The Role of Education in Native Dutch Adolescents' Muslim Population Size Perceptions

Anne Maaike Mulders[1] · Frank van Tubergen[2,3]

Abstract

This study investigates competing explanations for the effect of education on native adolescents' Muslim population size perceptions. Drawing on theories about heuristic reasoning, we analyze to what extent the effect of education on size perceptions may be explained by differences in contact with and prejudice towards Muslims. The hypotheses are tested using longitudinal data on adolescents in the Netherlands ($N = 1219$). Overall, there is a tendency to overestimate the size of the national Muslim population. Furthermore, we find that higher educated adolescents tend to provide lower estimates of the Muslim population size. This relationship is partially mediated by earlier differences in school composition, as Muslims are concentrated to a greater extent in lower education. The relation between education and size perceptions cannot be attributed to differences in prejudice. Hence, we conclude that the effect of education on size perceptions is likely due to greater numeracy rather than negative evaluations of the outgroup.

Keywords Innumeracy · Perceived outgroup size · Adolescence · Class composition · Friendships

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Introduction

Over the past decades, the inflow of migrants has become an increasingly salient topic in the public discourse in western societies (Hatton, 2021). Studies in Europe show widespread negative attitudes towards immigrants (Czaika & Di Lillo, 2018; Semyonov et al., 2006) and towards Muslims in particular (Savelkoul et al. 2011; Savelkoul et al., 2012; Schlueter et al., 2019). While concerns over the success of integration are subjective and therefore open to differences in opinion or experience, the extent of immigration and outgroup population sizes can be objectively measured. A recent study, however, has revealed that outgroup size perceptions can diverge significantly from objective statistics: respondents from a large number of European countries overestimate the size of the Muslim population with percentage point differences ranging from a 7 percentage point to a 22 percentage point overestimation (Ipsos, 2018).

A recurring finding in studies investigating minority population size perceptions is that higher educated individuals tend to provide lower estimates of local and national outgroup sizes (Gorodzeisky & Semyonov, 2020; Herda, 2010; Laméris et al., 2018; Nadeau et al., 1993; Sides & Citrin, 2007; Strabac, 2011; Wong, 2007). Although this finding is robust across different countries and minority groups, little is known what contributes to the effect of education. Different mechanisms may play a role. The most straightforward explanation of this effect is that higher educated individuals are more comfortable processing and interpreting relevant numeric information and thus are less inclined to overestimate minority population sizes based on intuitive judgments (e.g., Peters, 2012). Alternative explanations include that higher educated individuals are less likely to come into contact with minority members in their school context or that higher educated individuals tend to be less prejudiced.

The aim of this study is to open the "black box" of the impact of education on size perceptions. We look at two possible intervening pathways, namely, intergroup contact and prejudice. Using mediation analysis, we examine how much of the "education gradient" in misperceptions can be attributed to these two pathways and how much of the education effect remains. To do so, we investigate native adolescents' perceptions of the size of the Muslim population in the Netherlands. We draw on a large-scale, longitudinal survey among adolescents. Specifically, we use wave 1 data of CILS4EU (Kalter et al., 2013), which were collected when adolescents were around 14 years old, and combine it with wave 6 data of the Dutch continuation of CILS4EU (Jaspers & Van Tubergen, 2018), when they were around 19. We take advantage of the fact that the Netherlands has a tracked school system and that by the age of 14 children are sorted into different levels of education (tracks). Using these two waves, we then estimate the impact of adolescents' educational level (measured at age 14) on their Muslim population size perceptions (measured at age 19) and how strongly this association is mediated by intergroup contact and prejudice (at age 14).

To put this study in context, at the time when the first wave was collected (i.e., 2010), around 5% of the Dutch population considered themselves Muslim

(CBS statline, 2019). By contrast, surveys among the adult Dutch population showed estimates that Muslims comprise 20% of the national population on average (Ipsos, 2018). The largest Muslim groups in the Netherlands are those with a Turkish or Moroccan migration background, amounting to around 80% of Muslims in the Netherlands between 2010 and 2015 (CBS statline, 2021). These two groups largely migrated to the Netherlands in the 1960s and 1970s, as a part of a Dutch plan to address a shortage of low-skilled manual laborers.

Theoretical Framework

Mechanisms of Judgment

This study draws on several mechanisms which can be used to understand the link between education and outgroup size estimation. Following dual-process theory, there are two main modes of reasoning about population size estimation: providing an intuitive answer or consciously reasoning about relevant information (Frankish, 2010; Kahneman, 2003). *Conscious reasoning* about populations requires effort and skill, as it likely involves recalling relevant population statistics and processing them to fit the format of the question. Numeracy, or objective numeracy, refers to "the ability to process, communicate and interpret numerical information in a variety of contexts" (Askew et al., 1997, p. 336). Highly numerate individuals are more likely to use numeric information in reasoning and decision-making, which increases their performance on judgment and decision-making tasks which involve numbers (Peters, 2020).

