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Intergroup contact, contact heterogeneity, and cross-group friendship: evidence from a global prosocial mobile game

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Abstract

Video games serve as virtual spaces where members from different social groups encounter each other and interact. This study ($N = 3{,}612$) tests intergroup contact theory in the context of a global prosocial mobile game, leveraging unobtrusive in-game behavioral data alongside survey measures. Findings indicate that a higher proportion of interaction with foreign players is related to lower levels of future contact intentions. However, interacting with a diverse pool of foreign players significantly predicts an increased willingness for future contact with foreigners. Additionally, cross-group friendship is linked to lower levels of xenophobia. A three-way interaction shows that when high-contact heterogeneity is combined with fewer cross-group friends, intergroup contact can significantly mitigate xenophobia. Extending contact theory to the mobile gaming context, this study provides evidence from a global player base, highlighting the potential of video games, when designed to foster prosocial interactions, to promote positive intergroup relationships at both international and intercultural levels for billions of players engaging in the virtual world.

Lay Summary

In this study, we tested the effects of interaction with foreign players in a prosocial mobile game, *Sky: Children of the Light*, among nearly 4,000 players worldwide. We found that when a more stable friendship was formed after initial encounters, players had more positive attitudes toward immigrants. Additionally, playing with a diverse group of foreign players predicted higher intentions to interact with foreigners in the future. However, if a player maintains friendship with too many different foreign friends, a backfiring effect may occur. We suggest that this is probably due to the limited availability of resources such as time and cognitive capacity.

Decades of intergroup contact research have demonstrated its efficacy in reducing outgroup prejudice, increasing trust, and enhancing future contact intentions (Amir, 1969; Dovidio et al., 2017; Harwood et al., 2013; Imperato et al., 2021). Interacting with individuals from outgroups facilitates mutual understanding, empathy, and trust, while decreasing perceived threats and anxiety toward outgroup members (Pettigrew & Tropp, 2008). In addition to face-to-face direct contact originally proposed by Allport (1954), various other forms, such as extended, vicarious, imagined, and mediated contact, have shown similar positive effects (Dovidio et al., 2011; Harwood et al., 2013; Ortiz & Harwood, 2007; Wojcieszak et al., 2020).

Virtual contact through computer-mediated and mobile-mediated communication has garnered significant scholarly attention (Imperato et al., 2021; Žeželj et al., 2017). Meeting individuals from outgroups on the internet is more convenient and cost-effective than face-to-face interactions and affords individuals greater control over the extent of personal disclosure (Amichai-Hamburger & Furnham, 2007; Amichai-Hamburger & McKenna, 2006). Among various online spaces, online multiplayer games offer players the opportunity to interact with people from all over the world. Given that over a billion players engage in these virtual

environments daily (Katatikarn, 2023), it is crucial to understand whether intergroup contact occurring within games can yield similar positive effects in mitigating outgroup prejudice under specific conditions (Williams, 2010).

Accumulating evidence supports the contact hypothesis in gaming contexts. Scholars have discovered that playing with virtual outgroup characters (Mulak & Winiewski, 2021) or real individuals (Adachi et al., 2015; Benatov et al., 2021) can reduce perceived anxiety and threat while enhancing attitudes toward outgroups. However, some studies have exclusively focused on attitudes toward characters (Vang & Fox, 2014) or examined how violent gameplay increases aggression toward outgroups (Greitemeyer, 2014). Moreover, many scholars have adopted experimental designs using student samples (Benatov et al., 2021; Lee & Chen, 2022), limiting the generalizability of their findings to naturally occurring intergroup interactions. Variables that are known to moderate the intergroup contact effect, such as cross-group friendship documented in the face-to-face contact literature (Dovidio et al., 2011; Harwood et al., 2013), have received less attention in computer-mediated contact research.

To address these theoretical and empirical gaps, the current study tests the contact hypothesis in the context of a massively multiplayer online game (MMOG) called *Sky:*

Children of the Light (hereafter *Sky*), a global prosocial mobile game with over 260 million downloads by players from more than 110 countries (Long, 2024). Combining survey measures ($N = 3{,}612$) and unobtrusive behavioral data, our findings show that contact heterogeneity within *Sky* predicts increased intentions to engage with foreigners in the future. Furthermore, higher levels of cross-group friendship are associated with lower levels of xenophobia. Additionally, a three-way interaction effect among intergroup contact, contact heterogeneity, and cross-group friendship suggests the optimal condition for intergroup contact to mitigate prejudice.

These findings advance intergroup contact theory in a computer-mediated context by highlighting how contact heterogeneity and cross-group friendship shape the impact of intergroup contact on intergroup attitudes and intentions. These effects remain robust even after controlling for offline contact and feelings toward foreigners. With participants from over 90 countries, our global sample suggests that some video games, when designed to facilitate prosocial interactions, could serve as a promising tool for promoting intercultural exchange and reducing xenophobia at scale. This approach is particularly appealing due to its simplicity, accessibility, and playfulness.

Intergroup contact theory and intergroup bias

Prejudice and stereotypes are common biases towards outgroup members and can have profound influences in shaping attitudes, beliefs, and behaviors at the individual, organizational, and even societal level. Originally proposed by Allport (1954), intergroup contact theory states that under optimal conditions, face-to-face intergroup contact can mitigate intergroup prejudice through the buildup of mutual understanding and sympathy. First, members from both groups should enjoy similar status and have a common goal so they can cooperate. Then, the contact should be legitimized via institutional support, meaning that their contact is encouraged or endorsed by the wider social structure such as authorities and norms. Pettigrew (1998) added another condition: the contact should foster cross-group friendship that lasts. Since its birth, the theory has been widely examined across many disciplines such as social psychology, sociology, political science, and communication (Paolini et al., 2021). A number of meta-analyses and reviews of hundreds of studies have established a consistent negative relationship between intergroup contact and prejudice. In addition, the original conditions proposed by Allport were found to be facilitating rather than indispensable to effective intergroup contact (Banas et al., 2020; Dovidio et al., 2017; Harwood et al., 2013).

Research on the mediating mechanism of intergroup contact reveals that affective factors are particularly important in explaining why it works. Group-based anxiety and threat can be reduced during intergroup contact while empathy and perspective-taking are encouraged (Harwood et al., 2013; Pettigrew & Tropp, 2008). Contact also changes how individuals perceive the norms that guide intergroup interactions. Learning that other ingroup members have contact with outgroup members can create a more inclusive social norm (Dovidio et al., 2017). From the cognitive perspective, intergroup contact enables individuals to learn new knowledge about outgroup members, much of which directly contrasts with stereotypes, a process called stereotype disconfirmation (Harwood et al., 2013).

