Serendipity in Esports: Understanding How Complementary and Redundant Information from Robotic Game Companions Influence Game Satisfaction

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Abstract

Robotic Game Companions (RGCs) are AI-driven non-player robots designed to enhance player experiences by delivering contextualized information in the context of multiplayer online battle arena games. Given that RGCs can deliver unsolicited information in real time, this study explores how complementary and redundant information provided by RGCs impacts game satisfaction through perceived serendipity, as well as the moderating role of perceived game performance. A scenario-based experiment with 272 participants reveals that (1) complementary information (vs. redundant information) of RGCs has a greater impact on both game satisfaction and perceived serendipity; (2) perceived serendipity fully mediates the effect of complementary information (vs. redundant information) on game satisfaction; (3) perceived game performance moderates the relationship between complementary information (vs. redundant information), perceived serendipity, and game satisfaction. Contributions to theory and practice are then discussed.

Keywords: complementary and redundant information, robotic game companion, serendipity theory, perceived game performance, game satisfaction

1. Introduction

Imagine this: you are in the middle of an intense multiplayer online battle arena (MOBA) game, where split-second decisions determine victory or defeat. In these digital battlegrounds, information is king, yet critical cues are often missed amidst the chaos. Now, an ally joins your fray—a robotic game companion, whispering timely advice: "Enemy missing from lane! Be cautious!".

This is not science fiction but the burgeoning reality of robotic game companions (RGCs), AI-driven non-player robots designed to augment player experience in MOBA games (Bouquet et al., 2021).

MOBA games have become a popular way for people to have fun in daily life (Xia et al., 2019), attracting a large number of devoted players worldwide (Wang et al., 2022). In the high-stakes environment of this kind of game, players must continuously integrate a wide range of in-game data to make timely and strategic decisions (Reeves et al., 2009; Xia et al., 2019). However, due to the overwhelming flow of information during matches, it is easy for players to overlook subtle yet crucial cues (Schmitt et al., 2018). With the advancement of artificial intelligence, game developers have begun to introduce RGCs to assist players by providing context-related and voice-based information support that delivers timely guidance without interfering with the gameplay visuals. These RGCs are autonomous virtual agents that operate outside of the core gameplay as non-participating assistants rather than teammates and are not considered cheating, including in competitive mode.

Although RGCs can provide informational reminders for players during gameplay, their reception has been mixed; some players view them as essential aids, while others find them distracting or even annoying. One key reason for this divergence may be that the information provided by RGCs does not always succeed in enhancing the user experience (Kosa &

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Uysal, 2022). Given that different types of information may lead to different gameplay experiences (Ghasemaghaei & Hassanein, 2015; Li & Tuunanen, 2022), this study aims to examine how different information types delivered by RGCs influence players' experiences and under what conditions these effects occur.

During gameplay, players must actively gather information, connect it with their existing knowledge, and make timely decisions (Reeves et al., 2009). While players can detect certain cues on their own, they may also receive additional input from RGCs, whose alerts are generated randomly. As a result, the information provided by RGCs may either repeat what the player has already noticed or offer new insights the player has missed. Therefore, we define ***complementary information*** as important content provided by RGCs that reminds players of critical aspects they may have overlooked during gameplay (Soda & Furlotti, 2017). In contrast, ***redundant information*** refers to similarly important content that RGCs highlight but that players have already noticed or are aware of (Ari et al., 2014). While both types of information may be relevant, their effects on players' experiences may differ significantly.

