

No player is an island: Belonging, identity and skill in online game teams[☆]

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ABSTRACT

Team-based online multiplayer games have created virtual environments where social dynamics shape both team and individual performance. Although prior research has emphasized the cooperative nature of online multiplayer games, less is known about how players' group identity influences both group outcomes and individual performance development. Drawing on Social Identity Theory and the Transfer of Learning framework, this study examines how group identity translates into group performance and how group-based performance subsequently contributes to individual performance. Using large-scale, time-series behavioral log data from the online game *World of Tanks*, the research analyzes how these relationships vary across player–group contexts. The results show that players' identity with their groups positively predicts group performance and that this relationship is moderated by group competence but not by player skill alone. In contrast, the transfer of group performance to subsequent individual performance depends on the joint configuration of player skill and group competence rather than on either factor independently. Group performance also serves as a mediating mechanism linking group identity to later individual performance. In keeping with previous research, these findings support the idea that online game teams function simultaneously as identity-based social contexts and learning environments. The results advance game research by providing large-scale, temporally ordered evidence of how collective experiences translate into individual outcomes within multiplayer game settings.

1. Introduction

The rapid advancement of digital technology has significantly transformed the video game industry, particularly with the growth of shared online gaming environments. Online games allow players to interact with others in shared virtual spaces that transcend geographic boundaries. Reports indicate that these online games are thriving in the global market, attracting an estimated 1.2 billion people worldwide [1]. In 2025, the global online gaming market generated approximately 225.28 billion U.S. dollars in revenue, projected to reach 501.91 billion U.S. dollars by 2034 [2].

Among the many forms of online games, team-based multiplayer games represent a major gameplay environment in which players collaborate with teammates while competing against opposing teams in shared virtual spaces [3,4]. These environments function as social systems where players coordinate strategies, share information, and synchronize their actions to achieve in-game goals [3–5]. Success is often rewarded at the group level, reinforcing cooperation and sustained engagement among team members regardless of physical proximity

[5–7]. These games are usually organized around relatively stable social structures, such as clans or guilds, that facilitate repeated interaction among players [3,4,8,9]. Through these repeated interactions, players develop shared norms, expectations, and collaborative routines that shape group performance, defined as the collective outcomes achieved through the coordinated actions of group members [10–12]. Such repeated interaction also fosters social bonds and a sense of community among players, including perceived belonging and emotional attachment to other members of the group [6,11,13,14]. However, team-based online multiplayer games such as *World of Tanks* also include match-making environments, where players enter individually and coordinate with temporary teammates who change across matches. These temporary team settings differ from stable group-based contexts because players coordinate with teammates without belonging to a stable shared group.

Building on this view of team-based online multiplayer games as social systems, Social Identity Theory (SIT; [15]) provides a useful framework for understanding how individuals' perceptions of group membership shape their engagement in collective performance. Within

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this framework, the group identification process refers to the psychological mechanism through which individuals perceive the group as part of their self-concept [15]. Through this process, individuals develop group identity, which reflects the extent to which membership in a group becomes integrated into an individual's self-concept [15]. Specifically, in the gaming context, players who feel a strong group identity tend to invest more effort in coordinated tasks and contribute more consistently to collective goals [5,11], leading to improvements in overall group (team) performance [10–12]. Given that group identity serves as a key mechanism explaining collective behavior, it may help explain why some teams are able to achieve higher group performance than others. This relationship is particularly relevant in contemporary environments where many activities are organized around collaborative teams [16,17]. A large body of literature has emphasized the importance of studying group performance in such group-based environments [17–21], as effective group outcomes depend on the interdependent efforts of individuals pursuing a shared objective [16]. Team-based multiplayer online games provide a useful context to examine these processes in that they involve large numbers of players interacting and coordinating their actions to achieve shared objectives [3–5]. Beyond serving as interaction-rich environments, these games have been conceptualized in prior literature as mediated social spaces that capture dynamics of real-world social relations [22–24]. Accordingly, examining how players interact within online games can provide insights into broader social processes [25].

At the same time, factors beyond group identity may also influence group performance. For example, individual capability (e.g., players' gameplay skill) and group (team) competence may shape how players engage with their groups [26–30]. Group competence refers to the overall capability of a team to perform a task effectively [26,27]. Considering the potential influence of these contextual factors, little is known about whether the relationship between group identity and group performance differs across such conditions. Examining these contextual influences can help clarify how group performance may be enhanced in collaborative environments. Moreover, as noted above, because online games present interaction dynamics of real-world social systems [22–24], insights from this context may also inform our understanding of how the group identity–performance link operates in broader social settings.

Meanwhile, online games serve as informal learning environments where players acquire and refine skills that could be transferred to other contexts, drawn from the Transfer of Learning perspective [30–32]. As these games evolve into large-scale social systems characterized by extensive player interaction and coordination, there is a growing need to examine the mechanisms through which players develop skills in these environments. Prior research on Transfer of Learning suggests that group interactions create opportunities for individuals to acquire skills and knowledge that can later be applied to independent tasks, a phenomenon observed across workplace and academic environments [33–35]. However, few studies have explored how group performance, shaped by group identity, translates into individual performance in gaming contexts. Limited studies on players' individual performance have primarily been explained in terms of individual traits, which may fail to fully capture the learning dynamics embedded in team-based gaming environments [36–38]. Therefore, addressing this gap is imperative given the highly interactive nature of contemporary online games, where performance emerges through ongoing coordination among players in combination with their individual abilities [3–5,7]. Examining the relationship between group performance and individual performance can therefore clarify how team-level processes shape individual outcomes in team-based gameplay and provide insights for game design, particularly in understanding how collaborative systems support player development and sustained performance improvement.

Similar to the way player skill and group competence shape the relationship between group identity and group performance, these factors may also influence how group-based performance translates into

subsequent individual performance [35,39–42]. In gaming contexts, player skill may affect how effectively individuals internalize strategies encountered during group play [7], while group competence shapes the quality of coordination and strategic exposure available within the gaming group [43,44]. Consequently, the extent to which group performance contributes to subsequent individual performance may depend on the interplay between player skill and group competence. Identifying when and for whom group performance leads to individual improvement can provide valuable insights for designing collaborative game systems that better support player development and skill progression.

To address the aforementioned gaps, this study proposes a two-step process linking group identity and performance outcomes. First, we examine the influence of players' group identity on group performance (collective outcomes). Second, we examine whether performance experiences in group-based gameplay, where players play with familiar group members, translate into subsequent individual performance in random matchmaking battles, where team composition changes across matches. To further clarify the role of individual and social context in the identity–performance relationship, we analyzed how these pathways vary across player–group contexts by modeling player skill and group competence as continuous moderators.

By leveraging large-scale time-series game log data from *World of Tanks*, this study integrates Social Identity Theory and the Transfer of Learning framework to show how online game teams function simultaneously as social groups that shape group performance and as learning environments through which collective experiences translate into individual skill. The study also examines how these processes vary across player skill and group competence contexts.