Intergroup contact theory has been greatly expanded beyond the original idea of direct offline contact. Extended contact refers to the recognition that an ingroup member has an outgroup member as a friend. Vicarious contact occurs when individuals observe an ingroup member interacting with an outgroup person (Vezzali et al., 2014). Imagined contact is when individuals simply imagine themselves interacting with the outgroup members (Dovidio et al., 2011). Mediated contact is exposure to outgroup members through media representation (Wojcieszak et al., 2020). In addition to the mode of contact, researchers also found that positive intergroup contact with an outgroup member not only reduces prejudice towards the primary outgroup but the effect also generalizes to other outgroups through enhanced empathy and more perspective-taking, a process known as the secondary transfer effect (Boin et al., 2021; Pettigrew, 2009; Tausch et al., 2010). These variants of direct and offline contact and the generalization of contact effects expand the applicable contexts of the theory and provide researchers opportunities to test generalizable mechanisms, boundaries, and conditions within intergroup contact theory.

Virtual contact: from computer-mediated contact to video games

The internet and digital technologies afford a new form of contact, computer-mediated, which significantly lowers costs in terms of time, money, and other resources (Amichai-Hamburger & McKenna, 2006). According to the theory of Social Identity and Deindividuation Effects (SIDE; Lea & Spears, 1991; Postmes et al., 1998), a lack of social cues, disinhibition, and deindividuation can lead to different behavioral patterns in computer-mediated communication. In particular, the relative salience of social identities under varying levels of anonymity will influence group salience and conformity to group norms. Thus, when individuation is hindered, social boundaries may be reinforced, which can lead to stereotyping and ethnocentrism. The social level of interaction will gain more attention than the individual level and a shared social category may emerge from shared group cues in an anonymized communication environment (Postmes et al., 1998). However, when individuating information such as self-disclosure increases between members from different social groups in online communication (Amichai-Hamburger & Furnham, 2007), previous social categorizations such as gender and nationality will be activated. The physical absence of the other party might also alleviate perceived threat and anxiety, two important affective mechanisms underlying intergroup bias (Harwood et al., 2013).

Graded contact, or the gradual model, establishes a link from online contact to offline contact: individuals start to communicate with outgroup members based on text only, then move to multimedia communication such as image and video, and finally move to a face-to-face environment (Amichai-Hamburger & McKenna, 2006). A meta-analysis suggests that online intergroup contact is able to reduce prejudice toward outgroup members and the effects are stronger when participants were engaged in a cooperative condition (Imperato et al., 2021).

While earlier online intergroup contact research primarily focuses on communication channels such as emails, online discussion forums, and social network sites (Imperato et al., 2021), online multiplayer video games emerge as an

important area of interest to explore intergroup interactions and their effects. Online multiplayer games are public spaces for players to connect with each other and build up relationships (Steinkuehler & Williams, 2006). Given that many games attract millions of players all over the world, they have become an important platform for intercultural interaction. Roughly one-seventh of the world's population plays an online game daily (Katatikarn, 2023). Unlike traditional methods of cross-cultural exchange, which often require extensive travel and resources, online gaming provides a cost-effective and readily accessible means for individuals to engage with players from different cultures and nations. In many cases, online games offer players their first, and perhaps only, opportunity to interact with foreign cultures in a playful way, an opportunity that may be difficult or impractical to have in real life. This, as well as the sheer volume, makes video games a unique and critical context to examine intercultural contact and its consequences as a virtual mapping of the real world (Williams, 2010).

A body of accumulating evidence suggests that playing with outgroup members can reduce outgroup bias. Stiff and Kedra (2020) found that playing with an outgroup member in a simple game called *Worms Armageddon* significantly enhanced positivity toward the outgroup. In the narrative game *Bury Me, My Love*, participants (playing the role of husband) guided a virtual wife Nour, a Syrian refugee, to travel to Europe. Comparing with the control group who read two news articles related to the Syrian refugee crisis, the gaming participants were more inclusive of others and reported less perceived threat and anxiety and more empathy (Lee & Chen, 2022). Likewise, White participants who played with a Black avatar in the virtual world *Second Life* later reported more favorable attitudes to a virtual Black partner (Vang & Fox, 2014). A longitudinal study with both virtual and face-to-face contacts found that after playing *Minecraft* together, Jewish-Israeli and Palestinian-Israeli children reported less stereotypical views and discrimination and an increased willingness to engage with each other in future social contact (Benatov et al., 2021). Even indirectly measured contact with minority characters in a game was found to be associated with increased players' acceptance of minorities (Mulak & Winiewski, 2021).

However, not every video game serves as a suitable virtual world that promotes intergroup contact with benefits as described by intergroup contact theory. Playing violent video games can increase the levels of ethnocentrism and bias toward outgroup members (Greitemeyer, 2014). According to the scapegoating model of prejudice, when negative emotions such as aggression and frustration are evoked, individuals place hatred and repulsion onto marginalized groups (Rothschild et al., 2012). Toxic behaviors in combat games where competition is prioritized by players could lead to increased conflicts among players (Liu et al., 2025). Separating intergroup cooperation and intergroup competition, Adachi and colleagues (2015) reported findings that suggest even in a violent game, cooperating with an outgroup member inhibits intergroup bias. When individuals from different groups play together, they might recategorize themselves as members of the same team, thus lowering the original group salience and starting to build a common ingroup identity (Gaertner & Dovidio, 2000). Compared with neutral games, prosocial games provoked more prosocial thoughts and behaviors (Li & Zhang, 2023). Thus, effective bias reduction in video games requires researchers to identify cooperative intergroup interaction.

There are several theoretical and empirical research gaps in the current virtual contact studies in video games. First, participants in experimental designs were recruited from universities (Stiff & Kedra, 2020; Vang & Fox, 2014) and grade schools (Benatov et al., 2021) and the intergroup contact was designed as part of the gaming experience by the researchers (e.g., Benatov et al., 2021). Less is known about how real-life gamers interact with outgroup members in uncontrolled settings. Second, the outcomes (e.g., prejudice and bias) were primarily measured against only one specific outgroup such as another university (Stiff & Kedra, 2020), another racial or ethnic group (Benatov et al., 2021), or just the outgroup characters (Vang & Fox, 2014). The generalizable effects of virtual contact on attitudes toward outgroups in real life are unclear (Adachi et al., 2015). An exception is that when Mulak and Winiewski (2021) measured attitudes toward minorities, six minority groups were included (e.g., Jews, Roma, Muslims). However, in this study, the intergroup contact was measured by the presence of minority characters in games rather than contact among actual players from these ethnic groups. Finally, moderators that usually condition the effects of intergroup contact receive less attention in the literature (Adachi et al., 2015). In the next section, we focus on two moderators that might condition the effects of virtual contact in video game settings.

Contact heterogeneity and cross-group friendship as moderators

Decades of intergroup contact research have identified many moderators that can either strengthen or mitigate the negative effects of contact on prejudice (Dovidio et al., 2017). For example, the varying degrees of categorization, or group membership salience, can influence the effects of contact. If the outgroup member being involved in the contact is perceived as typical, the contact should reduce the bias toward the outgroup as a whole (Harwood et al., 2013). Or, individuals from minority groups tend to feel stronger anxiety than their majority group counterparts in intergroup encounters (Harwood et al., 2013). Different contexts such as regions, districts, or neighborhoods alter how individuals perceive the norms of interacting with outgroup members (Christ et al., 2014).

