# The Influence of Controllers on Immersion in Mobile Games

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## ABSTRACT
The controls for digital games understandably have an important part in building up the gaming experiences that people have. Whilst there is substantial work on innovative controllers for consoles, like the XBox Kinect, relatively little has been done to understand the effect of the different control mechanisms that can be used to play games on mobile devices like smartphones. A well-defined framework of naturalness has emerged as potentially useful concept in area of game controllers. This paper reports two experiments that look at how the naturalness of the game controls influences the experience of immersion in mobile games. It seems that where there is an a prior natural mapping, this will improve immersion in the game but in the absence of a prior mapping, naturalness alone is not sufficient to account for immersion. This opens up the need for a more thorough investigation of this area.

### Author Keywords
controllers; immersion; mobile games; natural mappings; gaming experience

### ACM Classification Keywords
H.5.0. Information Interfaces and Presentation (e.g. HCI): General

## MOBILE GAME CONTROLLERS
In recent years, there has been an explosion in the number of people who regularly play digital games [15]. In part, this increase can be attributed to the proliferation of mobile devices that have suitable computing capabilities with more than a third of all gamers playing games on their smartphone *(ibid)*. This is perhaps not surprising given the technological advances in smartphones in recent years. They now have the display and computational capacities to deliver a high-end gaming experience. Games that once could only be played on the PC or on the game consoles are now available in mobile versions, for example the later games in the *Need for Speed* series. In bringing cutting-edge digital games to our pockets though, mobile devices also bring limitations that challenge both game designers and gamers. Small screen size, even if high resolution, requires more attention to game interface designs and also what aspects of the game arena can be displayed at any one time. Another challenge is allowing players to interact naturally with the game.

Until recently, digital games with any claim to sophistication were primarily played on bespoke platforms such as Sony's Playstation or on PCs suitably souped up to cope with the demands of the games. The move to mobiles has meant losing the controllers that these traditional platforms relied on and so has called for new ways to interact. Fortunately, the enhanced input mechanisms such as touch screens, accelerometers and microphones have inspired new game interactions. A game like *DoodleJump* with control of the jumping alien being done through tilting the mobile would have made no sense on traditional platforms. Despite the innovations and adaptations around mobile platforms, some traditional game types, such as first person shooters, have struggled to adapt to the new mobile platforms and only now are more effective interaction mechanisms emerging with games like *The Drowning* [33] where the interaction space is deliberately being explored away from the most obvious, well-trodden paths.

Of course, games are all about the experience [19]. They are played for fun, socially or even just to while away a few spare minutes. But what makes it worthwhile to use time this way is the experience that the games offer. With the move to mobile gaming, the question becomes what is the effect of the devices themselves on the gaming experience. Thompson et. al. [40] showed that a game played on an iPad was more immersive than the exact same game played on the iPod Touch. This could only be attributed to the change in screen size of the device as all other attributes of the devices and game were the same. What then of the control of mobile games? There are several mechanisms that are used as game controls on mobiles. Some are more traditional where games that previously used a mouse simply use the very first pointing device, that is a finger, like in *Bejeweled 2*, and others exploit the new ca-


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pabilities using the orientation of the device, such as the *Real Racing* games, or even the physical location of the device, as in *Zombies, Run!*. In many cases, whether the game is ported from another platform to the mobile platform or an entirely new game, there are clear choices that need to be made about the control mechanisms and each might influence the gaming experience in different ways.

Skalski et al. [38] have developed the notion of naturalness to describe the different ways in which controllers map into games and the effect naturalness has on the experience gamers have. Generally, the more natural a controller, in this formulation, the better the experience. The purpose of this paper is to address the relationship between the naturalness of control in mobile games in relation to the experience of players, thus extending the existing, substantial work on controls and the gaming experience in the area of console games. We report two studies looking at the effect of the naturalness of controls for mobiles on the specific experience of immersion in games because immersion is a dominant experience that results from playing digital games [7]. The first study therefore considers whether using the mobile device as a "steering wheel" in a driving game is more immersive than a button-like control. The results are in favour of the steering wheel mechanism, supporting the previous work on natural mappings [38]. The second study therefore considers a more abstract game where there is no obvious mapping of input actions to control and here the picture is more complicated with immersion seeming to arise more from the sense of the connection with the game. These studies show that players are sensitive to the effects of controllers in this mobile context and that natural mappings help immersion but are not the whole story. Before going into the details of both studies, it is necessary to discuss different gaming experiences and how the controls of a game influence them.

## CAPTURING GAMING EXPERIENCES

Digital games are hugely varied enabling players to experience everything from (virtual!) Galaxy spanning quests over a period of months to short bursts of puzzle solving while waiting for a bus. Accordingly the experiences that games offer vary enormously and so though it is easy to say that digital games are all about the experiences they offer, exactly what experiences people have and how those experiences are engendered in the players is not simple (as is true of any experience of interactive systems [24]). When it comes to studying gaming experiences (GX), the goal is perhaps not to capture and represent the individuated experiences of gamers but rather to capture to some extent the shared experiences of players and relate this to specific games and playing occasions. Within the more generic understandings of gaming experience, there are, of course, experiences that are not offered only by digital games but by any entertainment medium such as enjoyment [41] and fun [5] but any research with gamers quickly shows that this can at best only be a starting point for understanding GX [28]. Instead, common experiences discussed specifically by gamers alongside enjoyment are experiences like flow [12], immersion [19], spatial presence [39], challenge [19], control [28] and social presence [14]. These different experiences naturally overlap and correlate to different degrees in different games but they do allow for a finer-grained consideration of what games mean to players.