2. Literature review

2.1. Social identity theory

Social Identity Theory (SIT) is a foundational framework in social psychology that explains how individuals construct, internalize, and express their sense of belonging to social groups [15]. Social identity (i.e., group identity) is defined as “part of an individual's self-concept which derives from his knowledge of his membership in a social group (or groups) together with the value and emotional significance attached to that membership” [15]. Within this framework, the identification process refers to how individuals come to perceive a group as part of their self-concept and develop psychological attachment to that group, through which group identity emerges as the integration of group membership into the individual's self-concept [15]. Prior research suggests that individuals who strongly identify with a group are more likely to engage in behaviors that enhance group cohesion, cooperation, and group performance [45], defined as the collective outcomes achieved through the coordinated actions of group members [5,46]. Consequently, SIT has been widely applied in studies of organizational behavior and teamwork to explain how group identity shapes group commitment, group dynamics, and group performance [5,46].

Several studies on online games have employed SIT as it is relevant in explaining how players develop group identities within long-term game teams (e.g., clans or guilds) and how these identities shape their engagement in those groups. Previous research has demonstrated that SIT effectively explains the players' identification processes within familiar online gaming groups [47]. Group identity can serve as an important motivation for players to join gaming groups (teams) in team-based online multiplayer games [48]. Players who play with familiar teammates often develop a strong group identity through repeated cooperation, shared goals, and group-level success [3,4,8,9]. This identification process promotes a sense of belonging and encourages players to internalize group goals and norms [5,49], fostering a stronger sense of responsibility for group performance [50] and then increasing their psychological investment in group performance [7,51].

Empirical evidence supports the positive relationship between strong group identity and group performance. Teams formed through pre-existing group affiliations (e.g., clans) tend to outperform those composed of unfamiliar individuals because shared identity fosters role commitment and strategic alignment [52,53]. Furthermore, groups with strong identity demonstrate improved performance over time by sustaining member engagement and reinforcing cooperative norms [7]. However, groups with a fragmented identity may struggle to achieve shared goals or sustain engagement over time.

In summary, when players strongly identify with their in-game group, they are more likely to internalize its success as their own and work toward collective goals. Group members with strong group identity enhance their contribution to coordinated efforts, thereby improving overall group performance [10–12]. Conversely, weak group identity may undermine group performance. Based on the studies rooted in SIT, this study hypothesizes that group identity is positively associated with group performance. Therefore, the following hypothesis is proposed:

H1: Players' group identity has a positive relationship with group performance.

2.2. Transfer of learning

Transfer of Learning is a theoretical framework that explains how knowledge acquired in one context is applied to another related context [35,54,55]. Prior research has emphasized that transfer is crucial in education, particularly when knowledge or skills acquired in one context are applied in contexts that differ from the original learning environment [35]. Transfer of Learning is commonly categorized into near and far transfer based on the similarity between learning and application contexts. Near transfer occurs when knowledge and skills are applied to closely related contexts, whereas far transfer involves the application of learned competencies to more distinct settings.

For example, in gaming contexts, near transfer may occur when skills acquired in team-based gameplay are applied to similar team-based situations. Far transfer, in contrast, can take multiple forms. One form involves applying skills developed in team play to individual gameplay performance, which requires players to abstract and reapply knowledge outside the immediate group context. Importantly, transfer processes are not inherently unidirectional [35]; skills acquired through individual play may also inform subsequent group performance. However, the present study focuses specifically on the transfer from group performance to individual performance, as its theoretical interest lies in understanding how group identity and collective performance translate into individual-level outcomes.

2.2.1. Transfer from group performance to individual performance

The concept of Transfer of Learning has been extensively examined in education and management research, where it is well-established that learning within a group setting can enhance individual performance through both cognitive and social mechanisms [40,56–59]. Group interactions create opportunities for individuals to acquire skills and knowledge that can later be applied to independent tasks, a phenomenon observed across workplace and academic environments [33,34]. Related work in gaming contexts similarly suggests that learning transfer is rooted in socially structured interaction rather than individual characteristics alone. Using longitudinal behavioral data from *World of Tanks*, a few studies have demonstrated that socially embedded player interaction can function as a learning environment through which performance improvements emerge [30,32]. Building on this literature, the present study conceptualizes group performance as a collective learning environment whose outcomes may subsequently influence individual gameplay performance.

However, despite the extensive literature on group learning in traditional domains, limited research has explored how team-based performance translates into individual (independent) performance

enhancement in gaming contexts. Existing studies on player performance primarily emphasize individual factors, such as player traits [36–38], rather than investigating whether skills developed in a team setting translate into individual outcomes. However, a large volume of contemporary online games is fundamentally structured around team-based gameplay (e.g., *League of Legends*, *Dota 2*, *World of Tanks*, *Valorant*, *Overwatch*), where performance emerges from the interaction between individual skills and team collaboration. Consequently, approaches that explain player performance solely in terms of individual factors may fail to fully capture the learning dynamics embedded in team-based gaming environments.

Furthermore, the limited research on individual player performance in team-based gameplay has produced findings that differ from those reported in traditional Transfer of Learning research mentioned above. Prior research has suggested that team-based gameplay can be particularly beneficial for lower-skilled players, as it provides a structured and supportive environment that facilitates skill acquisition [7]. Conversely, high-skill players may face challenges due to coordination costs and reliance on less-skilled teammates, potentially constraining individual performance gains. However, [60] found that gaming experience in team-based online games mitigates individual gameplay performance deterioration. Players with more teamplay experience exhibited less performance decline than those with less teamplay experience. However, the study noted that it remains unclear whether this mitigation stemmed from gameplay experience itself or from social factors.

Despite these insights, prior studies are limited in that they have not directly examined the relationship between group performance and individual performance. Rather, they have focused on measuring individual performance within team-based settings without explicitly assessing how team success translates into individual outcomes. Examining the directional relationship between group performance and individual performance, therefore, offers an important opportunity to understand how social interaction within team-based gaming environments contributes to learning and performance improvement. Moreover, investigating this relationship can provide insight into whether team-based gameplay functions not only as a cooperative activity but also as a learning environment that facilitates players' skill acquisition and performance development. Such findings may also have practical implications for game design, helping to clarify how collaborative structures or team-based training environments contribute to player growth and performance improvement.

To address this gap, the present study examines the directional relationship between group performance and subsequent individual performance, leveraging temporally ordered behavioral data to support causal inference (see [61]). The following research question is:

RQ1: How does group performance impact individual performance?

2.3. Combining SIT and transfer of learning

Given the combined insights of the two theoretical frameworks, prior research suggests that group performance may function as a bridge linking players' group identity to their subsequent individual performance. SIT posits that players with strong group identity tend to invest more effort, coordinate more effectively, and contribute meaningfully to their group's success [50,51]. Simultaneously, the Transfer of Learning literature indicates that skills and knowledge developed through coordinated group activity can generalize to individual tasks in related contexts [34,40]. Together, these two perspectives suggest a sequential process: (1) players who strongly identify with their group are more motivated to contribute to group performance, and (2) the experiences gained through successful group performance may subsequently enhance their individual play. Although the two theoretical traditions have not been jointly examined in gaming research, together they suggest a plausible mediating role for group performance in linking group identity to individual outcomes. Therefore, the following research

question is proposed to examine this potential mediation pathway:

RQ2: Does group performance mediate the relationship between group identity and players' subsequent individual performance?

2.4. Role of player skill and group competence in identity–performance processes

Prior work in Social Identity Theory–related game research suggests that the relationship between group identity and group performance is not uniform across players or groups, but is systematically shaped by the interplay between individual gameplay skill and group competence [26,27]. In the gaming context, group competence refers to the overall capability of a gaming team to perform effectively, reflecting the collective skills and abilities of the players within the team [26,27]. Classic SIT research demonstrates that individuals tend to strengthen their identity with successful groups while distancing themselves from poorly performing ones, indicating that group competence plays a central role in determining the extent to which group identity is maintained and enacted [26,27].