By contrast, when individuals do not have relevant information at hand or are unable to use numeric information in context, they must rely on their intuition. Intuitive judgments are often based on rules of thumb, called heuristics. The *availability heuristic* mechanism predicts that when an individual has to estimate the probability of an event or the size of a group, they rely on how easily this event or members belonging to this group can be retrieved from memory (Tversky & Kahneman, 1974). The rule of thumb is that more easily recalled groups are larger than groups which are more difficult to remember (ibid). Instead of drawing on population statistics, individuals base their population size judgments on personal experience with the population in question. There is widespread evidence that the (perceived) presence of minorities in individuals' neighborhood or workplace is positively associated with their judgments of minority population size in the larger regional or national context (Alba et al., 2005; Herda, 2010; Semyonov et al., 2008; Sigelman & Niemi, 2001; Strabac, 2011; Wong, 2007). Personal experiences with individuals from small minority groups can easily lead to overestimation of the size of the group in question. Individuals generally overestimate the frequency of rare events, as these events are more distinctive and therefore more easily recalled from memory (McConnell et al., 1994). Consequently, encounters with individuals from small minority groups weigh more heavily in individual's population size estimates based on personal experiences. In sum, people tend to take their local context as an approximately representative sample of the national population.

The *affect heuristic* mechanism is another rule of thumb which can shape intuitive judgments of population size. Affect is considered the "feeling aspect" of emotion, constituting rash evaluations of stimuli as positive or negative (Gray & Bjorklund, 2014). The affect heuristic originally posed that these affective responses form the basis of individuals' risk perceptions (Finucane et al., 2000). Risk is a combination of the perceived negative and positive impact of an event (Slovic et al., 2004), as well as the perceived probability that the risk will occur (Mukherjee, 2010). When the consequences of an event evoke a strong affective reaction in an individual, they tend to ignore the actual risk probability and instead focus their risk perception solely on the intensity of the perceived negative or positive impact (Slovic et al., 2004). Thus, people tend to judge events where they feel strongly about the consequences as more frequent (Rottenstreich & Hsee, 2001). Later studies have extended the affect heuristic to population size estimation, arguing that individuals base outgroup size perceptions on the perceived negative impact of the outgroup on society and related feelings of fear. When estimating the size of a population, individuals may be guided by their affective reaction to Muslims as a group. Consequently, majority individuals who have strong negative feelings about Muslims may provide higher Muslim population size estimates.

Understanding the Link Between Education And Outgroup Size

The starting point of this study is the hypothesis that *education track negatively influences perceived Muslim population size* (**H1**). Basing on the mechanisms discussed above, the education track in which adolescents are enrolled is theorized to affect Muslim population size perceptions through different pathways (see Fig. 1).

The first main pathway that can explain the education-perceived size link is via intergroup contact. Adolescents in different tracks might have varying levels of
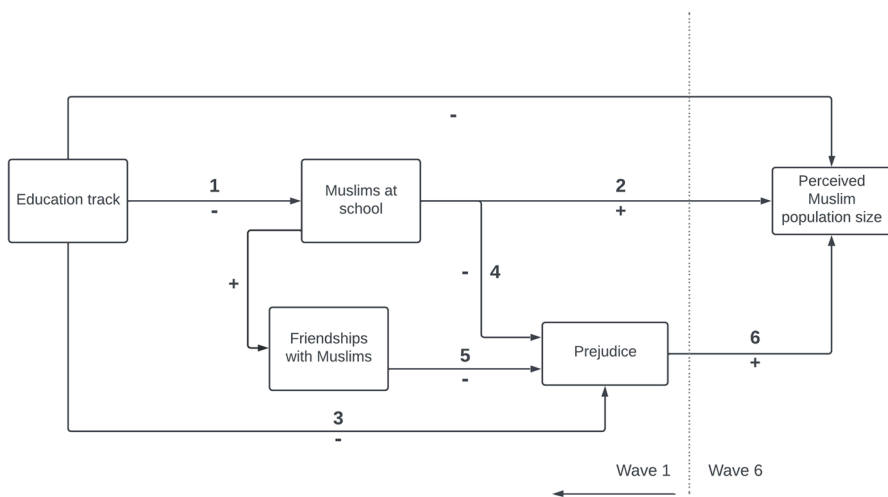

Fig. 1 Conceptual model

contact with Muslims. Since they spend a substantial amount of their time at school, the school context is highly relevant for adolescents' perceptions of society. Based on the availability heuristic, it can be expected that a greater presence of Muslims at school increases majority individuals' perceptions of the national Muslim population size. Muslim minority members are, however, unevenly distributed among the tracks. Although the educational attainment of second-generation migrants from Turkey and Morocco is generally higher than their parents' educational attainment, Turkish and Moroccan adolescents are still less likely than their Dutch peers to be enrolled in the higher tracks in secondary education (CBS, 2020). Since pupils are inclined to socialize mostly with people within the same track and school, majority individuals in higher tracks likely come into contact with fewer Muslims (Leszczensky & Pink, 2017; Smith et al., 2014). Therefore, individuals in the higher tracks likely have fewer recollections of encounters with Muslims on which they can base their estimates of the Muslim population size. It is hypothesized that education track negatively influences perceived Muslim population size, because there are fewer Muslims in higher tracks (**H2**). This hypothesis thus relates to paths 1 and 2 in Fig. 1.