Despite existing literature has explored various aspects of the MOBA gaming context, several research gaps exist in understanding their impact on players' gaming experience. First, while prior work focuses on human-human coordination in MOBA games (Xia et al., 2019), human-AI collaboration, where RGCs act as proactive co-agents in information acquisition, has been largely neglected. Investigating how RGCs enhance user satisfaction through such human–AI collaboration offers valuable insights not only for improving game design, but also for advancing our broader understanding of effective human–AI teaming in high-stakes, information-rich contexts. Besides, given that information provision is central to RGCs, the differential impacts of information types remain unexamined. Clarifying how complementary and redundant information influence player experience can help distinguish the roles of different information types in human-AI collaboration within gaming contexts, thereby supporting the optimization of RGC design and coordination strategies. Therefore, we propose the first research question: *RQ1. To what extent does complementary information (vs. redundant information) provided by RGCs influence players' game satisfaction?*

To better understand how complementary and redundant information provided by RGCs affects the user experience, we propose that their ability to deliver unsolicited information in real time may generate unexpected insights that evoke delight and curiosity, which is known as *perceived serendipity* (Kim et al., 2021). Unlike in traditional recommender system contexts, where serendipity happens in relatively calm environments (Mora-Cantallops & Sicilia, 2018), serendipity in gaming scenarios evokes players' sense of excitement and emotional arousal during high-pressure and intense matches, which is a critical facilitator that enhances players' ability to recognize and exploit opportunities within tight cognitive and temporal limits and shapes their overall gameplay experience (Schmitt et al., 2018). While serendipity has been acknowledged as a critical driver in enhancing user experiences in intelligent systems (McCay-Peet & Toms, 2015), its impact in high-stakes and competitive environments, especially MOBA games, remains underexplored. Exploring how serendipity functions in this context helps reveal the psychological mechanisms through which information affects players. Therefore, this study examines how perceived serendipity mediates the effect of information type on game satisfaction.

Furthermore, while identifying information types and examining their impact on game satisfaction is a valuable step toward understanding the mechanism of RGCs, it is also essential to incorporate game-specific factors to better capture the unique dynamics of MOBA gameplay. In particular, players in MOBA games vary widely in skill and experience, which leads to significantly different gameplay experiences (Johnson et al., 2015). Therefore, in this study, we have to consider this particular key factor in the RGC scenario: Players' game performance. Perceived performance reflects players' strategic ability and adaptability, shaping how they respond to real-time gameplay information (Ko & Park, 2021). High-performing players typically possess more extensive gameplay experience, which enables them to recognize the significance of overlooked information, integrate prior knowledge more effectively, and seize opportunities that lead to surprising and meaningful experiences (McCay-Peet & Toms, 2015). They are also more adept at identifying informational gaps and processing complex cues for decision-making (Gao et al., 2025), which can evoke stronger emotional responses and contribute to a more engaging gaming experience. Therefore, we propose the second research question: *RQ2. To what extent does perceived game performance moderate the impact of information types on perceived serendipity, as well as the impact of perceived serendipity on game satisfaction?*

To address these research questions, we develop a research model to examine how information types provided by RGCs (complementary vs. redundant) influence players' game satisfaction through perceived serendipity, and how perceived game performance moderates the relationships between them. Following a review of the theoretical background, we present a scenario-based experiment involving 272 participants to

test our hypotheses. We then discuss the results and conclude with reflections on the study's theoretical contributions, practical implications, and limitations.

2. Theoretical background and hypotheses development

2.1 Complementarity and redundancy

Complementarity and redundancy are widely used concepts in collaborative contexts, originally derived from ecological research. In this domain, they describe whether species play similar (i.e., redundant) or distinct (i.e., complementary) roles in delivering specific functions or services within an ecosystem (Wilkinson et al., 2018). These concepts have since been applied across various fields, such as pathology (Mastellos et al., 2024) and resource management (Li & Tuunanen, 2022). Across these domains, complementarity and redundancy emphasize the match between collaborative elements. For instance, during resource integration, resources that differ in quality or type can be complementary, while those that are similar and increase the overall volume can be considered redundant (Li & Tuunanen, 2022).