Contact heterogeneity

For virtual contact in online multiplayer games, we argue that contact heterogeneity and cross-group friendship are two important moderators that are less studied. Contact heterogeneity captures the *breadth* of intergroup contact experience while cross-group friendship maps their *depth*. We define contact heterogeneity as the degree of the diversity of outgroup members within a person's contacts. In most of the contact studies with an experimental design, researchers typically observe the bias from one group against another group (e.g., Benatov et al., 2021; Stiff & Kedra, 2020; Vang & Fox, 2014) and test the effects of target-specific contact on target-specific prejudice (Meeusen et al., 2017).

Nevertheless, in real life, individuals will have the opportunity to have contact with multiple outgroups and *where* the intergroup contact occurs matters. For instance, intergroup contact that occurs in neighborhoods generally reduces more

prejudice and increases more community trust (Christ et al., 2014; Lundåsen, 2023). The diversity of a neighborhood matters because it potentially enables intergroup contact with multiple outgroups. As a macro-level context, a diverse neighborhood creates more opportunities to interact with outgroup members, and positive intergroup contact derived from these opportunities leads to less prejudice (Schmid et al., 2014; Wagner et al., 2006). Van Laar and colleagues (2005) examined the narrower version of a neighborhood in the context of university dormitories and found that roommate heterogeneity reliably predicted improved attitudes to other racial groups. However, one study revealed that neighborhood diversity was directly associated with a lack of warmth toward outgroups (Meeusen et al., 2017). Without measuring the valence of intergroup contact, this particular finding aligns more with the threat hypothesis, that is, a more ethnically diverse neighborhood might create competition over resources and thus provoke perceived threat and ultimately impair attitudes toward outgroup members (Dinesen et al., 2020; Meeusen et al., 2017).

While neighborhood diversity falls into what Harwood called *contextual* diversity, which likely determines *if* intergroup contact will occur (Harwood, 2021), contact heterogeneity directly measures the diversity of contacts that actually occur rather than an opportunity structure where more diverse intergroup contacts are more probable (i.e., contextual diversity). By directly capturing how varied one's actual intergroup contacts are, contact heterogeneity helps disentangle three related but distinct components: the overall level of intergroup contact, the diversity within those contacts, and the resulting attitudes toward outgroups. Theoretically, contact heterogeneity can shape attitudes toward outgroups in two different ways. On the one hand, contact with a multitude of outgroups can boost knowledge and familiarity levels toward different outgroups and gradually develop an aggregated understanding of what "outgroups" (not any specific outgroup) look like as a whole. This likely reduces ethnocentrism and overcomes stereotypes that originate from limited knowledge of any particular outgroup. On the other hand, an overly diverse contact network may require excessive cognitive and affective resources to manage variation among the outgroup members such that the positive effects of intergroup contact will be weakened.

Unlike the face-to-face context of contact (e.g., neighborhoods), a virtual world is much less constrained physically and it is very likely a player would meet someone from another country daily in a multiplayer online video game with a single-shared server like *Sky*. As of 2025, 82.1% of internet users worldwide play video games and some countries have a penetration rate of nearly 90%, such as the Philippines, South Africa, Mexico, Brazil, and Greece (Statista, 2025). Given adequate data granularity such as contact-level information from video games, researchers can precisely determine the level of contact heterogeneity for each player and do not have to rely on the likelihood of diversity (e.g., how diverse the whole game population is) to infer the actual impact of contact heterogeneity. Therefore, contact heterogeneity in virtual contact can meaningfully advance intergroup contact research because of its clear operationalization and data granularity.

To the best of our knowledge, the only study that has used the term contact diversity in a video game context found null effects between the diversity of interactions and attitudes toward minorities (Mulak & Winiewski, 2021). However, in that study, intergroup contact was inferred solely from the presence of minority characters in the game, not the actual intergroup contact with other players. Players were assumed to have intergroup contact if there was a minority character in the game. Likewise, contact diversity was operationalized as the percentage of minority characters over all the characters in the game. In other words, it primarily used diversity of Non-Playable Characters (NPCs) as a proxy for actual individuals. The present study builds on this line of research by moving beyond inferring contact to directly observing it. It is also able to hold contextual diversity constant, as over-time data are effectively random for each player. Overall, these data allow us to examine how actual intergroup contact diversity, rather than opportunity alone, relates to players' attitudes.

Cross-group friendship

Cross-group friendship refers to stable and lasting relationships formed between an ingroup member and an outgroup member and it is often a result of repeated and positive contact (Davies et al., 2011). Building up strong relationships with outgroup members has been shown to reduce anxiety, threat, and prejudice (Christ et al., 2014; Meeusen et al., 2017; Pettigrew, 1997; Žeželj et al., 2017). A three-wave longitudinal study found that intergroup anxiety and empathy mediated the effects of cross-group friendship on positive outgroup attitudes (Swart et al., 2011), suggesting that having outgroup friends can lower intergroup anxiety and promote empathy, which further leads to more favorable outgroup attitudes. Compared with incidental and superficial encounters with outgroup members, the stronger effect is likely due to the self-disclosure and increased trust with outgroup friends (Pettigrew, 1997, 1998). Therefore, intergroup contact with close outgroup friends or strong ties can reduce outgroup prejudice, whereas contact with more distant or weaker social relations may have little to no effect (Bobowik et al., 2022).

We expect similar patterns to be found in virtual worlds when online friendship is facilitated and supported by the game affordances. Many video game players are motivated by the need for social interaction with other players (Williams et al., 2008). For people who are shy and emotionally sensitive, forming friendship is much easier in video games than in real life (Kowert et al., 2014). Friendships formed in virtual worlds can also potentially be transformed into offline close relationships and to provide emotional and social support (Lai & Fung, 2020). In games that operate in multiple markets or even globally, there are tremendous opportunities for players to make friends from other cultures that are not always accessible due to geographical constraints. Once the cross-group friendship is established, repeated contact with outgroup friends should strengthen mutual understanding and sustain trust.

Research context: testing contact hypothesis in a global prosocial game

To examine intergroup contact in a video game and to explore the moderating roles of contact heterogeneity and cross-group friendship, we selected *Sky: Children of the Light* (*Sky*), a free mobile MMOG developed by *thatgamecompany* in 2019, as the research context. *Sky* places players in a

fantasy kingdom, where players control an avatar that can fly across various maps to explore and find fallen ancestor spirits (Kim et al., 2022). The introductory goal in *Sky* is to restore the spirits to the constellations in the sky. Importantly, players do not compete against each other in *Sky*. Instead, the game was designed to encourage collaboration, such as flying together, guiding newbies, and exchanging in-game currency (i.e., candles) to unlock social functions. *Sky* is popular with gamers around the globe, with players from more than 110 countries represented (Huang-Isherwood & Tang, 2024). Nearly seven million players from different cultural communities are active in *Sky* every day and make meaningful connections (Porr, 2022). Therefore, *Sky* is a particularly suitable virtual world where positive intergroup contact with multiple outgroups is both possible and encouraged by its design and in-game norms.

