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Traditional play theories emphasise voluntary participation, bodily autonomy, and player agency. Emerging human augmentation technologies, however, challenge these foundations by introducing shared control between players and systems. In response, we propose Homoludic Augmentation: the intentional integration of augmentation technologies to extend, modify, or subvert established forms of play. Building on Caillois' four categories—Agon, Alea, Ilinx, and Mimicry—we outline four corresponding forms of Homoludic Augmentation: Arete (augmenting competition), Tyche (augmenting risk and chance), Dionysia (sensory augmentation), and Mimesis (augmenting embodied role-play). Through historical, cultural, and contemporary examples, we examine how these forms reshape traditional play dynamics. We advocate for inclusive, ethically responsible design that centres consent, accessibility, and player autonomy. Rather than fixed typologies, these forms serve as fluid lenses for critical reflection. This paper invites designers and researchers to reimagine the possibilities and boundaries of play in an increasingly entangled human-technology landscape.

CCS Concepts: • **Human-centered computing → HCI theory, concepts and models**; *Interaction paradigms*; Interaction design theory, concepts and paradigms; User centered design;

Additional Key Words and Phrases: Homoludic augmentation, human-computer integration (HInt), human-computer interaction (HCI), game design

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1 Introduction

Play is constantly evolving—blurring the boundaries between the human body and technology in increasingly profound ways. Traditional play theories, such as those by Huizinga [16] and Caillois [7], have long emphasised voluntary participation, bodily autonomy, and player agency as core components of play. Yet, emerging human augmentation technologies—ranging from Virtual and Augmented Reality (VR/AR) to body-actuating systems like electrical muscle stimulation (EMS), pneumatics, and exoskeletons (e.g., [4, 22, 28, 32, 36])—are beginning to challenge these assumptions. We consider augmentation here as the technological modification of the body's capacities—its movement, perception, or control—through wearable or bodily integrated systems. By introducing shared control between the player and technological systems, these tools unsettle traditional notions of agency and embodiment, demanding new ways of conceptualising augmented play.

In response, this article offers preliminary reflections on what we term Homoludic Augmentation: the intentional integration of human augmentation technologies to enhance, subvert, or reconfigure established forms of play. Derived from homo (human) and ludus (play), the concept foregrounds the interplay between embodied experience and technological intervention. Drawing from Caillois' [7] seminal taxonomy of play—Agon (competition), Alea (chance), Ilinx (vertigo), and Mimicry (simulation)—we introduce four corresponding forms of Homoludic Augmentation: (1) "Arete" (augmenting competition, inspired by Agon), (2) "Tyche" (augmenting risk and chance, inspired by Alea), (3) "Dionysia" (sensory augmentation, inspired by Ilinx), and (4) "Mimesis" (augmenting embodied role-play, inspired by Mimicry). Each form offers a conceptual lens for linking specific augmentation technologies to core play dynamics, offering designers and researchers clearer ways of thinking about intervention and impact.

Existing conceptual approaches, such as Human-Computer Integration (HInt) [13, 30, 31, 46] and bodily-integrated play [30] offer valuable insights about augmenting play experiences but do not explicitly engage with established play theories [7, 16]. Homoludic Augmentation addresses this gap by reinterpreting Caillois' framework by considering the emergence of contemporary technologies and design practices. We chose to engage with Cailliois' work as it categorises and classifies play by its fundamental psychological qualities, rather than specific technologies or social contexts [7]. This articulation allows us to move beyond a seemingly narrow focus on what a technology *is* and instead, examine what it *does* to the experience of play. The Homoludic Augmentation framework extends the original categories of play by demonstrating how emerging technologies can actively transform or subvert their core qualities, enabling designers and researchers to understand and articulate the new forms of augmented play that are not possible in traditional gaming. Furthermore, the framework also allows us to address enduring challenges in applying Caillois' work today, including the need to contextualise the four categories within the ludus/paidea distinction (structured vs. spontaneous play) and to acknowledge contemporary critiques, such as those by Trammell in Repairing Play [50], which interrogate the cultural assumptions and limitations embedded in traditional play theories.

To illustrate the potential of Homoludic Augmentation, we analyse examples of augmented play experiences (Sections 3 and 4). These examples demonstrate not only how human augmentation technologies align with Caillois' original categories but also how they might transcend or subvert them. Additionally, we also surface ethical questions—around accessibility, consent, and autonomy—that arise as these technologies become increasingly intimate and embodied. (Section 5).

