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How the Gaming Mouse Connects the Virtual World and the Body

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Abstract

Gaming mice have complicated designs for different online games. This study analyzes the following questions: How does the computer game type affect the mouse's shape? How can players exist in a game's physical and virtual world through their body movements while operating the gaming mouse? The results show that there are many interesting correlations between plays' gestures and game actions. The gaming mouse has a sophisticated design to better respond to players' body movements. Furthermore, players develop their own body strategies that respond to the mouse's shape and integrate them into their constructed imaginary world. Different visual elements and control devices in human-computer interfaces compensate for the "cybernetic loss" experienced during the dematerialization process. The application of such compensation extends from plane graphics to gaming mice, and ranges from visual perception to the physical experience of controlling the mouse.

Keywords

Gaming Mouse, Human-Computer Interaction, Virtual World, Online Game, Qualitative Research

1. Introduction

As revealed in the "2019 Global E-sports Market Report" released by Newzoo, a gaming market research agency, the global gaming market shall exceed the billion-dollar revenue mark for the first time, reaching a record-high value of $1.1 billion in 2019, or a year-on-year growth of +26.7%. As online gaming has gained popularity, the computer mouse has transformed from having the traditional role of signal input into a powerful tool in online battles. This trend has also encouraged manufacturers to introduce newly developed gaming mice into

the market. In addition to the Information and Communication Technology (ICT) industry, home appliance manufacturers have also joined the battle for market share, as evidenced by exhibits of gaming mouse sections in convenience stores.

While a mouse enables users to easily and intuitively control their computer by facilitating the utilization of the Graphical User Interface (GUI), the use of such a facilitator remounts to the original investigations of the obstacles in human-computer interactions. Alternatives to keyboards and mice, such as eye movement and hand gestures, which are more suitable for human-computer interface tools, were often tested and discussed before human-computer interaction took its current form. However, in the development of realistic human-computer interface technology, from GUI/WYSIWYG (What You See Is What You Get) to replacing words with on-screen visual images (Levy, 1997), the design philosophy of simulating real-life situations has been established. Subsequently, Wii and Xbox Kinect applied motion-sensing technology as the main mode of their game interface, which maintained user-friendliness and complied with the Natural User Interface (NUI) principle.

Multi-touch technology has been among the most used NUI technologies in recent years. It is often used in the control devices of mobile phones, tablet PCs, and other products. The interaction occurs naturally because of its easy and intuitive manipulation; therefore, it is very user-friendly. Along with this trend, manufacturers such as Apple and Logitech have developed multi-touch mice, which do not have normal buttons. Such designs allow users to employ the smooth back of the mouse directly as a trackpad while retaining the ability to move the cursor quickly. However, contrary to the NUI principle, a gaming mouse often has a complicated appearance. Based on a range of factors, the features of a gaming mouse are exaggerated and do not need to be practical, based on the usability principle. Thus, the aesthetic evolution of a gaming mouse and the developmental principles of the human-computer interface seem to have diverged. Consequently, it is impossible to comprehensively explain a gaming mouse's formal features exclusively from the perspective of technological innovation. The studies pertinent to the development of gaming mice are further examined in the following section.

2. Literature Review

2.1. Influencing Factors of Gaming Mouse and Experience

Most studies on mice in the field of human-computer interaction focus on its operational performance and are committed to click efficiency and correctness improvement (Murata, 1996, 1998; Pastel et al., 2007; Feathers et al., 2013; Li et al., 2019; Ericson et al., 2021). For example, Lerman (2022) designed an ultra-light, high-performing gaming mouse for drag-clicking and double-clicking by reducing weight in the mechanical components and the outer shell of the mouse. Such studies intended to improve the mouse's speed and efficiency when clicking on a

graphical object on the screen or performing complete actions such as dragging and moving. Physical injuries related to the intensive and sustained use of mice are investigated in human factor or ergonomics studies (e.g. Chen et al., 2012; Liu et al., 2016). In these cited studies, the researchers generally focused exclusively on the moment in which an image is clicked, and fewer emphasized screen image changes and subsequent psychological reactions of users after the click. However, the user's interaction with on-screen content via the mouse is a continuous, cyclic process that cannot be broken down into several discrete movements. This implies that studies on examinations of this entire process are not as popular as other types of related research.

