machines in this study.

2.1 Slot Machines

Slot machines along with video poker and video lottery machines are classified as Electronic Gambling Machines (EGMs) (Turner and Horbay, 2004). EGMs provide a variety of game mechanics (Adams and Dormans, 2012) which not only structure the core gameplay (Oberdörfer and Latoschik, 2018), but also target the evocation and exploitation of erroneous beliefs with respect to the game (Turner and Horbay, 2004). For instance, an EGM can disguise losses as wins (Graydon et al., 2017) or play exciting music and sound effects (Griffiths and Parke, 2005). The losses disguised as wins game mechanic presents payouts that are smaller than the initial bet like a significant win. This increases the trial-by-trial enjoyment of non-win outcomes (Sharman et al., 2015) and leads to the illusion of winning more frequently (Graydon et al., 2017). However, the event frequency causes highest risk potential of a slot machine and gambling game in general (Meyer et al., 2011). The event frequency describes the duration of a game round, i.e., time between bet, outcome, and next potential bet opportunity. By now, slot machines are no longer just found in casinos. They also exist as online slot machines played on desktop computers, smartphones, tablets (NetEnt, 2011–2022), and recently even immersive VR devices (SlotsMillion.com, 2014–2022; NetEnt, 2018–2022). This not only increases the availability of gambling opportunities and hence the risk potential (Meyer et al., 2011), but also can provide more audiovisually appealing effects. Online slot machines can directly integrate the gambling in a virtual environment without the need of a typical terrestrial machine as found in casinos. As a result of this, online slot machines can exploit the advantages of artificial worlds which might affect the perception and risk of gambling. Targeting immersive VR, this effect might be even increased as players can accept the virtual environment as their true location and further spatially inspect the gambling game that might dominate their visual field. Finally, the immersion blocks out external stimuli, thus reduces otherwise present distractors. This raises the importance of our research.

The surrounding environment and its characteristics can further contribute to the risk potential of gambling (Abbott et al., 2018). For casino environments, there are two main design directions. According to Kranes (Kranes, 1995), a casino environment should feature warm colors, open areas with a high ceiling, lots of plants and flowers, running water, warm and bright light, and other elements providing relaxation to the players. The design of such a relaxing playground environment intends to distract players from their potential loss of money. In contrast to this positive environment, Friedman (Friedman, 2000) argues for a gaming environment that directs a player's attention directly to the gambling games without providing any distraction. The environment design features narrow rooms, low ceilings, and no access to natural features. In comparative studies, the positive playground environment design yielded a higher joy and higher intensity of gambling contrast to the gaming design (Finlay et al., 2006; Finlay et al., 2010). As VR slot machines visually immerse a player in the virtual environments, their design not only can follow these two main directions, but also incorporate magical elements only possible in an artificial world. This might affect the gambling intensity and risk potential even further.

2.2 Harm-Inducing Factors

A key aspect determining the risk potential of playing a slot machine is to measure the gambling frequency and the sizes of the placed bets (Xuan and Shaffer, 2009; Folkvord et al., 2019). The faster and riskier a player gambles, the higher the risk potential of a gambling game is. However, as our research focusses the influence of different degrees of embodiment and VE design, the core gameplay of our VR slot machine remains unchanged. This could lead to a similar gambling behavior. Hence, purely measuring these two aspects would not detect changes on the psychological level potentially affecting the risk potential.

Therefore, we follow the approach suggested by Heidrich et al. (2019). They propose to measure specific psychological factors capable of causing harm in the context of playing EGMs. Their approach is in line with the typical process of determining the effectiveness of harm-minimization strategies (Cloutier et al., 2006; Blaszczynski et al., 2016). The harm-inducing factors do not depend on specific game mechanics or characteristics and demonstrated to increase the overall risk potential. The proposed collection includes the following harm-inducing factors.

Dissociation refers to a state of changed identity (Jacobs, 1988) and is colloquially called the zone (Schull, 2005). Dissociative states are associated with losing track of time, feeling like being someone else, blacking out, not recalling own actions, and being in a trance-like state (Griffiths et al., 2006). Players suffering from gambling disorder frequently report various types of dissociative states during or shortly after their participation in gambling (Kuley and Jacobs, 1988). The experience of dissociation is independent of the frequency of gambling. Several studies have found dissociative states in casual gamblers to be either less intense (Diskin and Hodgins, 1999) or even the same as in players suffering from gambling disorder (Gupta and Derevensky, 1998; Diskin and Hodgins, 2001). Dissociation is considered as the most harm-inducing factor with respect to gambling (Kuley and Jacobs, 1988; Wanner et al., 2006).

Dark flow is the dependency on the experience of flow by repeating a specific activity like running and surfing (Partington et al., 2009). Flow describes the complete absorption of a person into the performance of an activity (Csikszentmihalyi and Csikszentmihalyi, 1975). Dark flow originates from sports and also provides a possible explanation for exercise addiction (Partington et al., 2009). In the context of gambling, dark flow leads to a longer gambling time and a higher amount of money spent (Lavoie and Main, 2019). The loss of time and money in the state of dark flow is perceived as a positive experience (Lavoie and Main, 2019). Also, gamblers with a higher Problem Gambling Severity Index (Caler et al., 2016) indicated a stronger dark flow on a slot machine (Dixon et al., 2018b).

Dissociation and dark flow describe zone experiences. However, neither dissociation nor flow fully account for the slot machine zone (Murch and Clark, 2021). According to Murch and Clark (2021), the zone experience may feel like flow for people with less severe gambling problems and become more dissociation-like for people with more severe gambling problems. Thus, at the current state of research, measuring both factors avoids missing important symptoms and implications (Murch and Clark, 2021).

Urge to gamble is the desire, craving, and motivation to gamble again after gambling (Sharpe, 2002; Raylu N. and Oei T. P. S., 2004). This harm-inducing factor is a key aspect of the development, maintenance, and relapse of gambling disorder (Young and Wohl, 2009). An interruption while gambling can also evoke the desire to gamble (Stewart and Wohl, 2013). The desire is so strong that some players even spend money to skip a forced break (Blaszczynski et al., 2016). The experience of urge to gamble often is a symptom of a gambling addiction (Park et al., 2015).

Illusion of control is another key aspect of the maintenance of gambling behavior (Armstrong et al., 2017). Multiple factors contribute to the experience of an illusion of control, such as active or passive involvement, choice, familiarity, and competition (Langer, 1975). The will to be in control of events, like connecting success in gambling to own actions, can already evoke an illusion of control (Thompson, 1999). Gamblers assess their own strength and capabilities higher as they are (Taylor and Brown, 1988). This leads to a sense of personal competence and perception of skill. In return, gamblers make higher bets when being allowed to throw the ball in roulette (Ladouceur et al., 1987) or the dice (Langer, 1975). In the case of EGMs, interaction game mechanics can evoke an illusion of control despite technically having no influence on the final outcome (Dixon et al., 2018a).