When two players meet in *Sky*, they cannot initially chat. Interactions typically begin with simple nonverbal gestures, such as holding hands (which allows them to travel together) or bowing (to express appreciation). They may also engage in limited text-based communication when sitting on public chat benches located throughout the game world. The game's primary in-game currency, candles, is critical for player progression. Candles can be collected by exploring different realms or completing daily quests, and they are used to unlock or purchase cosmetic items (e.g., capes, trousers) and expressions (e.g., facial expressions, gestures). Players can also send and receive candles from others, making candle exchange a common form of positive interaction. To access more advanced social expressions such as hugs and high-fives, players must first become friends, which requires exchanging a certain number of candles. These friendships cannot be based on offline identity because players initially appear as identical silhouettes prior to forming friendships (see Figure 1). Once a sufficient number of candles have been exchanged and a higher level of friendship is established, players can mutually choose to unlock the chat function, enabling private communication. This is the stage at which players are most likely to learn each other's national identities because it allows for text and the many cues that can reveal and establish real-world identities.

As friendships deepen, language and time-zone cues become salient, revealing players' nationality and location and enabling more explicit ingroup–outgroup distinctions. This shifting individuation process in *Sky* makes it possible to disentangle the temporal sequence of interpersonal contact and social category recognition, thus offering a rare opportunity to examine how positive impressions may first develop without identity cues and only later extend to specific outgroups once those cues become available and salient (Amir, 1969).

As mentioned above, *Sky* has players from different countries in the world and is primarily a prosocial game that encourages collaborations among players. Therefore, in this study, we primarily consider the generalizability of the effects of intergroup contact in *Sky*. We do not focus on attitudes toward any specific outgroup that a player has had contact with but instead consider general attitudes (i.e., xenophobia and future intergroup contact intentions) as the main outcome variables. Drawing on the well-established secondary transfer effect in the literature (e.g., Boin et al., 2021; Pettigrew, 2009; Tausch et al., 2010; Van Laar et al., 2005), we expect that *Sky* players who usually have intergroup contact with players from more than one foreign country would

Figure 1. Examples avatar silhouettes in *Sky*.

develop a generalizable positive attitude toward foreigners. Since the previous literature (Adachi et al., 2015; Benatov et al., 2021; Mulak & Winiewski, 2021; Vang & Fox, 2014) has demonstrated that intergroup contact in games can reduce outgroup bias, we propose the following hypotheses:

> Hypothesis 1 (H1): Players in *Sky* who have more intergroup contact will have lower levels of xenophobia (H1a) and higher levels of future intergroup contact intentions (H1b).

We argue that contact heterogeneity should reduce outgroup prejudice in the context of *Sky*. As discussed above, a diverse pool of contacts accumulates knowledge of other cultures and allows players to develop empathy and practice perspective-taking. Therefore, contact with a diverse network of players from different cultural backgrounds is more likely to mitigate stereotypes. Thus, we propose:

> Hypothesis 2 (H2): Contact heterogeneity will be negatively associated with xenophobia (H2a) and positively linked to future intergroup contact intentions (H2b).

Likewise, as the contact literature has consistently identified cross-group friendship as one of the most effective strategies for reducing intergroup bias for its depth as a close relationship (Meeusen et al., 2017; Swart et al., 2011; Žeželj et al., 2017), we hypothesize:

> Hypothesis 3 (H3): Cross-group friendship in *Sky* will reduce xenophobia (H3a) and encourage future intergroup contact intentions (H3b).

In addition, we expect that the effects of intergroup contact will depend on contact heterogeneity and cross-group

friendship. First, bias against foreigners is a broad attitudinal construct (Tausch et al., 2010); encountering players from a myriad of distinct countries may enhance cultural knowledge and reduce prejudice. Second, cross-group friendship may further strengthen the impact of contact, as interactions with close ties such as friends typically bring more trust and social rewards (Bobowik et al., 2022). We expect to observe these moderating effects in the virtual world. Given that *Sky* is a low-threat environment, diverse contact is unlikely to provoke defensive attitudes, and thus, we propose:

> Hypothesis 4 (H4): Contact heterogeneity will strengthen the effects of intergroup contact on lowering xenophobia (H4a) and increasing future intergroup contact intentions (H4b).
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> Hypothesis 5 (H5): Cross-group friendship will strengthen the effects of intergroup contact on lowering xenophobia (H5a) and increasing future intergroup contact intentions (H5b).

Building on the previous discussion, the effects of intergroup contact are expected to depend on the breadth (i.e., contact heterogeneity) and depth (i.e., cross-group friendship) of the contacts. We further propose that the interaction effects between intergroup contact and contact heterogeneity will be moderated by cross-group friendship. When a player has positive experiences with a diverse pool of players from many outgroups, the diversified contacts would likely expand one's cultural knowledge and cognitive flexibility (Boin et al., 2021). The heterogenous contact network then makes members from multiple outgroups accessible to develop more intimate and deeper relationships. Once stronger social relations such as cross-group friendship have been formed, affect (e.g., empathy) and trust will strengthen the cognitive benefits. Worldviews are also more likely to be influenced by friendship, thus contributing to prejudice reduction (Davies et al., 2011; Žeželj et al., 2017). For example, Bobowik et al (2022) found that high ethnic diversity within strong ties (e.g., friends, family members) among immigrants in Barcelona predicted more positive attitudes toward outgroups.

Although Bobowik and colleagues (2022) did not test the three-way interaction effects among intergroup contact, contact heterogeneity, and cross-group friendship, the study will explore how effects of contact, breadth, and depth of these contacts unfold. Given that no prior literature has directly examined the nuanced three-way interaction effect, we ask:

> Research Question 1 (RQ1): How do intergroup contact, contact heterogeneity, and cross-group friendship jointly relate to xenophobia and future intergroup contact intentions?

Method

We collected the in-game behavioral data of *Sky* players from their respective first play to August 31, 2021 (Time One) to measure their intergroup contact. One month later, we distributed a survey (Time Two) within the game to gauge subjective and attitudinal variables such as xenophobia and contact intention. This time-lagged design allowed us to test the hypotheses with a desired time order without worrying about the possibility of reversed causality. The combination of in-game behavioral data and survey responses provided both objective and subjective measures. Ordinary Least Squares (OLS) regression models with interaction terms were used to test the hypotheses and answer the research question. We present details of data collection, measurement, and statistical analysis in the following sections.

Data

We collaborated with the publisher of *Sky*, *thatgamecompany*, in designing and distributing the survey to *Sky* players in June 2021. The survey was randomly sent to players between September 28 and September 30, 2021 on the global server of *Sky*, and only those who were 18 years old or above were eligible to proceed with the rest of the survey. The survey was part of a larger project examining the inter-cultural dynamics of the virtual setting and included variables and scales such as well-being and social capital. Only relevant variables are used for this current study and will be explained in detail in the next section.

