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Virtual contact improves intergroup relations between non-Muslim American and Muslim students from the Middle East, North Africa and Southeast Asia in a field quasi-experiment

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Given the current polarized climate in many parts of the world, finding effective interventions to address psychological factors that drive conflict is critical. Direct, face-to-face contact has the demonstrated potential to stem the tide of intergroup antipathy. However, modern socio-political conflicts often span great physical distances, making direct contact difficult, costly and rare. Programs for “virtual contact” have emerged in recent years, combining text-based computer-mediated communication with live video to extend intergroup contact’s benefits to broader audiences. While compelling, studies of such programs are typically conducted in laboratory settings, focusing only on change in outgroup attitudes. The current research tests how a semester-long virtual contact intervention that brings together non-Muslim US American students and Muslim students from the Middle East, North Africa and Southeast Asia shapes varied intergroup processes, across two large-scale field quasi-experiments (combined $N = 2886$). Compared to before the intervention and a control group, participants who engaged in virtual contact showed greater self-outgroup overlap, improved outgroup attitudes, and less outgroup dehumanization and meta-dehumanization. This research provides evidence that virtual contact can be an effective tool for promoting better intergroup relations.

In recent years, tensions and conflicts between groups of people have been highly salient, prompting a crucial question: How can we improve intergroup relations across divides? A common strategy to improve intergroup relations involves intergroup contact or promoting direct and positive face-to-face interactions between members of conflicting groups¹. Contact theory provides a theoretical framework for understanding how interactions between groups can improve relations through several key psychological processes^{2,3}. Recent theoretical work emphasizes that contact operates by shaping both cognitive and affective pathways: it can increase knowledge

about outgroups, reduce intergroup anxiety, enhance perspective-taking, and build empathy^{4,5}.

A fundamental premise of the theory is that positive interactions with individual outgroup members can generalize to improve attitudes toward the entire outgroup - meaning that even limited contact with a few representative group members can transform perceptions of the outgroup as a whole^{3,6}.

Moreover, contact theory suggests these processes work best under conditions that allow for personal connection while maintaining awareness

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of group identities^{7,8}. Yet translating these insights into effective interventions faces significant practical challenges - contact interventions may be limited by geographical distances, physical barriers, and entrenched patterns of segregation that often separate groups in conflict, such that engaging in contact may require exceptional levels of motivation, opportunities, and resources for people to do so⁷.

One approach to addressing these limitations involves the use of technology to facilitate connections among people from conflicting groups, fostering what is often referred to as *virtual contact*. Virtual contact refers to interactions between members of different groups that occur through electronic means (e.g., text-based messages, social media, and video conferences). This approach has demonstrated improved intergroup attitudes^{8,9}, yet potential effects on other dimensions of intergroup relations are not known. This raises important theoretical questions about whether virtual contact can activate the same psychological processes identified through face-to-face contact as crucial for improving intergroup relations. Furthermore, much of the existing research on virtual contact has been correlational, or lacking a control condition, and it has nearly always been conducted within controlled laboratory settings rather than with real-world field conditions; moreover, other contact research conducted in field settings suggests limits on its effectiveness^{10,11}.

In the present research, we therefore tested the effects of virtual contact utilizing two large-scale field studies among two geographically distant groups, namely, non-Muslim U.S. American students and Muslim students from the Middle East, North Africa and Southeast Asia, with two main goals. First, we sought to replicate prior research findings on virtual contact in a field setting, and using advanced methods of virtual communication, to demonstrate its applicability in real-world contexts. Second, we sought to extend prior research on virtual contact by focusing on two key psychological processes that contact theory suggests are critical for improving intergroup relations. While earlier perspectives have emphasized cognitive processes like knowledge acquisition and affective processes like anxiety reduction⁴, recent theoretical developments suggest that contact may function through psychological mechanisms that transform how group members see themselves in relation to others^{12,13}. Specifically, we examine self-outgroup overlap and humanization—processes that may explain why virtual contact promotes positive shifts in intergroup relations. While most existing research on intergroup contact has focused on prejudice reduction (e.g., ref. 14), examining these less researched outcome variables allows us to gain a more comprehensive understanding of how intergroup contact, and in particular virtual contact shapes intergroup perceptions and relations beyond prejudice reduction alone.

First, self-outgroup overlap, the extent to which an individual sees similarity with¹⁵ and feels psychological connectedness to members of an outgroup¹⁶, can significantly influence intergroup attitudes and behaviors^{17,18}. Research has shown that greater self-outgroup overlap is associated with more positive outgroup attitudes and reduced outgroup dehumanization, which may help to expand our understanding of the positive effects of intergroup contact^{5,19}. In line with earlier work on direct contact, the current research explores whether virtual contact can increase self-outgroup overlap, as it serves as a platform for individuals to engage personally with outgroup members. Of particular interest is whether, like in face-to-face contact²⁰, virtual contact can foster feelings of psychological connectedness despite the geographical distances that may exist between members of different groups, which is especially relevant in the context of the current research. Recent research has begun to explore this question, demonstrating that feelings of closeness and social presence in online intergroup contact can positively influence attitudes toward outgroup members²¹. This emerging work suggests the potential of virtual spaces to foster meaningful psychological connections between groups despite physical separation.

Second, dehumanization refers to the act of stripping away or overlooking others' basic human characteristics²². Studies around the globe underscore a tendency for people to dehumanize other groups, leading to the development of hostile attitudes and support for anti-outgroup

policies^{23,24}. Contact can reduce dehumanization by providing evidence that challenges one's beliefs that the outgroup is less than fully human²³. In addition, previous research identified key factors influencing dehumanization, including meta-dehumanization (i.e., the extent to which I think the outgroup dehumanizes my ingroup²⁵); perceiving less meta-dehumanization triggers reciprocal shifts, correspondingly reducing outgroup dehumanization^{25,26}. We argue that when groups are geographically distant, or separated by physical barriers, members of each group typically have limited exposure to outgroup members, and therefore have little knowledge regarding what they think about them. Thus, virtual contact should be particularly conducive in reducing meta-dehumanization, as greater engagement with outgroup members (even virtually) should inform individuals about outgroup beliefs and perceptions. Indeed, some small-scale field studies have linked participating in contact, including virtual contact, with reduced (meta-)dehumanization²³.

The current research

The present research extends prior work by conducting a large-scale field-based quasi-experiment to test the impact of a virtual contact intervention, the Soliya's Connect Program^{27,28}, on outgroup attitudes, self-outgroup overlap, and dehumanization (as well as meta-dehumanization). Soliya, a US-based non-governmental organization (NGO), facilitates multi-person video conferencing in small groups (see refs. 18,22). An added benefit of partnering with Soliya was our ability to reach participants from historically under-studied regions, including the Middle East and North Africa (MENA), and Southeast Asia.

