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Research Brief

Peripheral Vision Limitations Inhibit *Call of Duty* Multiplayer First-Time User Experience

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ABSTRACT – ***The Call of Duty Multiplayer heads-up display (HUD) relegates game-critical health and weapon information to widgets in the lower periphery of the screen, inhibiting the first-time user experience. Essentially, limitations in spatial resolution across a visual field impede peripheral vision in video game interactions such that new players cannot effectively localize the peripheral health and weapon widgets. This ultimately disrupts a new player's capacity to achieve success in Call of Duty's Multiplayer modes wherein health and ammunitions are precious resources anchoring the game experience. Eye-tracking and visual processing data suggest centralizing the health and weapon widgets improves the first-time user experience of interacting with Call of Duty's Multiplayer HUD. Therefore, relocating this critical information closer to the point of greatest visual fixation, the weapon crosshair, alleviates reliance on acute peripheral spatial resolution. This enhances the first-time user experience of new players for whom acutely localizing a peripheral target is more difficult.***

I. INTRODUCTION

Eye-tracking data gathered for new and veteran first-person shooter (FPS) video game players reveals distinct weaknesses, particularly among first-time players, in spatial resolution at the periphery of the visual field. More pointedly, first-time players have notably more difficulty localizing peripheral targets in a field of distracting objects [1]. At the crux, first-time players cannot effectively or efficiently process information presented at the periphery of a display. These limitations in peripheral vision inhibit the first-time player experience for *Call of Duty* Multiplayer's heads-up display (HUD), wherein game-critical information is positioned at the lower periphery of the screen. Placing the health widget and weapon widget in the lower corners disrupts a new player's ability to acutely see and process important information, ultimately interfering with a new player's capacity to achieve success [2].

In this analysis, eye-tracking data and visual stimulus research characterizing peripheral vision weakness suggest critical gameplay messaging best serves the first-time user experience of a first-person shooter video game when positioned within the central HUD region surrounding the weapon crosshair. Therefore, relocating the imperative health and weapon widgets in *Call of Duty's* Multiplayer modes from their current location at the HUD's lower periphery to a more central area in proximity of the weapon crosshair provides an enhanced first-time user experience. In sum, eliminating the dependence on peripheral spatial resolution for deducing gameplay-impacting information

lessens the disruptive effect of inefficient peripheral vision on the first-time user experience in *Call of Duty* Multiplayer.

II. CORE FINDINGS

Contextualized eye-tracking data reveals that video game players engaging with first-person shooter (FPS) games attain game-critical information almost exclusively from the near center of the screen, dedicating negligible visual attention to peripherally-located messaging. To this point, A. Kenny, H. Koesling, D. Delaney, S. McLoone, and T. Ward's research indicates that during FPS gameplay, 88% of all visual fixations occur within a 400 by 300 px rectangle encompassing the crosshair, a natural fixation point, at the center of an 800 by 600 px resolution screen [3]. In other words, "users [spend] 86% of fixation time and 82% of the [total] game time within the near center region" [3]. As a result, only 2% of visual attention was recorded as falling within peripheral regions dedicated to health, messaging, and score for an FPS game [3]. At the core, eye-tracking data in FPS gaming evidences the distinct tendency for players to dedicate a dominating level of attention to the center of the screen, focusing fixations about the crosshair. Accordingly, information messaging occurring outside the central 400 by 300 px rectangle for an 800 by 600 px screen receives only 1 out of every 50 visual fixations. Consequently, game-critical information presented on a screen's periphery is rarely cognitively processed by a player. That is to say, eye tracking data in video games suggests visual perception resources focus enormously on the foveal visual region at a HUD's center, neglecting the peripheral information widgets.