2.3 Immersive Virtual Reality

Immersive VR allows users to enter any VE and to perform any interaction possible within the boundaries of these artificial spaces. Thus, players can play any gambling game in every imaginable VE. Besides these potentials of artificial spaces to create high risk-potential gambling games, the mere immersion and audiovisual presentation already might influence the risk potential. Immersion is "the extent to which the computer displays are capable of delivering an inclusive, extensive, surrounding, and vivid illusion of reality to the senses of a human participant" (Slater and Wilbur, 1997). In this way, immersion depends on a system's objective properties reducing real world sensory inputs and replacing them with computer-generated information. This, for instance, can be achieved by wearing a Head-Mounted Display (HMD). The objective characteristics further include possible actions of a user within a given system (Slater, 2009). Immersion typically increases a user's visual angle on the VE in comparison to using a regular computer screen. With a higher visual angle, the emotional responses to audiovisual stimuli can be increased (Gall and Latoschik, 2020). The potentially increased emotional response might account for the differences found in the risk potential of a virtual slot machine (Heidrich et al., 2019) and the decision-making in the Iowa Gambling Task (Bechara et al., 1994; Brevers et al., 2013) when completed in VR (Oberdörfer et al., 2020).

Immersion directly evokes and influences presence (Slater et al., 1996; Waltemate et al., 2018). Presence, telepresence, or place illusion describes the subjective illusion of being in a real place despite being physically located in a different place (Slater, 2009). In this way, presence indicates the perceived realness of a virtual experience (Skarbez et al., 2017). Maintaining presence requires a support of sensorimotor contingencies (Slater, 2009) and a continuous stream of stimuli and experience (Witmer and Singer, 1998). A higher level of presence increases the intensity of experienced emotions (Riva et al., 2007). Also, presence improves a user's intrinsic motivation for learning (Makransky and Lilleholt, 2018) and enhances the overall performance in a training scenario (Stevens and Kincaid, 2015) especially when a high visual fidelity is provided (McMahan et al., 2012; Ragan et al., 2015).

Heidrich et al. (2019) compared in their study a desktop-3D to an immersive VR version of a slot machine. Their VR slot machine followed the concept of the online slot machine Gonzo's Quest VR (NetEnt, 2018–2022) by spatially integrating the core slot machine into a VE. Such an approach provides the greatest opportunities to exploit the advantages of entering an artificial world, especially as the immersion shuts out external distracting stimuli. In this study, the VR condition caused significantly higher dissociation, urge to gamble, and dark flow than the desktop-3D version. Both conditions did not differ significantly with regard to illusion of control.

Immersive VR already is successfully implemented in the therapy of gambling disorder (Bouchard et al., 2014; Park et al., 2015). It can provide stimuli and emotionally charged contexts to patients in the safety of a therapist's office (Bouchard et al., 2017). During VR-based therapy sessions, patients experienced a level of urge to gamble that is typically evoked by physical EGMs (Bouchard et al., 2017).

Taken together, this indicates the effectiveness and hence the risks of gambling in VR. It also raises the importance of this research to pave the way for more effective therapy methods and to ensure the safety of this approach.

2.4 Embodiment

Besides the design of game mechanics and VEs, the representation of a user in the VE can be of central

FIGURE 2 | Players of Slot Machine VB can adjust the bet level using the Vive controllers. Underneath the bet menu, the game displays a player's balance, win, level, and experience. On the lower left position, a green box indicates the multiplier. Players can watch themselves gambling in the virtual mirror positioned to the left of the slot machine grid.

importance for the overall experience. Depending on the goals, design, and available interactions, users are 1) not represented at all, 2) represented by 3D models of their game controllers, i.e., a minimal embodiment, or 3) represented by an avatar, i.e., a full embodiment (Oberdörfer et al., 2018). However, using a minimal or full embodiment are just the two extremes of the design space. User can also be represented by a partial embodiment (Lugrin et al., 2018). The utilization of an avatar as the proxy for a user's real physical body (IJsselsteijn et al., 2006; Lugrin et al., 2015) creates the so-called Illusion of Virtual Body Ownership (IVBO) (Slater et al., 2009). According to Kilteni et al. (2012), IVBO describes the acceptance of the avatar as the own body, agency as the perceived control over the virtual body, and self-location as the perceived own position. The IVBO can be influenced by providing photorealistic or even personalized avatars (Waltemate et al., 2018). Using an avatar can lead to a higher presence when interacting in VR in comparison to using a traditional user interface (Slater et al., 2010). The provision of an embodiment might intensify emotional response (Gall et al., 2021). Thus, fully embodied gambling games could potentially elicit a higher risk potential in contrast to minimal embodiment approaches.

Embodiment further can evoke the Proteus Effect (Yee and Bailenson, 2007). The Proteus Effect describes the conformation of an individual's behavior to their digital self-representation (Yee and Bailenson, 2007). Depending on the avatar appearance (Latoschik et al., 2016; Roth et al., 2016), users start to adopt certain characteristics of the avatar in their behavior. For instance, more sexualized avatars lead to more body-related thoughts (Fox et al., 2013), elderly avatars result in slower walking speed (Reinhard et al., 2020), and avatars of children result in objects being perceived as larger (Banakou et al., 2013). Users even accept avatars of a gorilla (Charbonneau et al., 2017) or acquire abilities to control artificial body parts like a tail (Steptoe et al., 2013). In this way, the Proteus Effect also could affect the risk potential of gambling games. The life and financial situation can have an influence on the chance to develop a gambling addiction (Johansson et al., 2009). While investigating income and financial problems produced contradictory results, unemployment and social welfare status are considered as probable risk factors for gambling disorder. Thus, the socio-economic status of the avatar potentially could affect the overall risk potential.

3 EMBODIED VR SLOT MACHINE

We extended the VR slot machine of Heidrich et al. (Heidrich et al., 2019) by a full embodiment to investigate the influence of an embodiment on the risk potential of gambling in VR as displayed in **Figures 1**, **2**. We made this decision as this slot machine was already evaluated in a previous experiment, thus indicating its effectiveness as discussed in **section 2.3**. Also, using the same slot machine as the basis for our investigation allows for a comparison of the results across multiple experiments. As discussed in **section 2.1**, the surrounding environment can contribute to the risk potential. To investigate this aspect, we also integrated the slot machine in two different environments. In this process, we changed the available symbols and slightly adjusted the payouts. We refer to this VR slot machine as Slot Machine VB.

3.1 Core Gameplay

A game round of Slot Machine VB involves 1) selection of a bet level, i.e., the bet size, 2) start of the round, 3) draw of a random selection of available symbols, and 4) payout of a potential win. Slot Machine VB limits a bet to a certain maximum, thus prohibiting all-in bets.

Targeting the HTC Vive (HTC Corporation, 2011–2022), a player selects the bet level using the trackpad of a game controller.

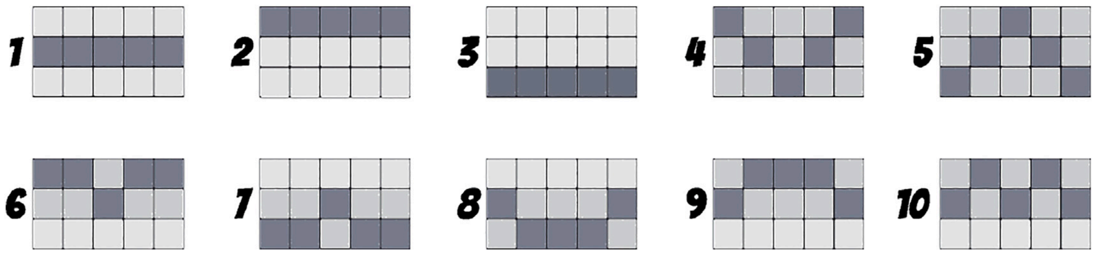

FIGURE 3 | Our slot machine provides 10 different win lines. A win line is a specific sequence of fields on the grid. For a win to occur a win line must contain at least three identical symbols.