The selection of American and Muslim students from MENA and Southeast Asia as focal groups reflects significant ongoing sociopolitical tensions between these communities. Following the September 11, 2001 attacks, Muslims in America have faced increased scrutiny, discrimination, and prejudice^{29,30}. These tensions have since been further inflamed by political rhetoric, particularly during the 2016 presidential campaign, when Donald Trump called for “a total and complete shutdown of Muslims entering the United States”^{31,32}. Such high-profile anti-Muslim rhetoric has been associated with increased hate incidents, with the Council on American-Islamic Relations reporting a sustained rise in anti-Muslim discrimination cases³³. Conversely, negative attitudes toward Americans remain widespread among populations in MENA and Southeast Asian countries, with surveys indicating consistently low favorability ratings and deep-rooted skepticism toward American society and its values³⁴. These persistent patterns of mutual distrust and negative intergroup attitudes underscore the critical need for interventions aimed at improving relations between these communities.

University students represent an ideal population for such interventions as they are at a formative stage in their development, where they begin to shape their value systems, worldviews, and perspectives on complex social, economic, and cultural issues³⁵. Recent research shows that structured opportunities for close interaction between majority and minority students in university courses can boost academic achievement and foster a sense of belonging among minority students³⁶. Additionally, university students play a key role in shaping societal norms, making them an ideal group for studying intergroup contact and the broader impact of such interventions on society³⁷. Lastly, universities provide a unique institutional framework that supports intercultural exchanges, offering academic structures and environments that foster sustained engagement and meaningful dialog. This institutional support is crucial for the effectiveness of contact interventions—research has shown that when universities facilitate frequent opportunities for positive interaction, whether in shared living spaces or other settings, students demonstrate reduced levels of intergroup prejudice^{38–40}.

This project consisted of two field studies with pre- and post-program measurements. Study 1 was a smaller-scale study and focused on the effect of virtual contact on outgroup attitudes and self-outgroup overlap; this study did not include a control condition. Study 2 was a large-scale study that included a control group, aimed to rigorously examine the effect of virtual contact on key intergroup outcomes in a global field setting.

Methods

The connect program

Operating for over two decades, Soliya's Connect Program is an online cross-cultural education program that, depending on the module, spans over a period of four, five, or in the primary Connect Global module, 8 weeks. It is offered as a marked component of a university course in more than 200 universities across 35 nations, bringing together American and Muslim university students (typically aged 18–30 years) from the US, Middle East, and North Africa (MENA), and Southeast Asia for online dialog. Participants who opt into the program meet with their group once a week for two hours of live, synchronous sessions using audio-, video-, and text-based tools on a videoconferencing platform; they also complete asynchronous activities and continue discussions in between sessions through text-based group chats on Soliya's learning management system.

While students entered the program through their university, they were assigned to discussion groups based solely on individual availability, so groups included students drawn from different classes and institutions. All sessions took place outside of regular class time, with students participating virtually from their preferred locations such as dorm rooms, campus libraries, computer labs, or other quiet spaces that fit their academic schedules. This structure ensures that the intervention and group dynamics develop independently of existing classroom relationships.

Each participant group is led by one or two Soliya-trained facilitators who guide discussions and the dialogic process, using a semi-structured curriculum and an extensive set of facilitation resources. Program participants explore pressing global and social challenges through a series of facilitated discussions; participants also complete readings and an independent, collaborative project that they jointly develop and complete over their weeks in the program. Group discussions cover a range of topics, including identity, values, social norms, cultural stereotypes, current events, religion, media, gender roles, inequality, and emerging technologies, among others. Participants know in advance that the dialog sessions will tackle a broad spectrum of issues, including some that may be sensitive and controversial, and that the program's goal is to promote participants' mutual understanding while honing their skills in cross-cultural communication, leadership, empathy, problem-solving, and critical thinking.

Each session begins with guided learning activities that enable participants to get to know each other on a personalized basis, examine the process of dialog, and begin to develop skills in active listening and cross-cultural communication, before moving into free-flowing discussions on participants' chosen topics. Participants' nationality is made salient when participants introduce themselves, and there is a deliberate attempt to highlight and value each participant's unique perspective and expertise. Facilitators are responsible for ensuring safe spaces where all participants may engage equitably and encouraging participants to deepen their engagement with the issues discussed by thinking about not just what, but why they and their peers think the way they do. Ultimately, Soliya's Connect Program has been designed to establish optimal conditions of positive intergroup contact, wherein group members share equal status during interactions and collaborate on projects with common objectives, and with institutional support and facilitation, while maintaining the salience of participants' backgrounds and differences, and continually addressing contentious issues (see, e.g., (25)).

Analysis strategy

Neither study reported in this article was preregistered. For both studies, attrition patterns were examined using binary logistic regression, with demographic characteristics and pre-intervention measures entered as predictors. Changes in outgroup attitudes and self-outgroup overlap were analyzed using repeated measures ANOVAs, with timepoint (pre- vs. post-intervention) as a within-subjects factor. In Study 1, participant ethno-religious background (Americans vs. Muslims) was included as a between-subjects factor, while in Study 2, condition (virtual contact vs. control) was added as a between-subjects factor. Additionally, in Study 2, three-way

interactions with participant group (American vs. Muslim) were tested to examine whether intervention effects generalized across cultural contexts.

To complement frequentist analyzes, Bayesian analyzes were conducted to assess the strength of evidence for null effects. Bayes Factors (BF_{10}) were computed for non-significant results, where $BF_{10} < 0.33$ was considered evidence for the null hypothesis, whereas BF_{10} values between 0.33 and 3 were interpreted as inconclusive evidence. All Bayes Factors for significant effects exceeded 3, providing strong evidence for the alternative hypothesis. Additionally, as a robustness check, difference-in-differences (DID) analyzes were conducted to account for potential time trends.

Reporting summary

Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Study 1

Participants

The Soliya program took place during the Fall semesters of 2011 and 2012. Participants in the virtual contact intervention were undergraduate students from the U.S. and from predominantly Muslim countries in the MENA region, and Southeast Asia. It should be noted that 59 non-Muslim European students also participated in the program. However, as the focus of the study and research questions were on American-Muslim divides, we did not include them in the final analysis. Based on the demographic data available at recruitment, none of the 163 American students identified as Muslim, and more than 90% of 341 students from the MENA and Southeast Asian countries identified as Muslim. We recognize that "American" is a complex social category that could also incorporate Muslims, but for simplicity purposes, we use the term "American". Additionally, for the purpose of methodological clarity we categorically designate participants from the predominantly Muslim MENA and Southeast Asian countries as "Muslims".