In total, 11,716 players responded to the survey, and 4,012 responses were complete and passed the attention checks, meaning that the respondents answered all questions that are relevant for the current study. We then retrieved the unobtrusive behavioral data of the participants up to one month prior to the survey such that the in-game behavioral predictors were measured before the outcome variables in the survey. All the data, including the survey responses and behavioral data, have been anonymized before reaching the authors. After removing players who could not recall any experience interacting with foreign players, the total sample was 3,612 players. A summary of descriptive statistics of variables between the final sample and the incomplete sample can be found in Supplementary Table 1 (see online supplementary material). Players in the complete dataset were slightly less xenophobic, expressed more future contact intentions, had slightly more intergroup contact and cross-group friends, and had interacted with players from more countries than those in the incomplete dataset.

Measurement
Behavioral measures: independent variables at time one
Intergroup contact

There are many opportunities for players to interact in *Sky*. Here, we focus on the candle exchange a player had with foreign players. We used the location data of players to infer their country (Supplementary Table 2, see online supplementary material, for the distribution of country of our sample and the game population) and counted the number of candle exchanges with the foreign players, relative to the focal player, from their first play up to August 31, 2021, one month before the survey. We also used device language variable to validate the location-based coding. We only counted the number of candle exchanges between the focal player and foreign players after their chat function was unlocked because that is when it becomes possible for the focal player to learn the counterpart's national identity. We consulted with the algorithmic engineer of the game, and got confirmation that no algorithmic intervention was implemented that could impact the chance a player meets a foreign player. To control for different players' tendency to exchange candles, we used the percentage rather than the raw number of candle exchanges to account for individual personality differences (e.g., introvert versus extrovert) and gaming preferences (e.g., for solo play versus group play), which can influence a

player's overall tendency of making interactions with others within *Sky*. We calculated the percentage of candles exchanged with foreign players ($M = 68.80$, $SD = 124.73$) over that with all players ($M = 502.94$, $SD = 1,472.85$), such that a higher percentage indicates more intergroup contact with foreign players ($M = .11$[1], $SD = .12$).

Intergroup contact heterogeneity

This is measured by the unique number of foreign countries from which foreign players had exchanged candles with the focal player after the chat function has been unlocked ($M = 5.95$, $SD = 6.07$). The range of contact heterogeneity is from 1 to 44 with a skewness of 1.49. A more diverse contact network contains players from more distinct countries.

Cross-group friendship

As we noted earlier, players in *Sky* can only add each other as friends after they have exchanged a certain number of candles and have both agreed to do so. Making friends in *Sky* is an essential part of the game as it facilitates social interactions and game progression. Players can join friends' sessions to explore maps and gain guidance from experienced friends or help newbies. To control for the overall tendency of forming in-game friendship, we calculate cross-group friendship by dividing the number of foreign friends ($M = 87.44$, $SD = 97.81$) by the total number of friends ($M = 123.77$, $SD = 124.71$) such that a higher percentage of foreign players indicate a more diverse friend network ($M = .68$, $SD = .22$).

Survey measures: dependent variables at time two

Xenophobia

We adopted a psychometrically and qualitatively validated measure of fear-based xenophobia (van der Veer et al., 2013). Participants were asked to use a six-point Likert scale (1 = "agree strongly", 6 = "disagree strongly") to rate five statements related to attitudes toward immigrants such as "Immigration in my country is out of control," "Interacting with immigrants makes me uneasy", and "I am afraid that our own culture will be lost with increase in immigration." The responses were reverse coded and then averaged to create a scale of xenophobia such that a higher value indicates a higher level of xenophobia ($M = 2.58$, $SD = 1.20$, Cronbach's $\alpha = .84$).

Future intergroup contact intentions

We asked respondents to rate three items on a seven-point Likert scale (1 = "Not at all interested", 4 = "Neutral", 7 = "Very interested") when they think about "the next time you find yourself in a situation where you could interact with a foreign national (e.g., queuing for a bus, with friends in a café, etc.)": (a) "How interested would you be in striking up a conversation?"; (b) "Learning more about these groups"; and (c) "Participating in a discussion that includes those groups on issues of discrimination." The questions were adapted from the survey questions used in Wojcieszak et al. (2020). The responses were averaged to create a scale of contact intentions ($M = 4.73$, $SD = 1.31$, Cronbach's $\alpha = .78$).

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[1] This means that on average, after unlocking the chat function, players in our sample had roughly 11% of their total candle exchange with foreign players.

Controls

Offline contact

Participants were asked to report offline contact through one item: "How often do you have contact with foreign nationals in your daily life?" (rated on a five-point Likert scale with 1 = "Almost never", 5 = "Every day", $M = 3.11$, $SD = 1.23$).

Device language

To control for cultural differences in aspects of interacting with foreigners and attitudes towards immigrants, we used the device language set by the player as a proxy. As the sample contains players using multiple languages such as Korean, Chinese, and Spanish, we coded this variable by grouping all English language users as a group ($N = 1,407$) and used the non-English-speaking users as a reference group ($N = 2,205$).

Demographics including age, gender, and education were also included as controls.

Statistical analysis

Correlations of variables can be found in Table 1. To test the proposed hypotheses and to answer the research questions, we performed two Ordinary Least Squares (OLS) regression models to predict xenophobia (Table 2 Model 1) and intentions to engage in future outgroup contact (Table 2 Model 2). The two models include the same independent variables, interaction terms, and controls. All continuous predictors in the models were mean-centered and standardized for better interpretation. We also conducted multicollinearity diagnostics using adjusted standard error variance inflation factor (aGSIF) and found no evidence for multicollinearity in the two models (all aGSIF < 1.60, see full results in Supplementary Table 3, see online supplementary material) (Fox & Monette, 1992).

Results

H1 predicts that intergroup contact should be associated with a favorable attitude to outgroup members. The OLS regression results in Table 2 Model 1 show that intergroup contact (e.g., candle exchange with foreign players) is not significantly related to xenophobia ($\beta = .00$, $p = .87$). However, it exerts a negative influence on contact intentions ($\beta = -.09$, $p < .001$). Thus, both H1a and H1b are rejected. H2 states that contact heterogeneity should predict a positive intergroup attitude. Results suggest that contact heterogeneity is not significantly linked to xenophobia ($\beta = -.03$, $p = .37$) but is positively associated with intentions to engage in future contact with foreigners ($\beta = .20$, $p < .001$). H2a is rejected and H2b is supported. H3 examines the effects of cross-group friendship. Having more foreign friends is significantly related to lower levels of xenophobia ($\beta = -.10$, $p < .001$) but not to contact intentions ($\beta = -.02$, $p = .29$). Thus, H3a is supported and H3b is rejected.

H4 proposes that contact heterogeneity would moderate the effects of intergroup contact on both intentions and xenophobia. The results are not able to support the significant moderating effects. Thus, H4 is rejected. H5 focuses on the moderating effects of cross-group friendship. Similarly, interaction effects are not significant in either model. H5 is rejected.