FIGURE 4 | A player selects the size of the bet and starts a game round **(A)**. The slot machine randomly draws symbols and checks for wins **(B)**. Finally, the slot machine displays the final win **(C)**.

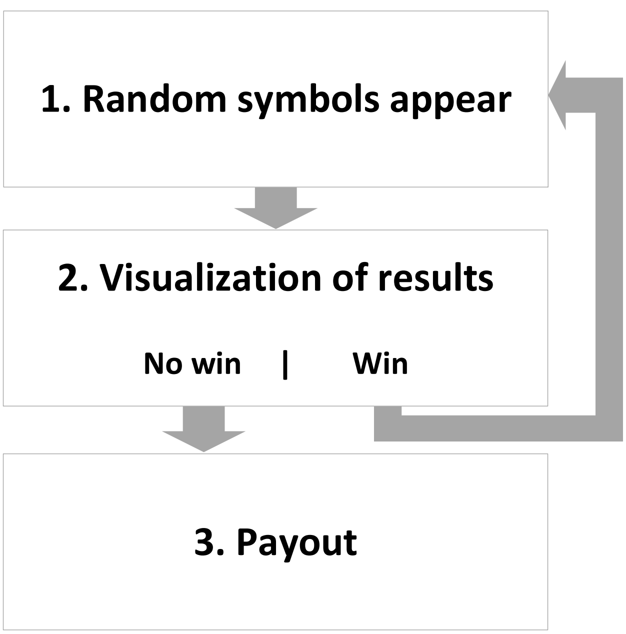

FIGURE 5 | Random symbols are drawn at the start of a round (1). Then, the game checks all win lines for wins. In the case of a win, they are visualized (2) and new symbols are drawn. If no (further) wins are detected, the final payout is displayed and added to the account (3).

By pressing the left or the right side, the player either decreases or increases the number of coins for the bet. The player starts a game round by pulling the trigger button of the controller. During a game round, Slot Machine VB draws a random selection of the eight encoded symbols and displays them in a 5 × 3 grid. Each symbol has a different value and chance of appearance. If the distribution of the symbols matches with one of the encoded win lines, a win occurs. **Figure 3** provides an overview of the ten available win lines. Slot Machine VB requires at least three identical symbols (starting from the left) to trigger a win line. If a line is triggered, the algorithm determines the size of the win based on the value of the identical symbols and their number as displayed in **Figure 4**. Subsequently, the slot machine increases a multiplier, replaces the involved symbols by new randomly drawn symbols, and checks again whether they match a win line. If the slot machine detects no (further) wins, the game round ends as depicted in **Figure 5**. The total win of a game round is the sum of all individual wins multiplied by the size of the bet and the multiplier.

Besides the core game mechanics, a slot machine is characterized by its return to player value (RTP), hit frequency (HF), and real hit frequency (RHF). The RTP indicates the percentage at which the total bets are returned as winnings. Commonly, physical slot machines have an RTP of 70–90% (Griffiths, 1993) and online slot machines of up to 99% (Barcrest, 2015–2022). HF is the rate at which a game round

TABLE 1 | Overview of the characteristics according to Meyer et al. (2011).

Characteristic	Scale	Score
Event frequency	Less than 15 s (4)	12
Cashout interval	Less than 15 s (4)	5.2
Jackpot	Not available (0)	0
Continuity of the game	More than 3 h of continuous gambling (4)	4
Prize-back ratio	More than 49% (4)	6.8
Availability	Gambling opportunities at home or work (3.5)	4.55
Multigame/stake opportunities	One game and one-stake opportunity (2)	4
Variable stake size	Variable but limited stake size (3)	4.2
Light and sound effects	Light and sound effects available (3)	4.5
Near miss	Intentionally generated by the game provider/producer, occurring frequently (4)	4.8
Total	–	50.05

results in a win, regardless of the size of the win. In contrast, RHF indicates how often the player receives a payout that is greater than the bet placed. Adjusting the value and probability of appearance of the symbols allows for balancing the RTP, HF, and RHF of a slot machine. We aligned Slot Machine VB with state-of-the-art online slot machines and balanced for an RTP of 99%, HF of 60%, and RHF of 25%.

The event frequency of Slot Machine VB is 15 s for game round including a payout and 8 s for a game round without any payout. However, in the case of a big win, i.e., multiple triggered win lines and money rain, a game round can last for 42 s. Calculating the risk potential of Slot Machine VB according to Meyer et al. (2011) results in a score of 50.05. This result is borderline between high risk potential and very high risk potential (Meyer et al., 2011). **Table 1** provides an overview of the characteristics.

Following a marine theme, we use aquatic animals and nautical elements for the symbols. Each symbol is displayed on stone cube. The symbols fall down from above after being drawn. Symbols involved in a triggered win line dissolve into bubbles, thus letting further symbols fall down. At the start of a new game round, all symbols dissolve into bubbles.

Slot Machine VB is integrated in an open area underwater scenario featuring warm colors, bright light, and plants. This not only reflects the theoretical best characteristics for positive VE design (Oberdörfer et al., 2021), but also fulfills the requirements of a playground environment as discussed in **section 2.1**. Hence, we refer to this environment as playground environment.

3.2 Game Mechanics and Properties

Slot Machine VB provides further game mechanics to allow for a comparison to commercial virtual slot machines. We kept the game mechanics the same to the original version of the slot machine (Heidrich et al., 2019) to avoid providing considerations for more engaging game mechanics and to ensure for a comparability.

Losses disguised as wins: Payouts smaller than the initial bet are presented the same way as a win.

Near wins: If there is a chance of a full line, the game slows down to create tension, regardless of the final result.

Level system: By gaining experience points, players can reach new levels indicating their personal progress. A player gains experience points by placing bets. A higher bet results in a greater amount of experience points. The slot machine rewards each new level with coins.

Money rain: The slot machine visualizes very large payouts that are three times greater the size of the bet placed with a rain of gold coins. The money rain lasts for 3 s.

Music: The slot machine plays a relaxing underwater ambient music. However, when the symbols match a win line for the first time of a game round, the music changes to a fast and exciting track, thus increasing the tension. Also, each event triggers a different sound effect.

3.3 Embodiment and Virtual Environment

We provide two levels of embodiment, i.e., minimal embodiment (minVB) and full embodiment (fullVB), to investigate whether IVBO influences the risk potential. The minVB condition represents a user by displaying 3D models of the Vive game controllers and Vive trackers used for realizing the fullVB condition. We made the decision to display the trackers as participants of the minVB condition should also wear the VR gear to rule out additional differences between the groups. The fullVB condition represents a user with a full avatar of the user's gender inside the VE. Furthermore, we are interested whether avatar appearance and in particular the socio-economic status of the avatar affects the risk potential. Hence, we provided two avatars eliciting either a high or a low socio-economic status per gender as displayed in **Figure 6**. To ensure this socio-economic difference, avoid an effect of Uncanny Valley (Mori et al., 2012), and rule out differences caused by the overall style, we integrated stylized generic avatars. In addition, current VR gambling games commonly use stylized generic avatars. We placed a virtual mirror on the left side of the slot machine grid to allow participants to observe themselves while gambling and hence to increase the IVBO.