Game research provides parallel evidence that performance and identity are mutually reinforcing, but not equally so for all players. Large-scale behavioral analyses indicate that highly skilled players tend to strengthen their group identity when placed in high-performing teams but weaken their group identity when placed in low-performing teams, reflecting a classic pattern of status inconsistency [28,29]. Similarly, lower-skilled players tend to develop stronger identity attachment in structured and successful group contexts, where clear coordination and shared success provide a basis for sustained identity [7]. Taken together, prior research suggests that the extent to which group identity translates into group performance is conditioned by the interaction between players' gameplay skill and the competence of the group environment.

Meanwhile, the broader Transfer of Learning literature emphasizes that performance gains are not isolated outcomes but emerge from the interaction between individual characteristics, such as prior skill, and the structure of the learning environment, such as group competence [7,39,40]. Prior studies highlight that player skill shapes how individuals benefit from collective contexts. For example, [7] demonstrates that lower-skilled players tend to benefit more from structured team environments, as coordinated play provides guidance, feedback, and strategic cues that are less accessible during individual play. In contrast, higher-skilled players, who rely more heavily on established internal routines, may experience fewer incremental benefits from collective coordination.

Group competence further represents a critical environmental factor that determines the quality of learning and coordination opportunities available to players. High-performing teams tend to develop structured coordination systems, shared tactical norms, and efficient communication patterns. These features have been widely documented in empirical studies of group performance in games such as *League of Legends* and *World of Tanks* (e.g., [43,44]). These findings align with broader teamwork research showing that high-functioning groups cultivate stable routines and organized communication structures that facilitate learning and collective problem-solving [41,42]. In contrast, low-performing teams often exhibit fragmented communication and inconsistent strategies, creating environments that offer fewer opportunities for effective learning or collaborative skill development [43,44,62]. As a result, high-performing teams operate as more effective “communities of practice” [63,64], providing players with structured settings in which strategies and skills can be internalized through collective play.

Taken together, these perspectives suggest that both the relationship between group identity and group performance and the transfer from group-based performance to subsequent individual performance depend on the interplay between player skill and group competence. Moreover, because these two relationships may form a sequential process linking group identity to individual outcomes, the indirect effect of group identity on individual performance could also vary systematically across

different player–team configurations. Building on this theoretical framework, the present study examines how player skill and group competence jointly condition the relationships linking group identity, group performance, and subsequent individual performance. Accordingly, we advance the following hypotheses.

H2: The relationship between group identity and group performance is moderated by the interplay between players' gameplay skill and group competence.

H3: The transfer of performance from group-based play to subsequent individual performance will be moderated by the interplay between players' gameplay skill and group competence.

H4: The indirect effect of group identity on subsequent individual performance via group performance will be moderated by the interplay between players' gameplay skill and group competence.

Accordingly, the study models player skill and group competence as continuous moderators to examine whether the effects of group identity on group performance and subsequent individual performance vary across player skills and group competence. The overall research framework and hypothesized relationships are illustrated in the path model shown in Fig. 1.

3. Method

3.1. Study design and timeframe

Building on the hypothesized path model summarized in Fig. 1, this study adopts a longitudinal design to examine how players' group identity translates into group performance and, in turn, into subsequent individual performance. The design allows us to evaluate the directional pathways linking group identity, group performance, and subsequent individual performance (H1; RQ1–RQ2). In addition, the study examines whether these temporally ordered relationships vary across player- and group-level conditions by modeling player skill and group competence as continuous moderators. This approach enables us to assess how the relationships among group identity, group performance, and individual performance depend on the interplay between player skill and group competence (H2–H4).

To support directional inference along the proposed pathway, key constructs are measured at sequential timepoints. The study follows a four-stage longitudinal structure. Timepoint 0 (T0) captures baseline player skill and group (clan) competence as of January 31, 2024, including player skill level and group (clan) ranking. Timepoint 1 (T1), February 2024, measures group identity through group engagement behaviors. Timepoint 2 (T2), April to May 2024, assesses group performance via group-based battle outcomes. Timepoint 3 (T3), June to July 2024, measures individual performance based on outcomes from individual battles in which players play with teammates who do not have stable group membership. This temporal ordering ensures that group identity (T1) is measured prior to group performance (T2), which in turn precedes individual performance (T3), which helps mitigate concerns about reverse causality and supports the examination of

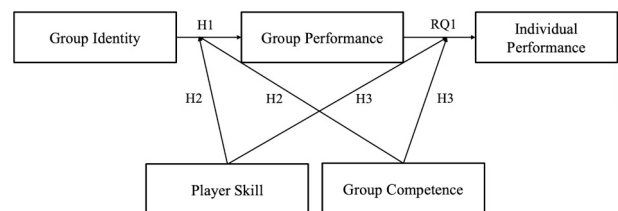


Fig. 1. Path Model of the Study. Note. Group performance mediates the relationship between group identity and individual performance (RQ2). Player skill and group competence moderate the indirect effect of group identity on individual performance through group performance (H4).

conditional and indirect relationships.

3.2. Research context: World of tanks

World of Tanks (WoT) is a team-based (player-versus-player) online multiplayer game developed by Wargaming, with a large and active global player base, providing a suitable context for examining identity-performance processes in competitive gameplay environments. As of 2024, *WoT* had approximately 8.78 million registered players and an estimated 12,500 daily active users, indicating sustained engagement within the broader team-based online multiplayer game ecosystem [65]. The game features a persistent clan system with relatively stable, long-term group membership, allowing repeated interaction among members and the development of enduring group identity. This structure aligns well with SIT's emphasis on ongoing ingroup membership and sustained social interaction within groups. In addition, *WoT* distinguishes between clan-based competitive gameplay and "random" matchmaking battles, where players are matched into teams for each battle based on tank type and power level. To isolate individual performance from pre-existing social ties, this study focuses specifically on solo-queue matchmaking battles, in which players enter the random matchmaking system individually rather than as part of a pre-formed group (known as a "platoon"). In this context, team composition changes across matches, and players typically do not share stable group membership, resulting in relatively weak group identity. As a result, repeated performance outcomes in solo-queue matchmaking battles provide a more stable indicator of players' individual performance. This structural distinction allows us to analytically separate group-based performance associated with stable team environments from individual-level performance.

3.3. Sample and data source

The study utilizes behavioral data from 4909 players on the North American server of *WoT*. The time-series dataset consists of anonymized player behavioral logs collected via the official *WoT* API. To ensure stable exposure to group contexts and sustained engagement, the analytic sample is restricted to active players who participated in at least one clan activity during January 2024 and remained within the same clan from January through July 2024. Players whose player skill rankings were coded as 0 were removed ($n = 3$), as these values may reflect technical errors or cases in which players had never participated in the types of battles used to calculate the ranking. Players who did not participate in clan battles ($n = 1200$) and solo-queue random battles ($n = 874$) during the corresponding time windows were also dropped. After these exclusions, the final analytic sample consisted of 2832 players.

An a priori mediation power analysis using Kenny's MedPower software [66] indicated that detecting the hypothesized indirect effect ($ab = 0.09$) with 0.80 power would require a minimum of 113 participants. Given that the final sample size substantially exceeded this threshold, the mediation analyses were adequately powered.