A second route through which education may impact the perception of outgroups is via prejudice (paths 3 and 6). Following the affect heuristic, negative reactions evoked by the outgroup can drive inflated outgroup size perceptions. Prior studies have found that perceived threat and social distance to immigrants are positively associated with outgroup size perceptions (Herda, 2015; Laméris et al., 2018). Since higher educated individuals tend to be less prejudiced towards outgroups compared to lower educated individuals, we may find that the association between education and size perceptions is partly due to differences in prejudice (Cavaille & Marshall, 2019; McLaren, 2003; Strabac & Listhaug, 2008). Therefore, higher educated individuals may be less inclined to overestimate the Muslim population based on strong negative affect or perceptions of threat. Thus, it is hypothesized that *education track negatively influences perceived Muslim population size, because higher educated individuals are less prejudiced towards Muslims* (**H3**).

The two pathways are not completely unrelated, and we also consider this interdependency. To begin, the availability heuristic suggests that a greater presence of Muslims at school should increase Muslim population size perceptions (path 2), but the opposite expectation could be formulated based on the affect heuristic (paths 4, 5, and 6). The critical issue determining the direction of the effect, then, is whether Muslims at school influence majority individuals' prejudice. When the presence of Muslims at school is sufficient to decrease majority individuals' prejudice towards Muslims, size overestimations based on negative affective reactions may be mitigated. The mere exposure effect holds that repeated exposure to a certain stimulus increases our preference for this stimulus and generates positive affect (Zajonc, 2001). Even if classmates are not mentioned as best friends, students in the same grade still spend considerable amounts of time with one another. Furthermore, interactions even beyond mere exposure to one another are expected to take place between classmates as they are required to work on joint assignments or sit beside one another. In the class context specifically, there is evidence that interactions with ethnic minority classmates in ethnically diverse

classes can generate positive affective evaluations which generalize towards the outgroup as a whole (Bubritzki et al. 2018); Stark et al., 2013). The presence of Muslims at school may therefore help to reduce negative affective reactions to Muslims which lie at the basis of size overestimations. Therefore, in contrast to hypothesis 2, this line of reasoning leads to the hypothesis that *adolescents with more Muslims at school are less prejudiced towards Muslims, which negatively influences the perceived Muslim population* size (**H4**). This hypothesis is visualized in paths 4 and 6 of Fig. 1.

A sizable Muslim group at school can also provide opportunities for more intimate forms of contact between majority adolescents and Muslims. Having outgroup friends decreases negative attributes associated with outgroups and decreases negative affective reactions to outgroup members (Tropp & Pettigrew, 2005a). Hence, majority individuals with Muslim friends will likely have a more favorable attitude towards Muslims in general. It is hypothesized that *having one or more Muslim friends decreases prejudice towards Muslims, which negatively influences the perceived Muslim population size* (**H5**). This hypothesis relates to paths 5 and 6 of Fig. 1.

Methods

Data Collection and Sample

The hypotheses will be tested using the first wave of CILS4EU from the Netherlands (Kalter, et al., 2013), and the sixth wave of CILSNL (Jaspers & Van Tubergen, 2018), the continuation of the CILS4EU study in the Netherlands. The first wave was collected in 2010/2011 when respondents were about 14 years old. The aim of the data collection was to survey adolescents with and without migration backgrounds and follows their development over the subsequent years (CILS4EU, 2016). To reach this target population, a stratified sampling design was utilized. First, secondary schools were assigned to strata corresponding to the proportion of students with a migration background in school. Then, schools were sampled from each stratum with probabilities proportional to school size. On average, two third grade classes were randomly selected from each school. Within schools, all sampled classes are in the same education track and grade. The participation rate in wave 1 at the level of classes was 94.5% and 91.1% at the level of individual students (CILS4EU, 2016).

Respondents were followed up with in later waves through the schools as long as they were still in school, or individually when they had left school. The sample size in wave one in the Netherlands is 2974 ethnic majority respondents, divided into 205 classes at 94 schools. Wave six was collected in 2016, when respondents were around 19 years old and were no longer enrolled in secondary school. Given the participation in the first wave, 56.1% or 1667 respondents also completed the survey in wave six. After the exclusion of respondents with missing values on any of the included variables, a sample size of 1219 individuals was reached.
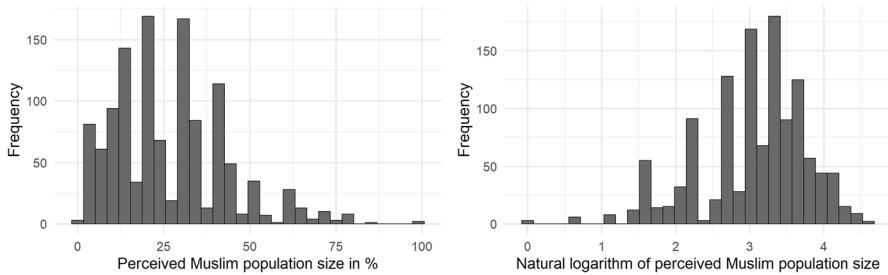
Fig. 2 Histograms of the raw estimates of Muslim population size (L, in percentages) and log-transformed estimates of the percentage of Muslims in the Netherlands (R)