Ultimately, by offering these preliminary reflections, we aim to inspire game designers, researchers, and players to reimagine the possibilities of play in an era where human and technological boundaries are increasingly entangled—reshaping what play is, and what it could become.

2 Historical and Cultural Perspectives on Homoludic Augmentation

Although Homoludic Augmentation might appear distinctly modern, its roots run deep in human history [12, 21]. The historical use of tools, prosthetics, and bodily modifications to enhance playful interactions highlights an enduring human desire to extend and reshape the body through play. From early humans repurposing everyday objects into toys, to the ritualistic use of masks and costumes enabling imaginative and embodied role-play (Mimicry) [14, 40], augmentation has always been interwoven with human culture.

The pursuit of enhanced physical prowess (Agon) spans from ancient Olympians applying olive oil for performance to modern athletes using controversial enhancement technologies [51]. Similarly, the use of randomisation devices such as dice and in early games (Alea) shows how augmentation has long been used to introduce uncertainty, challenge, and excitement [44]. This historical lineage even extends to more creative domains, as seen in Mozart's Dice Game, which used a random process to gamify and augment music composition [49].

Importantly, technological augmentation has also played a critical role in expanding access to play. From the use of prosthetics in sports that promotes accessibility, to adaptive game controllers for players with physical impairments, augmentation has enabled diverse bodies to participate meaningfully in playful experiences [18]. Contemporary research increasingly foregrounds accessibility as a design imperative—not as an afterthought, but as a driver of innovation in augmented interaction [28].

These developments are closely aligned with longstanding models of technology acceptance and adoption. For example, the Technology Acceptance Model (TAM) and its extensions (e.g., UTAUT) suggest that technologies are more likely to be adopted when they are perceived as useful and easy to use [11, 52, 53]. Within games, augmentation technologies—such as wearables, sensory feedback, or adaptive input—often gain traction when they enhance player competency or emotional engagement [2, 47]. This tendency toward adoption applies even in professional contexts, where research on AI-driven music systems has examined how creative professionals integrate new tools into their workflow. In these instances, the AI acts as a form of augmentation to enhance creative output, providing a competitive edge for professional music makers [55]. This example is a form of Arete, highlighting that our framework might be valuable for understanding any human-technology system where the core dynamic is to enhance skills for a competitive advantage, beyond just the idea of play.

Taken together, these historical, cultural, and technological perspectives situate Homoludic Augmentation within a longer arc of human play and tool use. They also foreground the importance of considering access, usability, and cultural context as central to the design and adoption of augmented play experiences. By recognising this continuity, we are better equipped to reflect critically on both the opportunities and limitations that augmentation introduces.

3 Homoludic Augmentation: Foundational Reflections for Designing Augmented Play

In contemporary game design, integrating human augmentation technologies is increasingly explored to create novel, meaningful, and engaging play experiences [30]. As designers grapple with augmentation's implications [23, 28], we propose foundational reflections to inform the design

Fig. 1. Examples of athletes using assistive augmentation technologies in sport. These images illustrate how prosthetics and wheelchairs function as performance-enhancing interfaces, aligning with the Arete category of Homoludic Augmentation by expanding who can participate in competitive and high-performance play. (Representative stock images; not identified as professional athletes.)

of augmented play experiences, aligning explicitly with Caillois' classic categorisation [7]. Below, we introduce four clearly defined categories of Homoludic Augmentation—each category linked to a descriptive phrase alongside the original Greek-inspired term—to aid clarity and practical understanding:

3.1 Arete (ah-reh-tay): Augmenting Competitive Play

In ancient Greece, Arete symbolised the pursuit of excellence, especially in competitive domains [9]. Within the context of Homoludic Augmentation, Arete refers to Competitive Augmentation—the use of emerging technologies to elevate, extend, or reframe competition. This might involve enhancing the capabilities of elite athletes/performers, introducing new skill modalities, or making competitive play more equitable and inclusive (Figure 1).

The Superhuman Sports movement [18, 19] exemplifies this potential by reimagining traditional sports through technological augmentation. Games like HADO [3], where players launch energy balls in AR, or League of Lasers [26], which visualises deflected beams in virtual arenas, push the boundaries of physical play. Similarly, D-Ball [43] applies diminished reality to obscure players' vision and increase the challenge. These games not only transform competition but introduce novel forms of embodied excellence. The Cybathlon [41] further expands this horizon by using assistive technologies—such as robotic limbs and brain-computer interfaces (BCIs), to enable individuals with disabilities to compete in high-performance events, illustrating how augmentation can make excellence more accessible.