In this study, we apply these concepts to MOBA games, where RGCs support human–AI collaboration and players integrate multiple information sources during gameplay. In such collaboration, RGCs act as supportive agents by providing players with timely in-game information to aid decision-making. However, due to the complexity and cognitive intensity of MOBA gameplay (Schmitt et al., 2018), players are often overwhelmed by simultaneous information streams, while RGCs can only deliver limited prompts. When the information provided by an RGC fills a gap in the player's situational awareness—highlighting something overlooked but critical—it complements the player's existing knowledge (Li & Tuunanen, 2022). Conversely, when the RGCs reiterate what the player has already noticed, although the information is significant, it becomes redundant (Endres et al., 2015; Li & Tuunanen, 2022). Although prior studies have examined how information quality and its type affect user experience (Ghasemaghaei & Hassanein, 2015; Li & Tuunanen, 2022), they have largely focused on the intrinsic characteristics of the information itself. However, the match between users' cognitive states and the system-delivered information has received limited attention, which is a critical factor in cognitively intense environments like MOBA games.

Building on this perspective, we classify the information delivered by RGCs into *complementary* and *redundant* types, providing a theoretical lens to examine how such distinctions shape players' experiences and satisfaction in fast-paced, high-stakes gaming environments. Specifically, *complementary information* refers to important content provided by RGCs that reminds players of critical aspects they may have overlooked during gameplay (Soda & Furlotti, 2017), while *redundant information* refers to similarly important content that RGCs highlight but that players have already noticed or are aware of (Ari et al., 2014). This classification provides a theoretical lens to understand how different forms of information given by RGCs influence player experience in fast-paced, information-intensive environments.

In cognitively demanding environments like MOBA games, where players must continuously integrate and respond to a large volume of dynamic stimuli, the ability to surface overlooked yet critical information offers clear strategic advantages (Schmitt et al., 2018). Such inputs can improve decision-making efficiency, as well as generate a sense of competence, which are key drivers of satisfaction during game playing (Reeves et al., 2009). In contrast, redundant information reiterates what players have already processed or are aware of, and while it may serve a confirmatory function (Ari et al., 2014), its marginal utility is limited in high-pressure, time-sensitive contexts. In some cases, it may even lead to cognitive fatigue or frustration by crowding limited attentional resources with non-novel cues, thus diminishing the perceived usefulness of the RGC and undermining overall satisfaction. Therefore, we propose that:

H1: *Complementary information (vs. redundant information) from RGCs has a greater impact on game satisfaction.*

2.2 Serendipity theory

Serendipity refers as the notion of surprising discovery that results from unplanned moments in which our decisions and actions lead to valuable outcomes (Busch, 2024), which plays a major role for individuals and organizations alike (Denrell et al., 2003; Kim et al., 2021). Many individuals and organizations credit serendipity as essential to their success, allowing for unexpected new products and services, insights, and market spaces (Pina e Cunha et al., 2015; Von Hippel & Von Krogh, 2016). Previous studies have explored the role of serendipity in various fields, such as entrepreneurship (Busch & Barkema, 2022; Dew, 2009), information seeking (Oh et al., 2022; Workman et al., 2014), and human-AI interaction (De Gemmis et al., 2015; Webber et al., 2024). The emergence of serendipity typically involves three key conditions: agency, surprise, and value (Busch, 2024). Briefly, agency involves intentional actions—such as being

prepared or able to spot and act on opportunities—that support unexpected discoveries; surprise is when something unplanned happens and causes mild amazement or curiosity; and value refers to the benefit gained, whether practical or simply finding something interesting (Busch, 2024).

The alignment between information provision and users' unarticulated cognitive needs can evoke surprise, a visceral response to unexpected yet contextually relevant stimuli (Reisenzein et al., 2019). In MOBA games, complementary information uniquely fulfills this role by addressing critical informational gaps that players may overlook under the context of high cognitive load (Schmitt et al., 2018), contrasting sharply with redundant information, which merely repeats known facts. When RGCs provide complementary information, they fill in these critical gaps by surfacing context-relevant insights that the player has missed. This information is often unexpected yet highly relevant—precisely the combination that fosters a sense of serendipity. In summary, complementary information (vs. redundant information) satisfies the key conditions of agency, surprise, and value. It aligns with players' active information-seeking (agency), highlights unexpected yet relevant cues (surprise), and aids strategic decision-making (value) (Busch, 2024). In contrast, redundant information lacks novelty and instrumental benefit, making it less conducive to serendipitous experiences. Thus, we propose that:

