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Effects of intergroup contact on explicit and implicit outgroup attitudes: A longitudinal field study with majority and minority group members

Loris Vezzali[1] | Simon Lolliot[2] | Elena Trifiletti[3] | Veronica Margherita Cocco[4] | James Richard Rae[5] | Dora Capozza[3] | Miles Hewstone[6]

[1]University of Modena and Reggio Emilia, Modena, Italy

[2]University of British Columbia, Vancouver, BC, Canada

[3]University of Padova, Padova, Italy

[4]University of Parma, Parma, Italy

[5]Zillow Research, Seattle, Washington, USA

[6]University of Oxford, Oxford, UK

Correspondence
Loris Vezzali, Università di Modena e Reggio Emilia, viale Allegri 9, 42121, Reggio Emilia, Italy.
Email: loris.vezzali@unimore.it

Abstract

A longitudinal field study tested the long-term effects (three years) of intergroup contact on both explicit and implicit outgroup attitudes. Participants were majority (Italian) and minority (immigrant) high-school students, who were tested at four waves from the beginning of their first year in high-school to the end of the third school year. Results revealed, first, a longitudinal association of quantity (but not quality) of contact with lower intergroup anxiety and more positive explicit attitudes, as well as bidirectional effects over time between explicit attitudes and intergroup anxiety, on the one hand, and quantity and quality of contact, on the other. Second, reduced intergroup anxiety mediated the association between quantity of contact and improved explicit attitudes over time. Third, the product of quantity and quality of contact longitudinally predicted more positive implicit outgroup attitudes over school years. We discuss the theoretical and practical implications of findings.

KEYWORDS
implicit attitudes, intergroup anxiety, intergroup contact, intergroup relations, prejudice

INTRODUCTION

Decades of research have demonstrated that, as Allport (1954) proposed, intergroup contact is a powerful tool for reducing prejudice. There are, however, three key limitations to the evidence base, which we address in this research: paucity of longitudinal studies, and especially rarity of tests of longitudinal mediation; greater focus on majority group members of existing studies; and lack of longitudinal studies including measures of implicit outgroup attitudes. Our study was aimed at filling these gaps.

Comparatively few of the 500 studies included in Pettigrew and Tropp's (2006) meta-analysis of the association between contact and prejudice are longitudinal or experimental studies, compared with the overwhelming number of cross-sectional studies (see Paluck et al., 2019), although Wölfer et al. (2016) found 41 longitudinal studies. Particularly, there only is limited evidence of the processes driving longitudinal effects of contact. A complicating factor is that, among the few studies examining longitudinal mediation of the effect of contact on attitudes, most only considered two time points. They are, thus, not fully suited to testing full longitudinal mediation effects, which requires measurement of predictor, mediator and dependent variables in each of at least three waves (Selig & Preacher, 2009; for exceptions, see Swart et al., 2011; Van Zalk et al., 2021). While researchers can test mediation models with two waves of data, they need to assume the existence of autoregressive and cross-lagged stationarity (see Little et al., 2007). Three waves (or more) are better suited for testing longitudinal mediation models as this allows for explicit testing of these assumptions. Second, longitudinal studies mainly considered majority or minority groups, and this is especially true when considering studies that also investigated mediation.

Finally, few studies investigated the effects of intergroup contact on implicit outgroup attitudes and, to our knowledge, there have been no field studies that have tested the longitudinal effects of contact on implicit outgroup attitudes, an additional limitation that is addressed in the reported research. Implicit attitudes not only have an important role in guiding spontaneous forms of behaviour (Dovidio et al., 2006), but they are also associated with controlled behaviour (Greenwald et al., 2009; Kurdi et al., 2019). In fact, Kurdi et al.'s (2019) meta-analysis revealed that implicit attitudes, unlike explicit attitudes, predicted different types of behaviour towards a wide range of target groups. Therefore, investigating the factors that may have long-term effects on implicit (in addition to explicit) attitudes in naturalistic contexts is crucial to tackle discrimination in society at large.

Specifically, we conducted a 4-wave longitudinal field study with Italian (majority) and immigrant (minority) adolescents in high-school. As outcome variables, we considered implicit, in addition to explicit outgroup attitudes. In line with Pettigrew and Tropp's (2008) meta-analysis of mediators of contact, which reported strongest evidence of intergroup anxiety as a mediator, we tested intergroup anxiety as a longitudinal mediator of contact effects. Finally, we provided an exploratory test of the relative contribution of quantity and quality of contact in predicting explicit and implicit outgroup attitudes.

Longitudinal evidence of contact effects

According to the contact hypothesis, contact between groups can reduce prejudice when optimal contact conditions (equal status, cooperation, common goals, institutional support) are present (Allport, 1954). Pettigrew and Tropp's (2006) meta-analysis, including over 500 studies and 250,000 participants, provided strong support for the negative association between contact and prejudice, even in absence of the optimal contact conditions (but see Di Bernardo et al., 2021). However, this evidence is not without limitation. Below we will focus on the gaps directly related to our research.

Pettigrew (1998) noted that cross-sectional studies are not suited to provide definitive evidence for the 'contact hypothesis'. Yet, 71% of studies included in Pettigrew and Tropp's (2006) meta-analysis were based on cross-sectional data. There are various ways to address the causal sequence problem (cf. Christ & Wagner, 2013). An optimal solution would be to use experimental methodologies. However, experimental methods typically have a short-term focus and prioritize internal over external validity (for an exception, see Vezzali et al., 2022). An alternative solution is to conduct longitudinal studies;

although they cannot demonstrate causality, they do permit stronger inferences and also allow researchers to test the reverse causal path (from attitudes to contact). Longitudinal research can be realistically implemented in the field, thus maintaining a good level of external validity. Although cross-sectional studies still prevail, evidence from rare early longitudinal studies (Stephan & Rosenfield, 1978) has now been supplemented by burgeoning research providing evidence that contact at earlier waves has significant effects on improved outgroup attitudes measured at later waves (Al Ramiah & Hewstone, 2012; Eller & Abrams, 2003; Kenworthy et al., 2016; Swart et al., 2011; Tausch et al., 2010, Study 4; Zagefka et al., 2009).

Scarcity of longitudinal research testing mediation

This longitudinal evidence has, however, some important shortcomings, in addition to being relatively sparse. First, longitudinal evidence for mediation of contact effects is surprisingly scarce compared with evidence provided by correlational research (Pettigrew & Tropp, 2006). Among these constructs, evidence of mediation with longitudinal data was found for intergroup empathy (Swart et al., 2011; Vezzali et al., 2010), outgroup trust (Grütter et al., 2018; Hässler et al., 2019), common in-group identity or identification (Eller & Abrams, 2003; Rompke et al., 2019), social norms (Christ et al., 2014), outgroup attitudes (Reimer et al., 2017; Tausch et al., 2010). Most evidence has been provided for the main mediator identified by contact research, that is intergroup anxiety (Pettigrew & Tropp, 2008). In this case, evidence for face-to-face intergroup contact has been provided by few studies (Binder et al., 2009; Swart et al., 2011; Turner & Feddes, 2011; Van Zalk et al., 2021; Vezzali et al., 2010).

In a widely cited study, Swart et al. (2011) obtained data among 'Coloured' high-school students in South Africa over three waves, collected at a distance of six months from each other. Results revealed evidence of longitudinal mediation: cross-group friendships were associated with improved outgroup attitudes, increased perceived outgroup variability and reduced negative action tendencies towards the outgroup via affective intergroup empathy; (reduced) intergroup anxiety mediated the longitudinal relation between cross-group friendships and perceived outgroup variability. Van Zalk et al. (2021), in a longitudinal, quasi-experimental field study, investigated changes among ethnic majority and minority adolescents associated with a unique ethnic merger of schools. Four waves of data were collected annually, of which three were analysed, covering a total time lag of three years. In all schools, change in adolescents' positive intergroup contact predicted change in explicit positive intergroup attitudes indirectly via two mediators, reduced intergroup anxiety and a novel measure of increased accuracy of perceived outgroup willingness for contact.

Other studies, however, only included two waves (Binder et al., 2009; Turner & Feddes, 2011; Vezzali et al., 2010); therefore, they were ill suited to investigate full longitudinal mediation (Christ & Wagner, 2013).

Greater focus on majority groups

A further limitation of existing evidence is that contact studies mostly focused on the majority group (Pettigrew & Tropp, 2006). This is especially true when considering longitudinal studies investigating mediation of contact effects. Reflecting the larger literature, longitudinal studies investigating mediating processes focused mostly on the majority group (Christ et al., 2014; Eller & Abrams, 2003; Grütter et al., 2018; Hässler et al., 2019), with some studies also considering the minority group (Swart et al., 2011). There are, however, some exceptions. Binder et al. (2009) conducted a longitudinal study with participants from both ethnic majorities and minorities from three European countries (Belgium, England, Germany). They collected data in two waves separated by six months. Results revealed that quantity and quality of contact were longitudinally associated with lower social distance and negative intergroup emotions, and these associations were mediated by intergroup anxiety. However, these effects

only emerged among the majority group. Reimer et al. (2017, Study 2) collected data among heterosexual and LGBT university student participants in UK and Germany. Data were collected in three waves, distributed across the academic year. Results for heterosexual participants revealed that positive contact was longitudinally associated with greater collective action. Analyses for the LGBT group, which only considered the first and last wave, only revealed longitudinal associations between negative contact and greater prejudice. In the study by Van Zalk et al. (2021), described above, there were no differences between ethnic majority and minority groups.