In addition to redefining who can compete, Arete also reshapes how we compete. One example is an augmented table tennis system that dynamically adjusts net height or paddle size to sustain fairness and engagement between mismatched players [1, 2]. Such systems reflect how augmentation can maintain competitive tension by actively managing player advantage. A similar principle is demonstrated in gesture-controlled wearable interfaces, such as VR gloves with real-time gesture recognition, which offer players enhanced precision and response time in fast-paced digital games. By directly translating motion into control with minimal latency, these gloves augment a player's technical edge in high-pressure environments [54].

Likewise, virtual performance augmentation (VPA) systems in VR exertion games (a digital game that requires players to move their bodies as part of the game [27, 29]) allow players to run or jump in place while their avatars perform exaggerated physical feats. This gives users the embodied sensation of outperforming their real-world limits, which, in turn, affects perceived competence [17, 20]. In such systems, players are rewarded not just for raw skill, but for their ability to engage with and master the affordances of augmented movement. By pushing the boundaries of physical, cognitive, and perceptual performance, Arete invites designers to consider how technologies can both challenge and support players in their pursuit of excellence.

3.2 Tyche (ty-kee): Augmenting the Unpredictable

In Greek mythology, Tyche embodies the goddess of fortune and chance, governing the unpredictability of events [6]. Within Homoludic Augmentation, Tyche represents the integration of randomness and indeterminacy into play through augmentation technologies. Rather than relying solely on traditional stochastic mechanics like dice or card draws, augmented chance emerges from systems that introduce unpredictability via procedural generation, real-time sensor input, or bio-signal-driven variability.

Stelarc's RE-WIRED/RE-MIXED installation [48] exemplifies this by randomly rerouting participants' various sensory inputs (e.g., visual input from a camera, auditory input from a microphone) and cross-mapping them to create unpredictable, involuntary bodily sensations or actuations. This leads to spontaneous, involuntary experiences that resist planning or mastery. In this way, chance enters directly through the body, making unpredictability a felt, lived experience. Similarly, AR games that transform mundane objects into randomised play elements [15] provoke serendipitous discovery and interpretation, actively embedding unpredictability into the material world.

An even more embodied example comes from the use of EMS. For example, Lopes et al. [24] used EMS to simulate physical resistance when interacting with virtual objects—such as pushing an invisible wall—creating unexpected constraints and reactions during gameplay. In such systems, players cannot fully anticipate how their body will respond, as the system controls muscle contractions dynamically and without their intention [38]. This injects mechanosensory unpredictability into the play experience, positioning the body as both a player and an unpredictable medium.

Unpredictability can also emerge from physiological variability, as seen in biofeedback-driven VR systems. For example, a VR game designed to reduce pre-MRI anxiety in children adjusts content based on live data from skin conductance, heart rate, and muscle tension [25]. In this case, the player's bodily state—often outside conscious control—becomes a semi-randomised input to the game world. By integrating such sources of uncertainty—neuromuscular, environmental, algorithmic—Tyche-based augmentation shifts the player's role from controller to co-navigator of chaos. It challenges the assumption that unpredictability must be external or aesthetic, instead making randomness intrinsic to the mechanics of bodily and technological play. In doing so, Tyche invites players to engage with the unknown, not as a bug in the system, but as a vital feature of meaningful play.

3.3 Dionysia (die-oh-nee-zhuh): Augmenting Sensory Alteration

In Greek mythology, Dionysus [10] represents the god of wine, ecstasy, and theatre—a deity associated with immersive states, blurred boundaries, and heightened sensations. In the realm of Homoludic Augmentation, Dionysia refers to the technological transformation of sensory perception—altering, amplifying, or remapping input to cultivate immersive, emotionally resonant, and often ecstatic play experiences.

This is exemplified by immersive hyper-reality environments such as The VOID [34], which blend VR visuals with synchronised physical props and spatial audio to create seamless, embodied illusions. Here, sensory boundaries blur as physical and digital inputs reinforce one another, heightening the player's sense of presence. Similarly, augmented tactile feedback systems [33] extend this principle through vibrotactile responses that anchor digital interactions in the tangible world, deepening sensory resonance.