H2: *Complementary information (vs. redundant information) from RGCs has a greater impact on perceived serendipity.*

H3: *Perceived serendipity mediates the effect of complementary information (vs. redundant information) on game satisfaction.*

2.3 The moderating role of perceived game performance

Perceived game performance of players reflects their ability to execute strategies and achieve goals in the context of MOBA games (Ko & Park, 2021). High-performing players are more capable of recognizing the latent value of complementary information compared to their lower-performing counterparts (Gao et al., 2025). They are also more skilled at identifying connections between external information and their own knowledge and experience, making them more likely to act on such cues and derive valuable outcomes (McCay-Peet & Toms, 2015). As a result, these players are more likely to experience serendipity, as they can interpret unexpected but relevant information as meaningful triggers, which amplifies the psychological impact of complementary information. In summary, we propose that:

H4a: *Perceived game performance moderates the relationship between complementary information (vs. redundant information) and perceived serendipity.*

Additionally, high-performing players tend to exhibit greater confidence in their abilities (Hollenbeck & Hall, 2004), and are more likely to attribute positive outcomes to their own skills rather than external factors (Zuckerman, 1979). Although information provided by RGCs can support in-game analysis and decision-making, high-performing players often credit their success to their own ability to detect and integrate information, make timely decisions, and execute precise gameplay actions (Hollenbeck & Hall, 2004). Moreover, players frequently derive satisfaction from demonstrating and enhancing their personal competencies during gameplay (Ryan et al., 2006; Wigfield & Eccles, 2000). Therefore, when serendipitous moments occur, high-performing players are more likely to perceive them as meaningful outcomes of their own skill, which in turn amplifies their game satisfaction. In contrast, players with low perceived performance are less confident and may view serendipitous information as merely luck or external help rather than their own capability, which does not significantly boost their satisfaction. Thus, we propose that:

H4b: *Perceived game performance moderates the relationship between perceived serendipity and game satisfaction.*

Figure 1 depicts the overarching research model.

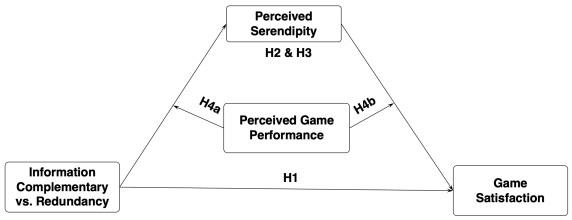

Figure 1. Research Model.

3. Phase 1: text analyzing

Honor of Kings is a MOBA mobile game developed by TiMi Studios. Its publisher Tencent Games has released Honor of Kings (henceforth HoK) in 2015 and it has become the most popular MOBA game in Chinese mainland. By 2017, the daily active players and monthly active players in HoK have reached over 80 million and 200 million, respectively (Yao & Chen, 2022). In February 2024, Honor of Kings introduced Lingbao as a game companion to accompany players throughout their gaming experience.

Douban (www.douban.com) is an online community where users can create content and interact

with others through group discussion. Established in March 2005, it had over 200 million registered users by the end of 2019. After searching for the keyword "Lingbao" in the "Honor of Kings" group discussion and filtered out posts related to the game performance of "Lingbao," ultimately retaining 76 valid posts for analysis. All 76 valid posts were written in Chinese, with an average length of 30.18 characters per post. The content of the posts focused on Lingbao's gameplay-related features, including users' opinions, levels of preference or dislike, and underlying reasons. Using Jieba for text segmentation, we identified the five most frequently occurring nouns: "Lingbao" (24 times), "voice" (24 times), "gameplay" (13 times), "feeling" (10 times), and "sound" (9 times). Subsequently, two raters coded the terms using preestablished coding criteria and category descriptions. This resulted in an inter-rater agreement of 90.79 %. The inter-rater agreement follows the recommended 90% benchmark for coder consistency (MacPhail et al., 2016).