3.4. Operationalization of constructs

3.4.1. Group identity

Group identity is operationalized as the total duration of non-combat clan activities recorded in February 2024 (T1). This measure includes time spent on clan management activities, such as contributing to the maintenance and improvement of the clan's virtual infrastructure and resources, as well as time spent communicating with clan members via clan chat. These activities do not involve direct battle participation but instead capture players' voluntary, community-oriented involvement in their clan, independent of immediate gameplay outcomes. Given that group identity reflects psychological attachment to a group, engagement in clan-based community activities serves as a behavioral indicator of players' identification with the clan community as a social unit rather

than as a tactical battle team.

3.4.2. Group performance

Group performance is defined as a player's clan battle win rate between April and May 2024 (T2), based on participation in structured competitive clan battle modes. Specifically, this measure includes Skirmishes, Advances, and Global Map events, which are the three primary formats of coordinated clan combat that require clan-based tactical execution and strategic planning. All three modes require high levels of communication and strategic cohesion, making them ideal for capturing clan-level performance.

3.4.3. Individual performance

Individual performance was operationalized as players' solo-queue random (non-clan) battle win rate between June and July 2024 (T3). Solo-queue random battles in *WoT* are engagements where players are automatically matched with and against unaffiliated players, making outcomes primarily dependent on personal skill rather than pre-existing group coordination. A player's solo-queue random battle win rate from April to May 2024 (T2) was included as a lagged covariate to ensure that any change in individual performance reflected effects associated with group-based experiences rather than stable individual ability.

In addition, to rule out the possibility that changes in individual performance stem from players' gameplay experience in solo-queue random battles rather than learning derived from clan battles, the change in total solo-queue random battle playtime between April–May (T2) and June–July (T3) was included as a control variable. This control accounts for the alternative explanation that increased individual play frequency, rather than skill transfer from group-based contexts, may underlie improvements in individual performance.

3.4.4. Player skill

Player skill level is determined using the Global Rating scale, provided by the official *WoT* API. It is a composite measure of player performance, computed by comparing a player's key performance indicators for each vehicle to the expected values for that vehicle and then aggregating these vehicle-specific scores using battle counts as weights. Player skill is measured at baseline (T0). Because the present study focuses on how player- and group-level conditions shape the relationships among group identity, group performance, and subsequent individual performance, player skill was retained as a continuous baseline variable, measured at T0. Because the original ranking variable was coded such that smaller values indicated higher skill, the scale was inverted to facilitate interpretation. Specifically, the variable was recoded by subtracting each player's ranking from the sum of the minimum and maximum ranking values in the dataset ($min\ 941 + max\ 11,379 = 12,320$). This transformation reverses the ordering of the scale while preserving the original range and distribution of the variable, thereby maintaining its statistical properties while allowing higher values to represent greater player skill.

3.4.5. Group competence

Group (clan) competence is defined using the Clan Rating (CR) provided by the official *WoT* API. The CR aggregates clan-level performance across competitive modes, incorporating win rates, average damage, and participation rates. Group competence is conceptually distinct from group performance in that group competence reflects the overall capability of a group (e.g., clan), whereas group performance represents the realized outcomes of that capability in specific clan-based battles. CR was retained as a continuous baseline variable measured at T0. As with player skill, CR was inverted to facilitate interpretation so that higher values indicate greater group competence. Specifically, each CR value was recoded by subtracting it from the sum of the minimum and maximum ranking values in the dataset ($min\ 228 + max\ 12,196 = 12,424$).

3.5. Measurement

To test the proposed longitudinal pathways, we estimated two primary Ordinary Least Squares (OLS) regression models and a total-effect model used to clarify the mediation pattern. The first model (i.e., the *mediator model*) examined whether group identity at T1 predicted group performance at T2 and whether this association varied as a function of player skill and group competence. The second model (i.e., the *outcome model*) examined whether group performance at T2 predicted individual performance at T3, while adjusting for prior individual performance at T2, changes in individual random-battle playtime between T2 and T3, and group identity. This model also tested whether the group performance–individual performance association varied as a function of player skill and group competence. Group identity was retained in the outcome model to estimate the residual direct effect (*c'* path) from group identity to individual performance after accounting for group performance, allowing the indirect effect of group identity on individual performance through group performance to be estimated within a mediation framework [38,60]. Both player skill and group competence were modeled as continuous moderators. All variables used in the regression analyses were standardized prior to estimation.

To interpret the interaction terms, conditional effects were tested at three reference values for each moderator: one standard deviation below the mean, the mean, and one standard deviation above the mean of player skill and group competence, following procedures for probing interaction effects [67]. At these reference values, the conditional slopes of the *a*-path (group identity → group performance) and the *b*-path (group performance → individual performance) were computed, and the corresponding conditional indirect effects (*a* × *b*) were derived from the fitted regression models.

The statistical significance of the indirect effect, including conditional indirect effects, was evaluated using bootstrap confidence intervals based on 5000 resamples [68]. Bootstrap confidence intervals were also used to assess the significance of the conditional slopes derived from the interaction models [69]. To distinguish the indirect pathway from the total and residual direct effects, we also estimated a total-effect model that excluded group performance from the outcome model while retaining the same covariates and allowing the group identity–individual performance association to vary by player skill and group competence.

All analyses were conducted in Python 3.11 using *statsmodels* for OLS estimation, *scikit-learn* for standardization, and custom scripts based on *pandas*, *NumPy*, and *statsmodels'* formula API for bootstrap-based conditional effect estimation.

4. Results

Based on the proposed theoretical framework and prior empirical findings, this study employed two primary OLS regression models (i.e., the *mediator* and *outcome models*) to examine how the relationships among players' group identity, group performance in team-based gameplay, and individual performance varied across player- and group-level conditions. To clarify the mediation pattern, a total-effect model was also estimated by excluding group performance from the outcome model. The analysis draws on a large-scale time-series behavioral log dataset ($N = 2832$) provided by the game developer (*War-gaming*). Throughout the results section, references to lower, mean, and higher values of player skill or group competence refer to one standard deviation below the sample mean, the sample mean, and one standard deviation above the sample mean, respectively, and are used to test continuous interaction effects.

4.1. Descriptives

Descriptive statistics for the study variables are presented in Appendix A. Overall, players showed substantial variability in both battle

participation and performance. Group identity, measured by time spent on non-battle clan activities, displayed a wide range ($M = 253.60$ min, $SD = 338.38$). Group performance, measured by clan battle win rate, averaged 44.30% ($SD = 19.37$), while individual performance, measured by random battle win rate, averaged 50.02% ($SD = 10.29$).

4.2. Model diagnostics

Prior to interpreting the regression estimates, we assessed the core assumptions of the two OLS models (the *mediator* and *outcome models*). Variance inflation factors (VIFs), which assess multicollinearity among predictors, were consistently low (mediator model: $VIFs < 1.47$; outcome model: $VIFs < 1.90$), suggesting no meaningful multicollinearity among predictors. No evidence of residual autocorrelation was observed, with Durbin-Watson statistics close to 2.00 in both models.