Religious demographic data was only collected in the 2011 cohort, after which Soliya discontinued collecting this information. In that cohort, demographic data collected during recruitment indicated that all American students identified with non-Muslim faiths or no religious affiliation, while ~92% of students from MENA and Southeast Asian countries identified as Muslim. While we cannot definitively extend these proportions to subsequent years, this historical data, combined with broader demographic patterns in these regions, provides support for our methodological decision to use these categorical designations. We acknowledge this as a limitation in our demographic data collection.

Participants did not receive monetary compensation for their participation in this study, instead, they received course credit. Overall, 65.6% of the American students and 47.2% of the Muslim students completed both the pre- and post-intervention surveys. This resulted in a total of 107 American students and 161 Muslim students in the final analytic sample. A sensitivity analysis using G*Power for a within- and between-subjects factors repeated-measures ANOVA shows that, with the achieved sample size and alpha of 0.05, we should be able to detect an effect size as small as partial $\eta^2 = 0.01$ with 80% power.

Measures and procedure

The institutional review board at the Massachusetts Institute of Technology approved all study procedures, and participants provided informed consent prior to participation.

Program participants completed surveys ~1 week before their first virtual contact session (baseline) and either during the final minutes of their last session or within several days of program completion. As noted in the Connect program description above, the intervention was implemented outside of the classroom. Measures included in the surveys were adapted to target each of the main groups involved in the Soliya program: American participants responded to items referencing Muslims, whereas Muslim participants completed items referencing Americans. The key variables of

interest in the present research were outgroup attitudes and self-outgroup overlap, with an added focus on (meta-) dehumanization in Study 2. Items were presented in a randomized order. We assessed changes in Americans' attitudes toward Muslims and change in Muslims' attitudes toward Americans by comparing their responses before and after the program. In addition, the studies included other intergroup-related variables of interest to Soliya, such as perceived conflict between Islamic countries and Western democracies. Due to our primary focus and objectives, however, we focus on outgroup attitudes and self-outgroup overlap in the current study, and we report analyses for any other available intergroup measures in the Supplementary Information (Supplementary Notes 1).

Participants completed surveys ~1 week before their first virtual contact session (baseline) and during the final minutes of their last session or within several days of completion (post-intervention).

Outgroup attitudes. Participants reported their attitudes toward each participating group (Americans, Arabs, Muslims) using “feeling thermometers”⁴¹. Ratings were made on unmarked slider bars anchored at “very cold/unfavorable” (0) and “very warm/favorable” (100).

Self-outgroup overlap. We used the self-outgroup overlap measure, adapted by Schubert and colleagues, to assess participants' feelings of psychological closeness between themselves and each participating outgroup. This measure is a modified version of the classic Inclusion of the Other in Self (IOS) scale, specifically adapted for intergroup relations. Participants rated their perceived overlap with the target groups (Americans, Muslims) and a non-participating comparison outgroup (Chinese) to assess their psychological connection with each group (see ref. 15). The graphic measure shows a small circle, labeled “you,” and a larger circle, labeled “group,” in progressively closer arrangement with each other; the first image shows the circles completely separated with some distance from each other, and the seventh and final image shows the “you” circle centered within the “group” circle. Participants made ratings in relation to each target group using the images as a 7-point scale (see SOM).

Study 2 Participants

Overall, 2382 students took part in the study across two cohorts during the spring semesters of 2020 and 2021 ($M_{\text{Age}} = 22.04$, $SD_{\text{Age}} = 5.34$; Gender: 1272 Men and 1110 Women). The study included 1,259 American students (1087 in the experimental condition and 172 in the control condition), out of whom 949 students completed both pre- and post-program surveys and answered the attention check items correctly (855 in the experimental condition and 94 in the control). Furthermore, 1123 Muslim students (956 in the experimental condition and 167 in the control condition) from the MENA region and Southeast Asia took part in the study, and of these students, 881 completed both pre- and post-program surveys and answered the attention check items correctly (770 in the experimental condition and 111 in the control).

In a sensitivity analysis using G*Power for within- and between-subjects factors repeated measures ANOVA, we found that with the achieved sample size and alpha of 0.05, we were able to detect an effect size as small as partial $\eta^2 = 0.001$ with 80% power for the within-subject effect and interaction, and partial $\eta^2 = 0.003$ for the between-subject effect. We note that in the 2021 Spring semester cohort we also wanted to examine a meta-perception correction intervention (e.g., ref. 42). Therefore, half of the participants in the experimental condition saw a short video of one of the researchers talking about meta-perceptions before they began the contact program, which was accompanied by some information about how meta-perceptions of prior virtual contact participants were erroneous. However, we found that there were no differences between the virtual contact conditions with and without this video, so we analyzed them together (see SOM for more information). Similar to Study 1 participants in either condition received monetary compensation for their participation in this study.

Intervention participants did however receive course credit for their participation in the program.

Measures and procedure

To ensure that the experimental and control conditions were as similar as possible, we sampled control participants from the classes of professors who had previously enrolled their students in the Soliya program but were not currently participating (although they were still in touch with the organization). While class sections determined condition assignment, intervention participants were mixed across classes into small discussion groups for the program implementation. These groups met virtually for 2-h weekly synchronous sessions over several weeks, led by trained facilitators following a structured curriculum (see full details in the introduction).

The institutional review board at University of Pennsylvania approved all study procedures, and participants provided informed consent prior to participation. All measures were included in the pre-program survey (February–March 2020, and February 2021), and post-program survey (May 2020, and May 2021). Similar to study 1, program participants completed surveys ~1 week before their first virtual contact session (baseline) and during the final minutes of their last session or within several days of completion (post-intervention). Control participants completed surveys at corresponding timeframes but on their own time rather than during scheduled sessions, which likely contributed to lower response rates.

Outgroup attitudes and self-outgroup overlap were assessed in Study 1.

Meta-dehumanization was assessed using the trait dehumanization scale (see e.g., refs. 23,43), where participants had to rate how members of the other group view their group on a series of six traits (i.e., backward and primitive, sophisticated (reverse coded), lacking morals, self-controlled (reverse coded), refined and cultured (reverse coded), and rational and logical (reverse coded)) characterize their target outgroup; Americans answered regarding Muslims, and Muslims regarding Americans, on a scale of *Strongly Disagree* (1) to *Strongly Agree* (100) ($\alpha_{\text{Pre}} = 0.76$; $\alpha_{\text{Post}} = 0.76$).