According to prior research, several factors should be considered when it comes to the gaming experience. Wang and Goh (2020) describe that game experience studies involve examining user perceptions and responses to the use of a system. Researchers focused on this topic have typically used human-computer interaction and entertainment media approaches to their research, including usability tests and user experience evaluations. For example, Kavakli and Thorne (2002) studied input device usability in computer games, and their results showed that selecting a dedicated input device for a specific game is crucial in improving players' performance and satisfaction. Thus, the findings of Kavakli and Thorne (2002) emphasized the significance of usability testing and input device selection to enhance the gaming experience. Regarding user experience evaluations, Widhiyanti et al. (2022) reviewed the use of the Game Design Factor Questionnaire in evaluating the user experience of the Selera Nusantara Game, which introduces the Nusantara culture. The study found that the game received high scores in various factors, including game goals, mechanism, interaction, fantasy, narrative, sensation, and value. Accordingly, the study conducted by Widhiyanti et al. (2022) emphasized the importance of user experience in game design and provides effective methods for evaluating and improving it.

However, describing game experience can be challenging, and traditional related methods may not capture all components of game experience. To address this, Wang and Goh (2020) used text analytics to identify components of game experience based on online user reviews and assess their importance to user satisfaction. They found that narrative and achievement were the most important components associated with user satisfaction in video games. Hooda (2018) examined the factors affecting gaming experience by exploring the various factors that influence user engagement in video games. The findings of this cited study showed that game mechanics, graphics, storyline, sound effects, user interface, and social interaction all significantly influenced user engagement. Specifically, while high-quality graphics, sound effects, and a compelling storyline may maintain user engagement, a user-friendly interface and social features (e.g. chat rooms and guilds) enhance engagement. By understanding and considering these elements, game developers can create games that are more likely to keep players engaged and coming back for more.

Immersion is another essential component of the gaming experience, allowing players to fully immerse themselves in the virtual world of the game (Jennett et al., 2008). The immersive experience of playing games is influenced by three dimensions of immersion (Ermi & Mäyrä, 2005): sensory immersion, which can be achieved through multi-sensory virtual reality environments or audiovisual content; imaginative immersion, which becomes most prominent when one becomes absorbed in a good novel; challenge-based immersion, which is essential in digital games since gameplay requires active participation and players are constantly faced with both mental and physical challenges that keep them playing. These three dimensions of immersion usually mix and overlap in many ways in contemporary digital games (Ermi & Mäyrä, 2005). Gaming mice are essential devices for players in their interaction with computers, and help bring about an immersive experience in games. Therefore, there is importance to further explore the impact of gaming mice on the gaming experience.

2.2. The Interactive Movements between the Player's Body and the Gaming Mouse

To explain various movements that players make in different computer games, it is not sufficient to observe only the control efficiency of these movements. Other factors should also be observed; for example, in an online game, the screen image may represent another living person, completely different from a mere fictional character. If the screen content is simplified as a combination of digital images, then much feedback and social interaction between users will be eliminated. In addition, the inseparability of the mouse, screen image, and the control functions of the mouse is ignored if we only focus on the mouse. A gaming mouse contains complex functions and meanings and spans different spaces, such as virtual/actual, sensible/rational, and social/technological. It is a hybrid of a human-computer interface tool and a computer game controller. Therefore, it is necessary to refer to various components in the physical environment of computer game activities to understand the player's movement in controlling the gaming mouse, its effect in the game world, and its practical significance.

Witkowski (2012) studied counter-strike teams playing pro/am games, examined the players' body movements in the game through qualitative research, and aggregated the data into three core themes: movement, haptic engagement, and the balanced body. Furthermore, based on the interpretation of how a body is incorporated into computer games, Witkowski questioned the legitimacy of a traditional sports ontology and advocated engagement with computer games as a legitimate sporting entity. By observing and interviewing players who engage in different-level body movements in different types of video games, Besombes and Maillot (2020) discussed the effects of video games on players' physical, psychological, and social dimensions. In addition, potential relationships between bodily involvement and health benefits were also found in this study. These studies show that a player's body movements in controlling game devices have various

implications, including those related to sports and health care.