In our study, in order to address these two relevant gaps (scarcity of longitudinal studies assessing both full longitudinal mediation and including both majority and minority group samples) in a single study, we collected data from both majority and minority participants at four time points over a period of three years, we measured both explicit and implicit outgroup attitudes (see next section), and we tested the mediating role of intergroup anxiety. This is the first study, to our knowledge, evaluating longitudinal mediation by intergroup anxiety with both majority and minority participants by using four waves of data collection (this way also allowing to exploratory test an extended chain-mediation model; see section of Results).

Intergroup contact and implicit outgroup attitudes

Contemporary study of social attitudes distinguishes implicit from explicit attitudes; implicit attitudes are activated by the mere presence of an attitude object, are unintentional and, as a result, are less influenced by social desirability or self-presentation concerns (Greenwald & Banaji, 1995, 2017). The interest in implicit attitudes depends not only on their ability to tap potentially undesirable responses, but also on their role as predictors of behaviour (Dovidio et al., 2006; Greenwald et al., 2009; Kurdi et al., 2019). Moreover, the implicit attitudes people hold influence how they are perceived and evaluated by others (Dovidio et al., 2002). To the extent that individuals generally hold negative implicit attitudes towards outgroups (Nosek et al., 2008) and that, outside of research, these implicit biases may go undetected, fostering positive implicit outgroup attitudes is of primary importance.

It is surprising that only a few correlational studies have thus far examined the relationship between intergroup contact and implicit outgroup attitudes (Aberson & Haag, 2007; Prestwich et al., 2008; Tam et al., 2006; Turner et al., 2007; Vezzali & Giovannini, 2011). There is, however, some evidence from experimental studies conducted in the lab supporting the role of contact in improving implicit outgroup attitudes (e.g. Lowery et al., 2001). Outside the lab, Shook and Fazio (2008) found, in an experimental study in the field, that White freshmen randomly assigned to live in interracial rooms at the beginning of the academic year reported an improvement in implicit outgroup attitudes at the end of the first quarter; no such improvement was observed in students assigned to live with same-race roommates. Unfortunately, this study did not assess quantity or quality of contact, so it is not possible to unequivocally attribute the effect to frequent or positive contact. In addition, only majority participants were considered. Finally, we are aware of only one study examining the longitudinal association between contact and implicit outgroup attitudes. Onyeador et al. (2020) surveyed non-Black first-year medical students across a period of six years in three waves (fall 2010, spring 2014, spring 2016). Results revealed longitudinal associations of quantity of contact at wave 1 on implicit attitudes towards Blacks at wave 2 and of quantity of contact at wave 1 and quality of contact at wave 2 on implicit attitudes towards Blacks at wave 3 (see also Van Ryn et al., 2015, who found marginal associations of contact quality with implicit outgroup attitudes at a distance of four years among university students, using however single-item measures, not testing mediators, and not differentiating between majority and minority respondents). Clearly, more research is necessary in order to provide evidence for the role of long-term contact and to test the duration of its effects (in addition to increasing external validity).

Allport (1954) acknowledged the distinction between the quantity (e.g. 'how often do you meet members of the outgroup?') and the quality (e.g. 'did you enjoy it?') of intergroup contact, placing emphasis on quality. Research has, however, not yet clarified which aspect of contact is more relevant to attitude

change (Vezzali & Stathi, 2021). Although there is consensus on the greater importance of qualitative contact (Davies et al., 2011), research has found that both quantity and quality of contact are associated with improved explicit outgroup attitudes (Brown & Hewstone, 2005; Pettigrew & Tropp, 2006). With respect to implicit outgroup attitudes, some studies revealed that they depend on quantity of contact (Prestwich et al., 2008; Tam et al., 2006). In contrast, other studies found that effects were driven by contact quality (Vezzali & Giovannini, 2011). Some studies also suggest that implicit outgroup attitudes may be a function of the combination of quantity and quality of contact (Aberson & Haag, 2007; Vezzali & Capozza, 2011). The fact that both quantity and quality of contact may be necessary to improve implicit outgroup attitudes is indirectly supported by findings showing that the number of cross-group friendships is positively associated with more positive implicit attitudes towards outgroup members (Turner et al., 2007, Study 1).

Based on these findings, we predict that contact will be longitudinally associated with more positive implicit outgroup attitudes, although we do not make specific predictions as to whether effects will be driven by contact quantity or quality or their interaction. In other words, our analysis of whether quantity and quality of contact, or their interaction, differentially predict explicit and implicit outgroup attitudes over time is exploratory. Given the often found dissociation between explicit and implicit attitudes (Nier, 2005), we expect intergroup anxiety to only mediate effects for explicit but not implicit attitudes.

The present research

We conducted a longitudinal field study involving Italian (majority) and immigrant (minority) students at high-schools located in a Northern Italian city, investigating associations of intergroup contact with both explicit and implicit outgroup attitudes, and the mediating effect of intergroup anxiety on explicit outgroup attitudes. Students were assessed at the beginning of the first year, followed by three assessments over the first three years of school. Participants completed a questionnaire at all waves and a measure of implicit outgroup attitudes at each wave except the first (see below).

The choice to focus on intergroup anxiety as the mediator was based, first, on its relevance in the contact field, where it was shown to be the strongest and more reliable mediator of contact effects (Brown & Hewstone, 2005; Pettigrew & Tropp, 2008). Second, given the complexity of analyses required by the study design (four waves), we had to restrict our choice to a limited number of key variables of contact research, specifically quantity and quality of contact, a single mediator (intergroup anxiety), and outgroup attitudes.

We believe that adolescence represents an especially relevant period to investigate. According to the developmental intergroup approach (Rutland et al., 2010), although prejudice slightly declines around the age of 8 years (Raabe & Beelmann, 2011), it does not necessarily decline in subsequent years. Several factors contribute to shape prejudice in adolescence, including a greater sensitivity to group norms and expectations, which may also lead to accept morally questionable behaviours (Rutland & Killen, 2015). Adolescents, therefore, typically display prejudice and stereotypes (Killen et al., 2010). Processes related to social identity, such as social norms, morality considerations and the influence of peers, are especially relevant in adolescence (Palmer & Abbott, 2018). We reasoned that positive experiences with outgroup peers may be especially relevant in this age group; they can communicate to individuals the outgroup's interest in contact and a socially accepting norm (Tropp & Bianchi, 2007).

We investigated the relationship between Italian and immigrant adolescents, given the relevance of immigration in Italy and, in particular, in the region where we collected the data, Emilia-Romagna. In particular, the percentage of immigrants is higher in Emilia-Romagna (12.1%) than in Italy as a whole (8.4%), also when considering adolescents aged 14–19 years old, that is the age of our sample (7.8% in Italy compared with 11.5% in Emilia Romagna; Italian National Institute of Statistics, 2021). In such a context, relations between Italians and immigrants remain tense or at best neutral, at least from the perspective of Italians. In a report published by Pew Research Center in, 2019, 54% of Italians believe that immigrants are a burden to the country, compared with only

12% who believe they make Italy stronger. Research reports that Italians evaluate many immigrant groups negatively (e.g. Romanians) and evaluate immigrants as a whole neutrally (Giovannini & Vezzali, 2012). A similar pattern of results emerged with research on adolescents of the same age as our sample, with Italians evaluating immigrants neutrally and immigrants evaluating Italians positively (Vezzali et al., 2010). Research using implicit attitude measures revealed, however, that attitudes towards immigrants are generally negative (Vezzali & Giovannini, 2011). Given the widespread and growing presence of immigrants in Italy, we believe that it is important to understand how to improve both explicit and implicit outgroup attitudes.

We tested the following predictions (in the hypotheses we consider the distinction between explicit positive and negative outgroup attitudes; see Method section):

H1: Quantity and quality of contact will be longitudinally associated with explicit positive and negative outgroup attitudes (positively and negatively, respectively) assessed in subsequent waves.

H2: The longitudinal association of quantity and quality of contact with explicit positive and negative outgroup attitudes assessed in subsequent waves will be mediated by intergroup anxiety.

H3: Quantity of contact, quality of contact or their product will be longitudinally positively associated with improved implicit outgroup attitudes.