The playful reconfiguration of sensory channels is further illustrated by DubHap [8], a game that replaces visual cues with thermal feedback to guide player interaction. This form of sensory substitution [18] challenges players to navigate unfamiliar input channels, prompting novel bodily interpretations and affective reactions. Such examples clearly distinguish Dionysia from Arete's competitive focus or Tyche's unpredictability—highlighting instead embodiment, emotionality, and altered perception.

A more introspective form of sensory augmentation is seen in Neo-Noumena [45], a neuroresponsive system that translates users' emotional states into shared, ambient visuals and sounds in mixed reality. It externalises internal affect into a sensory field, i.e., an interactive, perceptible environment that allows users to experience emotion as an interactive environment.

Together, these examples show how Dionysia-based augmentation immerses players in transformed states of perception, often evoking emotion, embodiment, or even catharsis. Whether by thermal cues, emotional data visualisation, or haptic illusions, Dionysia invites players not just to play with the world—but to feel and experience it differently.

3.4 Mimesis (mi-mee-sis): Augmenting Embodied Identities

Rooted in imitation and representation, Mimesis [5] within Homoludic Augmentation captures how technology enables embodied enactment of alternative selves—inviting players to imaginatively and physically inhabit roles beyond their everyday identity. These augmented experiences transform bodies into expressive agents, repositioning identity as something fluid, negotiable, and playfully constructed.

Involuntary EMS-based games [35, 36] challenge the very assumption that play must be voluntary or self-directed (Figure 2). By outsourcing control of limbs to electrical impulses, this systems blur lines between the self and the system, raising questions of agency, autonomy, and what it means to play when the body becomes both puppet and performer [37, 39].

An especially provocative example is Fused Spectatorship [38], where spectators loan control of their hands to an EMS system while watching them play games—creating a dissonant, hybrid experience of observing and embodying simultaneously. Participants reported uncertainty about whether they were playing or merely watching, highlighting how identity can fragment and fuse in technologically-mediated play.

These examples reveal how Mimesis in Homoludic Augmentation transcends passive roleplay, creating hybrid states of being where players can explore identity, agency, and embodiment through complex technological entanglements. It offers designers powerful tools for crafting play, that is, as much about *becoming* as it is about *doing*.

By drawing from these examples, the four forms of Homoludic Augmentation reveal how emerging technologies can reshape the very foundations of play. Whether enhancing competition, introducing embodied randomness, transforming perception, or inviting the playful inhabitation of new identities, these augmentations challenge traditional assumptions about agency, control, and the body. Rather than prescribing fixed paths, they open up space for reimagining what play can

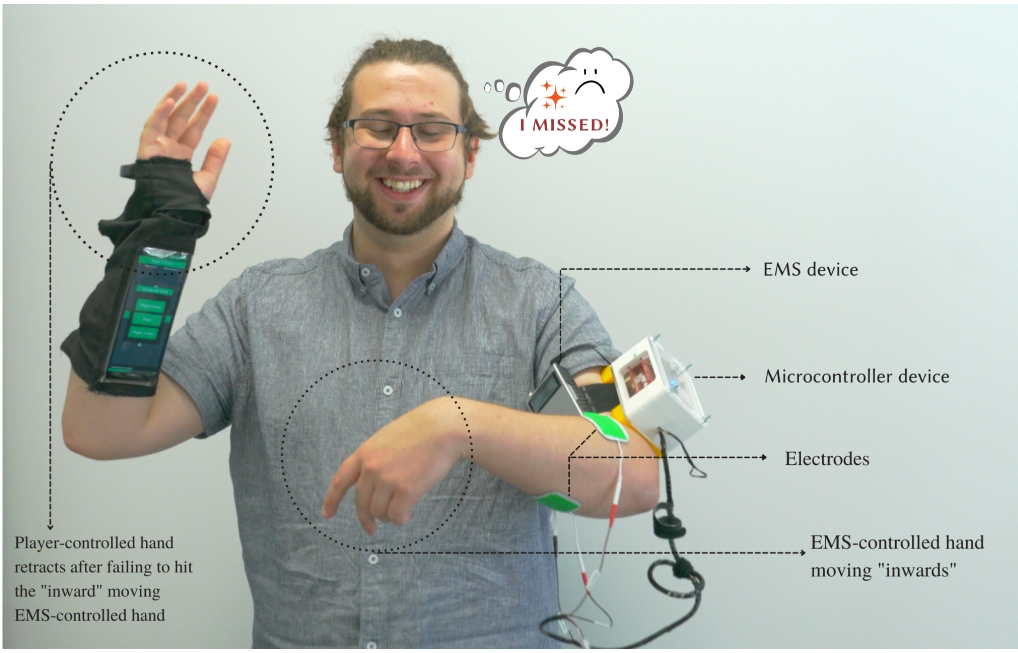

Fig. 2. An EMS device actuates the player's left hand, allowing the system to control its movements, while the player attempts to slap it using their right hand [35]. This playful experience illustrates "Mimesis" by blurring the line between self and system, transforming the body into both performer and observer in a technologised enactment of identity and agency.

feel like, look like, and mean—provoking new questions about ethics, inclusivity, and design in an age of increasingly entangled human-technology relations.