Measures

The dependent variable is *perceived Muslim population size.* This variable is based on the item "What percentage of Dutch inhabitants (0–100) is Muslim, in your opinion?" in wave six. Considering that Muslims constituted about 5% of the Dutch population when this question was asked (CBS Statline, 2019), estimates exceeding 50 are treated as extreme outliers and therefore set to 50. This group constitutes 9.7% of all respondents. Robustness checks excluding those with estimates of 50 or higher yielded the same conclusions as presented here. Alternative operationalizations of the dependent variable are presented as robustness checks below. The distributions of both the raw variable and the logarithm-transformed variable are displayed in Fig. 2.

The main independent variable, *education track*, is measured in wave one and distinguishes between three levels of secondary education: low (in Dutch: VMBO), middle (HAVO), and high (VWO). In the Netherlands, students are separated into these tracks at age 12, mostly based on a national standardized exam which is administered in the final year of primary education (Van de Werfhorst, 2021). The VMBO track prepares students for upper secondary vocational school in 4 years. The HAVO track takes 5 years and grants access to tertiary vocational education. The VWO track is 6 years long and prepares students for university.

The *presence of Muslims in school* is a school-level variable which is measured by calculating the percentage of adolescents who indicate that they are Muslim over all classes in the sample. It is important to note that all classes are sampled within the same grade and track. Therefore, this variable does not capture the school-wide percentage of Muslims, but rather the percentage of Muslims in adolescents' own class and other classes in the same grade and track. As such, it should be considered a measure of Muslims in adolescents' relevant context, the pool of peers from which they choose their friends and with whom they spend time during breaks and after school, rather than a measure of the complete school context.

For the variable, *friendships with Muslims*, we make use of the sociometric network data. Specifically, respondents were asked to nominate up to five best friends within their class. Using unique respondent identifiers, the religion of these best friends was determined. Importantly, the religion of a friend is based on the

self-reported religious affiliation of this friend. From these data on best friends and their religious affiliations, a binary variable is construed indicating whether the respondent has (1) or does not have (0) any Muslim best friends. We have chosen to include this as a binary variable instead of a continuous variable containing the number of Muslim best friends, since very few respondents nominated more than one Muslim best friend (5.6%).

Prejudice is measured using a feeling thermometer. This method is well-known to assess the affective component of prejudice (Alwin, 1997). Furthermore, the feeling thermometer correlates strongly with multi-item measures of prejudice including stereotypes, social distance, and perceived threat, even among adolescents (Radoš et al., 2019; Stangor et al., 1991; Velasco Gonzaléz et al., 2008). The item was formulated as follows: "Indicate how you feel about the following group in the Netherlands on a scale from 0 to 100. The higher your response, the more positive your feelings towards this group. The lower your response, the more negative your feelings towards this group." Respondents could provide answers between 0 and 100, in increments of 10. A value of 50 constitutes a neutral response. Responses were reverse-coded so that higher values correspond to more negative feelings towards the group in question.

In this study, we combine two feeling thermometer items relating to Turks and Moroccans in wave one. Most Turks and Moroccans in the Netherlands consider themselves Muslim, and they tend to maintain high levels of religiosity even in a relatively secular country such as the Netherlands (De Hoon & Van Tubergen, 2014). Furthermore, feeling thermometers in wave six reveal strong correlations between ethnic majority respondents' feelings towards Turks and Muslims ($r = 0.75$, $p < 0.0001$), as well as Moroccans and Muslims ($r = 0.82$, $p < 0.0001$). Combined, these lend support to the use of feeling thermometers about Turks and Moroccans as a proxy for prejudice towards Muslims. The prejudice variable was created by taking the mean of the reversed feeling thermometer responses relating to Turks and Moroccans. When a response to only one of these groups was missing, the response to the other group was taken as a proxy for prejudice towards both groups.