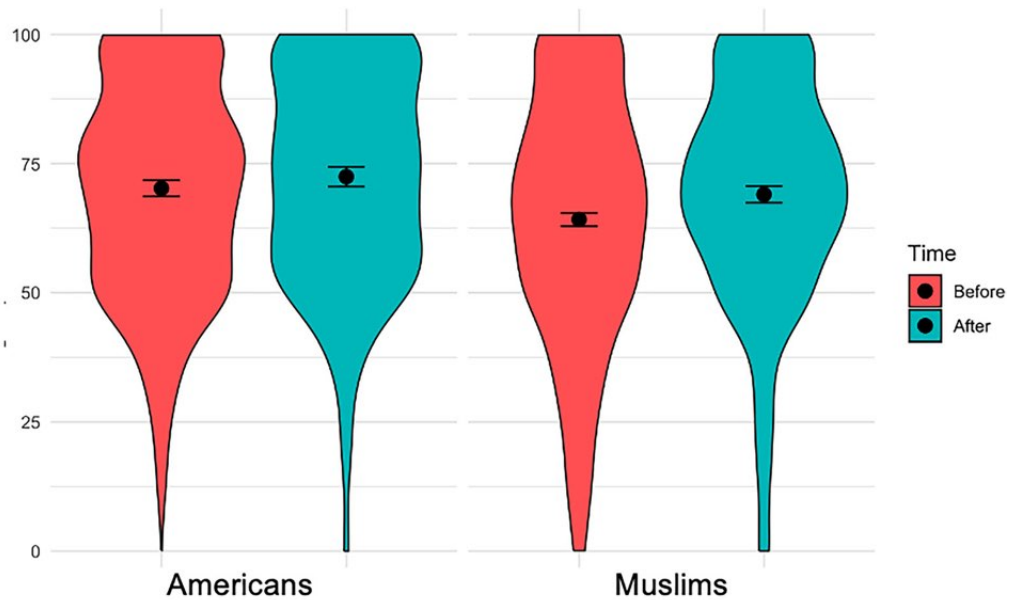
Dehumanization was assessed using the same trait dehumanization scale (see e.g., refs. 23,43), where participants had to rate how well the series of the same six traits characterize the target outgroup; Americans answered questions regarding Muslims, and Muslims answered questions regarding Americans ($\alpha_{\text{Pre}} = 0.76$; $\alpha_{\text{Post}} = 0.73$).

Results

Study 1

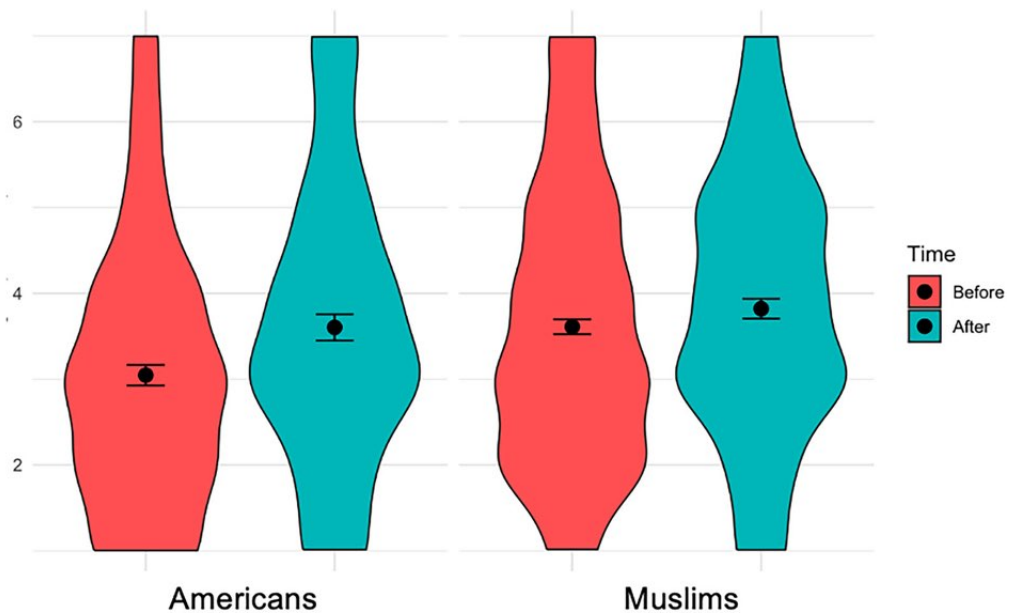
Attrition was not predicted by levels of self-outgroup overlap ($b = 0.10$, $SE = 0.06$, $p = 0.094$, 95% CI $[-0.02, 0.22]$). However, attrition was significantly predicted by participants' ethno-religious background ($b = 0.64$, $SE = 0.21$, $p = 0.002$, 95% CI $[0.23, 1.05]$), such that Muslim participants were more likely to drop out than American participants. Attrition was also predicted by pre-program outgroup attitudes ($b = -0.10$, $SE = 0.004$, $p = 0.046$, 95% CI $[-0.11, -0.002]$), such that participants with more negative pre-program outgroup attitudes were more likely to drop out. More specifically, the final participant sample had more positive outgroup attitudes ($M = 68.07$, $SD = 22.11$; responses ranged from 12 to 100, with 26.5% of sample rating outgroup 50 or below) compared to participants who dropped out ($M = 64.05$, $SD = 24.63$, responses ranged from 0 to 100, with 30.1% of sample rating outgroup 50 or below). However, pre-program levels of outgroup attitudes did not predict change across time on either of the dependent variables.

Assumptions of normality were assessed via visual inspection of Q-Q plots and evaluation of skewness and kurtosis, both of which indicated that distributions fell within acceptable ranges. There was a significant main effect of timepoint on both outgroup attitudes ($F(1, 266) = 5.15$, $p = 0.024$, 95% CI $[65.65, 71.08]$ to $[68.87, 73.98]$, partial $\eta^2 = 0.02$; see Fig. 1), and on self-outgroup overlap ($F(1, 260) = 28.17$, $p < 0.001$, 95% CI $[3.07, 3.45]$ to $[3.56, 3.96]$, partial $\eta^2 = 0.10$), such that levels of warmth toward the outgroup ($M_{\text{Before}} = 68.36$, $SD_{\text{Before}} = 22.11$, vs. $M_{\text{After}} = 71.42$, $SD_{\text{After}} = 20.80$) and overlap ($M_{\text{Before}} = 3.33$, $SD_{\text{Before}} = 1.58$, vs. $M_{\text{After}} = 3.77$, $SD_{\text{After}} = 1.58$) increased across timepoints regardless of participants' ethno-religious



$N=268$, Note: Error bars represent standard errors.

Fig. 1 | Change over time (pre-program to post program) in outgroup attitudes for Americans and Muslims.



$N=262$, Note: Error bars represent standard errors.