The problem of considering the plurality of gaming experiences is that in any study of gaming it would be likely to see differences in at least one of these different aspects of GX, even if only by chance. Moreover, even where effects on GX are real and meaningful, it can be hard to be sure that differences seen are not just chance when there is no focus on a particular aspect of experience. A further problem is that though some multidimensional measures of gaming experience are gaining in popularity, in particular the Gaming Experience Questionnaire (GExpQ) [17] and the PENS scale [30], these scales are not freely available and indeed, as far as we are aware, the GExpQ has never had a formal validation published [27].

The studies reported here therefore focus in on one particular aspect of gaming experience, namely immersion [19]. This is for three reasons. First, it is a commonly referred to aspect of gaming experience by gamers and reviewers [7] and is regularly seen as an important consideration in any attempt to address the breadth of GX, for example, [28, 29]. Secondly, there is substantial research showing the influence of different aspects of games on immersion be they internal to the game such as the challenge provided by the game [13], aspects not central to gameplay like music [32] or external factors such as the size of the device being played on [40]. Thirdly, Jennett et al. [19] have validated and published a practical measure of gaming immersion, the Immersive Experience Questionnaire (IEQ) that has been used in the previously cited studies as well as many others. This is not to say that this formulation of immersion is definitive — there is considerable debate around the exact meaning of the term, e.g. [9] — but rather that it is one that has reasonable conceptual and empirical support. A fuller discussion of the different types of immersion can be found in [8].

It is the IEQ that is used in the current studies. The IEQ effectively operationalises immersion as a unidimensional construct, which is also supported by independently developed instruments of gaming engagement [6], so that players can be understood to experience immersion within a single scale that varies from low levels to high. At the high end, it is believed that immersion corresponds closely to the experience of flow [36]. The IEQ consists of 31 questions scored on Likert scales (two versions are generally used with either 5 or 7 item Likert scales for the same items in the questionnaire). The factor analysis of the IEQ suggests that there are five constituent components of immersion, namely, cognitive involvement, emotional involvement, real world dissociation, challenge and control. Though they are meaningful concepts in their own right, as understood within the IEQ, they are in fact somewhat correlated facets of the underlying immersive experience [19] and are used here to offer insights into how immersion is built up within a particular gaming experience rather than as independent categories of immersion.

## CONTROLLERS AND GAMING EXPERIENCE

Control of a game is an important aspect of the gaming experience — it is how players gain agency that allows them to play the game and enter into the action-feedback-action loop that constitutes playing the game [31]. Players achieve control through the controllers that are used to play the game. In many classic games, the controls were necessarily iconic given the limitations of the technology with key presses being used, for example to guide people running through castles and shooting guns in games like *Wolfenstein*, but this has led to a recognised style of interaction that is still used in games today, e.g. *Exposure* [43]. In such games, there is a degree of arbitrariness to how these interactions are designed that is not intrinsic to the gameplay itself. By contrast, for games like *Fruit Ninja*, it seems plausible that the swiping motion of the game came first and the work of the designers was to make compelling gameplay that centred around this.

Game designers, of course, recognise the importance of good design of controls and think carefully about the mapping of controls to in-game actions and how the controls build up the player experience, e.g. [34]. So understandably it appears as an explicit aspect of gaming experience as reported by gamers both generally [17] and specifically in immersion [19]. Calvillo-Gamez et al. [10] though argued further that the control of a game is more fundamental than the positive experiences that arise from games. Rather, without control, players cannot have any form of positive experience. In this sense, control is a hygenic necessity rather than source of positive experience in itself. This theory was given the name puppetry to reflect the ability of the player to be the cause of the game to come to life. This is supported in the notion of effectance which is the capacity of players to have control within the game. Klimmt et al. [21] showed that whereas a reduction in control because of difficulty did not necessarily impair enjoyment, a reduction in effectance because of unreliable controls did reduce enjoyment. Without being able to project their agency into the games, players cannot progress to positive gaming experiences.

With the advent of more types of game controls such as the Wii, *Guitar Hero* guitar, Microsoft Kinect, Sony Move and so on, the interest has grown in what these new types of control bring to the gaming experience. Body movement seems to be an important constitute of engagement suggesting that some form of embodiment reinforces and enhances GX [3]. For example, Lindley et al. [23] showed that a more active game controller, namely the bongos for *Donkey Konga*, led to more social interaction and engagement for people playing in pairs. There is also evidence that the level of interactivity alone that controllers offer supports increased enjoyment and spatial presence in the game [37] though those studies must be interpreted carefully as the game played also varied with control devices used. Furthermore, Isbister et al. [18] found that different games that differed in the level of required movement did not necessarily influence the amount of fun players had. In more carefully controlled studies, Birk and Mandryk [4] showed that different controllers could enhance the gaming experience, in two purpose-built games. In particular, the Kinect offered more immersion than a GamePad where immersion was measured using the PENS scale [30]. More surprisingly, though, they also showed that the controller used also seems able to influence how players construe their in-game identity.

Given the recent proliferation of controllers, Skalski et al. [38] set out to relate the different types of controls in relation to the naturalness with which they mapped to the games where they were used. They characterised controls as being on a continuum of naturalness moving from arbitrary to fully realistic and tangible mappings but they also categorised the continuum into four levels:

1. directional natural mapping, where the directions on the controller match the results in the game such as use of a joystick
2. kinesic natural mapping, where physical movements correspond to real-life actions even if not realistically like Sony's *Air Guitar*
3. Incomplete tangible natural mapping, where the movement of the controls correspond to the movement of a real object like *Guitar Hero*
4. Realistic tangible natural mapping, where there is a physical controller that corresponds to a real object like a steering wheel for a driving game

Skalski et al. identified that both in a golf game and a driving game, where the mapping of controls were more natural, both spatial presence and enjoyment of the game was higher. In particular, a steering wheel interface to the driving game was perceived as much more natural than a keyboard, joystick or gamepad interface despite the likely increased familiarity and experience with the other input devices. Building on this, Williams et al. [42] showed that a more natural interface for a Wii boxing game (boxing gloves!) led to an increase in a measure of hostility and McGloin et al. [26] showed similarly that a boxing glove interface led to an increase in cognitive aggression. Interestingly though, in that study, players did not perceive the naturalness of the controllers as being different between the experimental conditions as measured by a 13 item questionnaire. This measure did not map onto the naturalness manipulation though both the manipulation and the measure of perceived naturalness did have effects on the game experience.