However, diagnostic tests revealed violations of normality and heteroscedasticity in both models. Jarque–Bera tests, which assess whether residuals depart from normality based on skewness and kurtosis, indicated significant departures from normal residual distributions (*Jarque–Bera* = 102.26 ($p < .001$) for the mediator model and *Jarque–Bera* = 1888.35 ($p < .001$) for the outcome model), with notable skewness and excess kurtosis. Breusch–Pagan tests, which assess whether residual variance is constant across fitted values, also indicated heteroscedasticity in both the mediator model (*Breusch–Pagan* $\chi^2 = 394.48$, $p < .001$) and the outcome model (*Breusch–Pagan* $\chi^2 = 176.01$, $p < .001$). Given these violations, all regression models were estimated using HC3 heteroskedasticity-robust standard errors [69,70]. Indirect and total effects were computed via nonparametric bootstrapping with 5000 resamples, an estimation approach that does not rely on normality assumptions [68,71].

4.3. Impact of group identity on group performance (H1 and H2)

We first examined whether group identity predicted group performance (i.e., the *mediator model*). Consistent with H1, group identity was positively associated with group performance ($\beta = 0.313$, $SE = 0.011$, $z = 27.59$, $p < .001$). Player skill ($\beta = 0.120$, $SE = 0.015$, $z = 7.75$, $p < .001$) and group competence ($\beta = 0.278$, $SE = 0.015$, $z = 18.97$, $p < .001$) were also positively associated with group performance. The model explained 27.0% of the variance in group performance ($F(7, 2824) = 365.50$, $p < .001$; $R^2 = 0.270$; *Adjusted R*² = 0.269).

We then examined whether this association varied across player- and group-level conditions. The interaction between group identity and player skill was not significant ($\beta = 0.008$, $SE = 0.013$, $z = 0.607$, $p = .544$), indicating that the association between group identity and group performance did not vary meaningfully as a function of player skill alone. In contrast, the interaction between group identity and group competence was negative and significant ($\beta = -0.077$, $SE = 0.013$, $z = -5.805$, $p < .001$), indicating that the positive association between group identity and group performance weakened as group competence increased. The interaction between player skill and group competence was also significant ($\beta = 0.055$, $SE = 0.012$, $z = 4.737$, $p < .001$), suggesting that these two baseline characteristics jointly shaped group performance levels. However, the three-way interaction among group identity, player skill, and group competence was not significant ($\beta = 0.007$, $SE = 0.013$, $z = 0.500$, $p = .617$). Taken together, these results indicate that the association between group identity and group performance varied as a function of group competence, but not as a function of player skill or the joint player skill and group competence configuration. Thus, H2 received partial support.

To facilitate interpretation of the continuous interaction pattern, we examined the conditional effect of group identity on group performance at one standard deviation below the mean, at the mean, and at one standard deviation above the mean for both player skill and group competence. The positive association between group identity and group

performance remained statistically significant across all nine probed values of player skill and group competence, including the mean levels of the moderators. The conditional *a*-path ranged from 0.222 to 0.390, with the strongest associations observed when group competence was lower and the weakest associations observed when group competence was higher (e.g., player skill = -1 SD and group competence = -1 SD ($a = 0.388$, 95% CI [0.340, 0.445]); player skill = Mean and group competence = Mean ($a = 0.313$, 95% CI [0.292, 0.337]); and player skill = +1 SD and group competence = +1 SD ($a = 0.251$, 95% CI [0.216, 0.289])). These estimates show that the group identity–group performance association was consistently stronger at lower levels of group competence, whereas differences across player skill values were comparatively small (see Table 1 for the regression results and Table 2 for the conditional *a*-path estimates from probing the interaction).

4.4. Transfer of group performance to individual performance (RQ1 and H3)

Next, we examined whether group performance predicted individual performance, controlling for prior individual performance (T2) and changes in individual solo-queue random-battle playtime between T2 and T3 (i.e., the outcome model). Responding to RQ1, group performance was positively associated with individual performance ($\beta = 0.108$, $SE = 0.018$, $z = 5.93$, $p < .001$). Prior individual performance remained the strongest predictor of individual performance ($\beta = 0.364$, $SE = 0.021$, $z = 17.04$, $p < .001$), and changes in individual playtime were also positively associated with individual performance ($\beta = 0.066$, $SE = 0.010$, $z = 6.73$, $p < .001$). Group identity was retained in the outcome model to estimate the residual direct effect, which was positive and significant ($\beta = 0.032$, $SE = 0.012$, $z = 2.72$, $p = .007$). The full model explained 20.0% of the variance in individual performance ($F(10, 2821) = 77.07$, $p < .001$; $R^2 = 0.200$; Adjusted $R^2 = 0.198$; see Table 3 for detailed regression results).

We then tested whether the group performance–individual performance association varied across player- and group-level conditions. The interaction between group performance and player skill was not significant ($\beta = -0.016$, $SE = 0.018$, $z = -0.884$, $p = .377$), and the interaction between group performance and group competence was likewise not significant ($\beta = 0.002$, $SE = 0.020$, $z = 0.088$, $p = .930$). The interaction between player skill and group competence was also not significant ($\beta = -0.017$, $SE = 0.017$, $z = -1.018$, $p = .309$). However, the three-way interaction among group performance, player skill, and group competence was positive and significant ($\beta = 0.031$, $SE = 0.014$, $z = 2.223$, $p = .026$). These results indicate that the effect of group performance on individual performance did not vary as a function of either moderator independently, but did vary as a function of their joint configuration. Thus, H3 was supported at the level of the combined

Table 1 Standardized Regression Coefficients for the Mediator Model Predicting Group Performance.

Predictors	β	SE	z	p	[0.025]	[0.075]	F-statistics
Intercept	-0.012	0.014	-0.878	>0.05	-0.040	0.015	
Group Identity	0.313	0.011	27.585	< 0.001	0.291	0.335	
Player Skill	0.120	0.015	7.752	< 0.001	0.090	0.150	
Group Identity x Player Skill	0.008	0.013	0.607	>0.05	-0.017	0.033	
Group Competence	0.278	0.015	18.966	< 0.001	0.249	0.306	$F(7, 2824) = 365.50, p < .001$
Group Identity x Group Competence	-0.077	0.013	-5.805	< 0.001	-0.103	-0.051	
Player Skill x Group Competence	0.055	0.012	4.737	< 0.001	0.032	0.078	
Group Identity x Player Skill x Group Competence	0.007	0.013	0.500	>0.05	-0.020	0.033	

Note. All predictors were standardized (z-scores).

Note. Group identity was operationalized as time spent in non-battle clan activities in minutes at T1. Players' group performance was measured using the players' clan battle win rate at T2. Player skill refers to a player's ranking, provided by the official game company API and measured at T0. Group competence refers to the clan ranking, reflecting clan-level performance across competitive modes, and it was measured at T0.

Note. Player skill and group competence were modeled as continuous moderators, and their interaction terms were included in the regression models.

Note. Interaction terms represent the multiplicative effects of the corresponding predictors (Group Identity × Player Skill, Group Identity × Group Competence, Player Skill × Group Competence, and Group Identity × Player Skill × Group Competence).

Table 2 Conditional Indirect Effects of Group Identity on Individual Performance via Group Performance Across Player Skill and Group Competence.