METHOD

Sample size

Considering the usual effect size of contact on prejudice ($r = -.215$; Pettigrew & Tropp, 2006) and a desired power of 80%, we needed to recruit from available nearby high-schools, so as to yield a sample of >167 respondents (for both the majority and the minority group, separately) to test our hypotheses. In fact, we decided to oversample, given concerns about matching anonymous participants' responses over time, attrition over a planned 3-year study and the need to ensure, especially, a sufficiently large minority sample at the final wave.

Participants and procedure

Data for this study was collected from students in mixed classes of five high-schools located in a Northern Italian city, for which participation of the requested mixed-ethnicity classes was granted (see Table S1 for the breakdown of participants by school). The schools, selected on the basis of their availability, were technical and vocational schools, where male presence is generally higher. Data was collected in four waves: the start of the first year of high-school (T1); and the end of first, second and third school years (T2; T3; T4; please refer to Table S2 for indications on grade equivalents in Italy and UK). The research was presented as a study on social attitudes. The distinction between majority and minority participants was made on the basis of the schools' current intake of students, taking into account the family background of children (i.e. whether children had immigrant both parents).

The initial sample (T1) consisted of 589 participants, 399 Italians (233 males, 159 females, 7 missing) and 190 immigrants (111 males, 68 females, 11 missing; mean age = 14.44, SD = 0.91). Of the initial participants, 481 (T2), 325 (T3) and 316 (T4), participated at subsequent waves; 119 (88 Italians, 31 immigrants; 70 males, 47 females, 2 missing; mean age at T1 = 14.23, SD = 0.64) completed the measure of implicit outgroup attitudes.

At each wave, respondents were asked to complete a questionnaire, administered in group sessions during regular class times, which was identical for majority and minority members, except for the target-group. Due to organizational and practical difficulties, a computerized measure of implicit outgroup attitudes could only be assessed from T2– to T4. In order to complete the implicit attitude measure, participants were taken to the computer lab of their school and completed the task individually. Because

a computer room was not available in two of the five schools at the time of testing, the implicit attitude measure was administered in only three of the five schools.

Measures[1]

Contact quantity

The amount of contact was assessed with two items (Vezzali & Capozza, 2011; see also Lolliot et al., 2015): 'How much contact do you have with immigrant/Italian youth people in your school?' and 'During the day, how often do you interact with immigrant/Italian youth people in your school?'. For both items, a 5-point scale was used; responses ranged between *none* (1) and *very much* (5) for the first item, and between *never* (1) and *very often* (5) for the second item.

Contact quality

Four bipolar scales were used to assess quality of contact with outgroup members (e.g. *competitive/cooperative*; *hostile/friendly*; Vezzali et al., 2010). On the 5-point scale, 1 denoted the negative and 5 the positive pole; 3 was the neutral point.

Intergroup anxiety

Participants were asked to rate anxiety towards the outgroup using eight items (e.g. anxious; relaxed, reverse-scored; Capozza et al., 2013). The 5-point response scale was anchored by *not at all* (1) and *very much* (5). After reverse-coding the appropriate items, we subjected the eight items at all four time points to an exploratory factor analysis (EFA). Two factors emerged, a factor with all the positively worded items and a factor with all the negatively worded items. At each wave, however, these two factors were strongly correlated with each other ($r_{T1} = .56$, $r_{T2} = .50$, $r_{T3} = .62$, $r_{T4} = .58$). As such, we combined the positively and negatively worded items into one measure of intergroup anxiety. Higher scores reflect more intergroup anxiety.

Explicit outgroup attitudes

Explicit attitudes towards outgroup members were measured using eight items (e.g. friendly; lazy, reverse-scored; see Vezzali et al., 2010). Responses were given on a 5-point scale, ranging from *not at all* (1) to *very much* (5). After reverse-coding the appropriate items, we subjected these items at all four time points to an EFA. At each time point, the EFA revealed two factors. The four positively worded items loaded onto a single factor whereas the four negatively worded items loaded onto another single factor. We decided to keep two separate attitude factors, given that the two factors did not correlate strongly with each other ($r_{T1} = .12$, $r_{T2} = .07$, $r_{T3} = .01$, $r_{T4} = .09$). Thus, we averaged the four positively worded items to create a measure of *explicit positive attitudes* where higher scores reflect more positive attitudes. Similarly, we averaged the four negatively worded items to create a measure of *explicit negative attitudes* where higher scores reflect more negative attitudes (i.e. greater prejudice).

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[1]The questionnaire included additional measures: direct and extended cross-group friendships, optimal contact conditions, attitudes towards known ingroup and outgroup members, anxiety and empathy (including both affective and cognitive components) towards known outgroup members, group representations, meta-group representations, empathy towards unknown outgroup members (including both affective and cognitive components), attitudes towards unknown ingroup members, ingroup and outgroup stereotypes, meta-stereotypes, intergroup expectancies.

TABLE 1 Means, standard deviations and reliabilities for the study variables at all four waves

	Quantity of contact		Quality of contact		Intergroup anxiety		Explicit negative attitudes		Explicit positive attitudes		Implicit attitudes
	M (SD)	ω	M (SD)	ω	M (SD)	ω	M (SD)	ω	M (SD)	ω	M (SD)
T1											
Whole sample	3.25*** (0.94)	.68	3.90*** (0.76)	.79	2.37*** (0.83)	.88	2.52*** (0.75)	.64	2.98 (0.78)	.71	—
Italians	3.11*** (0.86)	.66	3.90*** (0.76)	.79	2.44*** (0.86)	.90	2.54*** (0.75)	.65	2.86*** (0.76)	.69	—
Immigrants	3.52*** (1.03)	.71	3.92*** (0.76)	.79	2.24*** (0.75)	.84	2.48*** (0.73)	.63	3.22*** (0.76)	.72	—
T2											
Whole sample	3.40*** (0.92)	.78	3.84*** (0.79)	.83	2.35*** (0.79)	.88	2.54*** (0.73)	.71	3.01 (0.73)	.76	−0.10* (0.42)
Italians	3.27*** (0.87)	.74	3.83*** (0.78)	.83	2.43*** (0.82)	.90	2.53*** (0.75)	.72	2.89** (0.73)	.77	−0.11* (0.44)
Immigrants	3.66*** (0.98)	.83	3.88*** (0.84)	.83	2.19*** (0.69)	.81	2.56*** (0.68)	.69	3.24*** (0.66)	.71	−0.09 (0.38)
T3											
Whole sample	3.58*** (0.79)	.79	3.96*** (0.70)	.87	2.19*** (0.72)	.91	2.52*** (0.64)	.72	3.07** (0.64)	.79	−0.01 (0.46)
Italians	3.47*** (0.77)	.78	3.93*** (0.72)	.88	2.25*** (0.75)	.93	2.53*** (0.65)	.75	3.00 (0.68)	.82	−0.01 (0.51)
Immigrants	3.81*** (0.79)	.81	4.00*** (0.68)	.85	2.05*** (0.61)	.87	2.50*** (0.62)	.66	3.24*** (0.54)	.67	−0.03 (0.37)
T4											
Whole sample	3.62*** (0.81)	.81	4.05*** (0.65)	.86	2.19*** (0.70)	.91	2.41*** (0.63)	.74	3.09*** (0.61)	.78	−0.02 (0.54)
Italians	3.46*** (0.80)	.87	4.02*** (0.69)	.87	2.29*** (0.74)	.92	2.41*** (0.64)	.75	3.02 (0.64)	.82	−0.02 (0.56)
Immigrants	3.95*** (0.73)	.83	4.12*** (0.60)	.83	1.99*** (0.57)	.87	2.41*** (0.62)	.74	3.23*** (0.51)	.66	−0.02 (0.50)

Note: For contact quantity, contact quality, intergroup anxiety, and explicit positive and negative attitudes, sample size was $N = 589$ ($N = 399$ for Italians, $N = 190$ for immigrants). For implicit outgroup attitudes, sample size was $N = 119$ ($N = 88$ for Italians, $N = 31$ for immigrants). For contact quality, intergroup anxiety, explicit positive and negative attitudes, asterisks indicate that the mean differs from the midpoint of the scale (3). For implicit outgroup attitudes, asterisks indicate that the mean differs from 0. Positive D-scores reflect positive implicit outgroup attitudes, negative D-scores reflect negative implicit outgroup attitudes. ω = McDonald's ω, a preferred measure of reliability. T1 = wave 1; T2 = wave 2; T3 = wave 3; T4 = wave 4.