The analysis results confirmed two types of information provided by "Lingbao", which is aligned with what we have discussed before. Specifically**,** the posts indicated that "Lingbao" provides *complementary information* by reminding players of crucial details they might have overlooked during a match. This additional layer of support enables players to make better decisions and take more effective actions: "*I feel that sometimes it's quite useful. Once it reminded me that the enemy marksman on the lane had gone missing, and it turned out they had all gone to the mid-lane bushes to gank...".* In contrast, "Lingbao" sometimes provides *redundant information* that players already know, which can be particularly annoying: "*It's really a bit noisy, feels like it's just repeating what I've already done.*". Based on these two types of information, we developed a research model, which was verified through a scenario-based experiment (Phase 2)

4. Phase 2: quantitative study

4.1 Data collection procedure.

A scenario-based, between-subjects experiment (complementary information vs. redundant information) was employed to test our hypotheses. To ensure the validity of the experimental materials, we collected 80 questionnaires on Credamo, an online platform for targeted participant recruitment, for the pilot experiment. The result shows that the manipulation of information type of RGCs was effective.

We then conducted the main experiment using stimulus materials that passed the pretest and distributed the questionnaire via Credamo. Respondents were screened based on their most frequently played MOBA and relevant game-specific questions. This approach allowed us to manipulate complementary versus redundant information while maintaining experimental control, a well-established method for examining causal relationships in gaming research.

In the scenarios, participants were asked to imagine themselves playing a MOBA game accompanied by an RGC called "XiaoBao." Then, participants were randomly assigned to one of the two MOBA game scenarios: an RGC reminding the player of the details of the game before they are aware of it (complementary information) or repeating reminders after the player has already realized the details (redundant information). Attention check questions were asked. The valid sample after screening is 272. The detailed sample demographic description is in Table 1.

Table 1. Demographics.

		Frequency	%
Gender	Male	125	46%
	Female	147	54%
Age	< 20	9	3.3%
	21-30	159	58.5%
	31-40	90	33.1%
	> 40	14	5.1%
Education	High school or below	3	1.1%
	College	14	5.1%
	University	181	66.5%
	Master or above	74	27.2%
Experience of MOBA game	< 1 year	5	1.8%
	1-3 years	30	11%
	3-5 years	95	34.9%
	5-10 years	124	45.6%
	> 10 years	18	6.6%

4.2 Measures.

After reading the scenario, participants were directed to answer a questionnaire about their reactions to this experience. All measurement items employed in this study are derived from prior studies and have been appropriately modified to align with the specific context of our investigation. A seven-point Likert-type scale was adopted to measure all variables. The details are in Appendix A. Appendix B illustrates the scenario setting.

4.3 Data analysis and results.

The independent samples t-test results showed that the manipulation of the two information types in the context of RGCs was successful. Participants in the complementary information group rated the complementary information of game companion

significantly more favorably than participants in the redundancy information group ($M_{complementary\ information}$= 5.7, SD = 1.205 vs $M_{redundancy\ information}$ = 2.33, SD = 1.354, t = 21.649, p < 0.001). Participants' ratings of the redundancy information of game companion were significantly greater in the complementary information group than in the redundancy information group ($M_{complementary\ information}$= 2.32, SD = 1.145 vs $M_{redundancy\ information}$ = 5.55, SD = 1.324, t = −21.596, p < 0.001). Moreover, participants also indicated that the situation described in the scenario was real (M = 6.16) and that it was easy to imagine themselves in the situation (M = 6.02). Results show that all factor loadings exceed the threshold of 0.7, ranging from 0.814 to 0.930 (Fornell & Larcker, 1981). The values of composite reliability (CR) and average variance extracted (AVE) meet the recommended criteria of 0.7 and 0.5 (Fornell & Larcker, 1981). Table 2 shows that the value of each square root of the AVE on the diagonal is much greater than the corresponding inter-construct correlations below it.