Several individual-level control variables were included. First, respondent *sex* was taken into account (female = 1). Second, the *education level of the mother* in wave one is added as a control. Parental education has been found to negatively affect adolescent children's prejudice (Miklikowska, 2017), which may in turn influence respondents' population size estimates. We choose to include mother's education since mothers have been found to be more influential in the socialization of racial and ethnic prejudice compared to fathers (Castelli et al., 2009). A categorical variable is used for mother's education level, containing four response categories: secondary education or lower (1), lower vocational education (2), higher vocational education (3), and university education (4). Thirdly, the *stratum* variable is used to control for presence of ethnic minorities in school. This variable is distinct from the independent variable *presence of Muslims in school* in two ways. First, it denotes the percentage of ethnic minority students in school and thus includes a larger range of (ethnic) outgroups compared to only Muslims. Second, this variable is based on the whole school, while the *presence of Muslims in school* only refers to the sampled classes. Since classes are sampled within the same grade and education track,

the two variables are expected to differ. Schools are divided into four strata: 0–10, 10–30, 30–60, and 60–100%. Finally, *survey mode* is added as a control variable. A binary variable is added specifying whether the respondent filled out an online or paper-and-pencil survey (0) or was interviewed (1) in wave six. This control variable is added since an interview may provoke socially desirable answers to sensitive topics such as prejudice (Krumpal, 2013).

The descriptive statistics for the dependent and independent variables are presented in Table 1.

Analytical Strategy

We investigated the effect of education on Muslim population size perceptions using a number of models. We start with model 1, containing only education track and the control variables as covariates. In model 2, we add the percentage of Muslims at school as a covariate. In model 3, prejudice is added. In model 4, we add friendships with Muslims as well as all indirect paths. All analyses are performed using multilevel generalized structural equation models (GSEM) in Stata/SE 14.2. GSEM

Table 1 Descriptive statistics

Variable	Wave	Mean/prop	SD	Min	Max
Dependent variables					
Perceived Muslim population size	6	25.794	13.803	1	50
Log (perceived Muslim population size)	6	3.072	.722	0	4.605
Individual-level independent variables					
Muslim friends: at least one	1	.120		0	1
Prejudice	1	49.626	22.159	0	100
School-level independent variables					
Muslims at school	1	9.990	14.120	0	85.185
Education track: low	1	.633		0	1
Education track: middle	1	.167		0	1
Education track: high	1	.200		0	1
Individual control variables					
Sex: female	1	.576		0	1
Mother's education: max. secondary school	1	.317		0	1
Mother's education: lower vocational	1	.365		0	1
Mother's education: higher vocational	1	.259		0	1
Mother's education: university	1	.058		0	1
Survey mode: interview	6	.085		0	1
School-level control variable					
Stratum: 0–10%	1	.178		0	1
Stratum: 10–30%	1	.389		0	1
Stratum: 30–60%	1	.300		0	1
Stratum: 60–100%	1	.133		0	1

allows for mediation analysis and can take into account data with a multilevel structure.

Before fitting models with main effects and mediations, an intercept-only model was estimated, which is used to calculate the intraclass correlations (ICC) of perceived Muslim population size at the level of classes and schools. The ICC gives the percentage of variation in perceived Muslim population size that can be attributed to school- or class-level differences rather than individual differences. Due to convergence issues and low variance at the level of school classes, the models presented here are based on a two-level model of pupils nested in schools. The ICC at the school level is 0.22.

Results

Inspection of the descriptive statistics reveals a pattern of Muslim population size perceptions in line with earlier studies on population innumeracy: overestimation is far more common than correct estimation or underestimation. Around 93% of respondents overestimate the size of the national Muslim population, while just over 2% of the respondents underestimate it. On average, respondents estimate that Muslims constitute almost 26% of the Dutch population, meaning an average overestimation of over 20 percentage points. Furthermore, in line with findings of Alba and colleagues (2005), respondents tend towards estimates which are divisible by 10 and otherwise 5.

The results of the main analyses are displayed in Table 2 and graphically represented in Fig. 3. Model 1 only contains the main effect of education track and control variables. In line with prior studies, we find that those in the higher tracks perceive the Muslim population to be smaller than those in the lower tracks. Compared with those in the lowest track, those in the middle track estimate the Muslim population to be 5.690 percentage points smaller on average ($p < 0.001$, model 1). When comparing those in the highest track with those in the lowest track, Muslim population size estimates are 10.491 percentage points lower on average ($p < 0.001$, model 1). Hence, we clearly find that education is negatively associated with overestimation of the share of Muslims in the Netherlands. This confirms hypothesis 1.

Model 2 includes the share of Muslims in school. It was expected that at the higher tracks, there would be fewer Muslims, which would decrease native adolescents' Muslim population size estimates. The percentage of Muslims at school is indeed lower at the highest track compared to the middle and low track (Appendix, Table 4). In line with the hypothesis, we indeed find that adolescents in schools with more Muslims provide higher Muslim population size estimates ($B = 0.194$, $p < 0.01$, model 2). When adding the share of Muslims at school in model 2, the coefficients for education track decrease from -10.491 to -9.679 for the highest track and from -5.690 to -5.275 for the middle track. Since the inclusion of the share of Muslims at school leads to a decrease in the effect of education, the presence of Muslims at school appears to explain some of the education gradient in Muslim population size estimation. Thus, hypothesis 2 is supported.