Implicit outgroup attitudes

We used the Single Target-Implicit Association Test (ST-IAT; Bluemke & Friese, 2008; Wigboldus et al., 2004) to index implicit outgroup attitudes. The ST-IAT measures the strength of the association between a target category and the two poles of an attribute dimension. In this study, the target category was 'immigrants' for Italian participants and 'Italians' for immigrant participants; the attribute dimension was positive–negative for both groups. Therefore, we investigated Italians' (immigrants') associations between immigrants (Italians) and both positive and negative concepts. In the ST-IAT for majority members, stimuli (taken from other studies using the IAT conducted in the same context; for example Vezzali & Giovannini, 2011) included: 10 names (e.g. Mohammed, Sanae) typically associated with immigrants (the target category); 5 positive words (e.g. happiness, holiday); and 5 negative words (e.g. sickness, pain). Stimuli were presented one at time at the centre of the computer screen. Participants were asked to categorize each item by using one of two different keys ('w' or 'p', which are symmetrically placed either side of the centre on the Italian keyboard). The task consisted of one practice block (in which participants categorized positive and negative words) and two experimental blocks, each including 35 trials, preceded by 17 practice trials. In one experimental block, typical immigrant names (10 trials) and negative words (10 trials) shared the same response key, while positive words (15 trials) were categorized using a different key. In the other experimental block, the association was reversed, so that immigrant names (10 trials) and positive words (10 trials) shared the same key, while negative words (15 trials) were categorized using a different key. The order of the experimental blocks was counterbalanced across participants. Incorrect responses were followed by a red 'X' presented in the middle of the screen; in the case of incorrect responses, participants had to provide the correct response before continuing with the task. In the ST-IAT for minority members, the 10 immigrant names were replaced with 10 typical Italian names (e.g. Elena, Matteo). The task lasted about 5 minutes. Following Greenwald et al.'s (2003) D-algorithm, a D-score score was computed. Positive D-scores reflect positive implicit outgroup attitudes, while negative D-scores reflect negative implicit outgroup attitudes.

RESULTS

Overview

Given the complexity of longitudinal analysis, we begin this section by reporting introductory analyses: descriptives, summary of attrition analyses (to test for systematic drop out) and group by time comparisons (comparing mean ratings of Italian-majority and immigrant-minority groups on the main study variables and testing for any between-group differences in the structural relationships of the hypothesized longitudinal model). Then, we report the main longitudinal analyses, separately for explicit and implicit outgroup attitudes.

Introductory analyses

Descriptives

Descriptives are presented in Table 1, correlations in Table 2. As can be seen, contact was quite frequent and was significantly higher than the midpoint of the scale across all four waves for both majority and minority participants. Quality of contact was also high, as shown by the average score for both the majority and the minority group, again significantly higher than the scale midpoint at all four waves. Moreover, only a small percentage of the sample reported contact quality that was below the scale midpoint (10.4% at T1, 10.9% at T2, 7.5% at T3 and 6.1% at T3). Relations between groups were moderately positive: intergroup anxiety and explicit *negative* attitudes were significantly lower than the scale

TABLE 2 Correlations between the study variables at T1, T2, T3 and T4

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
T1																						
1. Cont. Quant	—																					
2. Cont. Qual	.37***	—																				
3. Anx.	-.28***	-.36***	—																			
4. Exp. Neg. Atts	-.08*	-.25***	.31***	—																		
5. Exp. Pos. Atts	.26***	.36***	-.43***	-.23***	—																	
T2																						
6. Cont. Quant	.59***	.34***	-.35***	-.10*	.30***	—																
7. Cont. Qual	.25***	.40***	-.32***	-.20***	.30***	.41***	—															
8. Anx.	-.28***	-.22***	.54***	.18***	-.27***	-.39***	-.40***	—														
9. Exp. Neg. Atts	-.05	-.11**	.18***	.35***	-.17***	-.14***	-.28***	.35***	—													
10. Exp. Pos. Atts	.23***	.23***	-.32***	-.27***	.47***	.42***	.45***	-.40***	-.18***	—												
11. Imp. Atts	.09	.10	.04	-.18	.12	.25**	.07	-.08	-.13	.08	—											
T3																						
12. Cont. Quant	.51***	.29***	-.28***	.01	.26***	.60***	.24***	-.26***	-.07	.32***	.15	—										
13. Cont. Qual	.27***	.46***	-.23***	-.13**	.17**	.36***	.51***	-.34***	-.20***	.34***	.13	.48***	—									
14. Anx.	-.21***	-.15**	.41***	.10*	-.20***	-.25***	-.20***	.53***	.16***	-.27***	-.14	-.37***	-.40***	—								

TABLE 2 (Continued)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
15. Exp. Neg. Atts	−.03	−.19***	.28***	.27***	−.15***	−.01	−.24***	.26***	.39***	−.16***	−.03	−.02	−.32***	.38***	—							
16. Exp. Pos. Atts	.24***	.23***	−.22***	−.05	.38***	.22**	.12**	−.26***	−.08	.42***	.03	.45***	.40***	−.47***	−.20***	—						
17. Imp. Atts	.15	.17	−.12	−.05	.14	.25*	.08	−.09	−.08	.01	.20	.16	.06	−.08	−.03	.11	—					
T4																						
18. Cont. Quant	.43***	.27***	−.18***	−.08	.21***	.51***	.33***	−.26***	.01	.37***	.33***	.59***	.43***	−.31***	−.09*	.40***	.19	—				
19. Cont. Qual	.22**	.50***	−.15***	−.21***	.21***	.21***	.38***	−.21***	−.12**	.31***	.15	.37***	.54***	−.29***	−.24***	.29***	.08	.49***	—			
20. Anx.	−.17***	−.19***	.39***	.10*	−.19***	−.27***	−.21***	.49***	.17***	−.26***	−.19*	−.40***	−.32***	.60***	.30***	−.42***	−.34***	−.43***	−.41***	—		
21. Exp. Neg Atts	−.02	−.21***	.18***	.31***	−.14***	.00	−.11*	.25**	.31***	−.07	−.05	−.12	−.25***	.31***	.52***	−.20***	−.08	−.15***	−.37***	.42***	—	
22. Exp. Pos. Atts	.10*	.18	−.24***	−.15***	.37***	.22***	.22**	−.23***	−.06	.46***	.02	.38***	.33***	−.38***	−.18***	.58***	.09	.49***	.49***	−.50***	−.28***	—
23. Imp. Atts	.22*	.27**	−.07	−.10	.31***	.25**	.18	−.14	−.10	.26**	.34***	.23*	.19*	.02	−.02	.18	.38***	.25**	.24**	−.17	−.03	.15

Abbreviations: Anx, intergroup anxiety; Cont. Qual, contact quality; Cont. Quant, contact quantity; Exp. Neg. Atts, explicit negative attitudes; Exp. Pos. Atts, explicit positive attitudes; Imp. Atts, implicit outgroup attitudes; T1, wave 1; T2, wave 2; T3, wave 3; T4, wave 4.

*p < .05.; **p < .01.; ***p < .001.

TABLE 3 Results of the time-by-group mixed-model ANOVAs

Construct	Time $F(3, 1758)=$	Group status $F(1, 586)=$	Time × group status $F(3, 1758)=$
Contact quantity	44.772, $p < .001$, $\eta_p^2 = .004$	46.002, $p < .001$, $\eta_p^2 = .004$	1.298, $p = .273$, $\eta_p^2 = .004$
Contact quality	15.180, $p < .001$, $\eta_p^2 = .004$	1.195, $p = .274$, $\eta_p^2 = .004$	0.390, $p = .759$, $\eta_p^2 = .004$
Intergroup anxiety	4.166, $p < .001$, $\eta_p^2 = .004$	18.900, $p < .001$, $\eta_p^2 = .004$	0.656, $p = .578$, $\eta_p^2 = .004$
Explicit negative attitudes	5.849, $p < .001$, $\eta_p^2 = .004$	0.164, $p = .684$, $\eta_p^2 = .004$	0.511, $p = .674$, $\eta_p^2 = .004$
Explicit positive attitudes	3.158, $p = .023$, $\eta_p^2 = .004$	42.306, $p < .001$, $\eta_p^2 = .004$	2.758, $p = .040$, $\eta_p^2 = .004$

midpoint at all waves for both groups. For the minority, explicit *positive* attitudes were slightly (although significantly) more positive than the midpoint of the scale across all waves. For the majority, explicit positive attitudes did not differ from (T3 and T4) or were lower than (T1 and T2) the midpoint of the scale for Italians, indicating generally neutral attitudes. Implicit outgroup attitudes were also neutral for both majority and minority participants. In fact, the average score did not differ from 0 (indicating neutrality) with one exception: implicit outgroup attitudes were slightly negative for the majority group at T2 (as shown by the score being significantly lower than 0).