We conduct one-way ANOVA test to test H1 and H2. Results showed a significant effect of information type on game satisfaction: Complementary information (vs. redundant information) led to enhanced game satisfaction ($M_{complementary\ information}$= 5.98, SD = 0.568 vs $M_{redundant\ information}$ = 4.83, SD = 1.617, F = 125.962, p < 0.001). Results also showed a significant effect of information type on perceived serendipity: Complementary information (vs. redundant information) led to enhanced perceived serendipity ($M_{complementary\ information}$= 5.68, SD = 0.566 vs $M_{redundant\ information}$ = 3.11, SD = 1.470, F = 335.262, p < 0.001). Next, we used SPSS 27.0 and PROCESS Model 4 to test H3. We made gender, age, education, and experience of MOBA game covariates. The total effect of information type on game satisfaction was significant (β = −1.130, SE = 0.152, t = -7.431, p< 0.001), but after introducing the perceived serendipity as mediator, the direct effect of information type on game satisfaction became nonsignificant (β = 0.043, SE = 0.207, t = 0.209, p = 0.835). The standardized indirect effect of information type on game satisfaction through perceived serendipity was statistically robust (β = -0.849, SE = 0.876, BootCI [-1.032, -0.685]). Therefore, we conclude that perceived serendipity fully mediates the effect of information type on game satisfaction. Then, we used PROCESS Model 58 to test H4a and H4b. Results revealed the significant moderating effects of perceived game performance on the relationship between information type and perceived serendipity (β = -0.392, SE = 0.120, t = -3.262, p<0.01) and the relationship between perceived serendipity and game satisfaction (β = 0.096, SE = 0.037, t = 2.628, p<0.01). Figure 2 and 3 show the moderating effects of perceived game performance. All the hypotheses are supported.

Table 2. Discriminant validity.

	PS	GS	PGP
Perceived Serendipity (PS)	**0.917**		
Game Satisfaction (GS)	0.573	**0.917**	
Perceived Game Performance (PGP)	-0.020	-0.072	**0.850**

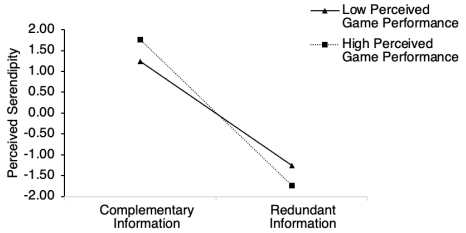

Figure 2. Moderating effect of PGP (a)

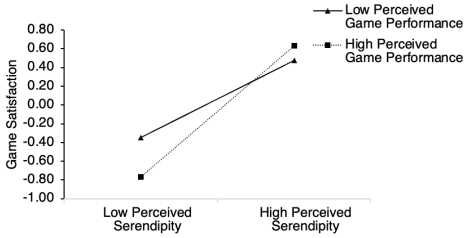

Figure 3. Moderating effect of PGP (b)

5. Conclusions and discussions

5.1 Key findings

This study conceptualizes complementary and redundant information in RGCs and examines how they influence game satisfaction via perceived serendipity, with perceived game performance as a moderator. The results illustrate that complementary information (vs. redundant information) from RGCs has a greater impact on both game satisfaction and perceived serendipity, and perceived serendipity mediates the effect of complementary information (vs. redundant information) on game satisfaction. Besides, Perceived game performance moderates the relationship between complementary information (vs. redundant information) and perceived serendipity, and the relationship between perceived serendipity and game satisfaction.

5.2 Theoretical contribution

This study contributes to the advancement of theoretical development in three aspects within the field of human-AI collaboration during gameplaying by conceptualizing complementary information and

redundant information, and integrating serendipity theory and perceived game performance to discover the different impacts of information types given by RGCs on game satisfaction in MOBA games. First, this study contributes to the human-AI collaboration literature by extending the concepts of complementarity and redundancy, which are originally developed in the field of ecology (Wilkinson et al., 2018), to the context of real-time game collaboration. Specifically, we apply these concepts to the interaction between players and RGCs, and propose two distinct types of in-game information: complementary information and redundant information. Unlike prior research that primarily focuses on the characteristics of information itself (Ghasemaghaei & Hassanein, 2015; Li & Tuunanen, 2022), our research emphasizes the match between the information provided by the RGC and the information already gained by the player. By conceptualizing this match, we offer a novel perspective on human–AI collaboration in games, highlighting how the complementary or overlap of informational contributions shapes user experience and cognitive processing.