4 The Fluidity of the Four Forms of Homoludic Augmentation

The four forms of Homoludic Augmentation—Arete, Tyche, Dionysia, and Mimesis—offer a structured way to reflect on how human augmentation technologies extend, modify, or subvert traditional modes of play. However, in practice, these forms are not experienced in isolation. Augmented play experiences frequently blur and entangle these boundaries, giving rise to hybrid forms of interaction that resist neat classification.

For example, Fused Spectatorship [38] blurs the line between Mimesis and Tyche. While spectators embody unfamiliar identities through involuntary EMS-induced motion (Mimesis), they simultaneously surrender agency to an unpredictable system that plays through their hands (Tyche). Similarly, VR exertion games [17, 27] with performance augmentation enhance physical ability to elevate competition (Arete), but the resulting illusion of superhuman movement also transforms bodily perception [18], producing "Dionysian-like" immersion.

In DubHap [8], thermal cues substitute visual guidance, aligning clearly with Dionysia's sensory reconfiguration. Yet the ambiguity of interpreting heat as direction introduces uncertainty and risk, bringing in elements of Tyche. Even Cybathlon [41], a seemingly clear example of Arete through competitive assistive technologies, contains threads of Mimesis, as athletes learn to embody and adapt to non-biological extensions of themselves, reimagining what human performance looks and feels like.

These examples emphasise the fluid and dynamic nature of Homoludic Augmentation. By recognising how these categories overlap, interweave, or shift during play, we can more fully appreciate the richness and complexity of augmented experiences. This does not diminish the value of the four forms, but instead positions them as "lenses in motion" that can trace the evolving relationships between player, body, system, and world.

Embracing this fluidity invites designers and researchers to create hybrid experiences that defy static categorisation—experiences that move between competition and surrender, immersion and estrangement, control and transformation. In doing so, we begin to uncover new potentials for augmented play: not as fixed modes of interaction, but as living negotiations of identity, agency, and embodiment.

5 Design Implications for Homoludic Augmentation

As the examples throughout this article illustrate, Homoludic Augmentation introduces new design possibilities—but also complex ethical, experiential, and technical challenges. Each of the four forms—Arete, Tyche, Dionysia, and Mimesis—brings distinct opportunities for play, while also provoking important questions around fairness, agency, embodiment, and identity. These implications become even more layered when forms intertwine, as they often do in practice.

To help surface these challenges and prompt further discussion, we offer a set of preliminary reflections as starting points for more nuanced and critical design. These considerations have been intentionally kept minimal and illustrative, in keeping with the exploratory scope of this article. Table 1 below outlines **design focus** (what each form tends to prioritise or shape in play), **key considerations** (questions or aspects designers should be aware of), **potential challenges** (risks and difficulties that may arise in practice), **ethical risks** (specific concerns related to power, agency, accessibility, or representation), and **practical recommendations** (high-level design suggestions based on examples and theoretical reflection) for each form, drawing directly from the cases and analyses presented earlier.

These reflections highlight that designing for Homoludic Augmentation is not simply a matter of technical integration. It involves navigating shifting landscapes of consent, perception, embodiment, and identity—often in real-time, across diverse bodies and contexts. Importantly, the fluidity between forms means that many play experiences will not fall neatly into one category. As new forms of sensory control, biofeedback, and performative embodiment emerge, so too must our approaches to designing them responsibly. Future work might expand this table into participatory toolkits, heuristic guidelines, or situated design principles for inclusive and critically aware augmented play.

6 Conclusion: Reflections and Futures of Homoludic Augmentation

In this article, we introduced Homoludic Augmentation as a conceptual lens for understanding how human augmentation technologies reshape the dynamics of play. Drawing from Caillois' foundational categories, we proposed four interrelated forms: Arete (competitive augmentation), Tyche (augmented chance), Dionysia (sensory alteration), and Mimesis (embodied role-play). Each form highlights how emerging technologies invite new configurations of agency, perception, embodiment, and identity—often pushing against traditional assumptions of voluntary participation and bodily autonomy in play.