Player Skill	Group Competence	a-path [95% CI]	b-path [95% CI]	Indirect Effect (a x b) [95% CI]
-1 SD	-1 SD	0.388 [0.340, 0.445]	0.153 [0.089, 0.217]	0.059 [0.034, 0.087]
-1 SD	Mean	0.305 [0.273, 0.341]	0.124 [0.074, 0.174]	0.038 [0.023, 0.054]
-1 SD	+1 SD	0.222 [0.174, 0.273]	0.094 [0.021, 0.171]	0.021 [0.005, 0.040]
Mean	-1 SD	0.389 [0.356, 0.432]	0.106 [0.053, 0.162]	0.041 [0.020, 0.064]
Mean	Mean	0.313 [0.292, 0.337]	0.108 [0.074, 0.144]	0.034 [0.023, 0.046]
Mean	+1 SD	0.236 [0.206, 0.267]	0.110 [0.061, 0.160]	0.026 [0.014, 0.039]
+1 SD	-1 SD	0.390 [0.337, 0.453]	0.060 [-0.018, 0.139]	0.023 [-0.007, 0.056]
+1 SD	Mean	0.321 [0.289, 0.356]	0.092 [0.043, 0.141]	0.030 [0.014, 0.046]
+1 SD	+1 SD	0.251 [0.216, 0.289]	0.125 [0.075, 0.178]	0.031 [0.018, 0.046]

Note. The a-path represents the conditional effect of group identity on group performance; The b-path represents the conditional effect of group performance on individual performance, controlling for group identity, the lagged covariate of individual performance at T2, and the change in individual playtime (solo-queue random battle playtime) between T2 and T3; The indirect path captures the effect of group identity on individual performance mediated through group performance, controlling for the lagged covariate of individual performance at T2 and the change in individual playtime (solo-queue random battle playtime) between T2 and T3.

Note. Confidence intervals are based on bootstrap estimates. Player skill and group competence were standardized, and conditional effects are reported at ±1 SD and the mean.

player skill × group competence context.

Conditional effects at the same reference values further clarified this interaction pattern. The conditional *b*-path was positive across all nine probed values and statistically significant in eight of the nine conditions, with a conditional effect ranging from 0.092 to 0.153. The only nonsignificant condition occurred when player skill = +1 SD and group competence = -1 SD ($b = 0.060$, 95% CI [-0.018, 0.139]). Therefore, the conditional effect was statistically significant across most of the probed moderator space, except in the high-skill, low-competence context (see Table 2 for the conditional *b*-path from probing the interaction).

Table 3
Standardized Regression Estimates for the Outcome Model Predicting Individual Performance.

Predictors	β	SE	z	p	[0.025]	[0.075]	F-statistics
Intercept	0.010	0.015	0.672	>0.05	-0.019	0.039	
Individual Performance (T2)	0.364	0.021	17.039	<0.001	0.322	0.405	
Individual Playtime Change	0.066	0.010	6.731	<0.001	0.047	0.085	
Group Identity (direct effect c')	0.032	0.012	2.718	0.007	0.009	0.056	
Group Performance	0.108	0.018	5.932	<0.001	0.072	0.144	$F(10, 2821) = 77.07, p < .001$
Player Skill	0.059	0.018	3.313	<0.001	0.024	0.094	
Group Performance x Player Skill	-0.016	0.018	-0.884	>0.05	-0.050	0.019	
Group Competence	-0.017	0.019	-0.873	>0.05	-0.054	0.021	
Group Performance x Group Competence	0.002	0.020	0.088	>0.05	-0.037	0.041	
Player Skill x Group Competence	-0.017	0.017	-1.018	>0.05	-0.050	0.016	
Group Performance x Player Skill x Group Competence	0.031	0.014	2.223	0.026	0.004	0.058	

Note. All predictors were standardized (z-scores).

Note. Group identity was operationalized as time spent in non-battle clan activities in minutes at T1. Players' group performance was measured using the players' clan battle win rate at T2. Individual performance was measured using solo-queue random battle win rate at T3. Random battle playtime refers to the total minutes spent in solo-queue random battles at each time point. Player skill refers to a player's ranking, provided by the official game company API and measured at T0. Group competence refers to the clan ranking, reflecting clan-level performance across competitive modes, and it was measured at T0.

Note. Individual performance at T2 was included as a lagged covariate in the regression predicting individual performance from group identity, mediated by group performance. Group identity was retained in the outcome model to estimate the residual direct effect from group identity to individual performance after accounting for group performance. The change in individual solo-queue random-battle playtime between T2 and T3 was included as a covariate. **Note.** Player skill and group competence were modeled as continuous moderators, and their interaction terms were included in the regression models.

Note. Interaction terms represent the multiplicative effects of the corresponding predictors (Group Performance \times Player Skill, Group Performance \times Group Competence, Player Skill \times Group Competence, and Group Performance \times Player Skill \times Group Competence).

4.5. Mediation of group performance between group identity and individual performance (RQ2 and H4)

Finally, we examined whether group identity influenced individual performance indirectly through group performance. To address RQ2, we first estimated the total effect of group identity on individual performance to clarify the mediation pattern. At the mean levels of player skill and group competence, the total effect of group identity on individual performance was positive and significant ($c = 0.061, SE = 0.012, z = 5.064, p < .001, 95\% CI [0.037, 0.085]$). After group performance was included in the outcome model, the residual direct effect of group identity on individual performance remained positive and significant ($c' = 0.032, SE = 0.012, z = 2.718, p = .007, 95\% CI [0.009, 0.056]$). The conditional indirect effect through group performance was also significant at the mean levels of the moderators ($a \times b = 0.034, 95\% CI [0.023, 0.046]$). Taken together, these results indicate that group performance accounted for part of the association between group identity and individual performance (i.e., partial mediation).

The index of moderated mediation indicated that player skill did not significantly moderate the indirect effect ($IMM = -0.004, 95\% CI [-0.015, 0.007]$), nor did group competence alone ($IMM = -0.008, 95\% CI [-0.021, 0.005]$). However, the joint configuration of player skill and group competence significantly moderated the indirect effect ($IMM = 0.012, 95\% CI [0.001, 0.021]$). This pattern indicates that neither player skill nor group competence alone conditioned the indirect pathway; rather, the indirect effect depended on their joint configuration. Therefore, H4 was supported.

As noted above, the conditional indirect effect was significant at the mean levels of player skill and group competence and remained significant in eight of the nine probed conditions, ranging from 0.021 to 0.059. The only nonsignificant indirect effect occurred when player skill was relatively high and group competence was relatively low ($a \times b = 0.023, 95\% CI [-0.007, 0.056]$) (see Table 2 for the full set of conditional indirect effects). Overall, these results indicate that the indirect pathway from group identity to individual performance through group performance was generally detectable across the moderator space, but was attenuated when player skill was relatively high and group competence was relatively low.

5. Discussion

This study examined how players' identity within their in-game groups shapes both group and individual performance, and how these relationships vary across player- and group-level conditions. By integrating SIT with the Transfer of Learning framework, the findings reveal a differentiated pathway through which players' group identity guides performance in group settings and, through group performance, influences subsequent individual performance. The results show that the two stages of this process were not moderated in the same way: the association between group identity and group performance varied primarily as a function of group competence, whereas the transfer of group performance to individual performance depended on the joint configuration of player skill and group competence.

5.1. Group identity and group performance

Group identity showed a robust positive association with subsequent group performance, offering support for SIT in a large-scale online gaming context. Players who invested effort in improving their groups consistently engaged in behaviors that contributed to group success, aligning with longstanding findings that identity promotes group performance [10–12,72]. Importantly, however, this association was not uniform across contexts. The group identity–group performance link varied as a function of group competence. Specifically, the positive association between group identity and group performance weakened as group competence increased, whereas player skill did not significantly moderate this relationship, and the three-way interaction among group identity, player skill, and group competence was not significant. These findings suggest that group competence, rather than player skill or their joint configuration, primarily shaped the extent to which identity translated into collective performance.