Continuing, an eye-tracking, data-driven analysis of the FPS franchise, *Halo*, further illustrates abundant player focus on the inner, central screen region surrounding the crosshair. Using "collected eye movement data of 350 consecutive frames from the game *Halo II*," S. Yan and M. S. El-Nasr determine that "the player's eyesight is always located on the center part of the screen [and] the range of the eyesight is relatively small, [focused around] the crosshair" [4]. Even further, Yan and M. S. El-Nasr conclude that "players playing first person shooter games tend to concentrate their eyes on the center of the screen [because] visual stimuli are more salient when located near objects that fit player's top-down visual search goals" [4]. Essentially, visual fixation in FPS games focuses on a screen's central region with limited visual processing of the screen's periphery. Eye-tracking data collected from *Halo II* gameplay alongside neurological psychology purports users expect game-critical information to populate the central region of the HUD. As a result, players perform visual lookups of strategic information almost exclusively within the region surrounding the weapon crosshair. Therefore, information relegated to the HUD's periphery cannot be effectively localized in a player's limited visual field, ultimately inhibiting cognitive processing of pertinent gameplay messaging.

Markedly, the inability to visually recognize and process information at the periphery of a display during FPS gameplay is exacerbated for first-time players. Namely, C. Green and D. Bavelier found that "avid action-video-game players (VGPs) were [able to] localize a peripheral target in a field of distracting objects more accurately than non-action-video-game players (NVGPs), as well as to process a visual stream of briefly presented objects more efficiently and to track more objects at once than NVGPs" [1]. Crucially, this research indicates that the cognitive load of visually localizing information messaging in FPS video games tangibly inhibits the first-time user experience. In comparison with veteran video game players, first-time users experience greater hardship discerning and processing gameplay information presented on the HUD from the game world. Specifically, spatial resolution research reveals distinct weaknesses among first-time players attempting to localize information widgets within distracting object fields at the periphery of a display. Accordingly, when compared with veteran video game

players, the inhibitive limitations of peripheral vision are intensified for first-time users engaging with an FPS video game's HUD.

Moreover, first-time FPS video game players experience a disadvantaged perceptual system that does not efficiently use spatial memory or visual attention to process peripheral gameplay messaging. For example, a study requiring "participants to detect targets while suppressing distracting peripheral information" found that "the actionVGP group generated a significantly larger P3 component compared with nonVGPs, which is indicative of increased perceptual discrimination and ability to suppress distracting non-target stimuli" [5]. In other words, non-video game players have slower visual stimulus response times and smaller fields of view, fundamentally disrupting peripheral target detection in the first-time user experience. Resultantly, first-time players cannot effectively see and process gameplay messaging affixed to the periphery of the game HUD.

Overall, eye-tracking data gathered for new and veteran first-person shooter video games illustrates insufficient peripheral visual processing, especially for new players. Strikingly, video game players dedicate only negligible amounts of game time, as measured in pupil fixations, to the periphery of the HUD. That is to say, gameplay-impacting messaging for FPS games comes almost exclusively from the region of the screen surrounding the crosshair. Consequently, critical information portrayed at the periphery of the HUD cannot be effectively localized in a player's limited visual field. These weaknesses in peripheral localization are exacerbated for first-time players.

III. SUPPORTING FINDINGS

Continuing, distracting objects and changing background environments inherent to FPS game worlds tangibly inhibit a first-time video game player's capacity to localize and process visual elements. In essence, the visual field and spatial resolution of non-video game players is limited, as research into performing object-tracking visual tasks evidences [6]. For example, research into an adult's capacity to visually localize multiple on-screen elements reveals that the average "adults' tracking threshold… translates to being able to track 3 targets and 2 distractors" [7]. Well below the number of HUD widgets and background object distractors generally present in an FPS video game, this data suggests that the average adult's peripheral vision and visual tracking capacity cannot account for the myriad of gameplay messaging elements. Strikingly, these limitations in the visual system's ability to localize and process complex visual data critical to gameplay inhibit the average adult's ability to achieve success in an FPS video game.

Moreover, a video game player's ability to localize and fixate upon a messaging element has a direct correspondence to that element's impact on the player's gameplay. D. T. Knoepfle and J. T.Y. Wang's research using eye-tracking at a pupil dilation sampling rate of 250Hz indicates that "the extent to which people look at the relevant information is likely to correlate with how that information influences decision-making" [8]. Therefore, information widgets placed at peripheral heads-up display locations, where visual fixations occur only minimally, have negligible influence on a player's decision-making. More specifically, gameplay messaging that occurs outside the centralized 400 by 300 px rectangle of visual focus for an 800 by 600 px display only minimally informs a player's gameplay strategy.