Second, this study extends serendipity theory (Busch, 2024; Dew, 2009; Yaqub, 2018) to the context of RGCs, which is a high-pressure and fast-paced environment rarely explored in prior serendipity research. By linking information types (complementary vs. redundant) to players' perceived serendipity, we unearth how different types of information can shape user experience. Our findings highlight the critical role of perceived serendipity in influencing game satisfaction under competitive gaming conditions, revealing its full mediating effect between information type and user outcomes. This integration broadens the theoretical scope of serendipity and underscores its significance in high-stakes, real-time decision-making contexts.

Third, this study clarifies the boundary of application of serendipity theory by introducing perceived game performance as a context-specific factor and examining its moderating role in the relationships between information type, perceived serendipity, and game satisfaction, complementing the predominant focus on the direct performance effect of player's performance in prior research (Gong et al., 2024; Ko & Park, 2021). By addressing the conditional effects of performance perception, this research moves beyond the impact of information provision and highlights how individual performance levels shape their perception of serendipity and game experience in competitive gaming. As such, our findings provide a starting point for refining the theoretical boundaries of serendipity in goal-driven, high-pressure human–AI collaboration contexts.

5.3 Practical implications

This study offers several practical implications. First, developers should tailor RGC information to minimize redundancy and improve the gaming experience. They could gather players' in-game information needs through surveys to optimize the content and timing of reminders, or allow players to customize the type of information they receive to better match individual preferences and habits, increasing the chance that RGC information is seen as complementary rather than redundant.

Second, RGCs can be personalized according to players' performance levels. Since performance moderates both the effect of information type on perceived serendipity and the effect of serendipity on satisfaction, developers could design different levels of informational support. For instance, novice players may benefit from more frequent and detailed reminders with guided tutorials, while experienced players may prefer lighter, more selective support. Such adjustments can help balance the gaming experience across varying skill levels.

5.4 Limitations and future research

This study has limitations that point to future research. First, this study only examines the general effects of RGC information types, without accounting for other contextual factors. For example, in MOBA games, future research could explore how players' perceptions of RGC information differ when the team is ahead versus behind. Second, players' interactions with RGCs may vary by gaming motivations. Some play for companionship or pastime, while others seek competence or control. Future research could segment players to analyze their responses more precisely. Third, RGCs' vocal style may influence players' perceptions, warranting future research on voice variations and their effects on receptiveness and engagement. Moreover, our scenario-based survey may not capture the attentional demands of real gameplay, limiting ecological validity. Real-time experiments or field studies could better validate the effects of information complementarity and redundancy.

6. Acknowledgement

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7. Appendices

Appendix A. Item analysis

Table. Item analysis with factor loading, composite reliability, and average variance extracted.

Construct and items		Factor loading	CR	AVE
Perceived serendipity (PE) Yi et al. (2017)			0.955	0.840
PE1	XiaoBao's voice announcements helped me discover some game details that suit my needs but I had not planned for.	0.929		
PE2	XiaoBao's voice announcements provided some unexpected but useful findings.	0.930		
PE3	In the game process, I encountered many good combat suggestions that were worth a try but were beyond my initial tactical plans.	0.892		
PE4	The game experience provided me with some surprising yet interesting findings about the match in the process.	0.915		
Game satisfaction (GS) Chen and Wang (2016)			0.941	0.841
GS1	I am satisfied with the experience provided by this MOBA game.	0.938		
GS2	This MOBA game is a good choice for entertainment.	0.925		
GS3	The experience of this MOBA game meets my expectations.	0.934		
Perceived Game performance (PGP) Ko and Park (2021) Relative to other MOBA game players…			0.929	0.723
GP1	I average higher scores per game than most.	0.848		
GP2	I am in the top 30% of the players in the game.	0.839		
GP3	I manage my playing better than most.	0.872		
GP4	I know more about this game.	0.785		
GP5	I get better game tips than most of the other players	0.903		