One plausible explanation is that identity becomes more behaviorally consequential when groups face greater room for improvement, consistent with the concept of social competition [38]. When a group is weak or unstable, members experience a motivation to improve their group's standing, and this upward pressure is especially potent among players who identify strongly with their group. For these individuals, identity functions as a motivational engine that translates directly into greater task engagement and in-game contributions. In higher-

competence clans, by contrast, established routines, clearer structures, and stronger norms may reduce the extent to which additional identity-driven engagement further amplifies performance. In this sense, the results suggest that identity-based motivation matters most where group competence is relatively limited. This pattern is consistent with uncertainty–identity theory [73], which posits that individuals rely more heavily on group identity when collective environments lack clear structure. By contrast, player skill did not alter the identity–performance link because skill operates independently of group identity. Technical proficiency and group identity represent distinct domains: players may be highly skilled without feeling strongly connected to their group, or deeply identified regardless of their gameplay skills. Therefore, H1 was supported, and H2 received partial support in that the identity–performance relationship varied as a function of group competence, but not player skill or their joint configuration.

5.2. Transfer of learning: From group to individual performance

Responding to RQ1, the findings also demonstrated that group performance positively predicted subsequent individual performance, supporting the Transfer of Learning perspective. Even after accounting for prior individual performance and changes in individual playtime, players who performed better in group-based gameplay subsequently performed better in individual contexts. This result suggests that players may internalize strategies, routines, and forms of situational awareness developed in coordinated play and carry them into later individual performance. However, this transfer process was not uniform across player- and group-level conditions. The effect of group performance on individual performance did not vary as a function of player skill alone or group competence alone, but it did vary as a function of their joint configuration. Conditional effects indicated that the transfer pathway was statistically significant across most of the tested moderator space, but not when player skill was relatively high and group competence was relatively low. This pattern suggests that group-based performance is most likely to support individual improvement when the group environment provides learning opportunities that match or extend the player's existing skill level.

One plausible interpretation is that the learning value of coordinated group performance depends on the fit between players' preexisting skill and the competence of the group environment in which that performance occurs. This pattern aligns with educational psychology perspectives on person–environment fit in learning. The concept of aptitude–treatment interaction suggests that the effectiveness of a learning environment depends on the match between learners' abilities (player skill) and instructional conditions (group competence) [74]. Accordingly, learning outcomes often depend on the interaction between individuals' abilities and environmental conditions rather than on either factor independently, which is consistent with the joint interaction pattern observed in our results.

This joint interaction effect manifested differently across combinations of player skill and group competence. Prior research on learning and prior knowledge suggests that individuals with lower expertise often benefit broadly from socially structured learning environments because group interaction exposes them to strategies, decision processes, and adaptive responses that they may not yet possess individually [75,76]. Observing effective strategies provides successful models for less skilled players to emulate [77], while witnessing failures offers corrective feedback and vicarious learning opportunities [78]. Through these mechanisms, less skilled players may internalize elements of team-based play that subsequently improve their independent, individual performance. As a result, coordinated group performance may provide learning opportunities for less skilled players across a wide range of group competence conditions.

For more skilled players, however, comparable learning gains may depend more strongly on whether the group environment provides sufficiently informative experiences. Research on the expertise reversal

effect suggests that learning environments that are beneficial for individuals with less expertise may become redundant for those with higher levels of prior knowledge [79]. When more skilled players participate in lower-competence groups, coordinated group performance may therefore provide limited additional information beyond what these players already know, reducing the likelihood that group performance translates into improved individual performance. By contrast, when more skilled players operate within more competent groups, the coordination demands and strategic complexity of group play may still provide opportunities for further learning [80].

In this sense, the present findings suggest that transfer depends on the player–group context in which group performance is embedded. Therefore, H3 was supported through a joint player skill \times group competence effect, even though neither moderator independently altered the transfer pathway.

5.3. Group performance as a mediating mechanism

Building on these findings, the analysis examined whether group performance served as a mechanism linking group identity to subsequent individual performance. Responding to RQ2, the conditional indirect effect was significant at the mean levels of player skill and group competence, indicating that players' group identity influenced later individual performance through its positive association with group performance. The total-effect analysis further indicated that group performance partially mediated the association between group identity and individual performance. Thus, players who were more strongly engaged with their groups tended to perform better in coordinated group contexts, and those group-based performance gains were in turn associated with improved subsequent individual performance. This pattern can be interpreted through the lens of deliberate practice. Strong identity makes players pay closer attention and try harder during group activities because they treat the team's success as their own and invest greater cognitive effort [81]. This elevated engagement transforms teamplay into a form of deliberate practice [82], in which players repeatedly make strategic decisions, coordinate with others, and adapt to changing situations, contributing to improved group performance. Over time, these group experiences become internalized, shifting from socially guided actions to individual procedural knowledge that players can draw upon independently [74].

Meanwhile, this indirect pathway was not equally detectable across all parts of the moderator space. Although the indirect effect was statistically significant across most combinations of player skill and group competence, it was not detectable when player skill was relatively high while group competence was relatively low. This pattern is consistent with the earlier transfer results. Because the indirect pathway operates through group performance, the conditional mediation pattern largely mirrors the interaction observed in the group performance–individual performance relationship. Specifically, the indirect effect was attenuated when highly skilled players operated in relatively low-competence groups. In such contexts, coordinated group performance may provide limited additional learning opportunities for highly skilled players, reducing the extent to which group-based experiences translate into subsequent individual performance. Overall, these findings suggest that the mediating role of group performance depends on the joint configuration of player skill and group competence, providing support for H4.

5.4. Theoretical and practical implications

Together, these findings highlight the importance of differentiating identity-driven group performance from learning-driven performance transfer while recognizing that both are context-sensitive in distinct ways. Identity processes depended primarily on group competence: group identity was more strongly associated with group performance when group competence was relatively low. By contrast, the transfer of group performance to individual performance depended not on player

skill or group competence alone, but on their joint configuration. This layered pattern suggests that online gaming teams function not only as social groups that cultivate psychological identity, but also as contingent learning environments whose developmental value depends on both who the player is and what kind of group context surrounds them.

Building on this integrated account, this study advances game research by demonstrating that two major frameworks, SIT and the Transfer of Learning, jointly explain how players' social and individual experiences in group contexts shape individual outcomes. The findings show that group environments (i.e., group competence) create meaningful contextual variation in how group identity translates into group performance, whereas the transfer of group-based performance to individual settings depends on the joint configuration of player skill and group competence rather than on either factor independently. By applying the Transfer of Learning perspective to an online gaming environment, the study also expands the scope of prior work, illustrating how learning processes observed in traditional settings can manifest in large-scale team-based multiplayer games. Empirically, the study leverages time-series behavioral log data, allowing for rigorous and temporally ordered tests of identity, performance, and transfer processes within naturally occurring play environments.