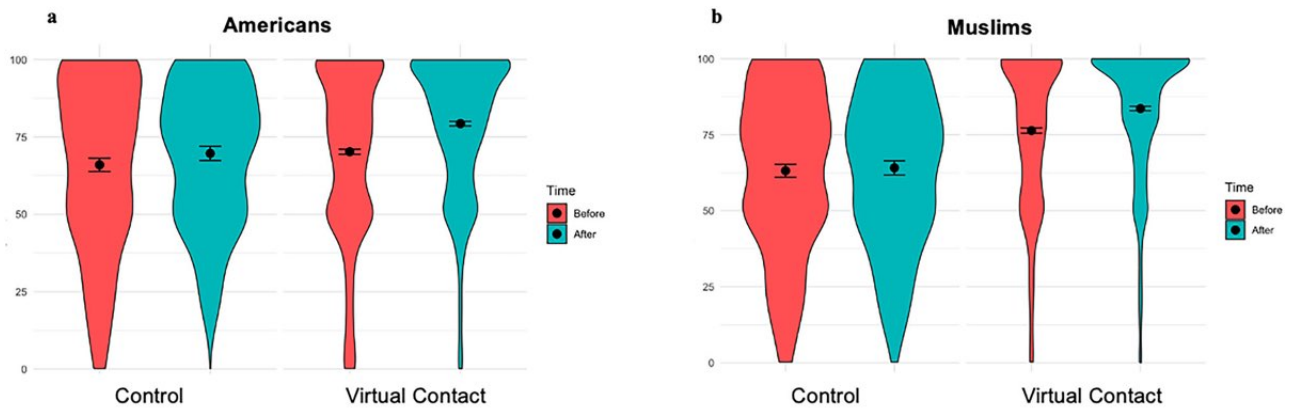
Fig. 2 | Change over time (pre-program to post program) in self-outgroup overlap for Americans and Muslims.

background. Moreover, while the interaction between timepoint and ethno-religious group was not a significant predictor of outgroup attitudes ($F(1, 266) = 0.08, p = 0.785, 95\% \text{ CI} [-6.78, 6.38]$, partial $\eta^2 < 0.01, \text{BF}_{10} = 0.14$), it was for self-outgroup overlap ($F(1, 260) = 6.97, p = 0.009, 95\% \text{ CI} [-1.03, -0.46]$, partial $\eta^2 = 0.03, \text{BF}_{10} = 0.47$). Both American and Muslim students reported feeling higher sense of overlap with the outgroup after (vs. before) the program, although the effect was stronger among Americans ($M_{\text{Before}} = 2.92, \text{SD}_{\text{Before}} = 1.63$, vs. $M_{\text{After}} = 3.67, \text{SD}_{\text{After}} = 1.69, p < 0.001, 95\% \text{ CI} [0.46, 1.03]$, partial $\eta^2 = 0.09$) than among Muslims ($M_{\text{Before}} = 3.60, \text{SD}_{\text{Before}} = 1.50$, vs. $M_{\text{After}} = 3.85, \text{SD}_{\text{After}} = 1.51, p = 0.034$, partial $\eta^2 = 0.02, 95\% \text{ CI} [0.02, 0.48]$; see Fig. 2). It should be noted that Results remain the

same when controlling for region (US, MENA and South-East Asia). See Supplementary Information for full results.

Study 2

Study 2 sought to replicate the effects of the virtual contact program observed in Study 1 on students' intergroup attitudes (a) relative to a control group, and (b) with a larger sample. Moreover, beyond addressing the methodological limitations of Study 1, Study 2 also examines two additional important outcome measures that were not included previously, namely, dehumanization and meta-dehumanization, both of which have previously been found to correspond with participation in virtual contact in small-scale field studies²³.



$N = 1826$, Note: Error bars represent standard errors.

Fig. 3 | Interaction between timepoint and condition on outgroup attitudes. American (a) and Muslim (b) participants.

Attrition was significantly predicted by participants' ethno-religious background ($b = 1.40$, $SE = 0.15$, $p < 0.001$, 95% CI [1.11, 1.69]), such that American participants were more likely to drop out than Muslim participants. Attrition was also predicted by condition ($b = -1.17$, $SE = 0.14$, $p < 0.001$, 95% CI [-1.44, -0.90]), such that participants in the control condition were more likely to drop out than those in the virtual contact condition. Additionally, attrition was predicted by pre-program scores on dehumanization ($b = 0.02$, $SE = 0.004$, $p < 0.001$, 95% CI [0.012, 0.028]), such that the final participant sample reported lower pre-program dehumanization scores ($M = 29.57$, $SD = 18.45$; responses ranged from 0 to 99.83, with 15.0% of sample rating outgroup 50 or above) compared to participants who dropped out ($M = 33.39$, $SD = 19.74$, responses ranged from 0 to 89.67, with 23.8% of sample rating outgroup 50 or above). Gender ($b = 0.142$, $SE = 0.116$, $p = 0.221$, 95% CI [-0.085, 0.369]), age ($b = 0.013$, $SE = 0.013$, $p = 0.286$, 95% CI [-0.012, 0.038]), pre-program meta-dehumanization ($b = 0.005$, $SE = 0.003$, $p = 0.116$, 95% CI [-0.001, 0.011]), pre-program outgroup attitudes ($b = 0.003$, $SE = 0.003$, $p = 0.225$, 95% CI [-0.002, 0.008]), and pre-program self-outgroup overlap ($b = -0.025$, $SE = 0.036$, $p = 0.486$, 95% CI [-0.096, 0.046]) did not significantly predict attrition.

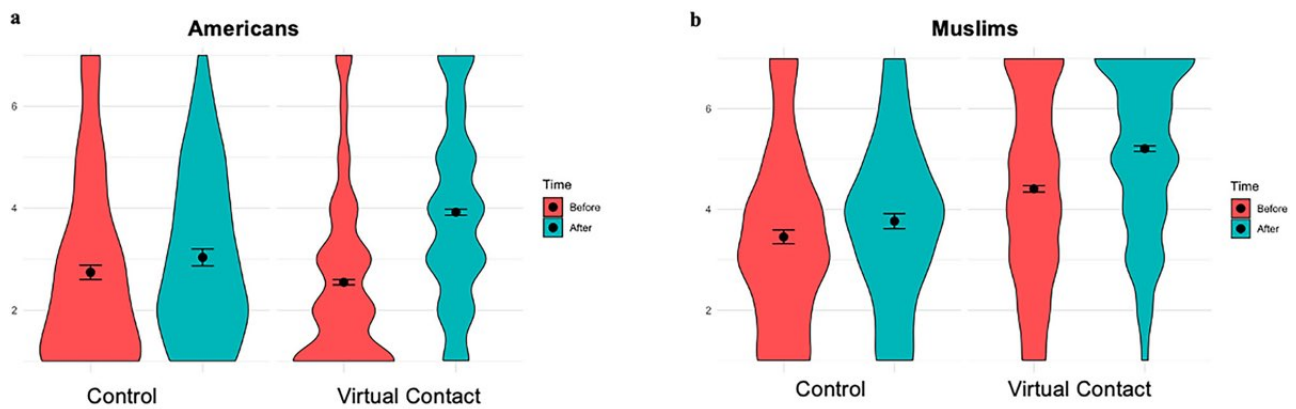
Ultimately, the predictors explained 8% of the variance of attrition. Pre-program levels of dehumanization in the virtual contact condition predicted more positive change across time in outgroup attitudes ($F(1, 1824) = 18.869$, $p < 0.001$, partial $\eta^2 = 0.01$), dehumanization ($F(1, 1810) = 14.863$, $p < 0.001$, partial $\eta^2 = 0.01$) and meta-dehumanization ($F(1, 1812) = 12.248$, $p < 0.001$, partial $\eta^2 = 0.01$), but not in self-outgroup overlap ($F(1, 1818) = 0.056$, $p = 0.813$, partial $\eta^2 = 0.00$). Assumptions of normality were assessed via visual inspection of Q-Q plots and evaluation of skewness and kurtosis, both of which indicated that distributions fell within acceptable ranges.