Appendix B. Scenario setting

"Please imagine the following scenario based on your own experience: You are playing a MOBA game alone, as you usually do. Your teammates are randomly matched strangers. In this match, you have chosen the hero you are most skilled at. During the game, a virtual assistant named "Xiaobao" is always present with you. At certain moments during the match, it delivers voice messages to you. When delivering these messages, Xiaobao briefly appears in a corner of the game interface as an anthropomorphized character. At other times, Xiaobao does not appear on the screen. This feature is freely available to all players. You have not spent any extra money or time to access Xiaobao. Please use your imagination and place "Xiaobao" into the gameplay context of the MOBA game you play most often:"	
Scenario 1: Complementary Information	
Based on real-time in-game information, Xiaobao gives you voice alerts about certain details you might have missed or aren't familiar with. Here are some examples: (1) When an enemy player disappears from your vision and you haven't noticed, Xiaobao says: *"An enemy has gone missing! Stay alert~"* (2) When your team's total kills surpass the enemy's and you haven't realized it, Xiaobao says: *"We've overtaken them in kills! Let's keep it up!"* (3) When you're unsure which item to purchase, Xiaobao says: *"Buying Item A can really boost our power. We're definitely going to win~"* (4) When you're about to fight an enemy but unsure how to respond, Xiaobao says: *"We can wait until they use their movement skill before using ours — that way we'll definitely win!"*	Based on real-time in-game information, Xiaobao gives you voice alerts about certain details you might have missed or aren't familiar with. Here are some examples: (1) When an enemy player disappears from your vision and you don't notice, Xiaobao says: *"Oh come on~ The enemy slipped away and you didn't even see it?"* (2) When your team's total kills surpass the enemy's and you haven't realized it, Xiaobao says: *"We're ahead in kills now! Did the other team all disconnect or are they just lagging out~?"* (3) When you're not sure which item to buy, Xiaobao says: *"Go straight for Item A—let's crush them so hard they teleport back to base crying!"* (4) When you're about to fight an enemy player and don't know how to handle it, Xiaobao says: *"Wait for them to use their movement skill, then hit them with ours. If that's too hard, maybe it's time to uninstall the game~"*
Scenario 2: Redundant Information	

Based on real-time in-game information, Xiaobao still delivers voice alerts even when you have already noticed or become aware of certain in-game details. Here are some examples: (1) When you've already noticed that an enemy has disappeared from your vision, Xiaobao still says: *"An enemy has gone missing! Stay alert~"* (2) When you've already seen that your team's total kills have surpassed the enemy's, Xiaobao still says: *"We've overtaken them in kills! Let's keep it up!"* (3) When you've already decided to buy Item A, Xiaobao still says: *"Buying Item A can really boost our power. We're definitely going to win~"* (4) When you're about to engage an enemy player and already know exactly how to deal with them, Xiaobao still says: *"We can wait until they use their movement skill before using ours — that way we'll definitely win!"*	Based on real-time in-game information, Xiaobao still delivers voice alerts even when you have already noticed or become aware of certain in-game details. Here are some examples: (1) When you've already noticed that an enemy has disappeared from your vision, Xiaobao still says: *"Oh come on~ The enemy slipped away and you didn't even see it?"* (2) When you've already seen that your team has a gold lead over the enemy, Xiaobao still says: *"We're ahead in kills now! Did the other team all disconnect or are they just lagging out~?"* (3) When you've already decided to buy Item A, Xiaobao still says: *"Go straight for Item A—let's crush them so hard they teleport back to base crying!"* (4) When you're about to fight an enemy and already know exactly how to handle it, Xiaobao still says: *"Wait for them to use their movement skill, then hit them with ours. If that's too hard, maybe it's time to uninstall the game~"*

7. References

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