Driving games perhaps offer the most obvious natural mapping of using a steering wheel interface to control a virtual rather than a real car and was considered already in the formulation of naturalness [38]. Bateman et al. [1] considered the influence of both the view, whether first person or third person and if third where the camera was, and the controller on the experience of driving games. While players preferred thumbstick or steering wheel controls to a mouse, they in fact performed better with the less natural thumbstick interface. This is attributed to the style of interaction in the game, with a thumbstick favouring a more discrete driving style rather than a smooth cornering action that a steering wheel interface would give. McEwan et al. [25] noted differences in the gaming experience between different controls including different styles of steering device for the XBox driving game *Forza Motorsport 4* but as there are no statistical tests reported, it is not clear to what extent the differences seen are meaningful. By contrast, Schmierbach et al. [35] also considered the effect of using a steering wheel control and a gamepad in the XBox game *Need for Speed: Pro Street* but found no correlation between the type of controller used and enjoyment but the perceived naturalness of the controller might in fact be a predictor of enjoyment.

Overall then, there is substantial research that looks at the effect of game controls on GX. Understandably, there has been an emphasis on the recent control devices that have become available for consoles but there seems to have been little done to specifically focus on the gaming experience arising from mobile devices and their associated potential control mechanisms. There have been research efforts to consider how best to exploit the new interaction possibilities arising from mobile games, for example [11], and the importance of control on gaming experience is certainly recognised [22]. However, there has not been a specific focus on empirically investigating the role of controllers in mobile game experience. The fact that mobiles are tangible objects that can map to game objects in a variety of ways suggests the naturalness framework of Skalski et al. [38] is a useful starting point to explore the relationship between controllers and the gaming experience in this context. This paper therefore addresses this gap by considering how different naturalness types, particularly as represented by common game control methods, influence the gaming experience in games played on smartphones.

## STUDY ONE: STEERING IN A MOBILE GAME

Games on mobile devices are limited by the restricted physical size of the device. They are able to overcome this in part by using the device itself as the controller for the game. The aim of this experiment is therefore to see how the use of the device as the controller in the interface to the device influences the gaming experience, specifically the sense of immersion in the game. A car-racing game was chosen for two reasons. First, because such games offer a style of interaction that is seen in many racing games on mobile devices, which is the use of the device as a "steering wheel" for the car by virtue of the accelerometers in the device. Even though clearly the device is not like steering wheel interfaces available for console games, it can be said to be more natural than a button-style interface because a steering wheel is an incomplete, tangible natural mapping whereas buttons are, at best, a directional natural mapping in Skalski et al.'s typology of naturalness [38]. Secondly, the existing work on steering interfaces did not give a wholly consistent view on whether a steering did in fact lead to a better gaming experience despite the increase in naturalness. Nonetheless, it was expected that naturalness of the steering metaphor would increase immersion over a more traditional-style control of direction through tapping button-areas on the device.

### Game

The game chosen in this experiment was *Beach Buggy Blitz* by Vector Unit. It is a third-person view car racing game, with the realistic environment on the beach road. Players control the direction of the car to avoid obstacles, collect the coins and follow the course along the beach, see Figure 1. Within the game, it is possible to choose the control mechanism of the game to use either tilting or touching. The games is played with the iPhone horizontal and held in two hands on either side of the phone. With tilting, players tilt the iPhone in the plane of the phone (ie roll) and so produce a motion like driving with a steering wheel to navigate the course. With touching, players tap the areas at either side of the screen with their thumbs to move left or right accordingly. The tapping area is anywhere on the side of the screen so there is no requirement for fine-precision to steer. Thus, the tilting control is an incomplete, tangible natural mapping and the touching control is a directional natural mapping [38].

The player starts a game with 30 seconds of time to play. When the time runs out, the game is over but players are given more time when they pass checkpoints every few hundred meters in the game. Therefore the players need to avoid the obstacles and get as far as possible to earn the time. There are no levels so a player cannot "complete" the race. The game ramps up rapidly in difficulty and single games rarely last more than a few minutes.


**Figure 1. Screenshot of Beach Buggy Blitz**

The reason for choosing this game is primarily motivated by the need to have a game that works well enough in an experimental setting. Casual games typically are much better in experimental studies because they usually are immediately playable and require little prior experience to start playing [20]. Moreover, casual games are expected to deliver a good gaming experience in only short periods of play. This game is very much in that casual tradition and therefore fit well in terms of an experimental stimulus. Additionally, the tilting controls provide the players with steering experience, while the touching controls enable the players play the same game without the steering metaphor and in doing so provide two common interaction paradigms for mobile games but without changes to the game itself. For experimental control, it might have been desirable to use a game that was especially written for this study. However, achieving the level of quality of a commercial release in a home-grown game can involve a prohibitive development time and even small weaknesses in the game design or controllers could introduce confounds into the study. The use of commercial games in research therefore has some real benefits despite the reduced experimental control and in addition provides a degree of ecological validity to the games [16]. Playing a game in this study is not like playing a real game, it *is* playing a real game.

### Design

The experiment was a between-subjects design to avoid the influence of improvements in play over the course of the study. The independent variable was the control mechanism (tilting or touching) that the participants used to play the game with. The dependent variable was the immersion level measured by the IEQ scores. Because of the problems of getting participants to identify naturalness seen in other studies [26], we did not attempt measure how natural the participants perceived the controls but instead relied on the clear mapping between the experimental manipulation and the naturalness typology as evidence of the experimental manipulation.