Attrition analyses

For the detailed attrition analyses, please see the Supporting Information. We checked for evidence of attrition using four steps suggested by Goodman and Blum (1996). This thorough investigation of attrition indicated, for the most part, that there was little evidence of non-random attrition across the waves. Given this pattern of results, we decided to impute missing data using the expectation maximization algorithm (EM). EM methods are robust against various forms of missingness (see Gold & Bentler, 2000) and, by imputing the data, we maximize power by retaining the full sample at T1.[2]

Group by time comparisons

To compare differences between majority and minority members, we performed a series of 2 (Group: majority vs. minority) × 4 (Time: T1 vs. T2 vs. T3 vs. T4) mixed-model analyses of variance (ANOVAs), with repeated measures on the Time factor (see Table 3 for the results of these mixed-model ANOVAs). There were main effects of group status for intergroup anxiety ($F[1, 586] = 18.90$, $p < .001$, $\eta_p^2 = .07$), contact quantity ($F[1, 586] = 46.00$, $p < .001$, $\eta_p^2 = .07$) and explicit positive attitudes ($F[1, 586] = 42.31$, $p < .001$, $\eta_p^2 = .07$). Minority respondents reported less intergroup anxiety (collapsed across all waves, $M = 2.19$, $SE = .04$) than did majority group respondents ($M = 2.44$, $SE = .04$, $t[586] = -4.347$, $p_{\text{Tukey}} < .001$). Minority group respondents also reported higher contact quantity (collapsed across all waves, $M = 3.66$, $SE = .04$) compared to majority group respondents ($M = 3.26$, $SE = .04$, $t[586] = 6.782$, $p_{\text{Tukey}} < .001$). Regarding explicit positive attitudes, majority group respondents reported less favourable attitudes towards minority group members (collapsed across all waves, $M = 2.89$, $SE = .03$) than

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[2]Replacing missing data using EM methods is not optimal when dealing with hypothesis testing (see Graham, 2009). To this end, we re-ran the models using the full information maximum likelihood approach to handling missing data, a technique that is most often endorsed for handling missing data (Schafer & Graham, 2002). The results remain essentially identical between the two approaches to handling missing data. Given that we still rely on the EM data set for the remainder of the analyses, to increase power, some caution should be exercised while interpreting the results.

minority group respondents did towards majority group members ($M = 3.18$, $SE = .03$, $t[586] = 6.504$, $p_{Tukey} < .001$).

The main effect of Time was significant for all variables, $Fs(1, 1758) \geq 3.158$, $ps \leq .023$, $\eta_p^2 > .005$. For the main effect of time on contact quantity, respondents reported the lowest contact quantity scores at T1 (see Table 1 for the means and standard deviations), which was significantly lower than contact quantity scores at times 2, 3 and 4 (all $ps_{Tukey} < .001$). Respondents also reported significantly less contact quantity at T2 compared to times 3 and 4 (both $ps_{Tukey} < .001$). Respondents reported similar levels of contact quantity between times 3 and 4 ($p_{Tukey} = .332$). The main effect of time on contact quality revealed that respondents reported the greatest contact quality at T4 compared to times 1, 2 and 3 (all $ps_{Tukey} < .019$). Respondents reported significantly more positive contact at T3 compared to T2 ($p_{Tukey} = .002$). The main effect of time on anxiety showed that participants reported the lowest intergroup anxiety at T4 compared to T1, T2 and T3 (all $ps_{Tukey} < .001$). With regards to explicit negative attitudes, participants reported the least negative attitudes at T4 compared to T1, T2 and T3 (all $ps_{Tukey} < .013$). Similarly, with regards to explicit positive attitudes, participants reported the most favourable attitudes at T4 compared to T1, only ($p = .048$).

There was a group by time interaction only for explicit positive attitudes, $F(3, 1758) = 2.76$, $p = .040$, $\eta_p^2 = .004$. Decomposing this interaction effect showed no significant change in explicit positive attitudes across time for minority group respondents (all $ps_{Tukey} > .999$). For majority group respondents, there were no significant differences in explicit positive attitudes between T1 and T2 ($ps_{Tukey} = .978$). Majority group members' explicit positive attitudes at T3 and T4 were significantly more favourable compared to T1 attitudes ($ps_{Tukey} < .003$). T2 explicit positive attitudes for majority group respondents were statistically similar to explicit positive attitudes at T3 ($p_{Tukey} = .083$), but were significantly less positive than attitudes at T4 ($p_{Tukey} = .016$). T3 and T4 attitudes were statistically comparable ($p = .999$).

Lastly, we set up the hypothesized longitudinal model and tested for any differences in the structural relationships between majority and minority. Research shows that contact effects are stronger among majority group members compared to minority members (Tropp & Pettigrew, 2005), an effect also replicated in longitudinal research (Binder et al., 2009). Although this was not the focus of the present article, we tested whether group status (Italian-majority vs. immigrant-minority) moderated any of the hypothesized relationships. The multigroup analysis returned non-significant ($x^2[130] = 156.489$, $p = .56$). As such, we analysed the model collapsing across majority and minority participants and used participant status as a covariate.

Main longitudinal analyses

Analytic strategy

To explore the reciprocal temporal effects of intergroup contact, intergroup anxiety and positive and negative outgroup attitudes, we used a cross-lagged panel design. We explored these relationships using manifest variables and followed the approach outlined in Little et al. (2007). We set up our full model regressing variables at later time points (T_{n+1}) onto all variables at earlier time points (e.g. T_n). We also regressed all variables at a two-lag period (e.g. $T_n \rightarrow T_{n+2}$), which allowed for tighter control of confounders (see Lüdtke & Robitzsch, 2021). We first tested for autoregressive stationarity whereby we constrained the autoregressive paths to equality across time. Using the scaled chi-square difference test, we were able to constrain all autoregressive paths to within-construct stationarity at a 1-lag period ($\Delta x^2[10] = 14.212$, $p = .163$). Next, we tested for cross-lagged stationarity by constraining all relevant cross-lagged paths to equality with their counterpart relationships at different time lags (e.g., *intergroup contact quality$_{t1}$* → *intergroup anxiety$_{t2}$* constrained to *intergroup contact quality$_{t2}$* → *intergroup anxiety$_{t3}$* constrained to *intergroup contact quality$_{t3}$* → *intergroup anxiety$_{t4}$*). We were able to achieve partial cross-lagged stationarity ($\Delta x^2[35] = 49.064$, $p = .057$). See below and Tables 4 and 5 for more details. For more details on the analytic strategy, see the Supporting Information.

Explicit attitudes

The path analyses were conducted using R (R Core Team, 2012) and the lavaan package (Yves, 2012). Given that our data was collected across five schools, we tested to see if there was any evidence of clustering by school using the ICC package (Wolak et al., 2012). There was evidence of significant clustering by school ($-.008 <$ ICCs $< .061$; $0.08 <$ design effect < 8.00). Although none of our hypotheses required multilevel modelling (and there were too few schools to run any reliable multilevel models; Raudenbush & Bryk, 2002) we controlled for clustering by school using the lavaan.survey package (Oberski, 2014).

For fit indices, refer to Table 4. Generally, H1 was confirmed: contact was longitudinally positively associated with explicit positive attitudes and negatively associated with explicit negative attitudes. These results however only emerged for quantity of contact. As can be seen in Table 5, quantity of contact was reliably longitudinally associated with explicit positive and negative attitudes in the predicted manner, with only one exception (a slight increase in explicit negative attitudes between T1–T2 and T2–T3). In contrast, quality of contact was not associated with either positive or explicit negative attitudes (and, contrary to expectations, it was associated with lower explicit positive attitudes between T2–T3).

Although our hypotheses focused on the predictive role of contact, our analyses allowed us to test bi-directional paths. Results that emerged were not surprising. Intergroup anxiety was associated over time with lower quantity (but only between T1–T2) and quality of contact; it was also negatively associated with explicit positive attitudes and positively associated with explicit negative attitudes. Explicit positive attitudes were longitudinally associated with greater contact quantity and quality (with the exception of the association with contact quality between T3–T4) and lower intergroup anxiety and explicit negative attitudes. Explicit negative attitudes were longitudinally associated with lower quality of contact, greater intergroup anxiety and more negative explicit positive attitudes.

In line with H2, intergroup anxiety mediated the relationship between contact quantity at earlier time points and explicit negative attitudes at later time points, $b < -.01$, $SE < .002$, $p = .031$. Intergroup anxiety also mediated the relationship between contact quantity at earlier time points and explicit positive attitudes at later time points, $b = .01$, $SE = .002$, $p < .001$. Given that contact quality was not longitudinally associated with intergroup anxiety, we did not test if intergroup anxiety mediated any of the relationships between contact quality and the attitudinal outcome variables.

Exploratory analyses testing complex chain-mediation models

Given the four-wave nature of this data set, and that we were able to meet the assumptions of stationarity, we were also able to test a more complete picture of the contact hypothesis. To date, authors have focused on the prediction, and finding, that contact reduces prejudice (e.g. Pettigrew & Tropp, 2011) but also acknowledged that, even if this latter effect tends to be weaker, prejudice may be related over time to contact (people who are less prejudiced may also seek out more contact, and those more prejudiced may avoid it; for example Binder et al., 2009), and both directional effects may be found in the same study. In this data set, we were able to test hypotheses 1 and 2 in an extended chain-mediation model (Taylor et al., 2007). We tested if contact quantity at T1 first is negatively associated with intergroup anxiety at T2, which then results in more favourable explicit positive attitudes at T3, which, in turn, promote more contact quantity at T4. Results provided support for this cyclical model of intergroup contact, $b = .001$, $SE = <.01$, $p < .001$ (see Figure 1). Similarly, intergroup anxiety at T1 was associated with contact quantity at T4 through the chain mediation of reducing explicit positive attitudes at T2: less favourable explicit positive attitudes at T2 were associated with lower contact quality at T3, which was then associated with lower contact quantity at T4. This chain mediation reached significance, $b = -.002$, $SE = .001$, $p = .044$ (Figure 1).