RQ1 asks how the interaction effects between intergroup contact and cross-group friendship might depend on contact heterogeneity. A significant three-way interaction effect is

Table 1. Correlations of variables.

Variables	Xenophobia	Intergroup contact	Contact heterogeneity	Cross-group friendship	Feeling	Playtime	Offline contact	Language (English)	Education	Female	Age
Intentions	−.20	.01	.06	.08	.31	−.05	.15	.13	.03	−.03	.02
Xenophobia	1.00	–	–	–	–	–	–	–	–	–	–
Intergroup contact	−.03	1.00	–	–	–	–	–	–	–	–	–
Contact heterogeneity	−.02	.59	1.00	–	–	–	–	–	–	–	–
Cross-group friendship	−.12	.43	.33	1.00	–	–	–	–	–	–	–
Feeling	−.29	.06	.07	.10	1.00	–	–	–	–	–	–
Playtime	−.05	.28	.67	.08	−.03	1.00	–	–	–	–	–
Offline contact	−.09	.13	.12	.14	.17	.03	1.00	–	–	–	–
Language (English)	−.10	.16	.15	.35	.13	−.04	.17	1.00	–	–	–
Education	−.01	.04	.05	.10	.02	.03	.06	.08	1.00	–	–
Female	.03	−.03	.02	−.07	.03	.06	−.03	−.11	−.02	1.00	–
Age	.05	−.01	.08	.07	−.02	.10	.01	.08	.35	−.01	1.00

Table 2. OLS models predicting xenophobia and intentions to engage future contacts.

Variables	Xenophobia (Model 1)			Contact intentions (Model 2)		
	β	SE	95% CI	β	SE	95% CI
Intercept	−.02	.03	[−.09, .05]	.01	.03	[−.05, .08]
Main effects						
Intergroup contact	.00	.02	[−.05, .05]	−.09***	.02	[−.13, −.03]
Contact heterogeneity	−.03	.03	[−.09, .03]	.20***	.03	[.13, .25]
Cross-group friendship	−.10***	.02	[−.14, −.05]	−.02	.02	[-.06, .03]
Interaction effects						
Contact × Heterogeneity	−.02	.03	[−.07, .02]	−.02	.02	[−.07, .02]
Contact × Friendship	.02	.03	[−.03, .07]	.02	.03	[−.04, .06]
Heterogeneity × Friendship	−.00	.03	[−.06, .05]	−.07**	.03	[−.12, −.02]
Contact × Heterogeneity × Friendship	.05*	.02	[.00, .09]	.02	.02	[−.02, .06]
Covariates						
Age	.05**	.02	[.02, .08]	.02	.02	[−.01, .06]
Gender (female)	.06^	.03	[−.01, .13]	−.05	.02	[−.12, .01]
Education	−.01	.02	[−.04, .02]	.01	.02	[−.03, .04]
Language (English)	−.07*	.04	[−.14, −.00]	.13***	.04	[.06, .20]
Offline contact	−.03^	.02	[−.06, .00]	.09***	.02	[.06, .12]
Total play time	.05*	.02	[.00, .09]	−.15***	.02	[−.19, −.10]
Feeling	−.27***	.02	[−.32, −.25]	.27***	.02	[.24, .31]
F	28.97***			37.67***		
Adjusted R^2	.10			.12		
N	3,612			3,612		

Note. All continuous predictors are mean-centered and scaled, SE = standard error, CI = confidence interval.

* $p < .05$.
** $p < .01$.
*** $p < .001$.
^ $p < .10$.

found in predicting xenophobia ($\beta = .05$, $p = .03$) but not intentions ($\beta = .02$, $p = .44$). The moderator value defining the Johnson-Neyman significance region is 1.17 (mean-centered standardized score) for contact heterogeneity. For contact heterogeneity less than 1.17 (88.8%), the interaction effect between intergroup contact and cross-group friendship is not statistically significant. For higher levels of contact heterogeneity (> 1.17, 11.2%), the interaction is statistically significant. Table 3 provides a subgroup analysis of the three-way interaction effect, showing that with increasing levels of contact heterogeneity, the interaction effect between intergroup contact and cross-group friendship becomes significant

and positive. The effect size of the interaction term increases as contact heterogeneity gets larger. Figure 2 illustrates the effect. When contact heterogeneity is low (.11), intergroup contact is generally not associated with xenophobia regardless of high or low levels of cross-group friendship. In contrast, when contact heterogeneity is high (1.92), the effects of intergroup contact on xenophobia become negative for a lower proportion of cross-group friends and positive for more cross-group friendship. In other words, intergroup contact mitigates xenophobia only when a player has high levels of contact heterogeneity and fewer cross-group friendships. A very diverse contact network plus a high proportion of

foreign friends could have a backfiring effect in reducing xenophobia.

As we modeled a three-way interaction term in the models, a two-way interaction term between contact heterogeneity and cross-group friendship was also added to the regression models. The effect of contact heterogeneity is significantly moderated by cross-group friendship ($\beta = -.07$, $p = .006$). The positive impact of contact heterogeneity on contact intentions is more pronounced among players with lower levels of cross-group friendship (see Figure 3), which is consistent with the three-way interaction effect. For the three-way interaction effects predicting xenophobia, the optimal condition where intergroup contact can mitigate xenophobia occurs for a diverse contact network with fewer cross-group friendships. Likewise, for contact heterogeneity to exert stronger positive effects on contact intentions, the level of cross-group friendship should be ideally lower. We provide the reversed directionality analysis in Supplementary Table 4 (see online supplementary material).

Discussion

With billions of players immersed in online games, virtual environments have become increasingly important spaces for intergroup contact and intercultural exchange (Benatov et al.,

2021; Mulak & Winiewski, 2021; Vang & Fox, 2014; Williams, 2010). Extending this line of inquiry, the present time-lagged study combined unobtrusive behavioral data with self-reported measures to test intergroup contact theory in a mobile-mediated prosocial game, *Sky*. Unlike traditional self-report methods, which are often limited by recall bias or social desirability, in-game behavioral data allowed us to capture naturally occurring interactions among players from diverse cultural backgrounds, an approach rarely seen in intergroup contact research. This integration of objective behavior and subjective attitudes provides a more ecologically valid approach to how virtual contact unfolds in an online, prosocial environment and allows us to directly measure previously less-studied variables such as contact heterogeneity.

The study presents empirical evidence on how intergroup contact, contact heterogeneity, and cross-group friendship jointly influence outgroup bias and behavioral intentions in a multiplayer online game that encourages cooperation among players. Surprisingly, our findings regarding intergroup contact seem to be inconsistent with previous studies in gaming contexts (Adachi et al., 2015; Benatov et al., 2021; Greitemeyer, 2014; Mulak & Winiewski, 2021; Vang & Fox, 2014). Specifically, a higher proportion of interactions with foreign players predicted lower intentions to engage in future intergroup contact.