Regarding the form of bodily involvement in a game, Calleja (2007) integrated six types of digital games and proposed a conceptual model to explain game involvement on a variety of experiential dimensions to replace "immersion". Rush (2011) further described the state of game players between two different orders of entering and leaving the real physical gesture and its on-screen representation with "embodied metaphors". Kinetic materiality was added to the abstractions of contemporary informatics organizations, making them concrete and tangible. Reeves et al. (2009) found that during counter-strike gameplay, players developed a special sense of the terrain of play when connecting their movements with the environment, which is different from static spatial knowledge. Although these studies pointed out the special cognitive mode of players in the context of switching between real and virtual worlds during gameplay and attempted to describe it, there is a lack of detailed analysis of the interaction process between players and system technology. Jørgensen (2012) found that players seldom care about the system features of computer games in the game world but are more concerned about whether they are integrated into modern computer game aesthetics. Regarding the aesthetic form of the interface device for players involved in computer games, there are still limited studies on how it is used to facilitate the imagination of the game space, which is an important clue to explain why the gaming mouse developed a unique aesthetic form that differs from the NUI design philosophy.

The gap between innovative technology and actual goods in the market can be explained by the argument of the technology historian David Edgerton. Edgerton (1999) suggested that using technology, particularly massively used technology rather than innovation, significantly impacts economic development. This view has also been proven in online game-related markets. While it is not necessarily the most advanced technology in terms of effectively driving the product trend, it is the most widely accepted and used among players. Consequently, the multi-hotkey mouse was designed as the player's control tool rather than the mouse with multi-touch panels instead of buttons.

After online games gained popularity, computer games embraced online sports, and the gaming mouse changed dramatically. The action of a game player using a mouse is quite different from the actions performed during word processing. Because the gameplay is different in various games, the way the player controls the mouse, the range of movement, the frequency, and other characteristics also vary. The shape and functionality of a gaming mouse must be tightly linked to suit various game features.

Based on the above information, this paper analyzes a range of issues: As the touch control technology becomes increasingly mature, the operation of electronic products focuses on a simple and intuitive operation interface. However, as an interface device, a gaming mouse has a fancier and more complex form. As the shape of the gaming mouse responds to the operational needs of games, a few questions arise: How does the type of computer game affect the shape of the

mouse? How can players move in the physical and virtual worlds of a game through their body movements while operating the gaming mouse?

3. Materials and Methods

3.1. Typological Analysis

A gaming mouse is essentially an interface tool for users to enter and exit a virtual space. Various gaming mouse designs correspond to different types of computer games. Therefore, the classification of a gaming mouse is closely related to the type of computer game. The classification framework is not only a system for capturing many exotically shaped, functionally complex, and ingeniously constructed gaming mice, but also a perspective for interpreting material meaning. Ruth Schwartz Cowan, a historian of science and technology, offered a theoretical perspective on the history of housing industrialization that is worth drawing on. Cowan (1983) adopted the "work process" and "technological system" as the two central concepts for organizing the study. "Work process" suggests that any single operation needs to be examined within a chain, while "technological system" emphasizes that technological change reflects the historical process of industrialization. These two concepts contribute to the classification of the gaming mouse and the definition of this field of study: the gaming mouse is not only a tool for controlling games, but also involves computer equipment, specification levels, and software. The gaming mouse's evolution also relates to how technology is used and how the institution agents, including game software developers, gaming mouse manufacturers, video game operators, the e-sports industry, and gaming players, mediate this complex process. Therefore, the websites of famous gaming mouse companies and related online communities are also the sources of data collection and observation, which form a sample in the selection of research participants for this study.

3.2. Qualitative Research & Sampling Considerations

This study first employed typological analysis to roughly classify the types of gaming mice and then interviewed manufacturers about their considerations in product development and design to understand the market trends and design guidelines for gaming mice. Since this study explores gamers' experience using the gaming mouse and analyzes its relevance to its design, a qualitative approach was adopted. Specifically, visual and oral data were collected through the participant observation and in-depth interview. The main questions were identified through semi-structured interviews.

Compared to quantitative research, which emphasizes objectivity and neutrality, qualitative research may be more flexible in terms of going deeper into participants' experiences and feelings. Therefore, first, this study observed the physical movements of operating the game mice and compared them with the game screen and visual experience. Then, the players were interviewed to interpret the meaning of gaming mouse usage and understand the role of the gaming mouse

in the virtual and real worlds of gamers.