TABLE 4 Fit statistics and model comparisons for the longitudinal models at different levels of model constraint

Model	Model fit	Model comparison	$\Delta \chi^2$ (*df*)
1a	$\chi^2(20) = 62.646$, $\chi^2/df = 3.132$, $p < .001$, CFI = .987, RMSEA = .061 [.046, .076], SRMR = .013		
1b	$\chi^2(30) = 76.202$, $\chi^2/df = 2.540$, $p < .001$, CFI = .986, RMSEA = .052 [.040, .065], SRMR = .017	1b vs. 1a	14.212 (10)
1c	$\chi^2(70) = 201.877$, $\chi^2/df = 2.883$, $p < .001$, CFI = .959, RMSEA = .057 [.049, .066], SRMR = .033	1c vs 1b	127.491*** (40)
1c[1]	$\chi^2(65) = 127.436$, $\chi^2/df = 1.949$, $p < .001$, CFI = .981, RMSEA = .041 [.032, .050], SRMR = .022	1c[1] vs 1b	49.064 (35)
2a	$\chi^2(80) = 134.615$, $\chi^2/df = 1.682$, $p < .001$, CFI = .873, RMSEA = .094 [.063, .123], SRMR = .061		
2b	$\chi^2(81) = 137.923$, $\chi^2/df = 1.702$, $p < .001$, CFI = .870, RMSEA = .097 [.063, .128], SRMR = .066	2b vs. 2a	3.308 (1)
2c	$\chi^2(96) = 152.182$, $\chi^2/df = 1.585$, $p < .001$, CFI = .862, RMSEA = .090 [.061, .116], SRMR = .073	2c vs. 2b	14.631 (15)

Note: Model key: Explicit attitudes model, 1a = Freely estimated model, 1b = autoregressive stationarity, free cross-lagged, 1b[1] = partial autoregressive and full cross-lagged stationarity. Implicit attitudes model, 2a = Freely estimated measurement model (saturated), 2b = autoregressive stationarity, free cross-lagged, 2c = autoregressive and cross-lagged stationarity.

Abbreviation: *ns*, non-significant.

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

Implicit outgroup attitudes

We used path analysis to test whether implicit outgroup attitudes are a function of contact and, if so, whether of contact quantity, contact quality or their product (H3). Although we did not have any mediation hypotheses relating to implicit attitudes, given the often observed dissociation between explicit and implicit measures, we kept the same model constraints reported in the model above. With the inclusion of implicit outgroup attitudes in the model, we kept the same equality constraints (both autoregressive and cross-lagged) as reported above, for the mediation model. We also kept the same covariates. We then tested if we could constrain the autoregressive and cross-lagged paths involving implicit outgroup attitudes to equality across time, which we were able to do (see Table 4, Models 2a, 2b and 2c).

Results are presented in Table 6. The autoregressive relationships for implicit outgroup attitudes were positive and significant, thus providing evidence for the relative stability of this construct over time. None of the longitudinal relationships treating implicit attitudes as the dependent variable reached statistical significance.

Testing the reverse path, implicit attitudes were significantly and positively associated with contact quantity over time. This finding supports the role of implicit attitudes as predictors of behaviour (Kurdi et al., 2019). They were not longitudinally associated with any of the other outcomes.

For the moderation analysis, we only included the longitudinal interaction effects for contact quantity, contact quality and implicit attitudes. We created our interaction variable using the package *semTools* (semTools Contributors, 2016; see Little et al., 2006). This package aids in centring variables and creating the interaction term. We also assessed whether we could constrain to equality the cross-lagged moderated relationship between contact quantity, contact quality, the interaction term and implicit attitudes. Being able to do so would demonstrate a consistent moderated effect across time. For this set of constraints, we also tested if we could constrain the $n + 2$ cross-lagged paths to equality (e.g., T1 contact quantity/quality and T3 implicit prejudice). When we compared the model with the interaction terms unconstrained to a model in which the interaction terms were constrained there was no drop in fit, $\Delta x^2(5) = 2.623$, $p = .757$. The interaction term between contact quantity and quality was not associated with implicit attitudes at one time lag (e.g. T1 interaction term was not associated with T2 implicit attitudes, $b = -.03$, $SE = .02$, $p = .191$). It was, however, associated with implicit outgroup attitudes at

TABLE 5 Unstandardized regression coefficients for the longitudinal associations of the predictors (T1–T2, T2–T3 and T3–T4) with the dependent variables

Predictors	Dependent variables				
	Quantity of contact	Quality of contact	Intergroup anxiety	Explicit positive attitudes	Explicit negative attitudes
Quantity of contact	.40*** (03)	.10*** (02)	−.10*** (01)	.05** (02)	.06**/−.10$_{t3-t4}$** (02/04)
Quality of contact	.12***/−.04$_{t2-t3}$*** (03/01)	.25*** (01)	.03 (02)	.03/−.16$_{t2-t3}$*** (03/03)	−.03 (03)
Intergroup Anxiety	−.02/−.17$_{t1-t2}$*** (03/03)	−.13*** (04)	.39*** (04)	−.11*** (02)	.05* (03)
Explicit positive attitudes	.09*** (03)	.13***/−.05$_{t3-t4}$* (04/02)	−.08*** (02)	.31*** (02)	−.06* (03)
Explicit negative attitudes	>−.01 (04)	−.04* (02)	.03* (01)	−.06*** (01)	.32*** (02)
R^2 − T1	.05	.04	.03	.06	.02
T2	.36	.24	.30	.26	.15
T3	.42	.39	.33	.29	.26
T4	.55	.45	.47	.45	.33

Note: Standard errors are in parentheses. The numbers on the diagonal are autoregressive paths. Unstandardized regression coefficients that could not be constrained to stationarity across time are separated by '/'. The subscripts indicate where in the longitudinal model the path could not be constrained to equality. T1 = wave 1; T2 = wave 2; T3 = wave 3; T4 = wave 4.
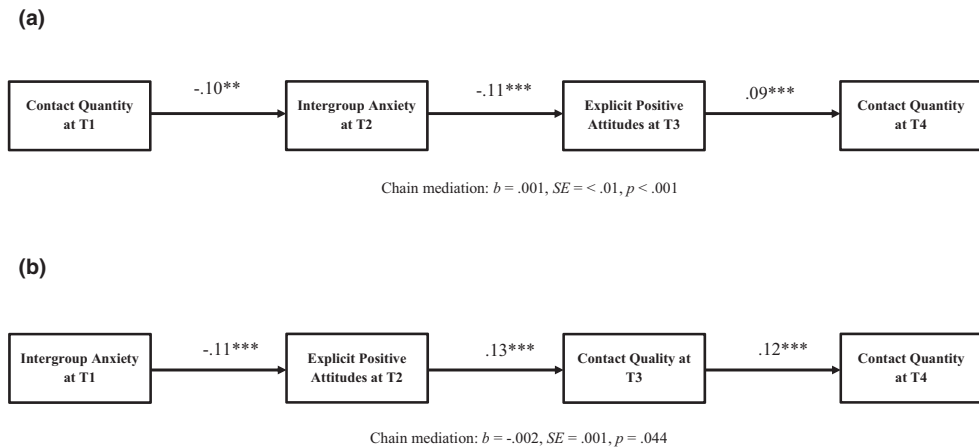
*$p<.05$, **$p<.01$. ***$p<.001$.

(a)

| Contact Quantity at T1 | $\xrightarrow{-.10^{**}}$ | Intergroup Anxiety at T2 | $\xrightarrow{-.11^{***}}$ | Explicit Positive Attitudes at T3 | $\xrightarrow{.09^{***}}$ | Contact Quantity at T4 |

Chain mediation: $b = .001$, $SE = < .01$, $p < .001$

(b)

| Intergroup Anxiety at T1 | $\xrightarrow{-.11^{***}}$ | Explicit Positive Attitudes at T2 | $\xrightarrow{.13^{***}}$ | Contact Quality at T3 | $\xrightarrow{.12^{***}}$ | Contact Quantity at T4 |

Chain mediation: $b = -.002$, $SE = .001$, $p = .044$

FIGURE 1 Simplified path model demonstrating the chain mediations tested. T1 = wave 1; T2 = wave 2; T3 = wave 3; T4 = wave 4. *$p < .05$, **$p < .01$. ***$p < .001$

two time lags (e.g., the association between T1 interaction variable and T3 implicit attitudes; $b = .04$, $SE = .01$, $p < .001$; see Figure 2).