The four integrated avatars were selected in a two-step process. In the first step, a female and a male researcher independently selected two low and two high socio-economic avatars per gender out of a pool of available avatars. The inter-rater reliability was high with Cohen's $k = 0.87$. In the second step, we presented the selected eight avatars to 25 participants (1 diverse, 15 females, 9 males; $M_{age} = 26.6$ years, $SD_{age} = 5.68$) in a pre-study and asked them to rate the socio-economic status of the avatars. We only

FIGURE 6 | Comparison of the used avatars. The left avatar of each gender represents the high socio-economic appearance.

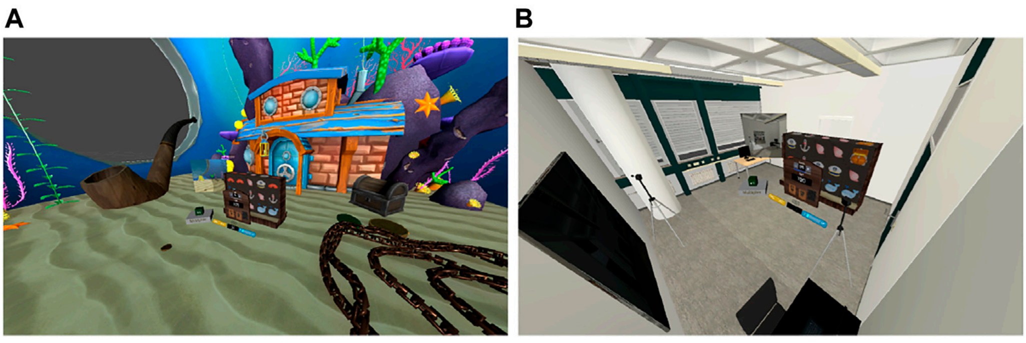

FIGURE 7 | We embedded the slot machine in two VEs to investigate their influence on the gambling behavior. The **(A)** screenshot shows the playground environment and the **(B)** screenshot the lab environment.

used the ratings for the avatars of the participant's gender in the analysis. The final avatars for our experiment were selected based on the greatest difference with respect to the socio-economic status; Tukey test t (7) = 5.52, $p < 0.000\,1$ for male avatars and t (14) = 3.67; $p = 0.003$ for female avatars.

Finally, as discussed in **section 2.1**, the environment in which the gambling takes place can influence the intensity of gambling. To investigate whether the provided playground environment influenced the gambling behavior, we integrated the slot machine in a virtual replicate of our lab as displayed in **Figure 7**. This VE uses artificial light, provides no access to nature, and features shut blinds, thus creating a confined environment. These characteristics also reflect the negative design space of emotional VE design (Oberdörfer et al., 2021). We refer to this environment as lab environment. We placed the slot machine in the center of the room and at the same distance to the player as in the playground VE. This ensured that no differences in the visual angle on the slot machine cause differences in the emotional response and hence on the measurements (Gall and Latoschik, 2020). We decided against using the alternative gaming environment as this could in the end also result in a higher gambling intensity and hence provide no insights whether the environment affected the gambling behavior. In addition, by remodeling the real laboratory, we intend to investigate the effects of immersion on the risk potential. In contrast to the change of technology and hence also change in the visual angle in the inaugural study by Heidrich et al. (2019), our lab environment only adds the element of immersion to a gambling scenario in an otherwise unchanged real environment.

3.4 Technology

Slot Machine VB was made with Unity 2020.1.4f (Unity, 2021) using the SteamVR plugin in the version 2.7.1 (Valve Coorperation, 2015–2022). To design the playground VE, we used the 3D asset Aquarium (van den Biggelaar, 2016–2022). We modeled the lab VE ourselves. For symbols, we used the 2D icon pack Sealife (Freepik, 2017–2022). To provide the full embodiment, we used the avatars CartoonMan30 Man, CartoonGirl007 Girl, Cartoon-Man007 SuitMan, and CartoonGirl008 Office-Girl of Baria CG (Baria, 2022) and animated them using the Final IK plugin in the version 1.9 (RootMotion, 2014–2022).

4 STUDY

Based on the indications discussed in **section 2** and the design decisions presented in **section 3**, we assume the following hypotheses (H):

TABLE 2 | Overview of the seed used.

Round	RTP	Round	RTP
1	0.3	11	0
2	0	12	3.25
3	3	13	0.15
4	2.55	14	0
5	0	15	5.9
6	0	16	0
7	0	17	1
8	1.8	18	1
9	0.8	19	0.15
10	0	20	0.2
RTP	–	–	**0.99**
HF	–	–	**0.6**
RHF	–	–	**0.25**

H1: The fullVB condition of Slot Machine VB causes a higher risk potential than the minVB condition.

H2: A low socio-economic status of the avatars causes a higher risk potential of Slot Machine VB than a high socio-economic status.

H3: The playground version of Slot Machine VB causes a higher joy and higher gambling intensity than the lab version.

We determine a higher risk potential based on the gambling intensity and selected harm-inducing factors. Gambling intensity describes the frequency of gambling and the size of the bets placed. A condition elicits a higher risk potential when either one or more factors are higher in this condition than in the other condition.

To answer our hypotheses and to compare the conditions with respect to the identified harm-inducing factors, joy, and gambling intensity, we conducted a between groups experiment. We randomly assigned the participants to one of the conditions: 1) fullVB high socio-economic status (fullVBhigh), 2) fullVB low socio-economic status (fullVBlow), 3) minVB playground VE (minVB), and 4) minVB lab VE (minVBlab). Both fullVB conditions used the playground VE.

We implemented a seed that was used in all conditions to achieve comparability as displayed in **Table 2**. This ensured a similar gambling experience for every participant. At the beginning of the experimental trial, we instructed the participants to maximize their money by gambling without revealing the number of available game rounds. The experimental trial ended after 20 game rounds. Players started with 3,000 coins and could place bets in the range from 20 to 1,000 coins. Slot Machine VB allowed for changing the bet size in steps of 100 coins. A player unlocked a new level after spending 1,500 coins and received 300 coins as a reward.

4.1 Apparatus

The experimental setup consisted of a desk, a roll container, a chair, a computer (CPU: Intel i7-9700K @3.6GHz, RAM: 16GB, GPU: NVIDIA GeForce GTX 2070 SUPER), an HTC Vive Pro (1440 × 1600 px resolution per eye, 110° FOV) with its two controllers, three trackers and two lighthouses on tripods, a monitor (1920 × 1,080 px, 24 inches), a mouse, and a keyboard as shown in **Figure 8**. We used the three Vive trackers to determine the position of a participant's upper body and the feet needed for the embodiment. The tracker for the upper body is attached to a belt, thus allowing users to position the device at their backs just above the hip bone. We attached the trackers for the feet to non-slip overshoes for an easy equipment of the VR gear. During preparation for each experimental session, we placed the VR gear on top of the roll container for an easy access. The tracking area had a size of 2.5 × 2 m. Inside the VE, symbols had a size of 0.5 × 0.5 m and the player was positioned 2.70 m away from the grid.