### Participants

Thirty participants took part in this study, 15 in each condition, recruited by opportunity sample though they were assigned randomly to the conditions. Their age ranged from 19 to 30. Fourteen of them were women. Only 2 of them had experience with the game used in this study. Eight participants played mobile games very rarely, and the rest at least play mobile games several times a week. Only two participants claimed that they had never played car racing games before. Most of them would normally choose to play social games and adventure games. When they did play games, they typically spent around 30 minutes playing.

### Materials

The device used was a fourth-generation Apple iPhone. The game as described above was installed as an App on the device. The sound came from the built-in speakers turned up to around 80% volume. The Immersive Experience Questionnaire (IEQ) developed by Jennett et. al. [19] was used to measure the immersion level. The questionnaire was printed out on paper for each participant. A demographic questionnaire was included asking about age, gender, frequency of playing mobile games, average playing time, and preference of mobile game types.

### Procedure

The experiment was run with one participant at a time in a quiet room. After a brief description of the experimental procedure, each participant was asked to read and sign a consent form. The participants were then given the demographic questionnaire to complete. Before starting the actual test, the experimenter explained how to play the game and each participant was given a short practice to become familiar with the controls until they were comfortable with them.

When they were ready, the experiment started. The experimenter then left the room while they were playing. The first group was asked to play the game with motion controller and for the second group with the keypad controller. Each participant was left to play for 7 minutes which has been found long enough to allow players to get immersed [32] and could offer the chance to get into this game. After 7 minutes, the experimenter stopped the player and asked them to complete the IEQ questionnaire and related questions. The game scores were also recorded as their performance.

### Results

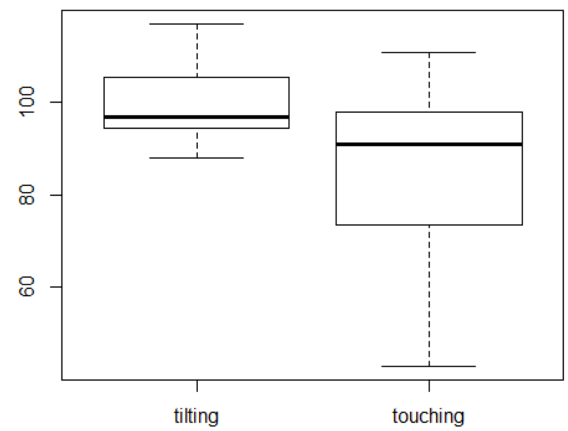


**Figure 2. The boxplot of IEQ scores both conditions in Expt 1**

The scores for the IEQ and its components are shown in Table 1. As can be seen, players are more immersed in the motion condition than in the keypad condition by a difference of 15 points on the IEQ scale, see Figure 2. This difference is significant, $F(1, 28) = 8.03$, $p < 0.01$, Cohen's $d = 1.03$ . The increased in immersion may be due to better performance in the game with the different controllers but the game scores show no significant difference, $F(1, 28) = 0.254$, $p = 0.254$, Cohen's $d = 0.45$.

| Condition | Motion | Keypad |
|---|---|---|
| **IEQ** | 100.5 (9.56) | 85.1 (18.76) |
| Cognitive Involvement | 33.1 (4.18) | 27.5 (7.21) |
| Emotional Involvement | 18.1 (3.27) | 14.7 (3.94) |
| Real World Dissociation | 19.9 (1.88) | 16.4 (4.58) |
| Challenge | 13.7 (2.12) | 11.8 (2.65) |
| Control | 15.7 (2.82) | 14.7 (4.08) |
| Game Scores | 2690 (796) | 2359 (758) |

**Table 1. Mean and (Standard Deviation) for IEQ, IEQ Components and Game Scores in the different conditions**

Because the immersion scores are significantly different, the components of the IEQ can be used to offer insights into which aspects of immersion lead to the difference. All of the components are therefore compared giving significant differences for Cognitive Involvement ($F(1, 28) = 6.77$,

$p = 0.015$, Cohen's $d = 0.98$), Emotional Involvement, ($F(1, 28) = 6.88$, $p = 0.014$, Cohen's $d = 0.99$), Real World Dissociation ($F(1, 28) = 7.35$, $p = 0.011$, Cohen's $d = 1.02$), Challenge ($F(1, 28) = 4.865$, $p = 0.036$, Cohen's $d = 0.83$) but no significant differences for Control ($F(1, 28) = 0.531$, $p = 0.472$, Cohen's $d = 0.28$).

### Discussion

As expected, the experiment shows that the tilting controls that are more like a steering wheel resulted in a higher levels of immersion and the effect is quite substantial. This may of course be due to players performing better with the motion interface but though the scores are on average higher in the motion condition and there is a small but not negligible effect size, nonetheless the difference is not significant. It may indeed be that players are more immersed because they are performing better but this experiment is not sensitive enough to justify that. However, it would be hoped that the designers of the experience intended the two modes of interaction to be comparable and so not provide a gameplay advantage to one mode over the other. Evidence for this comes from the analysis of the components of the immersion. Whereas four of the components that comprise immersion do show significant differences, the one that does not is Control. The Control component does not reflect actual measures of how well players controlled the game, for example in terms of keeping on the track, but rather the players' perceptions of control in relation to their engagement in the game. The Control scores are quite close between the conditions and the effect size is small suggesting that players felt equally in control between the conditions of the game.

Interestingly, the component-wise analysis also shows strong effects of the experimental manipulation on both emotional and cognitive involvement and real world dissociation. These ought to be understood as related facets of immersion and not to be wholly separated from the overarching concept. The differences seen are therefore merely suggestive that the steering wheel style interaction is actually provide a more engaging process in terms of getting into the game to the exclusion of the world around them.