Simple slopes analysis showed that contact quality was positively associated with $t+2$ implicit attitudes more for students who reported relatively higher (+1SD) contact quantity ($b = .12$, $SE = .02$, $p < .001$) compared to those who reported relatively lower (-1SD) levels of contact quantity ($b = .07$, $SE = .03$, $p = .044$). Thus, consistent with H3, we found evidence that the product of quantity and quality of contact was longitudinally associated with improved implicit outgroup attitudes.

DISCUSSION

In this longitudinal field study, we set out to study the longitudinal associations, mediated and unmediated, of different dimensions of contact (quality and quantity) with different types of outgroup attitudes (explicit and implicit). We found some evidence consistent with each of our three main hypotheses, and for members of majority and minority groups, but the findings were not always straightforward.

First, partially confirming H1, contact quantity was generally associated with an improvement in explicit outgroup attitudes: it was positively associated with explicit positive attitudes and negatively associated with explicit negative attitudes. Surprisingly, quality of contact, which was prioritized over quantity by Allport (1954) and subsequently (Brown & Hewstone, 2005; Pettigrew, 1997), fared less well. The fact that quantity of contact had more positive effects on explicit outgroup attitudes than quality of contact is somewhat inconsistent with previous studies (Binder et al., 2009; Vezzali et al., 2010). This finding may be due, at least in part, to the specific context examined.

As can be seen from descriptive statistics, the mean quality of contact was high, among both majority and minority members, at each wave. Indeed, at each time point, respondents reported levels of contact quality that were significantly (and substantially) above the scale mean (cf. Table 1; all ts[588] > 25.709, all ps < .001; all Cohen's d > 1.06). Thus, it is possible that the quantity of contact reported by participants referred to frequent *and* high-quality contact (consistent with this suggestion, quantity and quality of contact were significantly correlated at each wave, .37–.49). Contact being generally positive, it is possible that quantity of contact already incorporated the effects of quality of contact, so that we revealed no longitudinal associations of contact quality alone with outcomes. In other words, quantity of contact may have overridden the effects of quality of contact. Indirectly supporting this argument, the standard deviation for contact quality was lower than that for contact quantity, and the lower variance in this

TABLE 6 Unstandardized regression coefficients for the longitudinal associations of the predictors (T1–T2, T2–T3 and T3–T4) with the dependent variables for the model including implicit attitudes

Predictors	Dependent variables					
	Quantity of contact	Quality of contact	Intergroup anxiety	Explicit positive attitudes	Explicit negative attitudes	Implicit attitudes
Quantity of contact	.31** (12)	.16*** (.01)	.01 (08)	.07 (09)	$-.04/-.41_{t3-t4}$*** (.04/08)	.00 (01)
Quality of contact	$.25***/15_{t2-t3}$ (06/09)	.26*** (06)	−.03 (07)	$.12/-.19_{t2-t3}$*** (12/05)	−.07 (11)	.02 (04)
Intergroup Anxiety	$-.04/00_{t1-t2}$ (08/04)	−.18* (09)	.34*** (08)	.09*** (02)	−.18*** (>.01)	.06 (07)
Explicit positive attitudes	.20*** (04)	$.23***/-.03_{t3-t4}$ (06/07)	−.16** (06)	.39*** (05)	.03 (04)	.05 (04)
Explicit negative attitudes	.15 (09)	.02 (03)	−.01 (04)	<.01 (14)	.30** (05)	−.03 (03)
Implicit Attitudes	.32*** (02)	.07 (13)	−.30 (20)	.04 (21)	.18 (37)	.20*** (04)

Note: Standard errors are in parentheses. The numbers on the diagonal are autoregressive paths. The model here is the same as the model with only the explicit attitudes included. The results do not change significantly if all paths are constrained to equality. Unstandardized regression coefficients that could not be constrained to stationarity across time are separated by '/'. *p < .05, **p < .01. ***p < .001. The subscripts indicate where in the longitudinal model the path could not be constrained to equality.
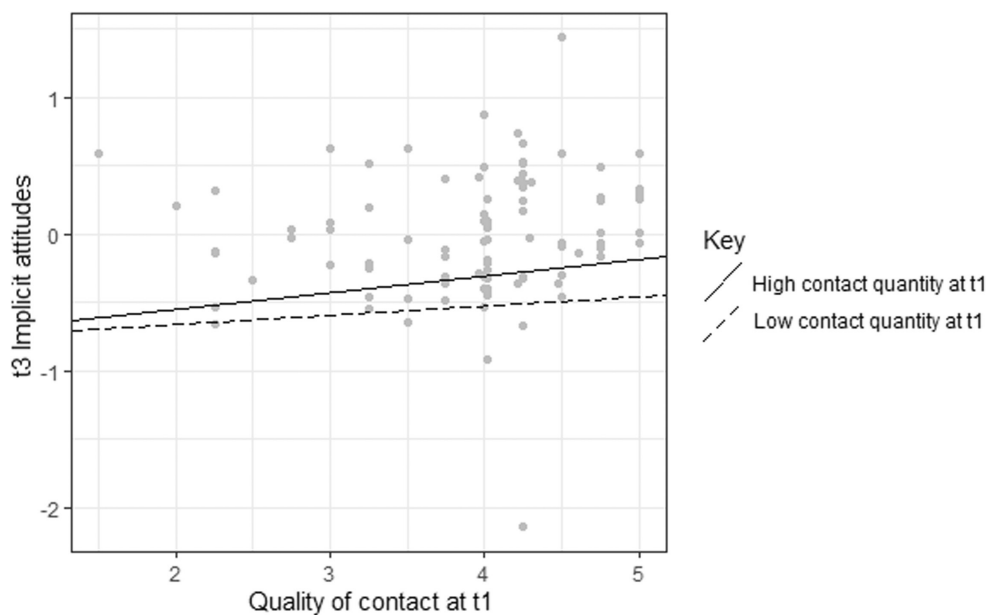
FIGURE 2 The relationship between quality of contact at T1 and implicit attitudes at T3 at high and low levels of T1 contact quantity. T1 = wave 1; T2 = wave 2; T3 = wave 3; T4 = wave 4

predictor would reduce the likelihood of it being correlated with attitudes. As can be noted in Table 2, quality of contact was, however, reliably associated with the other variables over time.

It should be noted that, while we assessed quantity and quality of contact, recent research has also considered the role played by negative contact. Pettigrew and Hewstone (2017) warned against the risk of ignoring key variables, whose absence may lead to distorted interpretations of findings. Research over the last decade has shown that both positive and negative contact jointly predict prejudice (albeit in different directions), and their effects can be additive (Schafer et al., 2021) or interactive (Árnadóttir et al., 2018). Therefore, it is possible that our results are inflated by the absence of a negative contact measure. Future studies should consider both types of contact, especially when examining implicit outgroup attitudes, for which evidence for negative contact is missing (but see Aberson et al., 2021).

Analyses also provided evidence for reverse paths (in the opposite direction to that proposed in the contact hypothesis; Allport, 1954), from intergroup anxiety and explicit outgroup attitudes to contact and other variables over time. Specifically, while explicit positive attitudes predicted more frequent and positive contact (with one exception; cf. Table 5), less intergroup anxiety and more positive explicit attitudes (that is, higher explicit positive attitudes and lower explicit negative attitudes), both intergroup anxiety and explicit negative attitudes had opposite effects. These findings are not surprising, and indeed reverse paths have often been reported in the literature (Binder et al., 2009; Levin et al., 2003; Swart et al., 2011). The indisputably bi-directional nature of the relationship between contact and other outcomes, notably attitudes and anxiety, adds to the importance of reducing intergroup anxiety and improving explicit outgroup attitudes.

Second, confirming H2, contact (in particular, quantity of contact) had an indirect longitudinal association with explicit positive and negative outgroup attitudes, via reduced intergroup anxiety. Most convincingly, we exploited all four waves of data to test a more complete picture of the contact hypothesis using an extended chain-mediation model. We found that contact quantity at T1 was associated with reduced intergroup anxiety at T2, which then related to improved explicit attitudes at T3, which promoted more contact quantity at T4. We also found evidence for a similar chain-mediation beginning with intergroup anxiety at T1 and ending with contact at T4. These results underline the importance of

investigating the reciprocal relationships between contact, intergroup anxiety and outgroup attitudes over time and across several time points.

In addition to confirming the longitudinal mediating role of intergroup anxiety in the relationship between contact and attitudes, as previously demonstrated (Swart et al., 2011; Turner & Feddes, 2011; Van Zalk et al., 2021; Vezzali et al., 2010), this is the first study to find full longitudinal mediation effects (i.e. by considering more than two time points, with measures of predictor, mediator and outcome measured at each time point) in a four-wave design over a larger time span and when considering both majority and minority group members (but see Van Zalk et al., 2021, who found full longitudinal mediation by intergroup anxiety in a three-wave design).