4.2 Measures

Participants filled in the computerized questionnaires before the experiment and after the gambling session. We presented the questionnaires in the common language of the study's location. Questionnaires were selected in alignment with the theoretical considerations of harm-inducing factors as risk indicators in **section 2.2**. In addition, Slot Machine VB automatically generates a protocol of a participant's gambling intensity.

4.2.1 Demographics

We asked for demographic information, i.e., age, gender, visual impairments, hearing impairments, language proficiency, gaming experience, VR experience, and attitude towards gambling. As control variables, the study included the Immersive Tendency Questionnaire (ITQ) (Witmer and Singer, 1998) and the predictive control subscale of the Gambling Related Cognitions Scale (GRCS) (Raylu N. and Oei T. P., 2004). The ITQ assesses a participant's immersive tendency, their current alertness as well as fitness, and their ability to focus. The predictive control assesses a participant's belief to which degree they can predict the outcome of gambling. A stronger belief could indicate a higher chance to be influenced by a gambling game.

4.2.2 Presence

The Mid Immersion Presence Questionnaire (MIPQ) is a single-item questionnaire assessing a person's current presence in the VE (Bouchard et al., 2004, 2008). The MIPQ consists of the orally presented question "To which extend do you feel present in the virtual environment, as if you were really there?“. Participants rate their current presence on a scale from 0 to 10. Higher scores indicate higher presence. We assessed the MIPQ after half of the game rounds.

4.2.3 Subjective Socio-Economic Status

To assess a participant's socio-economic status, we administered the Subjective Socio-Economic Status Scale (SSS) (Adler et al., 2000). The scale consists of a ladder with 10 rungs of which the top rung represents the highest and the lowest rung the worst socio-economic status. Participants rate their subjective socio-economic status by marking one of the rungs. We assessed this quality to investigate whether the status was affected by embodiment. We used the translated and validated version of the SSS (Hoebel et al., 2015).

4.2.4 Gambling Intensity

Slot Machine VB logged a participant's gambling frequency in seconds and the size of the bet in coins for each game round.

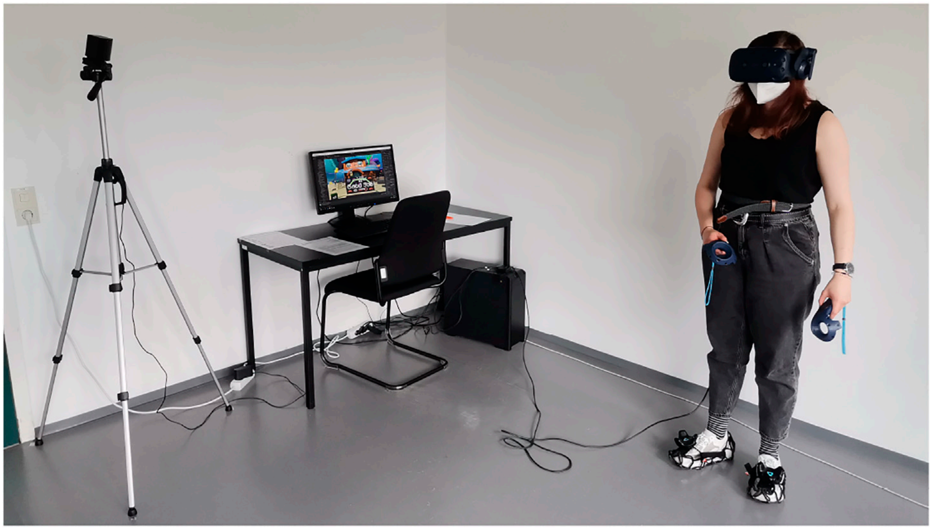

FIGURE 8 | Overview of the experimental setup.

4.2.5 Dissociation

The Clinician Administered Dissociative States Scale (CADSS) is a 23-item questionnaire measuring the current dissociation (Bremner et al., 1998). The items are answered on a 5-point Likert scale ranging from 0 to 4 (4 = highest degree of dissociation). The questions refer to the current state of the participant as assessed after the stimulus.

4.2.6 Game Experience

The Game Experience Questionnaire (GEQ) is a 42-item questionnaire with the subscales immersion, flow, competence, tension, challenge, positive affect and negative affect (Nacke, 2009). The GEQ uses a 5-point Likert scale ranging from one to five, higher scores indicate a higher experience. We used the GEQ to measure dark flow using the flow subscale. In addition, we used the positive affect subscale to determine the joy experienced while gambling.

4.2.7 Urge to Gamble

The Gambling Urge Scale (GUS) is a 6-item questionnaire measuring the current urge to gamble (Raylu N. and Oei T. P. S., 2004). Participants rate statements about their current urge to gamble on a 7-point Likert scale ranging from 1 to 7 (7 = strong urge to gamble).

4.2.8 Gamblers Beliefs Questionnaire

We administered the Illusion of Control factor of the Gamblers Beliefs Questionnaire (GBQ) to measure the illusion of control (Steenbergh et al., 2002). Participants assess their beliefs on a 7-point Likert scale ranging from 1 to 7 (7 = higher illusion of control).

4.2.9 Illusion of Virtual Body Ownership

The Virtual Embodiment Questionnaire (VEQ) allows for an assessment of the IVBO (Roth and Latoschik, 2020). The VEQ measures the factors body ownership, agency, and change on a 7-point Likert scale (7 = strongly agree).

4.2.10 Restoration

Following the gambling environment research of Finlay et al. (2006), we used their restoration scale to analyze the participants' perception of the VE. The scale assesses whether a participant felt distracted, attracted by the environment, and restricted in their freedom. The scale uses a 7-point Likert scale (7 = strongly agree).

4.3 Procedure

The study took place during the Covid-19 pandemic. To ensure for protection and hygiene, we took the following precautions. 1) Each participant was required to disinfect their hands before and after the study, constantly wear a mask, and report whether they stayed in a risk area or show signs of an illness. 2) The experimenter was required to disinfect their hands, constantly wear a mask, and daily report whether they show signs of an illness. 3) The experimenter and the participant were required to keep at least a distance of 1.5 m 4) All touched surfaces and used devices, like HMD, controllers, and keyboard, had to be cleaned with a disinfectant product after each experimental trial. 5) The laboratory had to be ventilated for at least 15 min after each experimental trial.

Each study session lasted about 50 min and consisted of the following stages:

1) **Welcome:** Each participant receives a short introduction to the experiment as well as the health and safety rules, performs a gambling behavior self-test, and signs an informed consent form.
2) **Pre-Questionnaire:** The participant fills in the demographics questionnaire, ITQ, and predictive control subscale.
3) **Introduction:** The participant receives an explanation of the game and the respective game controls via the questionnaire

FIGURE 9 | Participants performed body movements in front of a virtual mirror to acclimatize themselves.

system. Due to the hygiene rules, the participant equips the VR gear unassisted. We used the lab VE without the slot machine as the initial VE when entering VR to facilitate the acclimatization.