Of course, racing games are not to everyone's taste. It may be that for a person who is not a regular player of racing games, like some of our participants, there is sufficient novelty in the steering wheel style of mechanism to induce increased engagement, at least for the short time of a lab study. However, as this is a casual racing game and casual games are intended to be quickly provide good gaming experiences, this may not be a drawback. Alternatively, it may simply be that steering a car is not only a well-established metaphor but one which many young adults have first-hand experience of. The naturalness of the interaction may simply be tapping into previously established experience despite the very non-realistic style of driving in the game. Nonetheless, the study does give a good indication that a more natural mapping does in fact lead to a more immersive experience supporting the findings of Skalski et al. [38].

## STUDY TWO: COMPARING CONTROL MAPPINGS

In the previous study, though players were more immersed in the tilting mechanism this could be attributed to the use of the steering metaphor to provide an easy introduction into the control of the game and hence increased engagement rather than any aspect of the interaction itself. This second study therefore aims to address this by considering a game where there is no prior metaphor for the interaction but where the interaction nonetheless could be regarded to vary in the naturalness typology. For this reason, a *Doodle Jump* clone was used, which we developed for the purposes of the experiment.

*Doodle Jump* has been a very popular mobile game well suited to the casual format that mobiles encourage [20]. The idea is to get your little alien to jump up a series of platforms as high as possible. As with *Beach Buggy Blitz* there is no end to the game: there are always more platforms to be jumped onto. The snag is that the little alien constantly jumps and if it misses a platform and reaches the bottom of the screen then it falls to its doom and that particular game is over. In our clone, a bluebird was used instead and the richness of the *Doodle Jump* was not reproduced except that the player had coins to collect and the platforms steadily got more sparse making it harder to keep climbing higher, see Figure 3. By developing our own version of the game though, we were able to have full control over how players interacted with the game which was not possible with existing, commercial versions of the game.

The experimental manipulation was through three different interaction styles all of which are commonly seen in mobile games. One was the touching style as in *Beach Buggy Blitz*. Tapping the sides of the screen causes the bluebird to move towards that side. The second was through tilting the device. This is the control mechanism used in the original *Doodle Jump* and a tilt to the left or right causes the bluebird to move in that direction. The third control mechanism was the slipping mechanism where a person slid their finger along the device and the bluebird moved to follow the lateral position of the finger on the screen. Figure 4 illustrates how each interaction style looked to the player.

The touching controls are low in terms of the naturalness scale being only a directional natural mapping whereas the other two are higher on the scale being incomplete tangible natural mappings.The hypothesis was that the two more natural interactions would allow players to be more immersed than with the touching interaction. It was also conceivable that there would be differences between the tilt and slip mechanisms with the tilt mechanism being more immersive because it is the interaction mechanism of the original game that players are very likely to have seen previously.

### Design

This experiment applied a between-subjects design. The independent variable was the type of interaction style (touching, tilting or slipping). The dependent variable was immersion as measured by the IEQ. The score for each game played was also recorded.

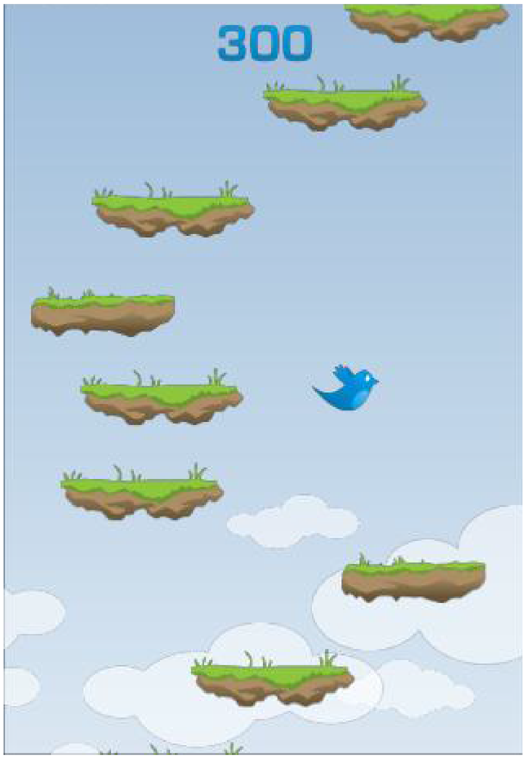


**Figure 3. A screenshot of the Bluebird game**

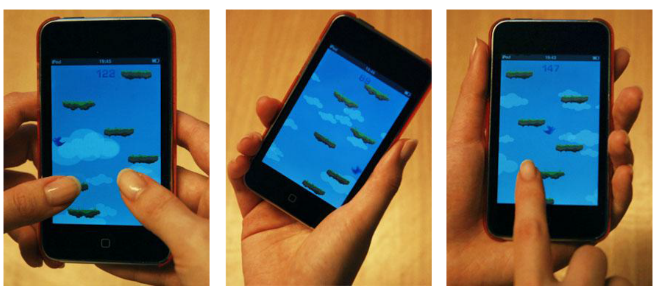

**Figure 4. The three interactions styles: touch, tilt and slip**

### Participants

30 participants, 15 men and 15 women, took part in the study, recruited by opportunity sample. They were allocated randomly to groups to give 10 participants in each group. Their age ranged from 18 to 36 years old. Most of them had experience using touch screen devices to play digital games and they play games at least once a week. 19 of the participants prefer to use the touching control interaction to play games, 9 of them prefer the gesture control which used fingers moving around the screen and the other 2 prefer the tilting control interaction. None of them played games on the touch screen devices longer than half an hour for every session, except two participants claimed that they played games on touch screen device lasted for an hour. They received £10 for taking part in the experiment. This differs from the previous study as it took place during the summer vacation and participant recruitment is usually more difficult without some form of incentive.