Third, confirming H3, we obtained evidence that the combination of contact quantity and quality was longitudinally positively associated with more positive implicit outgroup attitudes. Neither quantity nor quality of contact alone were sufficient to change implicit outgroup attitudes. Rather, implicit attitudes were predicted by frequent (quantity) and positive (quality) contact combined. In addition, and in contrast to explicit attitudes, effects of contact on implicit attitudes were unmediated (as found by Aberson & Haag, 2007; Turner et al., 2007; Vezzali & Giovannini, 2011; but not Prestwich et al., 2008), in this case by intergroup anxiety.

The present results are consistent with dual-process models, such as the associative-propositional evaluation (APE) model (Gawronski & Bodenhausen, 2006). The APE model proposes that explicit attitudes stem from propositional processes, that is, higher-order cognitive processes based on syllogistic inferences. In contrast, implicit attitudes stem from associative processes, reflecting the automatic activation of mental associations pertaining to an attitude object in the presence of a stimulus. Implicit attitude change may depend on changes in mental associations stored in memory as a function of evaluative conditioning processes (which do not necessarily operate outside awareness; Corneille & Stahl, 2019).

There is now consistent evidence demonstrating that repeatedly pairing a positive or a negative stimulus with an attitude object can change implicit attitudes towards that object (Forbes & Schmader, 2010; Gawronski & Sritharan, 2010). Some studies also demonstrated that evaluative conditioning can be used to improve implicit attitudes (Lai et al., 2014, 2016; Olson & Fazio, 2006). We argue that contact may have worked, at least in part, as a form of evaluative conditioning, such that the repeated association (quantity of contact) of positive experiences (quality of contact) with an attitude object (outgroup) might have changed mental associations in the direction of more positive implicit attitudes towards the outgroup (for similar findings using a correlational design, see Vezzali & Capozza, 2011).

According to the APE model (Gawronski & Bodenhausen, 2006) changes in implicit attitudes may occur in a variety of ways, including but not necessarily exclusively due to evaluative conditioning processes. For instance, implicit attitude change can also stem from propositional processes and, therefore, from changes in explicit attitudes. In this study, however, we did not find that changes in implicit attitudes were mediated by explicit attitudes, or by intergroup anxiety, in line with literature showing that explicit and implicit attitudes are often dissociated (Gawronski & Bodenhausen, 2012) and with previous findings revealing an unmediated association between contact and implicit attitudes (Aberson & Haag, 2007; Turner et al., 1987; Vezzali & Giovannini, 2011; for an exception, see Prestwich et al., 2008; for a model predicting unmediated effects of contact on implicit attitudes, see Vezzali & Stathi, 2021, Chapter 5).

Most research investigating implicit attitude change assessed implicit attitudes over only a relatively short time span (or even immediately after the manipulation of the independent variable; for example Lai et al., 2014; Olson & Fazio, 2006). In one of the rare exceptions, Devine et al. (2012) conducted a prejudice-reduction intervention considering multiple strategies, including intergroup contact, but were unable to disentangle the role of single strategies. Implicit outgroup attitudes in this case were assessed 4 and 8 weeks after the intervention. Moreover, effects did not replicate in a follow-up study (Forscher et al., 2017). The most notable exception is provided by the six-year study of white American physicians in training by Onyeador et al. (2020), which, however, could not investigate the effects of minority members' contact on their implicit attitudes towards the majority. To our knowledge, the

present findings are the first to show that a prejudice-reduction strategy can influence implicit outgroup attitudes over a period of three years among both majority and minority individuals.

Aside from testing the theoretically derived hypotheses, our findings are of practical value for the application of intergroup contact in schools. In line with previous research (Giovannini & Vezzali, 2012; Vezzali et al., 2010), findings depict a situation where relationships between Italians as the majority and immigrants as the minority are not negative, but they also do not qualify as positive (at least, from the majority's point of view). Results revealed that intergroup relations were rather stable, but did show a small improvement over time. It is, therefore, important to identify effective strategies, like intergroup contact, that can transform relations from rather neutral to more positive. This is especially relevant when considering adolescent samples like the one we investigated in this study. To the extent that the influence of peers and more generally groups start acquiring importance (Rutland et al., 2010), it is important to identify strategies to improve intergroup relations based on the peer group. The contact, which was assessed in a natural context rather than engineered in an intervention, was experienced positively. Of particular interest, our findings offer longitudinal support to MacInnis and Page-Gould's (2015) contention that, whereas initial intergroup contact may pose significant challenges (e.g., heightened stress and intergroup anxiety), these challenges diminish with further interactions and the elements of positive intergroup contact become more influential. There was a clear pattern for the amount and quality of contact to increase, and intergroup anxiety to decrease, over time. These findings should guide those planning interventions through the possibly more awkward first encounters, encouraging them to bolster the positive nature of initial contacts, and giving them confidence that, over time, majority and minority members will experience and benefit from positive contact.

Notwithstanding the novelty and practical value of our findings, we acknowledge some limitations. First, although our study was longitudinal, it was still correlational (that is, it was not experimental) and our measure of intergroup contact was based on self-reports (Christ & Wagner, 2013). Future studies might consider using experimental methodologies or observer reports, in particular making use of social network methodologies (Wölfer et al., 2015).

We must acknowledge the limitations of our modelling approach. We used a cross-lagged covariate-control panel design for modelling our longitudinal data, in which we controlled for the effects of gender, age and participant ethnicity at the first time point only (see Little et al., 2007). Even though we controlled for several pertinent covariates, we were still unable to account for all unmeasured confounding variables, leading to biased model parameter estimates (VanderWeele et al., 2020). This is especially the case with complex longitudinal data, such as that presented here. VanderWeele et al. (2020) propose the 'outcome-wide longitudinal design' which offers new metrics (e.g., the E-value that measures how robust the parameter estimates are; VanderWeele & Ding, 2017) and approaches to estimating and controlling for unmeasured confounding variables. Another approach to dealing with confounds is to use random intercept cross-lagged panel modelling (RI-CLPM; Hamaker et al., 2015). RI-CLPM offers some control over unobserved confounding variables by estimating both stable between-person associations and temporal within-person effects (Usami et al., 2019). Having said this, we included in our analysis lag-2 effects (e.g. $x_1 \rightarrow y_3$). Recent research using simulations has demonstrated that this lag-2 approach sufficiently controls for delayed effects of the covariates (see Lüdtke & Robitzsch, 2021). This modelling approach provides strong control against confounding (VanderWeele et al., 2020) and outperforms RI-CLPM, especially when longer lags are considered, as is the case here (Lüdtke & Robitzsch, 2021). A further benefit to the lag-2 approach (compared to the RI-CLPM approach) is that it is more appropriate when the goal is causal inference (as opposed to modelling developmental processes; Lüdtke & Robitzsch, 2021). Having briefly extolled the virtues and appropriateness of the lag-2 approach, we acknowledge that non-experimental study designs are unable to rule out all possible confounding variables (Reichardt, 2019) and, thus, caution should be applied while interpreting our results.

Second, despite our decision to over sample, the sample size for minority members was smaller than the power calculation indicated, thus a replication with a larger minority sample is needed. Third, for

practical reasons, we were not able to assess implicit attitudes at T1. However, since analyses using implicit attitudes were based on three waves of data collection, we are reasonably confident in the associations we found. Moreover, we included, where possible, a lag-2 approach for the implicit model as well, thus providing stricter control of confounders. Fourth, research has identified other relevant mediators, like intergroup empathy (Pettigrew & Tropp, 2008). Given the complexity of analyses required by our four-wave design, we only focused on the key variables that must be investigated by contact research (contact and attitudes) and a single mediator. We acknowledge, however, that the absence of important variables, like intergroup empathy, may have distorted results (e.g., by inflating the role played by intergroup anxiety); therefore, findings should be interpreted with caution.

To conclude, our study shows that establishing positive intergroup contact between majority and minority students from the beginning of high-school can contribute to determining better intergroup relations in subsequent years, as shown by longitudinal associations found for both explicit and implicit outgroup attitudes. Given the increased numbers of migrants worldwide, these findings suggest that contact in schools has an important role to play in promoting more positive relations between host and migrant groups.

AUTHOR CONTRIBUTIONS

Loris Vezzali, Ph.D. (Conceptualization; Investigation; Methodology; Project administration; Resources; Supervision; Validation; Writing – original draft; Writing – review & editing). **Simon Lolliot** (Data curation; Formal analysis; Writing – original draft; Writing – review & editing). **Elena Trifiletti** (Conceptualization; Data curation; Writing – original draft; Writing – review & editing). **Veronica Margherita Cocco** (Writing – original draft; Writing – review & editing). **James Richard Rae** (Writing – original draft; Writing – review & editing). **Dora Capozza** (Conceptualization; Writing – original draft; Writing – review & editing). **Miles Hewstone** (Conceptualization; Investigation; Methodology; Supervision; Validation; Writing – original draft; Writing – review & editing).

ACKNOWLEDGEMENT

CONFLICT OF INTEREST

Authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data are available at the following link: https://osf.io/34fxy/

ORCID

Loris Vezzali 🅾 https://orcid.org/0000-0001-7536-9994

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