Although veteran video game players possess augmented spatial processing, first-time players experience poorer visual acuity thresholds, which disrupts a first-time user's capacity to achieve success in an FPS video game. Markedly, first-time video game players have statistically slower response times when detecting visual targets and have a smaller "useful field of view suitable for accurate peripheral target detection" [5]. In contrast, veteran video game players "were able to track objects that moved at greater speeds, performed better in a visual memory test, switch between

tasks more quickly as well as make decisions about rotated objects more quickly and accurately" [9]. Notably, first-time players experience insufficient visual processing particularly at the periphery of the visual field. Altogether, weaker peripheral visual field processing and lower visual acuity thresholds inhibit the first-time user experience of engaging with an FPS video game's HUD wherein game-critical information is relegated to the display's periphery.

Collectively, these findings illustrate the disruptive effect limitations in peripheral vision have on the first-time user experience for new video game players interacting with a first-person shooter game's heads-up display. Although experienced players possess augmented spatial processing, a statistical analysis of eye-tracking data and visual cognition signal that non-video game players have larger "regions of spatial interaction" and poorer "visual acuity thresholds" than veteran video game players [1]. Namely, limitations in spatial resolution across a visual field impede peripheral visual processing, hindering a first-time player's aptness for localizing gameplay messaging. In essence, first-time users interacting with an FPS game's HUD experience inadequate peripheral visual acuity, causing a discrepancy that tangibly obstructs a first-time player's aptitude for in-game success.

IV. IMPLICATIONS FOR PRODUCT EXPERIENCE

Centrally, the *Call of Duty* Multiplayer HUD relegates game-critical health and weapon information to the lower periphery of the display, disregarding limitations in peripheral vision. This, in effect, inhibits the first-time user experience. Health and weapon ammunitions are precious gameplay resources anchoring the game experience for the FPS *Call of Duty* Multiplayer modes. Notably, the Health Bar and Weapon Ammo Counter widgets occupy the lower left and right corners of the HUD, respectively [2]. These locations fall distinctly outside the 400 by 300 px range of fixation focus that A. Kenny, H. Koesling, D. Delaney, S. McLoone, and T. Ward illustrate as the primary region for information communication and spatial resolution in FPS games. Limitations in spatial resolution across a visual field impede peripheral vision and, crucially, these hinderances more notably disrupt the peripheral visual localization of non-video game players, particularly during a first-time user experience. Unable to effectively localize the health and weapon informational widgets directly disrupts a new player's capacity to achieve success in *Call of Duty's* Multiplayer modes wherein health and ammunitions are essential resources.

Even further, Celia Hodent describes the implications of peripheral vision weakness on HUDs in FPS games, noting that "our visual acuity is very sharp at the center of our gaze, our fovea, but decreases rapidly as the distance from the fovea increases" [10]. That is to say, "players who typically gaze at the center of the screen [do not] grasp precisely whatever is popping up in their peripheral vision" and only perceive peripheral elements after "a visual saccade (a movement of the focal vision point)" [10]. Therefore, first-time users engaging with *Call of Duty's* Multiplayer HUD cannot visually process the health and weapon information widgets at the lower periphery of the display. The *Call of Duty* HUD relegates the health and weapon information widgets to the lower periphery of the screen where visual resolution thresholds fail to properly localize or cognitively process the data.

In fact, A. Kenny, H. Koesling, D. Delaney, S. McLoone, and T. Ward's research indicates that only 2% of visual attention falls in the regions containing game-critical messaging elements that portray health and ammunition status [3]. Instead, players naturally fixate visual attention around the weapon's crosshair at a display's center. That is to say, players engaging with the *Call of Duty* Multiplayer HUD spend only negligible gameplay time visually localizing the periphery of the HUD. Limitations to the useable visual field are exacerbated for first-time users for whom stimulus response times and fields of view are

statistically poorer than veteran video game players. Resultantly, first-time users cannot effectively see or process critical gameplay information that is presented at the lower periphery of the *Call of Duty* Multiplayer HUD. Therefore, insufficient peripheral vision inhibits the first-time user experience by disrupting a new player's capacity to process gameplay messaging essential for achieving success in *Call of Duty's* Multiplayer modes.