| Condition | Touch | Tilt | Slip |
|---|---|---|---|
| Immersion Scores | 129.7 (24.0) | 133.40 (21.1) | 156.5 (17.3) |
| Cognitive Involvement | 43.1 (8.6) | 45.1 (7.1) | 51.2 (6.2) |
| Emotional Involvement | 24.0 (8.2) | 25.1 (8.0) | 30.9 (7.0) |
| Real World Dissociation | 25.7 (3.9) | 24.2 (5.8) | 32.4 (4.3) |
| Challenge | 15.9 (3.4) | 16.5 (3.6) | 15.7 (4.4) |
| Control | 21.0 (4.8) | 22.5 (4.7) | 26.3 (3.5) |
| Total score | 14637 (4692) | 17561 (4116) | 15717 (1341) |

**Table 2. Mean and (Standard Deviation) for IEQ scores, components and game score in all 3 conditions**

### Materials

We used an iPod Touch- 8G size of second generation version with Apple 4.0 operation system. as the platform for the game. The game was developed in Objective C.

The Immersive Experience Questionnaire (IEQ) was used to measure immersion using the version based on 7-point Likert scales. All other components were kept the same. Demographic information such as age, gender, favourite game genre and playing time was measured with the demographic questionnaire. Both questionnaires were administered on paper.

### Procedure

Having discussed the experiment and signed the informed consent form, participants were taken into an empty room and explained the procedures of the experiment. They were explained on how to play the game based on the condition assigned to them. When the participants were comfortable with the controls, they were given 30 seconds for the trial session. When they were confident and ready to proceed, the experiment started. The playing time was 5 minutes. This is shorter than the previous game because for this game, typical game play was quite short and appreciably shorter than for *Beach Buggy Blitz*. Moreover, *Beach Buggy Blitz* has many rich graphical elements, music and sound that would entertain for longer than our simple bespoke game. We did not want players to get bored from playing this simple game for too long. If the player completed a game in that period, they were asked simply to start a new game. After 5 minutes, the experimenter stop them from playing and gave them the questionnaires.

### Result and Discussion

The mean and (standard deviation) of the immersion scores and the components of immersion are presented in Table 2.

There is a substantial difference in the immersion scores as seen in 5. An ANOVA test showed a significant difference between the conditions ($F(2,27) = 4.797$, $p = 0.017$, partial $\eta^2 = 0.26$). A set of follow up Tukey's HSD tests showed that immersion in the slip condition was significantly different from immersion in the touch condition ($p = 0.021$) and approaching significant difference from the tilt condition ($p = 0.052$) with no significant difference between the touch and tilt conditions ($p = 0.918$). This was not at the expense of performance as there was no significant difference in the highest scores achieved ($F(2, 27) =$, $p = 0.219$, partial $\eta^2 = 0.11$ (nor the total scores achieved over all plays though we do not report that here).

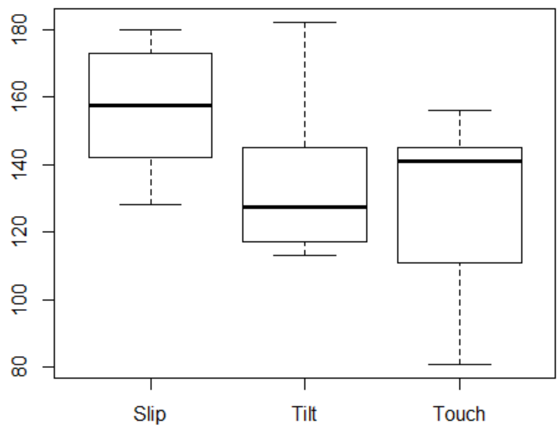


**Figure 5. The boxplot of IEQ scores for the three conditions in Expt 2**

Tests on the components of immersion showed a significant difference in Real World Dissociation ($F(2, 27) = 8.49$, $p = 0.001$, partial $\eta^2 = 0.39$) and Control ($F(2, 27) = 3.901$, $p = 0.032$, partial $\eta^2 = 0.22$). Differences in Cognitive Involvement approached significance ($F(2, 27) = 3.294$, $p = 0.052$, partial $\eta^2 = 0.20$) and there was no significant difference in Emotion Involvement ($F(2, 27) = 2.294$, $p = 0.12$, partial $\eta^2 = 0.15$) and Challenge ($F(2, 27) = 0.118$, $p = 0.889$, partial $\eta^2 = 0.01$). Post hoc tests showed that for Real World Dissociation, slip was higher than the other two conditions and for Control, slip was higher than touch but tilt could not be discrimated from either of the other two conditions.

### Discussion

The results present a more complicated picture than the previous study. Despite both tilt and slip being classed as more natural mappings than the touch interaction, only slip stood out as more immersive than the touch condition and it was also tending to being significantly more immersive than the tilt condition. Tilt was not significantly more immersive than touch. Analysis of the components show in fact that this picture is reflected in the Control component of immersion and moreover people experienced more real world dissociation in the slip condition. This seems overall to suggest that the slip mechanism was leading to a more engaging experience and that it was because, to some degree, because of the feeling of control that it gave. Moreover, the differences seen are not due to improved performance as there is no significant difference in total scores (or highest scores) and players in the slip condition did not achieve the highest average scores. Thus it seems that where there is no obvious prior natural mapping, the naturalness typology alone is not sufficient to increase engagement in the game. What is also clear is that despite possible prior experience with the tilting mechanism through the existing game *DoodleJump*, this did not lead to improved performance or gaming experience in this game.

An interesting observation made during the study was that participants in the slip condition not only slid their finger side to side to control the bird but also moved their fingers up and down with the bouncing motion of the bird. This suggests that players might in some way perceive themselves as directly connecting with the bluebird through the finger contact. Thus, players were perhaps experiencing a strong sense of puppetry to the point where they felt the need to mimic in all respects the way that the bird moved. Or alternatively, the naturalness of the side-to-side slipping movement suggested that players ought to move entirely with the bluebird, that is move their fingers up and down as well. This is of course speculative but suggests an interesting line of work to develop whereby the game actions have multiple dimensions that map to multiple dimensions in the controller but only some of which are actual controlling the game. This might both explore how natural mappings and puppetry underlie GX.