To gain an initial understanding of the gamer profile in this field, convenience sampling was initially used to find appropriate respondents from the online gaming community. Later, snowball sampling was adopted to reach out to other respondents through recommendations. In addition, to further increase the diversity of data collection, theoretical sampling was employed to find people with considerable experience in using gaming mice and to consider players who are good at different types of games. The respondents were selected based on two factors, general gamers, and e-sports players, and the number of gaming mice owned by them, as shown in Figure 1. In addition to gamers, 3C experts or gaming mouse designers were also considered in the sample.

3.3. Participants' Description

Ten gamers were selected as respondents. Interviewees A and B were amateur gamers with over 10 years of gaming experience. Interviewee A has recorded many professional unboxing reviews of gaming mice in his blog and has been approached by many gaming manufacturers to test unlisted mice. Interviewee C has been involved in the ICT industry for a long time and is very experienced in electronics. On average, he uses a mouse for more than 8 hours a day for work purposes. Interviewee D is a design student with a long history of using drawing software and a mouse for projects, and also averages over eight hours a day using a mouse. Interviewees E, F, G, H, I, and J are all experienced gamers, each

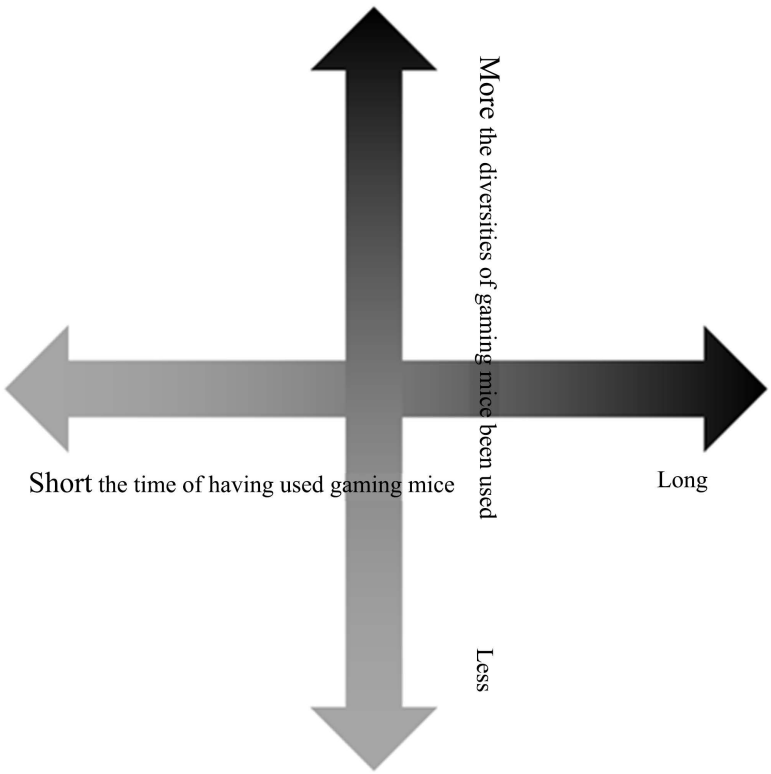

Figure 1. Sampling plan of study participants.

spending an average of one to five hours per day on gaming and owning between 3 to 50 gaming mice. In addition, two gaming mouse designers were interviewed in this study to verify the views of gaming manufacturers and gamers: K, a designer with four years of experience, and L, a product manager with five years of experience.

Despite the study having a modest number of participants, they were carefully selected based on two distinct criteria to minimize sample bias and increase representativeness. To enhance the scope and significance of the research, innovative sampling methods and flexible data collection techniques could be implemented. The objective of qualitative research is not typically to arrive at a generalization that can be universally applied but rather to collect diverse interpretations for the phenomenon under investigation.

The above research plan can be visualized in a flowchart format to help present it more clearly and concisely. The flowchart in Figure 2 outlines the various stages of the research process, including the problem definition, literature review, research design, data collection and analysis, results, and conclusion.