Outgroup attitudes. There was a significant time point \times condition interaction for outgroup attitudes ($F(1, 1824) = 18.87$, $p < 0.001$, partial $\eta^2 = 0.01$). In the virtual contact condition, both American participants (95% CI [6.27, 9.61], $p < 0.001$, partial $\eta^2 = 0.05$) and Muslim participants (95% CI [5.32, 8.84], $p < 0.001$, partial $\eta^2 = 0.03$) reported warmer attitudes toward the outgroup over time ($M_{\text{Before}} = 71.35$, $SD_{\text{Before}} = 26.37$ vs. $M_{\text{After}} = 79.29$, $SD_{\text{After}} = 21.84$ and $M_{\text{Before}} = 77.08$, $SD_{\text{Before}} = 24.60$ vs. $M_{\text{After}} = 84.16$, $SD_{\text{After}} = 20.76$, respectively). By contrast, in the control condition, neither American participants (95% CI [-6.21, 3.87], $p = 0.649$, partial $\eta^2 > 0.01$, $BF_{10} = 0.24$) nor Muslim participants (95% CI [-2.38, 6.90], $p = 0.339$, partial $\eta^2 > 0.01$, $BF_{10} = 0.26$) differed significantly in their levels of warmth toward the outgroup over time ($M_{\text{Before}} = 68.94$, $SD_{\text{Before}} = 25.02$ vs. $M_{\text{After}} = 70.11$, $SD_{\text{After}} = 22.08$ and $M_{\text{Before}} = 66.54$, $SD_{\text{Before}} = 25.62$ vs. $M_{\text{After}} = 64.28$, $SD_{\text{After}} = 24.79$, respectively) (see Fig. 3). Additionally, the three-way interaction between

timepoint, condition and group was not significant ($p = 0.488$, partial $\eta^2 > 0.01$, $BF_{10} = 0.15$). We replicated these results using the DID estimation (Full results including all interactions and DID analysis are reported in the SOM).

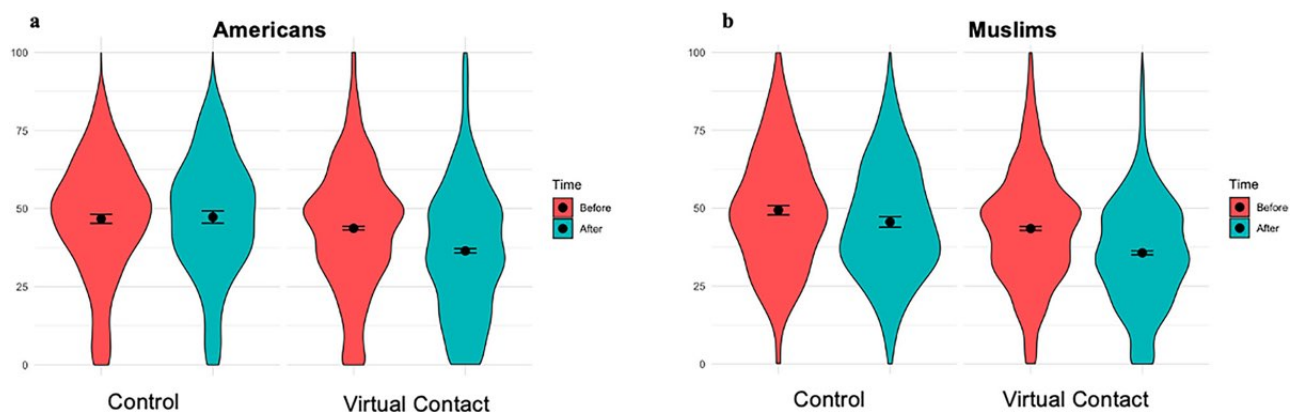
Self-outgroup overlap. There was a significant time point \times condition interaction for the self-outgroup overlap measure ($F(1, 1818) = 33.67$, $p < 0.001$, partial $\eta^2 = 0.02$), such that in the virtual contact condition, both American participants (95% CI [1.24, 1.48], $p < 0.001$, partial $\eta^2 = 0.21$) and Muslim participants (95% CI [0.70, 0.96], $p < 0.001$, partial $\eta^2 = 0.08$) reported greater overlap with the outgroup over time ($M_{\text{Before}} = 2.57$, $SD_{\text{Before}} = 1.68$; $M_{\text{After}} = 3.92$, $SD_{\text{After}} = 1.79$ and $M_{\text{Before}} = 4.41$, $SD_{\text{Before}} = 1.89$; $M_{\text{After}} = 5.24$, $SD_{\text{After}} = 1.63$, respectively). By contrast, in the control condition, there was no evidence of change for either American participants (95% CI [-0.70, 0.04], $p = 0.081$, partial $\eta^2 > 0.01$, $BF_{10} = 0.43$) nor Muslim participants (95% CI [-0.62, 0.06], $p = 0.108$, partial $\eta^2 > 0.01$, $BF_{10} = 0.52$), ($M_{\text{Before}} = 2.67$, $SD_{\text{Before}} = 1.80$; $M_{\text{After}} = 3.00$, $SD_{\text{After}} = 1.59$ and $M_{\text{Before}} = 3.46$, $SD_{\text{Before}} = 1.64$; $M_{\text{After}} = 3.74$, $SD_{\text{After}} = 1.61$, respectively) (see Fig. 4). The three-way interaction between time, condition and group showed no clear evidence of an effect ($p = 0.080$, partial $\eta^2 > 0.01$, $BF_{10} = 0.58$). We replicated these results using the DID estimation (Full results including all interactions and DID analysis are reported in the SOM).