This notion of matching controls to game actions in this way is reminiscent of the work on instrumental interaction [2] where an input device is described across several dimensions including the degrees of indirection (spatial and temporal), the degree of integration of physical movements with interface effects, and the degree of (real world) compatability. The naturalness typology is perhaps only considering the degree of compatability but it may perhaps need to account for these other dimensions to be complete. In particular, the touch interaction has a degree of spatial offset from the bird that it controls whereas the slip action, at least as performed by the participants, does not because they try to directly touch the bird. Interestingly though, the slip interaction has a lower degree of integration being a two-dimensional movement space for a one-dimensional control. Tilt also does not cleanly fit within this framework. The tilting hand is not spatial connected to the bird but it is spatially connected to the phone"over which the bird slides." There is low (no) spatial offset if the player is viewed as controlling the phone but some spatial offset if the player is viewed as controlling the bird. Thus, if there is a meaningful account of gaming experience in terms of instrumental interaction then it is not simple and would need supplementing with qualitative data to see what players think they are controlling when they play such games.

Indeed, it would have been helpful within this experiment to have gathered qualitative date to better understand how participants differently perceived the slip and tilt mechanisms. However, as with the previous experiment, it did not seem feasible to get reliable measures of perceived naturalness.

Also without players being able to explicitly compare conditions, this being a between-participants experiment, direct comparisons of experience were not possible. We could have of course asked about these differences explicitly but as they only emerged on analysis of the quantitative data, we had already lost that opportunity.

One major drawback of this study is the type of game developed for the purpose of the experiment. We developed the game because it allows us to control the manipulation of the control input. However, the gameplay was rather simple and certainly lacked the graphical and gameplay richness of *Beach Buggy Blitz*. In some ways though it does mean that the interaction style comes to the fore and rather like Birk et al.'s work [4] ensures a game that is adapted to all the different interaction mechanisms rather than having a "best fit" to one particular interaction style.

## CONCLUSIONS AND FURTHER WORK

Both studies show that the control mechanisms in mobile games, as in other games, are able to influence the gaming experience that players have. The concept of natural mapping [38] has some role to play in that where there is a prior natural mapping, such as steering a car, this promotes a more immersive experience. However, where there is not a prior natural mapping, naturalness alone does not predict the levels of immersion experienced. This of course requires further work to consider other mobile games where there are natural interactions, for instant tilting in marble rolling games, but it does perhaps suggest the limits of natural mappings in accounting for how gaming experiences are influenced by the game controllers. Another limitation in these studies is that they are confined to consideration of casual games, that is, games that are expected to be easy to pick up and provide good gaming experiences even in quite short playing periods. These are an important segment of mobile games but of course there are many more mobile games and platforms that do not fit the casual style. It would be useful work to see how the naturalness typology is able to account for gaming experiences in these more protracted and committed gaming contexts.

This work also adds to the existing literature on game controllers by moving from the large scale actions needed in Microsoft Kinect, Sony Move and the like to the smaller actions necessary to control mobile games. It seems that the influence of controller on gaming experience is not necessarily due to either the size of the actions or the level of interaction they require [37]. Mixed reality games also offer a further way to stretch the boundaries of the control of a game from the body movement actions centred around a device to actions that happen on the scale of a village or a town. And as was set out at the start, the aim here was to focus on one particular aspect of gaming experience, namely immersion, which whilst very relevant to gaming does not capture all the experiences games can offer. Thus, this is a rich area for further investigation and possibly ever expanding as mobile technology and game designers continues to explore the space of control devices for games.

## REFERENCES


1. Bateman, S., Doucette, A., Xiao, R., Gutwin, C., Mandryk, R. L., and Cockburn, A. Effects of view, input device, and track width on video game driving. In *Proc. of Graphics Interface 2011*, GI '11, Canadian Human-Computer Communications Society (2011), 207–214.
2. Beaudouin-Lafon, M. Instrumental interaction: An interaction model for designing post-wimp user interfaces. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '00, ACM (2000), 446–453.
3. Bianchi-Berthouze, N. Understanding the role of body movement in player engagement. *HumanComputer Interaction 28* (2013), 40–75.
4. Birk, M., and Mandryk, R. L. Control your game-self: effects of controller type on enjoyment, motivation, and personality in game. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '13, ACM (2013), 685–694.
5. Blyther, M., Overbeeke, K., Monk, A., and Wright, P. *Funology: from usability to enjoyment*. Springer, 2003.
6. Brockmyer, J. H., Fox, C. M., Curtiss, K. A., McBroom, E., Burkhart, K. M., and Pidruzny, J. N. The development of the game engagement questionnaire: A measure of engagement in video game-playing. *Journal of Experimental Social Psychology 45*, 4 (2009), 624 – 634.
7. Brown, E., and Cairns, P. A grounded investigation of game immersion. In *CHI '04 extended abstracts on Human factors in computing systems*, CHI EA '04, ACM (New York, NY, USA, 2004), 1297–1300.
8. Cairns, P., Cox, A., and Nordin, A. I. Immersion in digital games: a review of gaming experience research. In *Handbook of digital games*, M. C. Angelides and H. Agius, Eds. Wiley-Blackwell, 2014, 339–361.
9. Calleja, G. *In-game: from immersion to incorporation*. The MIT Press, 2011.
10. Calvillo-Gamez, E., Cairns, P., and Cox., A. L. Assessing the core elements of the gaming experience. In *Evaluating User Experience in Games*, R. Bernhaupt, Ed. Springer-Verlag, 2010, ch. Chapter 4, 47 – 71.
11. Calvillo-Gamez, E., Gow, J., and Cairns, P. Introduction to special issue: Video games as research instruments. *Entertainment Computing 2(1)* (2011), i.
12. Chen, J. Flow in games (and everything else). *Communications of the ACM 50*, 4 (2007), 31–34.
13. Cox, A., Cairns, P., Shah, P., and Carroll, M. Not doing but thinking: the role of challenge in the gaming experience. In *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems*, ACM (2012), 79–88.