Table 2 Parameter estimates from multilevel structural equation models predicting perceived Muslim population size

	Models							
	1: Direct effect track		2: Direct effects track and Muslims at school		3: Direct effects track, Muslims at school and prejudice		4: Direct and indirect effects	
	B	SE	B	SE	B	SE	B	SE
Direct effects								
Education track[a]								
Middle	−5.690***	1.462	−5.275***	1.349	−5.516***	1.386	−5.415***	1.429
High	−10.491***	1.329	−9.679***	1.242	−9.259***	1.290	−9.447***	1.319
Muslims at school			.194**	.058	.215**	.060	.175**	.064
Prejudice					.044**	.017	.031	.017
Muslim friends								
At least one							.879	1.187
Constant	26.017	1.453	25.102	1.383	22.214	1.743	23.185	1.833
Indirect effects								
Education track[a]								
Middle > Muslims at school							−.122	.108
High > Muslims at school							−.549*	.221
Middle > prejudice							−.047	.073
High > prejudice							−.237	.146
Middle > Muslims at school > prejudice							.006	.006
High > Muslims at school > prejudice							.025	.018
Muslims at school								
> Prejudice							−.008	.005
> Muslim friends > prejudice							−.001	.001

Table 2 (continued)

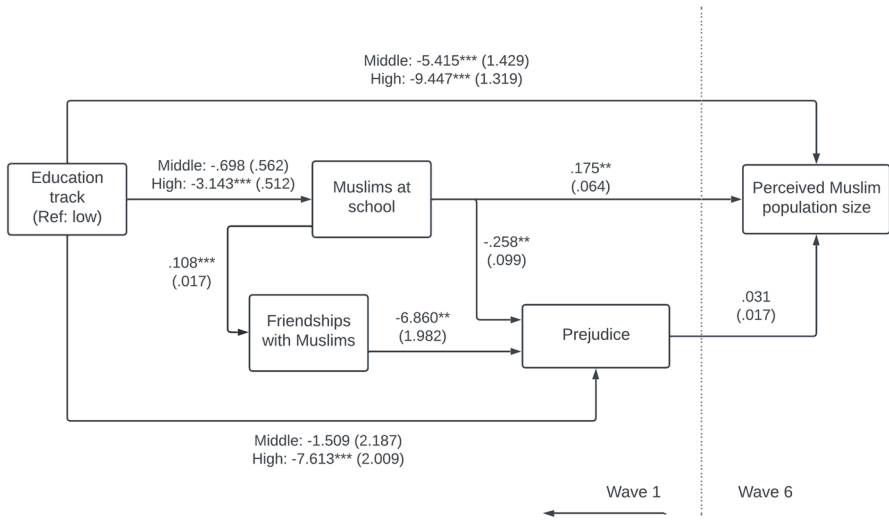|	Models							
	1: Direct effect track		2: Direct effects track and Muslims at school		3: Direct effects track, Muslims at school and prejudice		4: Direct and indirect effects	
	B	SE	B	SE	B	SE	B	SE
Muslim friends								
> Prejudice							-.213	.135
Variance components								
Individual variance	143.225	5.740	143.540	5.758	143.120	5.881	141.452	5.946
School-level variance	12.779	3.777	9.406	3.259	10.169	3.533	11.766	3.911
Controls included	Yes		Yes		Yes		Yes	

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

All control variables are included in models 1–4

[a]Reference category: low

[b]Reference category: none, primary school, or secondary school

Fig. 3 Direct and indirect effects of education on perceptions of Muslims in the Netherlands (model 4, Table 2)

Model 3 tests whether the effect of education track on perceived Muslim population size could be attributed to differences in prejudice. Prejudice has a very small but significant positive effect on size perceptions ($B=0.044$, $p<0.01$, model 3). The effect of prejudice, however, does not lead to a clear decrease in the coefficients for education track. As a consequence, hypothesis 3 is rejected. Although we find a significant positive effect of prejudice on Muslim population size perceptions, the effect is small, and it does not take away from the effect of education track.

Finally, we consider linkages between the two pathways in model 4. In line with the availability heuristic, we find an indirect effect of education track on size perceptions through the percentage of Muslims at school, which is significant for those in the highest track ($B=-0.549$, $p<0.05$, model 4). This constitutes additional evidence that the effect of education track is partially due to differences in the presence of Muslims between tracks. Regarding the affect heuristic mechanism, prejudice was not found to mediate the relationship between education track and perceived Muslim population size ($B=-0.047$, $p=0.517$ for the middle track; $B=-0.237$, $p=0.105$ for the highest track, model 4). Thus, differences in prejudice towards Muslims cannot explain the association between education track and perceived Muslim population size.

It was further hypothesized that the availability effects of contact would be partially offset by prejudice reduction and friendships with Muslims. We find no evidence that the presence of Muslims at school influences adolescents' Muslim population size estimates through prejudice ($B=-0.008$, $p=0.140$, model 4). Thus, hypothesis 4 is rejected. Furthermore, we find that native adolescents with Muslim friends do not provide significantly lower Muslim population size estimates ($B=0.879$, $p=0.459$, model 4). Relatedly, we find no indirect effect of having Muslim friends on size perceptions through prejudice ($B=-0.213$,

$p = 0.113$, model 4). Hypotheses 5 is thus not supported. These findings are interesting, given that respondents with a greater percentage of Muslims in school and respondents who have Muslim friends do report lower levels of prejudice (see Fig. 3). Thus, the lack of significant indirect effects of both contact measures on size perceptions is attributable to the insignificant effect of prejudice on perceived Muslim population size. While respondents are less prejudiced towards Muslim minorities when there are more Muslims in their grade, this does not seem to translate to reductions in perceived Muslim population size.