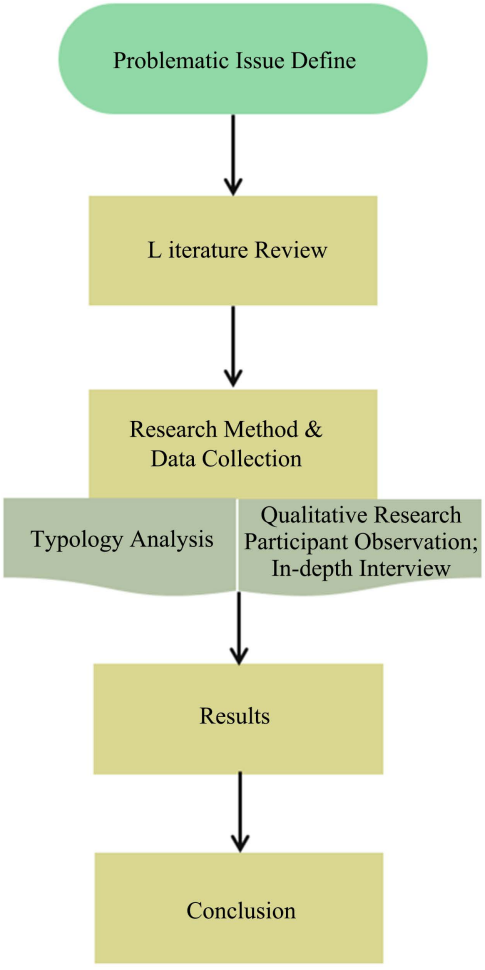

Figure 2. Research flowchart.

4. Results

The function of gaming mice is to control the courses of games, so the shape of the mouse for operating and the types of games are closely linked. The content of games determines the aims of movements controlled by gaming mice, making game design an essential content factor for the gaming experience. As mentioned earlier, the "classification framework" is not just a system for dividing gaming mice, but also a perspective for interpreting their meaning. Therefore, the types of computer games dominate the attributes of the mice. Manufacturers synthesize strategies to produce different gaming mice that respond to the demands of different games. However, according to Actor-Network Theory (ANT) proposed by STS scholar Latour (1987), gamers' agency is well demonstrated in the varied usage of gaming mice, which enables them to travel through both virtual and real worlds.

4.1. Typology Analysis of the Gaming Mouse

The gaming mouse is a tool to input commands in games; thus, the types of gaming mice vary with the types of games. There are three main types of games: 1) Real-Time Strategy (RTS)/Multiplayer Online Battle Arena (MOBA) games, 2) First-Person Shooter (FPS) games, and 3) Massive Multiplayer Online Role-Playing Games (MMORPG).

4.1.1. FPS RTS/MOBA Games

In RTS games, resource collecting, base development, and technological advancement within the game are the main components. As a commander, the player fights with other players. The Actions Per Minute (APM) performance of a player, which represents the total number of mouse and keyboard actions of the player in one minute, is the key variable in RTS games used to reflect the player's skill. In MOBA games, the rules of RTS games are simplified, and players are required to have similar skills. In such games, players must input as many commands as possible in a given time, click the mouse extremely frequently, and move the mouse slightly. Therefore, a mouse with quick response, excellent Dots Per Inch (DPI), and small size is used for such games, and also, most commonly, these mice have a symmetrical structure.

4.1.2. FPS Games

FPS games are shooting games played from the first-person perspective of the player, where players are required to move the mouse a lot and even make a "gun swing" movement when necessary; thus, the feeling of the mouse in hand and the steadiness of the read head are especially important. FPS games also require the player to focus on the target quickly; thus, the mouse must have a high DPI; however, it cannot be so high that it drifts during small movements; for example, when a sniper is being used, it requires steadiness. Therefore, gaming mice are generally designed for right-handers and are equipped with adjustable DPI for different uses under different circumstances, thus providing a comforta-

ble hand feeling for steady clicks, as well as durable buttons. In FPS games, the scroll wheel is often used to switch weapons, meaning that the player can focus the other hand on controlling the movement of the character with the keyboard without looking for the weapon switch key on the keyboard, which might lead to missing chances to kill an enemy. Consequently, the scroll wheel must have defined strokes to avoid excessive weapons switches with one click.