Meta-dehumanization. There was a significant time \times condition interaction on meta-dehumanization ($F(1, 1808) = 11.94$, $p < 0.001$, partial $\eta^2 = 0.01$). Specifically, in the virtual contact condition, both American participants (95% CI [-8.35, -5.80], $p < 0.001$, partial $\eta^2 = 0.06$) and Muslim participants (95% CI [-9.42, -6.74], $p < 0.001$, partial $\eta^2 = 0.06$) ($M_{\text{Before}} = 43.64$, $SD_{\text{Before}} = 20.37$; $M_{\text{After}} = 36.42$, $SD_{\text{After}} = 20.68$ and $M_{\text{Before}} = 43.17$, $SD_{\text{Before}} = 18.79$; $M_{\text{After}} = 35.09$, $SD_{\text{After}} = 17.10$, respectively) reported lower levels of meta-dehumanization over time. In the control condition, whereas American participants did not significantly differ in their levels of meta-dehumanization over time (95% CI [-4.19, 4.41], $p = 0.957$, partial $\eta^2 < 0.01$, $BF_{10} = 0.24$; $M_{\text{Before}} = 47.27$, $SD_{\text{Before}} = 18.70$; $M_{\text{After}} = 47.16$, $SD_{\text{After}} = 19.17$), Muslim participants surprisingly did (95% CI [0.90, 8.54], $p = 0.015$, partial $\eta^2 > 0.01$, $BF_{10} = 2.08$; $M_{\text{Before}} = 50.33$, $SD_{\text{Before}} = 18.89$) (See Fig. 5). The three-way interaction between time, condition and group was not significant ($p = 0.216$, partial $\eta^2 > 0.01$, $BF_{10} = 0.26$). The DID estimation for the interaction between condition and timepoint was not significant, but the change across time among the participants in the virtual contact condition replicated (Full results including all interactions and DID analysis are reported in the SOM).



N = 1820, Note: Error bars represent standard errors.

Fig. 4 | Interaction between timepoint and condition on self-outgroup overlap. American (a) and Muslim (b) participants.



N = 1810, Note: Error bars represent standard errors.

Fig. 5 | Interaction between timepoint and condition on meta-dehumanization. American (a) and Muslim (b) participants.

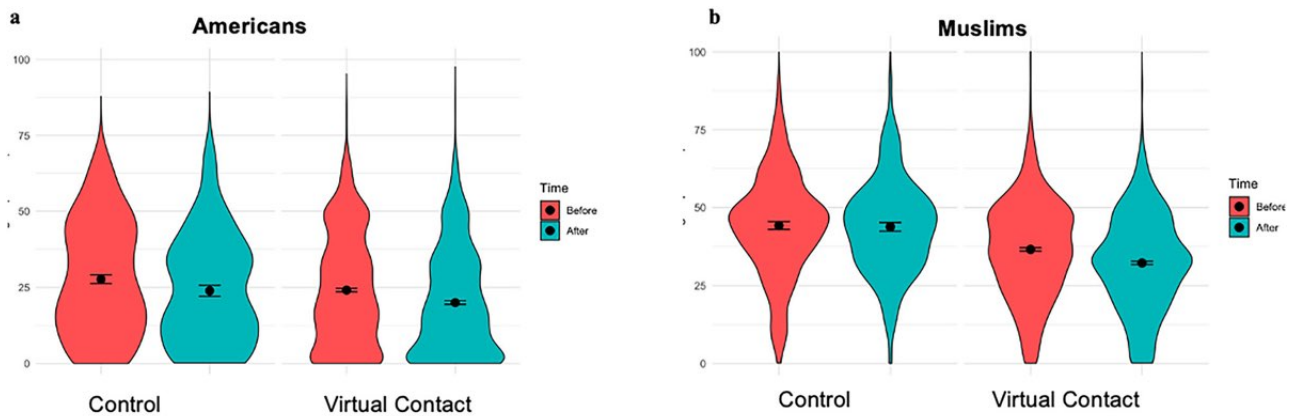
Dehumanization. There was a significant time point \times condition interaction for the dehumanization measure ($F(1, 1842) = 13.82, p < 0.001$, partial $\eta^2 < 0.01$). Specifically, in the virtual contact conditions, both American participants (95% CI $[-5.31, -3.06], p < 0.001$, partial $\eta^2 = 0.02$), $p < 0.001$, partial $\eta^2 = 0.02$ and Muslim participants (95% CI $[-5.38, -3.24], p < 0.001$, partial $\eta^2 = .03$) reported lower levels of dehumanization towards the outgroup over time ($M_{\text{Before}} = 24.11, SD_{\text{Before}} = 19.99; M_{\text{After}} = 19.94, SD_{\text{After}} = 17.49$ and $M_{\text{Before}} = 36.54, SD_{\text{Before}} = 15.52; M_{\text{After}} = 32.23, SD_{\text{After}} = 15.52$, respectively). In the control condition, neither American participants (95% CI $[-0.08, 6.94], p = 0.696$, partial $\eta^2 > 0.01, BF_{10} = 0.20$) nor Muslim participants (95% CI $[-2.74, 3.16], p = 0.385$, partial $\eta^2 > 0.01, BF_{10} = 0.20$) differed significantly in their levels of dehumanization towards the outgroup over time ($M_{\text{Before}} = 27.79, SD_{\text{Before}} = 18.84; M_{\text{After}} = 24.36, SD_{\text{After}} = 18.12$, and $M_{\text{Before}} = 44.23, SD_{\text{Before}} = 16.01; M_{\text{After}} = 44.02, SD_{\text{After}} = 14.60$, respectively) (see Fig. 6). The three-way interaction between time, condition and group was not significant ($p = 0.464$, partial $\eta^2 > 0.01, BF_{10} = 0.27$). The DID estimation for the interaction between condition and timepoint was only marginally significant, but the change across time among the participants in the contact condition replicated (Full results including all interactions and DID analysis are reported in the SOM). It

should be noted that all results remain the same when controlling for regions (US, MENA and South-East Asia). See Supplementary Information for full results.

The results of Study 2 reveal that virtual contact not only positively influences outgroup attitudes and self-outgroup overlap but also decreases dehumanization and meta-dehumanization. The fact that it was conducted a decade after the initial study strengthens our confidence that this approach to addressing intergroup psychological tensions remains effective in today's context. Nevertheless, it is important to recognize that we found a higher attrition rate among students with higher levels of dehumanization, raising concerns that our results were driven by dropout bias. However, there was no significant difference in the dehumanization dropout patterns between the two conditions, which partially addresses concerns about participant selection (see SOM for full analysis).

Discussion

The current research, conducted across two field studies—one smaller-scale study and one large-scale study—with a diverse sample including participants from less well-studied countries, provides robust evidence for the profound impact of virtual contact on intergroup relations. Our findings demonstrate that engaging in virtual contact is generally



$N = 1844$, *Note*: Error bars represent standard errors.

Fig. 6 | Interaction between timepoint and condition on dehumanization. American (a) and Muslim (b) participants.

associated with more positive outgroup attitudes, greater self-outgroup overlap, and less meta-dehumanization and dehumanization. Thus, our findings and methodology provide a meaningful contribution to the existing literature on intergroup contact interventions, highlighting how powerful virtual contact can be in shaping how different groups perceive and relate to each other. Although virtual contact may involve similar content or interactions as in-person contact, its unique advantage lies in its ability to occur when physical proximity is not possible or constrained by logistical or contextual barriers. This distinction underscores the transformative potential of virtual contact in fostering positive intergroup relations, especially when traditional face-to-face interactions are impractical or inaccessible.