The negative relationship between intergroup contact and contact intentions is particularly intriguing as it ostensibly challenges the intergroup contact hypothesis in a game context established by previous studies (e.g., Lee & Chen, 2022; Stiff & Kedra, 2020; Vang & Fox, 2014). We offer two plausible explanations for the negative link. First, virtual intergroup contact within *Sky* in effect replaces offline contact. That is, when players have already had many interactions with foreigners in *Sky*, the need to know and socialize with individuals from other cultures has been met, thus players would be less motivated to engage in future offline intergroup contact (Lai & Fung, 2020). Second, by design *Sky* encourages players to interact with individuals from all over the world in a safe and playful space. When asked about contact intentions with foreigners in the future, *Sky* players may
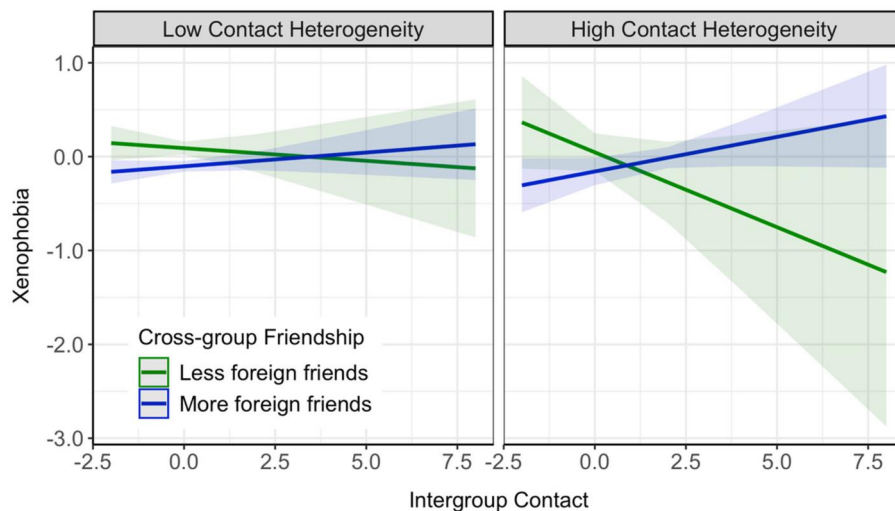
Table 3. Conditional interaction effects between intergroup contact and cross-group friendship on xenophobia at different levels of contact heterogeneity.

Contact heterogeneity	Interaction effect	SE	t	p	LLCI	ULCI
−.98	−.03	.03	−.82	.42	−.09	.04
.11	.03	.03	1.05	.29	−.02	.08
1.17	.08	.04	1.96	.05*	.00	.16
1.92	.12	.06	2.11	.03*	.01	.22
3.01	.17	.08	2.17	.03*	.02	.32

Note. SE = standard error, LLCI = lower limit of a 95% confidence interval, ULCI = upper limit of a 95% confidence interval.
   * *p* < .05.

Figure 2. Three-way interaction effect on xenophobia.
Note. Less and more cross-group friendship refer to −1 and +1. Low- and high-contact heterogeneity refer to .11 and 1.92, which are of equal percentiles below and above from significance threshold (see Table 3) to better illustrate the significant three-way interaction effect. All variables are mean-centered and standardized.
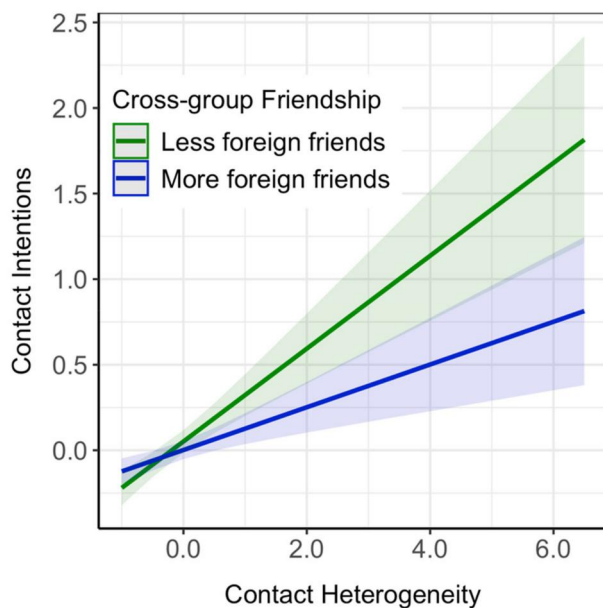
Figure 3. Two-way interaction effect between contact heterogeneity and cross-group friendship on intentions.

Note. Low and high cross-group friendship refers to −1 and +1. All variables are mean-centered and standardized.

contrast the contact in the game with offline contact, which requires resources such as money and time, takes commitment to maintain a face-to-face relationship with less flexibility, and perhaps most importantly, is less fun compared with playing with foreigners in *Sky*. Thus, more intergroup contact within *Sky* may reduce players' willingness to interact with foreigners in real life. However, future studies will need to measure mediators such as the need to interact with outgroup members and the perceived ease of offline contact to test our speculations here.

Our results show that contact heterogeneity is positively associated with contact intention, an underexplored concept in the intergroup contact process. Previous studies concerning "diversity" tend to focus on the contextual diversity, for example, how a certain neighborhood is diverse in terms of composition of racial and ethnic groups (Christ et al., 2014; Lundåsen, 2023; Schmid et al., 2014) or how the presence of minority characters in a game influences attitudes toward outgroups (Mulak & Winiewski, 2021). However, the diversity of the context typically serves as an opportunity structure, that is, people who live in a more diverse neighborhood or who play a game with more minority characters will have a higher chance of interacting with outgroup members or characters. The contact heterogeneity captured in the current study directly measures the level of diversity of intergroup contacts, rather than the likelihood of it. Our finding aligns with what Van Laar and colleagues (2005) found on the positive effects of roommate diversity in reducing prejudice. It is plausible to assume that a university student who lives in a dormitory will have contact with their roommates, thus, roommate heterogeneity in this study can be considered as contact heterogeneity as conceptualized in our study.

We believe contact heterogeneity is of particular importance in virtual contexts such as a multiplayer online game. Not only is the cost of interacting with multiple outgroups significantly lower (Amichai-Hamburger & McKenna, 2006)

but meeting a diverse group of outgroup members in the virtual world may provoke less perceived threat or anxiety. In such online spaces, people have more control over their self-disclosure and communication compared with encountering outgroup members in an offline setting (Harwood et al., 2013). If the infrastructure and norms in the virtual world (e.g., a prosocial game like *Sky*) support the preferred conditions to allow positive intergroup contact to occur (Allport, 1954; Imperato et al., 2021; Pettigrew & Tropp, 2008), meeting a diverse group of people online likely increases curiosity and confidence in developing offline relationships with outgroup members because one might feel more familiar and have lower levels of perceived risk in interacting with people from various backgrounds.

In this case, more contact heterogeneity not only reflects a breadth of cultural exposure but also quality interactions, where players from multiple countries have already demonstrated prosocial behavior. As individuals learn that nationality is a poor predictor of behavior, the salience of group differences may diminish. This supports Pettigrew and colleagues' (2011) argument that intergroup contact with multiple outgroups can generalize to improve attitudes toward outgroups in general.