Finally, it is important to note that the effect of education track remains highly significant in model 4. Hence, even when adding main effects for contact with Muslims and prejudice, as well as indirect effects, we find a persisting significant negative effect of education track, with differences in Muslim population size estimates as large as 9.4 percentage points between the highest and the lowest track.

Robustness Analyses

As additional checks, alternative operationalizations of perceived Muslim population size are utilized. First, we included a model with a stricter conceptualization of outliers. In our initial model, estimates larger than 50 were considered an outlier and therefore set to 50. In the stricter conceptualization, the boundary for outliers was set to 40. None of the hypothesized results changed under this different treatment of outliers. Second, a model was fitted with the logarithm-transformed estimates of the Muslim population size rather than raw estimates. Using this logarithm-transformation of the raw Muslim population size estimates did not change the direction or significance of any hypothesized effects.

Finally, since our findings did not replicate prior studies regarding the effect of prejudice, some additional analyses were performed using prejudice in intermediate waves. Before running these analyses, we inspected the correlations between prejudice in waves one to six, including the measure of prejudice towards Muslims which was added in wave six. The results of these correlations are displayed in Table 6 of the Appendix. The correlations reveal that prejudice in wave one is weakly to moderately correlated to prejudice in later waves, with coefficients ranging from 0.36 to 0.56. Next, we ran the complete mediation models again, but this time with prejudice in later waves. The results of these analyses provide a mixed picture: for prejudice in wave two and in wave four, the hypothesized positive association between prejudice and size perceptions is found, although the effect was very small ($B = 0.001$, $p < 0.001$ in both waves). Furthermore, having Muslim friends and the presence of Muslims at school did not have a significant effect on prejudice in wave four. When adding prejudice in wave three, the results were comparable to our main analyses, with no effect of prejudice on size perceptions. Models containing prejudice in wave five and six did not converge. Combined, these models provide little evidence for affect-based overestimation, as found in earlier studies (Herda, 2015; Laméris et al., 2018).

Discussion

Given the widespread negative sentiments towards immigrants and Muslims in Europe, and the link between misperceptions of outgroups and prejudice (Gorodzeisky & Semyonov, 2020; Grigorieff et al.,. 2020; Pottie-Sherman & Wilkes, 2017), research is needed on the origins of misperceptions. This study attempted to explain the effect of education on population size perceptions. More specifically, hypotheses were formulated based on complementary mechanisms of numeracy, availability, and affect. Greater numeracy increases an individual's ability to estimate small proportions, and hence, it was expected that numeracy would lower Muslim population size estimates among those in the higher tracks of education. The availability heuristic predicts that greater contact with minority individuals, in this case at school, would drive up size perceptions by making this group more accessible in memory. The affect heuristic, on the other hand, predicts that positive contact with minority friends and classmates could decrease size perceptions by attenuating prejudice.

Our results confirm that overestimation is common among adolescents, but less pronounced among those who had been in the higher education tracks. Additionally, we found that adolescents in schools with a larger share of Muslims tend to be more prone to overestimating the population size of Muslims in the Netherlands. Since Muslim adolescents are primarily concentrated at the lower education tracks, ethnic majority adolescents in the higher tracks have less opportunities for contact with Muslims, which explains part of the association between education and outgroup size perceptions.

Our study therefore provides an indication that availability effects may play a role in the association between education and outgroup size perceptions. Firstly, it is noteworthy that the presence of Muslims in majority adolescents' school remains relevant for their outgroup size perceptions up to 5 years later. Thus, we find some initial evidence for availability effects even after multiple years. Secondly, differences in contact with outgroups could have factored in prior findings regarding the effect of education on outgroup size perceptions. Thus, lower estimates of the outgroup size among higher educated individuals may partially be due to differences in exposure to outgroups. Different opportunities for contact with outgroups in secondary schools likely transfer over to tertiary education and professional contexts and perhaps even to neighborhoods due to residential segregation.