Moreover, extending contact theory beyond traditional measures^{1,44}, we show that virtual contact may not only be associated with the development of more positive outgroup attitudes but also with reduced dehumanization, which was found to be a focal predictor of hostile intergroup attitudes and support for anti-outgroup policies, above and beyond intergroup prejudice (e.g., ref. 22). A particularly compelling aspect of our findings is that interactions with a relatively small number of outgroup representatives through virtual contact led to improved attitudes toward the outgroup as a whole. This generalization effect—where positive experiences with individual outgroup members reshape perceptions of the entire group—demonstrates one of contact theory’s core premises in action. The fact that these broader attitudinal changes occurred through virtual interactions with just a subset of outgroup members underscores the potency of such contact experiences in transforming intergroup relationships⁴⁵. Moreover, recent research on secondary transfer effects suggests that such positive contact experiences may have even wider-reaching benefits, potentially fostering more tolerant attitudes toward other outgroups not directly involved in the contact⁴⁶. These positive effects highlight the profound potential of even limited intergroup contact to promote broader trends toward social harmony.

Additionally, we show that virtual contact can be an effective tool in reducing dehumanization in a manner similar to face-to-face contact. Our findings align with previous research⁴⁷ suggesting that verbal communication plays a significant role in reducing dehumanization and enhancing conflict resolution. Furthermore, we find evidence that participating in virtual contact is also associated with greater self-outgroup overlap and lower (meta-)dehumanization. These findings advance contact theory by demonstrating how virtual interactions can reshape fundamental psychological representations of intergroup boundaries¹², such as by shifting feelings of connectedness between “me” and “them” and by fostering more

reciprocal humanizing perceptions in terms of “how I think they see people like me” and “how I see people like them”^{17,48}.

The field study design of this research offers compelling evidence for the real-world applicability and scalability of virtual contact interventions. By demonstrating positive outcomes in authentic educational contexts, our findings suggest that such programs can be effectively integrated into existing curricula to promote improved intergroup relations on a broad scale. This approach not only enhances the ecological validity of our results but also provides practical insights for educators and policymakers seeking to implement large-scale interventions to bridge divides between geographically distant groups.

While much attention has been focused on technology’s role in amplifying societal divisions and conflicts⁴⁹, our findings highlight technology’s potential as a powerful tool for fostering meaningful cross-cultural connections and understanding. Our research demonstrates that when properly structured, virtual platforms can actually serve as bridges between communities, helping to break down prejudices and build genuine understanding. These positive effects of virtual contact could be even more profound with the recent emergence of large language models (LLMs), which can serve as simultaneous translators during online interactions.

By removing language barriers that have historically limited meaningful contact between different groups, LLMs can help address a fundamental challenge in cross-cultural communication—enabling each participant to express themselves in their native language while others can understand them in theirs. This creates a more equitable dialog where no one is disadvantaged by having to communicate in a non-native language. This suggests that as we continue to intentionally design virtual spaces for meaningful dialog, integrating technologies like LLMs could further enhance their potential for fostering genuine cross-cultural understanding.

Limitations

Still, our research has some limitations. Participants in this study were university students, which as we mentioned above is a population that provides a theoretically meaningful context for examining intergroup contact due to their active social engagement and influence in shaping societal norms³⁴. However, this focus also limits the generalizability of our findings to broader populations, where factors like differing educational backgrounds and life experiences may play a significant role^{50,51}. Future research should aim to replicate these findings across more diverse populations.

To address potential self-selection bias, we carefully constructed our control group by sampling from classes taught by professors who had

previously enrolled their students in the Soliya program but were not currently participating. However, our control group was significantly smaller than the experimental group, likely because control participants completed surveys without compensation or intervention, making recruitment and retention more challenging. Though our sampling approach helped create more comparable groups, we acknowledge that fundamental differences may still exist between conditions, and we cannot definitively establish causal effects of the virtual contact intervention. Despite these limitations, we observed significant positive changes in attitudes over time within both American and Muslim participants, suggesting that meaningful improvements occurred even among those who may have started with more favorable intergroup orientations.

Finally, the English-language medium of communication may have created power differentials and impacted interaction quality, as varying levels of language proficiency could affect participation and engagement during intergroup contact³². Future interventions should explore ways to mitigate linguistic barriers, perhaps by offering multilingual options or providing language support. More broadly, future research should aim to replicate these findings across more diverse populations, including those from different socioeconomic backgrounds and educational levels, while developing strategies to reduce selection bias in participant recruitment and program design.

Nevertheless, we observe that the final analytic sample included a sizable proportion of participants who harbored initial negative intergroup attitudes, and that participation in the virtual contact program corresponded with more positive change among participants who reported more negative pre-program intergroup attitudes. Although we cannot completely rule out that demand effects may have contributed to our results, we argue that these effects would have been strongest in pre-program scores across conditions. Changes in demand effects were unlikely to occur over the course of the virtual contact intervention. Thus, while they may have played some role in determining which participants stayed in the program, it is less likely that demands would have affected the changes observed in scores among participants who stayed in the program and completed surveys before and after program participation.

Conclusion

In sum, the current research delved into the impact of virtual contact on increasing self-outgroup overlap, improving outgroup attitudes, and decreasing (meta-)dehumanization. Through two quasi-experiments, which we conducted in the field while including a diverse sample of American students and Muslim students from the MENA and Southeast Asia, we provide valuable evidence and insights into the capacity of virtual contact interventions to promote positive intergroup relations between geographically separated groups. We believe our findings can provide hope and shed light on the practical applications of technology in facilitating meaningful connections between diverse groups, transcending geographical constraints, and thus expanding society's options to influence intergroup dynamics in a globalized world.

Data availability

The anonymized data is publicly accessible at: <https://osf.io/bea4f/>. <https://doi.org/10.17605/OSF.IO/BEA4F>.

Code availability

The code and materials for each study are publicly accessible at: <https://osf.io/bea4f/>. <https://doi.org/10.17605/OSF.IO/BEA4F>.

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Conceptualization: S.H.-S., B.H., L.R.T., S.L.M.-B., R.S., E.H., E.B.; Methodology: B.H., L.R.T., S.L.M.-B., R.S., E.B.; Formal analysis: S.H.-S., B.H., E.B.; Investigation: B.H., S.L.M.-B., E.B.; Writing—original draft: S.H.-S., B.H., E.B.; Writing—review & editing: S.H.-S., B.H., L.R.T., S.L.M.-B., R.S., E.H.

Competing interests

The authors declare no competing interests.

Additional information

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