4.1.3. MMORPG Games

In MMORPG games, magic spells or actions are performed through key combinations, that is, by pressing two or more keys simultaneously. Owing to the massive number of such commands, the side buttons of a mouse are often used to store macro sets of key commands and to perform game actions that require the simultaneous pressing of multiple keys. Situations change rapidly in games, and pressing two or more keyboard keys at the same time may result in incorrect commands; thus, if the buttons of a gaming mouse are used to store the key combinations, the player can easily perform special actions by pressing only one button, which shortens the response time and helps the player complete game missions more efficiently. MMORPG games are long-lasting and require players to perform massive actions; therefore, mice with multiple buttons are used to provide a comfortable hand feeling.

Furthermore, in MMORPG games, players spend much time collecting powerful weapons to kill ferocious monsters and evil entities, and such powerful weapons are matched to various actions for the greatest power. MMORPG-oriented mice allow players to perform actions more efficiently, and some are provided with software to customize the functions of the side buttons so that players can set their weapons by dragging corresponding icons into matching boxes. In addition, players can customize different contents of the thumb button to perform all killing magic spells or actions on demand.

4.2. Design Strategies of Manufacturers

Interviewee K said his company focuses on mainstream gaming: "*We just know that these are the mice we need, and we do not consider anything else. There are not many things that should be taken into account in e-sports. RTS, FPS, MOBA, what else?*" MOBA and RTS are similar in gameplay and suitable for the same type of mouse; thus, gaming mice can be categorized into MOBA and FPS according to the type of game. He used the term "lineage" to describe the different types of mice: "*I was thinking about gaming products, it also has a lineage; that is, it is something that generates from a certain lineage… its needs are the same, and so they are more similar in lineage. For example, we have the MOBA lineage and the FPS lineage*". For the MOBA mouse design, Interviewee K noted: "*The requirement is simple. I want a small, symmetrical grip, and then the grip is like this* (*grip*). *When designing a mouse, it is necessary to design a few gold dots and gold surfaces to be gripped. Because the gold surface of this* (*MOBA mouse*) *is smaller, it will not be too different when you grab it*". As for the FPS

mouse design, he said, "*Like the gold surface of this* (*FPS mouse*), *it needs to consider many things*; *from here to here*, *you have to consider all of them. Therefore*, *its shape is smaller*, *and it is not as flexible as that of MOBA mice. Basically*, *we define the height*, *width*, *angle*, *and grip of these surfaces*, *and then we can design the rest of it*". The basic grip of an FPS mouse is characterized by a flatter finger. Compared to a MOBA mouse, which has a higher finger arch and a more demanding grip, the contact area between the palm and the mouse is larger. For non-competitive games, which players spend much time on, the most popular is MMORPG, with a grip characterized by holding the entire palm flat against the mouse. Regarding a suitable mouse for this game, interviewee K said: "*The method of operating MOBA is to imagine your hand is in the most comfortable state when you put it down on this grip. It* (*playing a game*) *takes a long time*, *so our approach is using the mouse when one is completely relaxed*". Because of the long usage time and the need for comfort, this mouse needs to be well supported, and thus the manufacturers use a design with side wings to allow the fingers to rest on it. In addition to MMORPG, this mouse applies to some business simulation games.

The design of the gaming mouse is also influenced by the dominant hand of the gamer when using the mouse. Gaming mice are broadly divided into right-/left-handed mice and right-handed or left-handed mice. The former is mainly symmetrical in shape and suitable for both hands. In addition, as most gamers are right-handed, some mice are designed to be curved for right-handed users, while a few are designed for left-handed users. Gamers may sometimes call these one-handed mice "forced ergonomics" due to the presence of a groove in the thumb grip or a groove on the other side for the ring and little fingers.

Although the design may seem ergonomic, it may not be comfortable to use. Interviewee D usually works with many reports and spends a lot of time using the mouse, which is why he chose this "forced ergonomic" gaming mouse, as shown in **Figure 3**. However, after using it for a while, he found that the seemingly ergonomic design of the right side of the mouse was a drawback, as the ring and little fingers were placed in the groove, which required greater force to use. However, similar designs are also comfortable to use, such as the other mouse owned by Interviewee A, which also has a groove on the right side, but without the bulge separating the ring finger from the little finger (e.g. **Figure 3**, right). Specifically, it is easier and more comfortable to put two fingers together.

Figure 3. "Forced ergonomic" gaming mouse.