Altogether, these findings reveal that placing game-critical information including the health widget and the weapon widget at the lower periphery of the *Call of Duty* Multiplayer HUD hinders the first-time user experience. Limited visual resolution at a display's periphery combined with fundamentally poorer visual processing amongst new video game players disrupts a first-time user's effective visual localization of gameplay messaging. In other words, first-time players engaging with *Call of Duty's* Multiplayer modes experience difficulty localizing peripheral targets including the widgets portraying health and ammunition data. As a consequence, poor spatial localization across a visual field in new players hampers the first-time user experience for the FPS, *Call of Duty*, wherein gameplay decisions are anchored around health and ammunitions information.

V. DESIGN RECOMMENDATIONS & CONCLUSION

In sum, research into spatial resolution across a visual field in the context of first-person shooter video games depicts poor localization of peripheral messaging elements, particularly amongst first-time players. Consequently, new and first-time players of *Call of Duty's* Multiplayer modes cannot effectively or efficiently process information presented at the periphery of a heads-up display (HUD). In order to enhance the first-time user experience of engaging with *Call of Duty's* Multiplayer modes, relocation of the health and weapon widgets from the HUD periphery to a central location in proximity of the weapon crosshair is recommended.

Specifically, it is recommended that the health and weapon widgets be positioned within the 400 by 300 px rectangle at the center of an 800 by 600 px display. Anchoring these widgets within the central region of the *Call of Duty* Multiplayer HUD ensures that imperative health and ammunition data falls within the region of maximum visual acuity for FPS games. To this point, relocating the health and weapon widgets to the central 400 by 300 px rectangle encompassing the weapon crosshair puts this critical gameplay messaging in an area that receives 88% of eye-tracking fixations and 82% of total gameplay time [3]. Moving these elements of gameplay messaging out from the periphery into the center of foveal focus circumvents limitations in peripheral visual localization, particularly among first-time players. That is to say, eliminating the dependence on peripheral spatial resolution for deducing gameplay-impacting information lessens the disruptive effect of inefficient peripheral vision on the first-time user experience in *Call of Duty* Multiplayer.

Moreover, visual processing and eye tracking data suggest that relocating the health widget and weapon widget of *Call of Duty's* Multiplayer HUD from the lower corners on the screen periphery to a central area in proximity of the crosshair improves the first-time user experience. Visual localization resources focus enormously on the foveal visual region at the HUD's center and, therefore, placing gameplay-impacting data in this region caters most to a player's natural visual processing patterns. At the crux, the current positioning of the health widget and weapon widget for *Call of Duty* Multiplayer at the lower periphery of the HUD disrupts a new player's capacity to achieve success. To enhance the first-time user experience, this analysis indicates that anchoring the health widget and weapon widget within the central 400 by 300 px region of the HUD lessens reliance on peripheral visual field processing for *Call of Duty* Multiplayer. Consequently, repositioning the health and weapon information widgets to the central display region near the natural FPS game

fixation point, the crosshair, is recommended to best serve *Call of Duty's* first-time player experience.

To conclude, limitations in spatial resolution across a visual field impede peripheral vision in video game interactions such that new players cannot effectively localize the peripheral health and weapon widgets. This ultimately disrupts a new player's capacity to achieve success in *Call of Duty's* Multiplayer modes, wherein health and ammunitions are precious resources anchoring the game experience. Relocating important gameplay messaging closer to the point of greatest visual fixation, the weapon crosshair, alleviates reliance on acute peripheral spatial resolution. This enhances the first-time user experience of new players for whom acutely localizing a peripheral target is more difficult. As a result, relocation of the health and weapon widgets in *Call of Duty's* Multiplayer modes from their current location at the HUD's lower periphery to a more central area in proximity of the weapon crosshair is recommended in order to enhance the first-time user experience.

VI. REFERENCES

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