4) **Acclimatization:** The participant calibrates the avatar. Subsequently, the participant performs body movements in front of a virtual mirror to acclimatize themselves with the avatar as displayed in **Figure 9** (Waltemate et al., 2018). Slot Machine VB instructs the participant with text written on the wall above the mirror about the individual tasks. To avoid a confound, participants assigned to the minVB conditions also completed the acclimatization phase.
5) **Gambling:** Depending on the condition, Slot Machine VB either teleports the participant to the playground VE or places the slot machine in the virtual lab. We use the simulated blink transition technique to transition from the acclimatization to the gambling phase (Oberdörfer et al., 2018). The participant plays the slot machine for 20 game rounds. After half of the game rounds, we assessed the MIPQ.
6) **Post-Questionnaire:** Once the 20 game rounds are complete, the participant gets teleported back to the virtual lab and receives instructions to remove the VR gear. The participant completes the SSS, CADSS, GEQ, GUS, GBQ, VEQ, and restoration scale. We present the questionnaires in a randomized order to limit the effects of a fixed sequence on the results.
7) **End:** The participant receives information about the dangers of real gambling and watches a short information video about gambling addiction.

4.4 Ethics

The institutional review board of Human-Computer Media at the University of Würzburg approved our ethics proposal for this study. We also implemented the following measures as a precaution to limit the risk of playing a gambling game during this study: 1) The participants had to be of age 18 and older. 2) We only allowed participants to participate who had a negative result in a gambling behavior self-test (Bayern, 2022) and who did not gamble for the last 12 months 3) No real money was used in this study. 4) We informed the participants about the risks of gambling after the study. The participants had to watch a short information video about gambling addiction. We also provided further educational material.

4.5 Participants

In total, 90 participants were recruited from the undergraduate students who were enrolled at the University of Würzburg. We used an online participant recruitment system that rewards students with credits mandatory for obtaining their bachelor's degrees. However, we had to exclude eight participants due to technical issues and misbehavior during the experimental trial. Hence, our sample consists of 82 participants (57 females, 25 males). The participants had a mean age of 21.73 years (SD = 1.96). None of them had severe visual or hearing impairments, but four reported to have an uncorrected slight myopia. 65 participants used an HTC Vive or Oculus Rift (M = 6.55 h, SD = 15.99) before and 62 participants reported a previous computer game experience with a mean weekly playtime of 3.61 h (SD = 6.63). 27 participants reported a total lifetime playtime at slot machines for 0.73 h (SD = 1.48) on average. The participants' mean attitude towards gambling was 2.38 (1 = very negative, 5 = very positive, SD = 0.88) based on self-report.

Following the between groups experimental design, we randomly assigned the participants to one of our four conditions fullVBhigh, fullVBlow, minVB, minVBlab. **Table 3** provides an overview of the four groups. A comparison of the groups with regard to ITQ score revealed a significant difference, $F(3, 78) = 4.28$, $p = 0.008$. **Table 4** provides an overview of the Tukey post-hoc comparisons of the groups. Comparing the predictive control score revealed no significant difference, $F(3, 78) = 0.39$, $p = 0.76$.

5 RESULTS

As we found a significant difference with regard to the ITQ, we analyzed our results by computing analysis of covariance

TABLE 3 | Overview of the conditions. Values are either *M* (SD) or *n*.

Quality	fullVBhigh	fullVBlow	minVB	minVBlab
Females	15	16	13	13
Males	5	5	8	7
ITQ	87.65 (9.72)	78.05 (12.67)	82.33 (9.84)	76.8 (10.02)
Predictive control	1.98 (0.75)	2.13 (0.73)	1.91 (0.84)	2.13 (0.88)

TABLE 4 | Overview of Tukey test comparisons of the ITQ scores. The asterisk denotes a significant difference.

Conditions	t	df	*p*
minVBlab—minVB	1.78	38.82	0.40
minVBlab—fullVBlow	0.35	37.75	0.73
minVB—fullVBlow	1.22	37.68	0.40
fullVBhigh—fullVBlow	2.73	37.35	0.025*
fullVBhigh—minVBlab	3.48	38	0.011*
fullVBhigh—minVB	1.74	38.94	0.40

(ANCOVA) for a comparison with regard to one factor, multivariate analysis of covariance (MANCOVA) for comparing the harm-inducing factors, t-tests for the comparison of two conditions, and Cohen's D for determining effect sizes. We used the ITQ scores as a covariate. We combined fullVBhigh and fullVBlow to gain insights about the general effects of providing a full embodiment in a virtual gambling environment. fullVBcomb ($n = 41$) designates this group. Also, we calculated the average score of the CADSS ratings in addition to the total score to allow for a comparison to the results of Heidrich et al. (2019). **Table 5** provides an overview of the mean scores per group.

5.1 Presence

We analyzed the overall presence to check for the overall quality of Slot Machine VB. The comparison between the four groups showed no significant difference, F (3, 77) = 0.98, p = 0.40. However, the ANCOVA detected a significant influence of the ITQ scores on the MIPQ ratings, F (1, 77) = 5.72, p = 0.02.

5.2 Illusion of Virtual Body Ownership

To investigate whether IVBO is affected by either the levels of embodiment, avatar appearance, or VE design, we compared the four conditions with regard to the VEQ scores. We found a significant difference in Change, F (3, 77) = 3.44, p = 0.02. Bonferroni-Holm adjusted t-tests revealed a significantly higher score in the fullVBhigh condition in contrast to the minVB condition, t (25.84) = 4.12, p = 0.009. However, we did not find significant differences regarding Ownership, F (3, 77) = 0.62, p = 0.60, and Agency, F (3, 77) = 0.74, p = 0.53.

5.3 Influence of Embodiment

To analyze whether a full embodiment in contrast to a minimal embodiment increases the risk potential of gambling in VR, we compared fullVBcomp and minVB with regard to the gambling intensity and harm-inducing factors.

5.3.1 Illusion of Virtual Body Ownership

The comparison between the fullVBcomb and minVB groups showed no significant difference in Ownership, t (38.96) = 0.85, p = 0.40, d = 0.14, Agency, t (36.78) = 1.56, p = 0.13, d = 0.49, and Change, t (38.40) = 1.14, p = 0.26, d = 0.18.

5.3.2 Gambling Intensity

We found no significant difference with regard to the frequency between fullVBcomb and minVB, t (60) = −1.01, p = 0.84, d = 0.27. Also, the comparison of the bet sizes showed no significant difference between the two groups, t (60) = −0.92, p = 0.82, d = 0.25.

5.3.3 Harm-Inducing Factors

We did not find a significant difference between the two groups for the harm-inducing factors, F (4, 36) = 0.25, p = 0.91.

5.4 Influence of Socio-Economic Appearance

To analyze whether differences with regard to the socio-economic appearance of the avatars influence the risk potential of gambling

TABLE 5 | Overview of the mean scores per condition. Values are *M* (SD).