Cross-group friendship significantly reduced xenophobia, aligning with previous work showing that strong ties are particularly effective in reducing intergroup bias (Christ et al., 2014; Davies et al., 2011; Meeusen et al., 2017; Pettigrew, 1997). A prior study of *Sky* players found that playing together fostered reciprocity and social support (Kim et al., 2022). Given that friendship in *Sky* requires mutual candle exchange before enabling private chat, cross-group friendship likely solidifies casual positive interactions and may transform superficial candle exchange into long-lasting relationships. As friendship develops, players disclose more about themselves, build trust, and engage in repeated, positive interactions, which are all conditions conductive to stereotype disconfirmation. Some of the *Sky* friendships may even extend beyond the game into offline connections (Lai & Fung, 2020).

It is important to note how group membership is cued and experienced in the game gradually where anonymity and individuation vary as two players progress from an initial encounter to a more intimate friendship (Lea & Spears, 1991; Postmes et al., 1998). Avatars in *Sky* are humanoid figures with white hair and mitten-like hands, with no indication of nationality, language, or ethnicity during initial interactions (see Figure 1). It is only after sustained contact and the unlocked chat function that players learn each other's national identity. Thus, positive intergroup contact occurs at the individual level first and later extends to the social category of other players once nationality cues and language differences are salient (Amir, 1969).

It is worth noting that our measures on intergroup contact, contact heterogeneity, and cross-group friendship do not rely on self-reported responses or the limited sample of an experimental design. Our methodology complements these previous studies by observing intergroup contact that *naturally occurred* in an MMOG without an intervention, providing external validity to the effects of intergroup contact in virtual worlds. In addition, compared with most contact research, the target outgroup in the current study is not any specific outgroup (i.e., a specific foreign country) but rather a general category encompassing *all other countries*. Our findings

suggest that a general attitude and behavioral intentions (Tausch et al., 2010) could be explained by intergroup contact with multiple outgroups. Indeed, the participants in our sample were from more than 90 countries in the world and most of them had encountered players from different countries. To even further test effects such as majority and minority group status, future studies may measure players' attitudes toward a specific country and compare if the effects of intergroup contact vary.

Beyond main effects, our most significant theoretical contribution lies in the observed three-way interaction among intergroup contact, contact heterogeneity, and cross-group friendship, offering a nuanced account of how intergroup contact takes effect in a computer-mediated context (Boin et al., 2021; Harwood, 2021; Paolini et al., 2021). Although neither contact heterogeneity nor friendship independently moderates the effect of contact, their combined interaction reveals a nonlinear relationship: intergroup contact significantly reduced xenophobia only when contact heterogeneity was high and cross-group friendship was limited. In other words, when contact heterogeneity is low, cross-group friendship does not significantly moderate the effect of intergroup contact, and the effect of intergroup contact on xenophobia is basically nonexistent. When a player's contact network is highly heterogeneous, the positive effect of intergroup contact in reducing xenophobia is more pronounced for players with fewer but not more cross-group friends. The results seem to suggest that a diverse contact network is required for cross-group friendship to exert influence on intergroup contact.

This finding suggests that it is not always beneficial for a player to have both high levels of contact heterogeneity and cross-group friendship from the perspective of reducing prejudice toward outgroups. This is likely because establishing strong ties across multiple cultural boundaries requires considerable emotional and cognitive effort (Ortiz & Harwood, 2007). When contact heterogeneity is too high, the benefits of intergroup contact may weaken as individuals exceed their capacity to maintain meaningful connections. In classical face-to-face intergroup contact research, more intergroup contact often leads to more positive attitudes (e.g., Pettigrew, 2021). However, our findings suggest that it is not simply the quantity of contact that matters, but the balance between depth and breadth of those contacts, especially in virtual settings where meeting members from multiple outgroups is probable.

Though not formally proposed as a hypothesis, a significant two-way interaction effect between contact heterogeneity and cross-group friendship on contact intentions was found. More cross-group friends suppress the positive impact of contact heterogeneity on contact intentions. When *Sky* players build stronger relationships with outgroup members, they might transfer their online friendships offline and thus feel less motivated to meet new outgroup friends in real life.

Our model also controlled for known individual-level predictors of attitudes toward outgroups. Players who lacked offline contact with foreigners, or who had colder feelings toward foreigners tend to hold more negative views of outgroup members. Language fluency, especially in English, emerged as a critical factor. In a global game context, the inability to communicate effectively may hinder the formation of meaningful cross-group friendship. This suggests a concrete design recommendation: in-game translation tools may significantly enhance the quality and accessibility of intergroup interactions in digital environments to foster trust and rapport among players.

To sum up, this study offers several contributions to intergroup contact theory in virtual environments. First, it highlights the importance of moving beyond main effects to examine how frequency, depth, and breadth of online intergroup contact jointly influence attitudes toward outgroup members. Second, our data reflect naturally occurring contact among thousands of global players rather than traditional lab settings, enhancing ecological validity. Moreover, our study treats outgroups as a general category rather than focusing on a single national or ethnic target. This allows us to test the broader proposition that intergroup contact can improve generalized attitudes and behavioral intentions across multiple outgroups. Finally, there exist different pathways to attitudinal prejudice and behavioral intentions, both as common outcomes of intergroup contact, and we recommend future research adopts affective and cognitive mediators to tease out their respective mechanisms.

Several limitations should be noted. First, while we captured objective candle exchange behavior, we could not verify whether each exchange was accompanied by communication or recognition of outgroup membership. Although we explicitly asked respondents if they recalled any foreign players in their *Sky* experience and only used candle exchange after the chat function was unlocked, future studies might leverage chat logs with consent to better assess recognizable intergroup contact. In addition, there exist many other intergroup contact forms in *Sky* such as spending time or exploring the map together. Future studies should explore as many forms of contact as possible to fully mirror players' intergroup contact experiences. Second, we primarily analyzed the individual-level data and used language use as a proxy for cultural background. A multilevel modeling approach might reveal group-level variance across national or cultural contexts. Third, our measures for xenophobia and contact intentions are cross-sectional. To provide even stronger evidence for a causal link, a panel design that allows researchers to obtain a baseline level of attitudes should be adopted in future research. Fourth, players in the complete sample had slightly more intergroup contact experience and showed less xenophobia and more contact intentions than those with missing data. Given the large sample size and small differences in mean scores, we believe these differences would not significantly alter our main conclusions. Finally, *Sky* is a unique case for testing the contact hypothesis, as it is a prosocial game encouraging cooperation with identity opacity. Generalizing to other game genres should be done with caution.

Supplementary material

Supplementary material is available at *Journal of Computer-Mediated Communication* online.

Data availability

The data underlying this article were provided by Thatgamecompany, Inc. by permission. Data will be shared on request to the corresponding author with permission of Thatgamecompany, Inc.

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Conflicts of interest

None declared.

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