4.3. Between Virtual and Real Battlefields

When playing a game, a player holds the mouse in three ways (Figure 4, left to right): bend-over holding in MMORPG games that have lower requirements for timeliness, grasp holding in RTS or MOBA games that have higher requirements for operations, and click holding in FPS games that have the highest operational requirements. The different holding postures correspond to the varied pictures respectively on the screens. Based on responses from interviewee B, he uses the bend-over hold when the battle is progressing slowly and the grasp hold when the battle becomes more intense. In view of players adjusting holding postures according to different situations while playing games, some manufacturers emphasized that the gaming mouse they designed is suitable to accommodate different postures accordingly.

In addition to these basic holding styles, players move their fingers in special ways when performing different actions in games. Interviewee A said that many players use the left button to switch weapons in shooting games and press upward on the side button with the thumb, similar to lifting the bumper of a gun for quicker actions (Figure 5). Taking note of this, some manufacturers designed side buttons with a gap in the lower part for easier switching, as shown in Figure 6.

Figure 4. Three basic mouse postures for players (left to right): bend-over holding, grasp holding, and click holding.

Figure 5. Thumb movement to switch weapons.

Figure 6. Side buttons with a gap in the lower part facilitate easier switching for players.

When observing interviewee A in a shooting game, we noticed that when he threw the grenade (pressed the left button), his index and middle fingers would unconsciously lift upward as if he was trying to throw the grenade (**Figure 7**; the corresponding pictures on the screen are shown in **Figure 8**). This movement is a vivid representation of what Kirkpatrick (2009: pp. 133-134) mentioned: "*a kind of crystalline representation of game action*", in which the body's tension, rule, operation on weight, and energy are all compressed into the hands.

In addition to the operations of keys, the life-saving "turn-back" movement is the most commonly used in shooting games. Using the mouse, turning back requires the player to set its appropriate sensitivity. One interviewee prefers to use high-sensitivity settings to shift the focus away by a slight movement of the mouse. While a player can simply swivel their wrist to make the movement to turn back the mouse, limited desktop space dictates that the mouse has to be dragged back when it is at the edge. In particular, when they reduce the degree of sensitivity of the mouse for accurate targeting, a great movement in which the player lifts the mouse and quickly drags it back is necessary. This movement is called the "gun swing" (**Figure 9**).

Figure 7. When the player threw the grenade (pressed the left button), his index and middle fingers would unconsciously lift upwards as if he was trying to throw the grenade.

Figure 8. Corresponding pictures on screen when the player threw the grenade in the game.

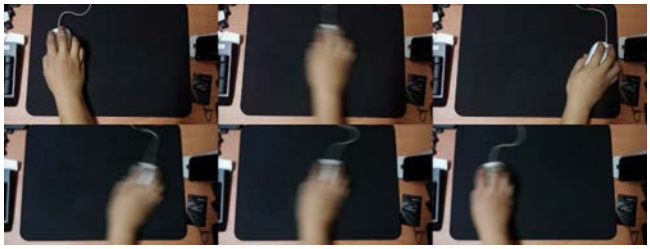

Figure 9. "Gun swing" movement.

As players usually lift the mouse when performing the violent left-right "gun swing" movement, some manufacturers designed a convex on the side of the mouse for players to tightly hold the mouse with their fingers (Figure 10). Whether a mouse can be tightly held also depends on its overall curve. According to an interviewee, separated by a curved section, a symmetrical mouse includes an up-trapezoidal design (Figure 11, left) and a down-trapezoidal design (Figure 11, right). The former has a wider middle part and milder concave, and is less likely to be held tightly, while the latter has a greater concave in the middle and is more likely to be held tightly.

Figure 10. The convex on the side of the mouse allows players to tightly hold the mouse with their fingers to execute the "gun swing" movement.

Figure 11. Up-trapezoidal mouse (left) has a wider middle part and milder concave and is less likely to be held tightly, while the up-trapezoidal mouse (right) has a greater concave in the middle and is more likely to be held tightly.