Quality —	fullVBhigh (*n* = 20)	fullVBlow (*n* = 21)	fullVBcomb (*n* = 41)	minVB (*n* = 21)	minVBlab (*n* = 20)
Presence	7.10 (1.21)	6.38 (1.96)	6.73 (1.66)	7.10 (1.64)	7.15 (1.57)
Socio-economic status	5.71 (1.31)	5.71 (1.35)	5.71 (1.35)	5.86 (1.59)	5.30 (1.56)
Frequency	16.02 (0.59)	16.14 (0.68)	16.14 (0.63)	15.98 (0.52)	16.26 (0.56)
Bet size	287.95 (152.25)	315.65 (169.76)	301.46 (159.61)	264.29 (130.65)	324.65 (136.44)
Dissociation (total score)	10.95 (9.13)	10.29 (6.54)	10.61 (7.82)	10.67 (5.51)	9.45 (7.17)
Dissociation (average)	0.50 (0.42)	0.47 (0.30)	0.48 (0.36)	0.48 (0.25)	0.43 (0.33)
GEQ—flow	3.37 (0.92)	2.95 (0.68)	3.15 (0.82)	2.87 (0.79)	2.94 (0.85)
GEQ—positive affect	3.59 (0.67)	3.17 (0.72)	3.38 (0.72)	3.02 (1.05)	3.22 (0.72)
Urge to gamble	1.68 (1.01)	1.24 (0.34)	1.46 (0.77)	1.42 (0.69)	1.43 (0.58)
GBQ—illusion of control	2.24 (1.17)	2.35 (1.03)	2.29 (1.09)	2.08 (0.85)	1.96 (0.79)
VEQ—ownership	4.14 (1.35)	3.76 (1.47)	3.94 (1.40)	4.07 (1.53)	4.34 (1.57)
VEQ—agency	5.77 (0.95)	5.22 (1.29)	5.49 (1.16)	5.58 (1.01)	5.50 (1.13)
VEQ—change	3.48 (1.58)	2.93 (1.46)	3.20 (1.52)	2.10 (1.22)	2.49 (1.01)
Restoration	4.25 (0.90)	4.00 (1.01)	4.13 (0.95)	3.82 (1.11)	3.96 (0.87)

in VR, we compared fullVBhigh and fullVBlow with regard to the gambling intensity and harm-inducing factors.

5.4.1 Gambling Intensity

We found no significant difference with regard to the frequency between fullVBhigh and fullVBlow, t (39) = −0.72, p = 0.76, d = 0.17. Also, the comparison of the bet sizes showed no significant difference between the two groups, t (39) = 0.55, p = 0.29, d = 0.17.

5.4.2 Socio-Economic Status

The comparison of the SSS scores between the fullVBhigh and fullVBlow groups revealed no significant difference, t (39) = 0.03, p = 0.51, d = 0.01.

5.4.3 Harm-Inducing Factors

We did not find a significant difference between the two groups for the harm-inducing factors, F (4, 36) = 0.24, p = 0.91.

5.5 Influence of Virtual Environment Design

To analyze whether differences with regard to the design of the VE influence the joy and intensity of gambling in immersive VR, we compared minVB and minVBlab with regard to the positive aspect, perceived restoration, gambling frequency, and bet sizes. We also checked whether the VE design caused differences in the harm-inducing factors.

5.5.1 Gambling Intensity

We found no significant difference with regard to the frequency between the two groups, t (39) = 1.69, p = 0.10, d = 0.26. Also, the comparison of the bet sizes showed no significant difference between the two groups, t (39) = 1.45, p = 0.16, d = 0.23.

5.5.2 Positive Affect

The comparison of the positive affect between the minVB and minVBlab groups showed no significant difference, t (39) = 0.71, p = 0.75, d = 0.11.

5.5.3 Restoration

The minVB and minVBlab groups did not significantly differ with respect to restoration, t (39) = 0.45, p = 0.67, d = 0.14.

5.5.4 Harm-Inducing Factors

We did not find a significant difference between the two groups for the harm-inducing factors, F (4, 55) = 1.08, p = 0.38.

6 DISCUSSION

We used the same measurements for dissociation, urge to gamble, and dark flow as Heidrich et al. in their study (Heidrich et al., 2019). Our minVB condition, despite using a virtual mirror and three additional 3D models of the trackers, is still close to their immersive VR version. Comparing our results of the minVB condition to their immersive VR condition, the measurements are on the same level. This not only validates their measurements, but also indicates that our work extends this research directions of investigating the risks of gambling in VR.

Presence in all conditions was high. A lack of difference between the playground and the lab environment is explainable as both VEs provided a high visual fidelity. Also, participants played the same slot machine in both versions, hence the interactions with the VE were the same. Overall, the high presence values confirm our design of an immersive VR slot machine. Interestingly, we found an influence of the immersive tendency on the presence ratings. This confirms that presence is also dependent on individual tendencies.

The lack of an influence of IVBO on the perceived presence could be explained by the VEQ results. We found no significant differences with respect to the subscales of ownership and agency. This is explainable by the structure of the VEQ, experimental procedure, and our realization of the minVB conditions. All groups went through the same acclimatization phase and hence accepted the mere controllers just as well as the full avatars as a proxy for their own bodies. This explains the similar ownership ratings. Likewise, the minVB 3D models followed the participants' movements as the full avatar did in the fullVB conditions, thus evoking a high degree of agency in all groups. Although only significantly different between the fullVBhigh and minVB conditions, we found generally higher ratings for the change subscale in the full embodiment conditions as displayed in **Table 5**. This indicates that the full avatar caused a perceptible effect on the participants and that our full embodiment was effective. Our results could even provide support for the assumption that there is a relation between change and the Proteus Effect (Roth and Latoschik, 2020). This result is notable. However, the general lack of a stronger difference could also be caused by the style of the avatars. Photorealistic and even personalized avatars can improve IVBO (Waltemate et al., 2018).

A different explanation for the results of the MIPQ and VEQ as well as the lack of an interplay between these two qualia could be approached by a recently proposed XR experience model (Latoschik and Wienrich, 2021). According to this model, these qualia are independently caused by the perceived plausibility of the simulation and not dependent on each other. Hence, the lack of an interplay of our results potentially could provide indications for the validity of the model.

6.1 Influence of Embodiment

The lack of an influence on the risk potential caused by the provision of a full embodiment is surprising. A central aspect of gambling games is evoking erroneous beliefs about the game in players. Hence, gambling games intend to evoke positive and rewarding emotions in gamblers during the gameplay. As embodiment potentially increases experienced emotions (Gall et al., 2021), providing this factor could have influenced the risk potential. However, as indicated by the VEQ ratings, participants accepted the minimal embodiment just as well as the full embodiment as a proxy for their own bodies. As a result, the potentially higher emotional response was on a similar level in all conditions. To investigate this effect even further, a future study shall provide a condition without any embodiment and also provide embodied interactions like pulling a lever to present the full avatars more prominently. Thus, H1 is rejected.

6.2 Influence of Socio-Economic Appearance

Research indicated that the socio-economic status potentially affects the risk to be attracted by gambling games and to develop a gambling disorder (Johansson et al., 2009). Hence, we hypothesized that altering a person's perceived socio-economic status using the Proteus Effect might also increase the risk potential. However, the two avatar appearances did not result in a difference between the fullVBhigh and fullVBlow conditions with regard to the socio-economic status. It is likely that the own perceived socio-economic status is not affected by the Proteus Effect. This explanation is supported by the descriptive statistics shown in **Table 5**. The socio-economic status was similar across all conditions. However, we only measured the socio-economic status after the experimental trial. We made this decision to avoid an effect of test fatigue. This limits the interpretation of the results. We can only gain insights from a comparison between the conditions, but cannot provide insights whether the avatar appearance influenced the perceived socio-economic status of a participant. Also, we used stylized generic avatars for the full embodiment conditions to avoid confounds by differences in their overall style. This approach, despite our best efforts to find a strong difference with respect to the socio-economic status, resulted in avatars that still were relatively similar. Also, we only recruited our participant from students enrolled at the University of Würzburg. Their wardrobe commonly consists of clothes worn by the high and low socio-economic avatar. Thus, the used avatars might have not provided a strong enough contrast to influence the socio-economic status using the Proteus Effect. Therefore, future work is needed to further investigate whether a person's perceived socio-economic status can be altered by an embodiment featuring a strong contrast. Thus, H2 is rejected.