Yet as our examples indicate, the four forms of Homoludic Augmentation rarely operate neatly within their categorical boundaries. Some of the most compelling experiences arise from hybrid entanglements—where players compete through augmented movement while navigating unpredictable feedback (Arete + Tyche), or where sensory modulation supports identity performance in mixed realities (Dionysia + Mimesis). These intersections point to the richness of Homoludic Augmentation not as a fixed taxonomy, but as a dynamic space of experimentation.

Designing within this space demands care. As new modalities like biofeedback, EMS, or sensory substitution gain traction, ethical and inclusive design practices become essential. This includes

Table 1. Design Implications for the Four Forms of Homoludic Augmentation

Form	Arete (Competitive Augmentation)	Tyche (Augmented Chance)	Dionysia (Sensory Augmentation)	Mimesis (Embodied Role-play)
Design Focus	Enhancing or balancing competition through augmentation—such as in Cybathlon's [41] assistive technologies or gesture-controlled VR gloves [54] that offer players enhanced reaction time and precision.	Embedding unpredictability via procedural, bodily, or environmental systems—as seen in Stelarc's RE-WIRED/RE-MIXED [48] or biofeedback-driven games [25] that adapt to players' stress responses.	Transforming sensory experience to evoke immersion or altered perception—exemplified by The VOID's [34] hyperreality environments or thermal feedback substitution in DubHap [8].	Enabling identity exploration through embodied or performative systems—illustrated by Fused Spectatorship's EMS-controlled spectatorship [38] or movement-driven expression in Cyber-physical Architecture [42].
Key Considerations	How augmentation affects fairness, skill, and perceived competence—especially when some players gain enhanced performance through tools like VR exoskeletons/exosuits or wearable controllers.	How randomness is introduced and whether it feels meaningful or frustrating—e.g., when EMS introduces unpredictable force feedback or environmental elements generate randomised game dynamics.	How sensory augmentation is delivered, perceived, and emotionally processed—considering player comfort in systems that use multi-sensory cues, like haptic suits or neuroresponsive environments.	How embodiment is represented and how players relate to alternate selves—such as when players experience a loss of agency or confusion in EMS-controlled identity scenarios like Fused Spectatorship.
Potential Challenges	Over-privileging augmented players; unclear boundaries of fairness and accessibility—particularly in competitive games using precision-enhancing wearables or performance overlays.	Loss of control or agency; confusion between random input and system error—as when procedural systems override player intention in bio-interactive games, i.e., games driven by real-time physiological data (e.g., heart rate or skin conductance).	Sensory overload or exclusion of users with different thresholds and needs—as seen in complex haptic or immersive audio-visual systems that may not be universally accessible.	Unintended identity caricature or emotional discomfort through forced embodiment—especially when players enact unfamiliar roles under system-imposed constraints.
Ethical Risks	Reinforcing inequality or technological elitism in competitive contexts—where access to augmentation technologies becomes a barrier to fair participation.	Involuntary bodily responses and unclear consent boundaries—as in EMS-based games where unpredictability is physical and unannounced.	Physical or emotional discomfort; issues of accessibility and overstimulation—particularly in systems that intensify feedback without adaptive options.	Manipulation of self-perception; risks of disembodiment or depersonalisation—arising when identity is mediated through externally controlled or hyper-real avatars.
Practical Recommendations	Design for adjustable augmentation levels; clarify distinctions between augmented and non-augmented play; ensure transparent, equitable mechanics.	Use unpredictability to enrich rather than frustrate; ensure players understand the origin of random effects and can opt into the experience.	Provide options for sensory calibration and clear onboarding; support comfort and agency in multisensory systems like DubHap or The VOID.	Support expressive identity play without stereotyping; allow opt-in control and reflection in systems that shift embodiment, such as EMS-driven avatar control.

attention to accessibility, transparency, and player autonomy—especially in systems that mediate control or perception in involuntary ways. The design table presented earlier offers only preliminary reflections; future work might expand this into participatory toolkits or situated guidelines for critical, inclusive augmented play.

Ultimately, Homoludic Augmentation invites us to rethink what it means to play with—and through—technology. It opens space for not only enhancing or extending play, but for reimagining its boundaries, questioning its assumptions, and designing for futures where play becomes a shared negotiation between bodies, systems, and the worlds they co-create.

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