The adaptability of the read head of the mouse to desktop materials is also very important, as a poorly designed read head that does not adapt well to the desktop material may result in the cursor drifting out of control. Interviewee T had an unpleasant experience: "*Because its reader uses a… Twin-eye… from Philips, and the drawback of that is its high sensibility to surfaces, if you use a cloth pad at will, it just 'floats' for its failure to induct*". The quality of the reader has a significant impact on the stability of the mouse. Another interviewee offered a vivid description: "*If a soldier needs a life-saving gun that will not jam or blast on the battlefield, I need a mouse that can enable me to perform my actions steadily without causing frame drops or going out of control*". When asked what makes a good read head, the interviewee said, "*A good read head should be highly adaptive to the material of the mouse pad, so that I can use the mouse even when I am in the mud, a snowfield, or a chilling environment. A good read head should enable the mouse to be used on a poor mouse pad*". As this interviewee played shooting games regularly, he described the mouse as a gun, indicating that some mouse designs include recesses on both sides, allowing players to press them and mimic the pulling of a gun trigger.

5. Conclusion

Computer games construct a virtual world through on-screen graphics, which constitute a major part of games. Baudrillard affirmed that the computer screen is "a material transform" rather than "a material form" and that it is indistinguishable from works of art, books, and newspapers because it is not fixed and continuous (Zurbrugg, 1997). The potential for constant changes regarding screen graphics paves the way for a unique method of imagining and seeing the world, which he called "transaesthetic". Concerning the gap between this special method of imagination and perception of the real world, Julier (2014) offered a further description: "In either the Macintosh or the Windows interface, the metaphors of a trash can, file, briefcase, and so on serve to fill in for what has been lost in the process of dematerialization. Much is lost in shifting away from the material world of weight, texture, smell, or incidental sound. On the screen, this cyber loss is compensated for by providing a heightened allusion to materiality".

In the process of digitization of material experience, the design appropriately compensates for the loss of materiality in weight, structure, sound, and smell. For different types of games, the application of such compensation extends from the plane graphics in the human-computer interface to the gaming mouse and other types of mice. Compared to the traditional or multi-touch mice with a smooth and flat appearance, their material and color combination, buttons with various special functions, and even a replaceable micro-switch and shell can drive game players to associate with other objects. This is a type of compensation for lost realness.

With rapidly changing screen graphic patterns, such compensation ranges from visual perception to the physical experience of controlling the mouse. Targeting the role of the game controller, Kirkpatrick, a scholar of video game cul-

ture, described the relationship between tensions in gameplay between fingers, thumbs, and the controller and the action of the on-screen game fiction: "*The tensions in the hand are shifting and if we recorded the movements of fingers and thumbs against the plastic buttons, we would find a kind of crystalline representation of game action. In a sense, the important forces that drive the action of the on-screen game fiction are present in the tension between fingers, thumbs, and plastic controller*" (Kirkpatrick, 2009: pp. 133-134).

As a game controller, the gaming mouse takes on the function of linking the player's body experience to the game world. In computer games, players can observe many interesting correlations between gestures and game actions. Moreover, players have vivid imaginations of the role played by the gaming mouse because of the different types of games they play. For example, the military atmosphere in shooting games makes the player handle the mouse as if it were a gun, influencing the effectiveness of fighting opponents in the game. When Taiwanese players play FPS with a Western war background, most of them need the assistance of video media similar to movies to achieve the spatial experience of self-imagination and enhance their sense of participation. Compared to the movie medium, the gaming mouse further materializes the player's imagination, compensating for the material senses that cannot be obtained in virtual space through stereoscopic vision, touch, and even hearing (the sound produced by clicking the mouse button) when the player controls the mouse. In the fictional world of RTS, the mouse is a chess player in the sandbox, following the commands of the controller to mobilize the troops and elicit the most appropriate response in a tense situation. The design of different game movements has enabled gaming mice to develop their own aesthetic style.

The gaming mouse is designed to be complex in response to the player's body movements. For example, the side key facilitates thumb toggle, the mouse's body curve is suitable for fast swinging, and the curve of the mouse body makes it easy to clamp and hold with fingers. Therefore, Kirkpatrick's so-called "*kind of crystalline representation of game action*" is not only about the tension in a player's hand, but also translates into the shape of the mouse through design. Different visual elements and control devices in the human-computer interface are used to compensate for the "cybernetic loss" during the process of dematerialization. In addition, players develop their own body strategies that can coordinate the form of the mouse and integrate them into the imaginary world they have constructed. These are all factors to be considered in the comprehension and design of gaming mice.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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