14. de Kort, Y., IJsselsteijn, W., and Poels, K. Digital games as social presence technology: Development of the social presence in gaming questionnaire (spgq). In *Proceedings of PRESENCE 2007: The 10th International Workshop on Presence* (2007), 195–203.
15. ESA. Industry facts, 2012. `http://www.theesa.com/facts/`.
16. Gilbertson, P., Coulton, P., Chehimi, F., and Vajk, T. Using tilt as an interface to control no-button 3-d mobile games. *Computer in Entertainment 6(3)* (2008), Article 38.
17. IJsselsteijn, W., de Kort, Y., Poels, K., Jurgelionis, A., and Bellotti, F. Characterising and measuring user experiences in digital games. In *Advances in Computer Entertainment Technology, ACE 2007* (2007). Workshop 'Methods for evaluating games'.
18. Isbister, K., Rao, R., Schwekendiek, U., Hayward, E., and Lidasan, J. Is more movement better?: a controlled comparison of movement-based games. In *Proceedings of the 6th International Conference on Foundations of Digital Games*, FDG '11, ACM (New York, NY, USA, 2011), 331–333.
19. Jennett, C., Cox, A. L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., and Walton, A. Measuring and defining the experience of immersion in games. *International Journal of Human-Computer Studies 66*, 9 (2008), 641 – 661.
20. Juul, J. *A casual revolution*. MIT Press, 2010.
21. Klimmt, C., Hartmann, T., and Frey, A. Effectance and control as determinants of video game enjoyment. *CyberPsychology and Behavior 10* (2007), 845–847.
22. Korhonen, H., and Koivisto, E. M. I. Playability heuristics for mobile games. In *Proceedings of the 8th conference on Human-computer interaction with mobile devices and services*, MobileHCI '06, ACM (New York, NY, USA, 2006), 9–16.
23. Lindley, S. E., Le Couteur, J., and Berthouze, N. L. Stirring up experience through movement in game play: effects on engagement and social behaviour. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '08, ACM (New York, NY, USA, 2008), 511–514.
24. McCarthy, J., and Wright, P. *Technology as Experience*. MIT Press, 2007.
25. McEwan, M., Johnson, D., Wyeth, P., and Blackler, A. Videogame control device impact on the play experience. In *Proc. of The 8th Australasian Conf. on Interactive Entertainment: Playing the System*, IE '12, ACM (New York, NY, USA, 2012), 18:1–18:3.
26. McGloin, R., Farrar, K., and Krcmar, M. Video games, immersion, and cognitive aggression: Does the controller matter? *Media Psychology 16* (2013), 65–87.
27. Norman, K. L. Geq (game engagement/experience questionnaire): a review of two papers. *Interacting with Computers 25(4)* (2013), 278–283.
28. Poels, K., de Kort, Y., and IJsselsteijn, W. Its always a lot of fun! exploring dimensions of digital game experience using focus group methodology. In *Proc. of FuturePlay 2007* (2007), 83–89.
29. Qin, H., Rau, P., and Salvendy, G. Measuring player immersion in the computer game narrative. *Intl. Journal of Human–Computer Interaction 25*, 2 (2009), 107–133.
30. Ryan, R. M., Rigby, C. S., and Przybylski, A. K. Motivational pull of video games: A self-determination theory approach. *Motivation and Emotion 30* (2006), 347–365.
31. Salen, K., and Zimmerman, E. *Rules of Play: game design fundamentals*. MIT Press, 2004.
32. Sanders, T., and Cairns, P. Time perception, immersion and music in videogames. In *Proc. of BSC HCI 2010* (2010), 160–167.
33. Scattered. The drowning, 2013. `http://www.thedrowning.com`.
34. Schell, J. *The Art of Game Design*. Morgan Kaufmann, 2008.
35. Schmierbach, M., Limperos, A. M., and Woolley, J. K. Feeling the need for (personalized) speed: How natural controls and customization contribute to enjoyment of a racing game through enhanced immersion. *CyberPsychology and Behavior 15*, 364–369.
36. Seah, M., and Cairns, P. From immersion to addiction in videogames. In *Proc. of BCS HCI 2008* (2008), 55–63.
37. Shafer, D., Carbonara, C., and Popova, L. Spatial presence and perceived reality as predictors of motion-based video game enjoyment. *Presence 20*, 591–619.
38. Skalski, P., Tamborini, R., Shelton, A., Buncher, M., and Lindmark, P. Mapping the road to fun: Natural video game controllers, presence, and game enjoyment. *New Media Society 13* (2011), 224–242.
39. Tamborini, R., and Skalski, P. The role of presence in the experience of electronic games. In *Playing video games: motives, responses and consequences*, P. Vorderer and J. Bryant, Eds. Routledge, 2006, 225–240.
40. Thompson, M., Nordin, A., and Cairns, P. Effect of touch-screen size on game immersion. *BCS HCI 2012* (2012), 280–285.
41. Vorderer, P., Hartmann, T., and Klimmt, C. Explaining the enjoyment of playing video games: the role of competition. In *Proceedings of the second international conference on Entertainment computing*, ICEC '03, Carnegie Mellon University (Pittsburgh, PA, USA, 2003), 1–9.
42. Williams, K. D. The effects of video game controls on hostility, identification, and presence. *Mass Communication and Society 16* (2013), 26–48.
43. Zilix. Exposure, 2013. `http://jayisgames.com/games/exposure`.