From a practical standpoint, the findings help explain why identity-based engagement tends to produce stronger performance effects in lower-competence groups. Indeed, the game studies literature [3–6] and the game industry [83,84] have long supported the formation of player identity within gaming groups or communities through community-oriented design features such as cooperative raids and collective reward systems. Our results further show that group performance partially mediates the association between group identity and individual performance, and that both this indirect pathway and the transfer from group performance to subsequent individual performance vary depending on the joint configuration of player skill and group competence. These findings clarify the conditions under which existing identity-promoting game designs produce stronger effects on both collective and individual performance and help explain how performance improvement processes differ across combinations of player skill and group competence. Practically, the findings suggest that collaborative structures, matchmaking systems, and community features may need to be designed with consideration of players' skill levels and group competence in order to more effectively support player development and performance improvement. While many developers are aware of the importance of social features [83,84], the more nuanced link between community features and skill is not always fully integrated into the core design loop. Such design considerations may also clash with a product team's design philosophy.

5.5. Limitations and future research

Although this study makes several important contributions by analyzing the relationship between group identity and performance using large-scale behavioral data, several limitations should be acknowledged. First, it does not directly capture players' subjective sense of community within their online game groups, as the analysis relies solely on behavioral logs. Group identity was operationalized through clan investment time, a behavioral proxy that reflects accumulated involvement in clan activities. While such investment plausibly signals group identity, it does not necessarily indicate whether players psychologically internalize their group membership. Future research would benefit from incorporating survey measures or qualitative approaches to more precisely assess players' psychological identity with their gaming groups.

Second, the Transfer of Learning from group performance to individual performance was inferred using win rate as a behavioral outcome. Although win rate is a meaningful performance indicator, it provides limited insight into the underlying cognitive mechanisms of transfer. The data do not reveal what types of knowledge players acquire

in group settings, such as tactical coordination, situational awareness, or mechanical skill, or how those forms of knowledge translate into individual performance. Future studies should employ mixed-method designs, experimental approaches, or process-level behavioral traces to directly capture the mechanism of learning transfer.

Third, while the mediation analysis identified a statistically significant indirect effect of group identity on individual performance through group performance, consistent with prior work bridging social identity and Transfer of Learning, the mechanism generating this mediation remains unobserved. The present analysis establishes statistical associations but does not determine the cognitive or social processes through which identity-based involvement influences players' individual performance. Subsequent research should more directly examine the internal mechanisms underlying this indirect effect.

Finally, because this study relies exclusively on behavioral logs, it lacks information about players' demographic characteristics, such as age, gender, or cultural background. Given that the impact of demographic factors on gameplay patterns, collaborative styles, and learning tendencies is well established, integrating survey-based demographic data into future analyses would enable future research to examine whether identity processes and learning dynamics differ across player populations.

6. Conclusion

The current study leveraged large-scale, time-series behavioral logs from online game players and demonstrates that stronger group identity enhances group performance and that higher group performance subsequently predicts improved individual performance. In addition, group performance partially mediates the relationship between group identity and individual performance. Group competence moderates the relationship between group identity and group performance, whereas the transfer of group performance to individual performance depends on the joint configuration of player skill and group competence rather than on either factor independently. Overall, these results integrate insights from SIT and the Transfer of Learning framework, highlighting how group environments jointly shape collective and individual performance in team-based online gameplay.

Publication Ethics

The study data were preapproved by the institutional review board.

Data Statement

Study data is available upon request with the permission of the game publisher.

CRediT authorship contribution statement

Ji Ye Kim: Writing – original draft, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.
Dmitri Williams: Validation, Supervision, Project administration, Data curation.

Ethical Approval Statement

This study followed the ethical standards and guidelines of the University of Southern California's Institutional Review Board. The protocol was reviewed and classified as exempt under IRB protocol number UP-19-00138.

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Declaration of competing interest

The second author was engaged as a consultant for the company that provided the study's data. Work on this research project was not compensated.

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Appendix A. Descriptive Statistics of Study Variables

Variable	N	Mean	SD	Min	25%	Median	75%	Max	Skewness	Kurtosis
Group Identity (min)	2832	253.60	333.38	0.00	26.00	122.00	362.00	2471.00	2.19	5.94
Group Performance (%)	2832	44.30	19.37	0.00	33.00	45.83	56.52	100.00	-0.13	0.39
Individual Performance (%, T2)	2832	49.92	7.10	0.00	46.00	49.36	53.58	100.00	-0.03	5.81
Individual Performance (%, T3)	2832	50.02	10.29	0.00	45.53	49.33	53.94	100.00	0.36	10.29
Random Battle Playtime (T2)	2832	3092.66	2634.48	5.00	1141.00	2460.00	4359.50	25,403.00	1.63	4.68
Random Battle Playtime (T3)	2832	2678.24	2542.99	2.00	688.00	2077.50	3907.50	23,370.00	1.70	4.94
Player Skill	2832	5600.83	1782.99	941	4285.00	5340.00	6685.25	11,379.00	0.59	0.04
Group Competence	2832	8405.66	2050.14	228	6998.00	8509.00	10,011.00	12,196.00	-0.46	0.08

Note. Group identity was operationalized as time spent in non-battle clan activities in minutes at T1. Players' group performance was measured using the players' clan battle win rate at T2. Individual performance was measured using solo-queue random battle win rate at T3. Random battle playtime refers to the total minutes spent in solo-queue random battles at each time point. Player skill refers to a player's ranking, provided by the official game company API and measured at T0. Group competence refers to the clan ranking, reflecting clan-level performance across competitive modes, and it was measured at T0.

Note. Individual performance at T2 was included as a lagged covariate in the regression predicting individual performance from group identity, mediated by group performance. In addition, the change in total random battle playtime from T2 to T3 was used as a control variable. Player skill and group competence were modeled as continuous moderators, and their interaction terms were included in the regression models.

Appendix B. Pearson Correlation Matrix of Study Variables

	Group Identity	Group Performance	Individual Performance (T2)	Individual Performance (T3)	Random Battle Playtime (T2)	Random Battle Playtime (T3)	Player Skill	Group Competence
Group Identity	1.00	0.36***	0.10***	0.11***	0.09***	0.09***	0.05***	0.21***
Group Performance		1.00	0.31***	0.25***	0.22***	0.16***	0.29***	0.42***
Individual Performance (T2)			1.00	0.42***	0.26***	0.21***	0.24***	0.19***
Individual Performance (T3)				1.00	0.26***	0.29***	0.19***	0.15***
Random Battle Playtime (T2)					1.00	0.77***	0.04**	0.05***
Random Battle Playtime (T3)						1.00	0.03*	0.03
Player Skill							1.00	0.51***
Group Competence								1.00

Note. * $p < .05$. ** $p < .01$. *** $p < .001$; Diagonal entries are self-correlations ($r = 1.00$) by definition.

Note. Group identity was operationalized as time spent in non-battle clan activities in minutes at T1. Players' group performance was measured using the players' clan battle win rate at T2. Individual performance was measured using solo-queue random battle win rate at T3. Random battle playtime refers to the total minutes spent in solo-queue random battles at each time point. Player skill refers to a player's ranking, provided by the official game company API and measured at T0. Group competence refers to the clan ranking, reflecting clan-level performance across competitive modes, and it was measured at T0.

Note. Individual performance at T2 was included as a lagged covariate in the regression predicting individual performance from group identity, mediated by group performance. In addition, the change in total random battle playtime from T2 to T3 was used as a control variable. Player skill and group competence were modeled as continuous moderators, and their interaction terms were included in the regression models.

Data availability

Study data is available upon request with the permission of the game publisher.

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