6.3 Influence of Virtual Environment Design

Although we embedded the slot machine in two different VEs, we did not find an influence on the gambling intensity or risk potential. This investigation followed two main goals. We intended to investigate whether the mere immersion already affects the risk potential and whether the general design of a VE can influence the gambling intensity. The first slot machine study found significant differences between an immersive VR and a desktop-3D version with regard to the harm-inducing factors (Heidrich et al., 2019). Caused by the use of two different technologies, the two tested slot machine versions not only differed with respect to immersion, but also with respect to the visual angle on the task. By remodeling the real lab, we only manipulated the immersion. At the same time, the two tested VEs strongly differed with regard to the emotional design and the design guidelines for a gambling environment. This allowed us to further investigate the overall effects of the VE design. Surprisingly, we did not find significant differences between the two conditions. With regard to the investigation of the effects of immersion, this result provides further indications for a potential influence of the visual angle on the slot machine (Gall and Latoschik, 2020). In our two versions, the visual angle was the same, thus the potentially emotional response remained unchanged in contrast to the first study. This confirms indications found by similar research investigating the influence of immersion by keeping the visual angle on the stimulus the same (Oberdörfer et al., 2021). With regard to the overall effect of the VE design, our results are explainable by the structure of the gambling phase. We gave the participants the task to play the game. As a result, they might have started playing the game immediately without taking in the scenery. Alternatively, it is also likely that the exposure time was not long enough. The participants might have still been attracted by the slot machine itself without actually taking a look at their surroundings. Thus, H3 is rejected.

6.4 Dominance of Flow

A different explanation for all of our results could be the experience of flow while playing the slot machine. While in a state of flow, a person is completely absorbed by the performance of an activity (Csikszentmihalyi and Csikszentmihalyi, 1975). In this way, the participants might have directed their entire attention to the slot machine. Research already found indications for flow being an experience dominating other prominent VR factors like embodiment (Lugrin et al., 2018; Oberdörfer et al., 2018). Hence, the lack of differences between our conditions could also be contributed to the experience of flow. This explanation is supported by the flow measurements indicating that the participants experienced a medium to high degree of flow. As a result, our study potentially provides further evidence for the dominating effect of flow. With regard to the overall risk potential of gambling in VR, the flow-inducing potentials of the game as well as the prominence of the visual presentation, e.g., the visual angle, could be the primary influencing factors. This hypothesis is backed by the comparison of our results to the measurements of Heidrich et al. (2019).

6.5 Implications

Although we found no effects of providing different levels of embodiment or different VEs on the risk potential, our results do not show that these two factors generally have no effect on the risk of gambling. Using different avatar appearances or an embodied interaction with the slot machine like pulling a lever might still influence the risk potential. Also, we only focused on the measurements of gambling intensity and harm-inducing factors. This approach neglects potential effects on the overall attractiveness of a gambling game. While not directly affecting the risk potential, a higher attractiveness might lead to more people trying out a VR gambling game. Depending on the following gambling experiences, this could lead to more people developing a potential gambling addiction. Hence, embodiment, creative avatar appearances, and beautiful VEs could still indirectly affect the risk potential.

Despite these uncertainties, our results could be of high interest to therapists (Bouchard et al., 2017). As long as embodiment is implemented the same way as in our experiment, it can safely be used in exposure therapy applications without yielding unwanted side-effects with regard to the harm-inducing factors.

The comparison of the minVB and minVBlab condition provided first insights whether immersion affects the risk potential. We found no effects between these two conditions. However, we kept the visual angle on the slot machine the same. In the inaugural experiment, the visual angle on the slot machine differed. Hence, we provide further substantiations for the hypothesis that the risk potential of a gambling game is increased when a higher visual angle is provided and external stimuli are shut out. This typically happens when transferring a game from a desktop environment to an immersive VR environment. In this way, a technology transfer of a gambling game could still increase the overall risk potential.

6.6 Limitation

The underlying design of Slot Machine VB followed an online VR-based slot machine integrating the gambling game directly into the VE. This approach allows for the greatest freedom with respect to exploiting artificial worlds. However, in contrast to a simulation of a casino VE featuring virtual terrestrial slot machines, Slot Machine VB might be perceived as more abstract. Also, following the design of online slot machines, we used an RTP of 99% which is the highest end of the spectrum. Thus, our results only provide insights into the potential future of VR-based online gambling games, but might be limited with respect to approaches following a realistic casino VE like SlotsMillion VR (SlotsMillion.com, 2014–2022) or VR-based simulation of a terrestrial slot machine. Therefore, future research shall investigate the effects of gambling on a VR counterpart of a terrestrial slot machine.

A second limitation is our strict safety protocol protecting the participants. The selected gambling behavior self-test and the requirement to have not gambled for the last 12 months ensured that only participants without any gambling disorder participated in the study. At the same time, this rule limited our sample to participants with a very low tendency to respond to gambling stimuli. To keep the risk of getting attracted to gambling low, we limited the gambling time to 20 game rounds. This, however, neglected an individual trial phase allowing for the observation of further effects of longer and free gambling. Lastly, we used virtual coins without real countervalue. Winning money is the main motivation for playing gambling games Banz and Lang (2017). Gambling games often attempt to achieve some kind of suspension of judgement through the use of virtual currencies Griffiths (1993). This breaks the link between real and virtual money and causes players to place higher bets even though they are still playing with real money Lapuz et al. (2010). However, although virtual currencies may lead to higher stakes, the lack of an countervalue may have influenced gambling behavior at the beginning of the gaming phase. Taken together, our safety protocol protected our participants but also potentially restricted our findings and prohibited an unmasking of further effects caused by more intense and attractive gambling.

7 CONCLUSION

We presented a study investigating the effects of providing a full embodiment on the risk potential of a VR slot machine. Also, since the VE can affect the gambling behavior, we embedded our slot machine in two distinct environments. The embodiment conditions differed with respect to the degree of embodiment, i.e., minimal and full embodiment, as well as socio-economic appearance. The VEs either followed the design of a playground casino environment or an emotional design eliciting negative emotional characteristics.

We determined the risk potential of the different conditions by logging gambling frequency as well as stake size, and measuring harm-inducing factors. Our results revealed no influence of the level of embodiment, avatar appearance, and VE design on the risk potential of the VR slot machine. This outcome provides first indications that the risk potential of gambling in VR is not directly affected by an embodiment or VE design. However, our results provide further substantiations for the hypothesis that the visual angle and hence the influenced emotional response to the gambling stimuli affects the risk potential.

Future work shall investigate the effects of providing no embodiment and embodied interactions on the risk potential of gambling in VR. Another research direction shall evaluate the effects of changing the visual angle on an immersive VR gambling game. Finally, it is important to investigate the overall attractiveness of gambling when providing specific VR factors as this might lead to a higher number of people trying out gambling.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics committee of Human-Computer Media, University of Würzburg. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

SO, DS, and ML contributed equally to the conception of this research. DS developed the embodied VR slot machine system. SO as well as DS designed the user study and DS conducted it. SO and DS analyzed the data. SO, DS, and ML wrote the manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frvir.2022.828553/full#supplementary-material

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