We find no evidence for an affective component of Muslim population size perceptions: prejudice did not affect majority adolescents' estimates of the Muslim population size. This is a remarkable finding, given that previous studies repeatedly report that prejudice and outgroup size perceptions are positively related (Gorodzeisky & Semyonov, 2020; Pottie-Sherman & Wilkes, 2017). The development in prejudice in adolescence is a potential explanation for the lack of association between prejudice and Muslim population size perceptions. During adolescence, individuals are grappling with how to restructure and harmonize attitudes they have learnt from their parents with their own experiences into a more or less coherent perspective on the world (Vollebergh et al., 2001). This process of moving towards some degree of stability in attitudes could still be in process between the ages of 14 and 19, which is the period between our measurement of prejudice and size perceptions. Developments in prejudice during the latter half of the teenage years might explain why we do not

find an effect of prejudice at age 14 on outgroup size perceptions at age 19. Robustness analyses reveal that our findings on prejudice are highly dependent on the time at which prejudice is measured. Additionally, prejudice in wave one is only weakly to moderately related to prejudice in later years. Although we only have information on individuals aged 14 to 19, prejudice appears to become somewhat more stable over the years. If prejudice is substantially more stable in adulthood, this could explain why prior studies investigating outgroup size perceptions did find an association between prejudice and outgroup size perceptions while we did not.

If prejudice has not yet developed fully in mid-adolescence, this has interesting practical implications. The observed variability of prejudice over time suggests that prejudice in mid-adolescence is still malleable, for example, due to contact with relevant outgroups. This could imply that interventions to reduce prejudice and foster solidarity between groups have a greater chance at success among adolescents, since potentially negative intergroup attitudes are not yet set in stone. Our results seem to indicate that intergroup contact at school, whether through friendships or merely through being in the same grade, can be one strategy to foster more positive outgroup attitudes among ethnic majority adolescents.

An alternative explanation for the lack of association between prejudice and size perceptions is that cognitive and affective components of prejudice develop asynchronously. It has been found before that while positive contact with outgroup members predicts more favorable emotions felt in response to the outgroup, it does not affect cognitive aspects of prejudice such as outgroup stereotypes (Aberson, 2015; Tropp & Pettigrew, 2005b). Perceived outgroup size is perhaps less related to affective elements of prejudice, and more so to the cognitive dimension of prejudice. This would explain why prejudice as measured by feelings of warmth towards the outgroup and friendships with Muslims is not related to size perceptions.

Our findings indicate that education remains strongly linked to population size perceptions, even after taking into account outgroup contact and prejudice. There remains, therefore, a black box, which may be interpreted as evidence for the idea that education promotes people's knowledge of the world, their numeracy, and rationality of their beliefs, opinions, and worldviews. Those with more formal education tend to be more numerate and use numbers more often in everyday decisions (Jonas, 2018; Peters, 2020; Rolison et al., 2020). Thus, higher educated individuals may be better equipped to base their estimate on available numeric information, instead of personal experiences or emotion. Prior studies on population innumeracy confirm that higher educated individuals are less likely to overestimate the size of minority populations (Gorodzeisky & Semyonov, 2020; Herda, 2010; Laméris et al., 2018; Strabac, 2011). Since the higher tracks span more years, individuals in the higher tracks will receive more years of compulsory mathematics education. Furthermore, mathematics curricula are expected to be more abstract and complex for higher tracks, which will require higher arithmetic ability. Over the years, individuals in the highest tracks may thus become more comfortable processing, interpreting, and using numeric information compared to those in the lower tracks. If this is true, a case can be made to further develop numeracy across all levels of education. It is known that many individuals struggle with estimating probabilities and understanding numbers in general (Landy et al., 2018). Our findings indicate that secondary education can play an important role in diminishing these demographic misperceptions.

Appendix

Table 3 Pairwise comparisons of the effect of education track on Muslim population size perceptions (model 4)

	Contrast	S.E
Middle versus low	− 5.415***	1.429
High versus low	− 9.447***	1.319
High versus middle	− 4.031*	1.594

Table 4 Pairwise comparisons of the effect of education track on percentage Muslims at school (model 4)

	Contrast	S.E
Middle versus low	− .698	.562
High versus low	− 3.143***	.512
High versus middle	− 2.445***	.605

Table 5 Pairwise comparisons of the effect of education track on prejudice (model 4)

	Contrast	S.E
Middle versus low	− 1.509	2.187
High versus low	− 7.613***	2.009
High versus middle	− 6.103*	2.435

Table 6 Correlations between prejudice in waves 1–6

	W1	W2	W3	W4	W5	W6	W6: Muslims[1]
W1	-	.561	.427	.372	.357	.392	.382
W2	.561	-	.560	.537	.522	.521	.499
W3	.427	.560	-	.604	.534	.532	.494
W4	.372	.537	.604	-	.621	.606	.533
W5	.357	.522	.534	.621	-	.622	.582
W6	.392	.521	.532	.606	.622	-	.854
W6: Muslims	.382	.499	.494	.533	.582	.854	-

Coefficients are Pearson's correlation coefficients. All correlations are significant at $\alpha = .0001$

[1]Only in wave six, a measure of prejudice towards Muslims was included. All other prejudice variables are measured with respect to Turks and Moroccans

Data Availability Data are publicly available. Data references: Kalter, F., Heath, A.F., Hewstone, M., Jonsson, J.O., Kalmijn, M., Kogan, I. and Van Tubergen, F. 2016. Children of Immigrants Longitudinal Survey in Four European Countries (CILS4EU) – Full version. Data file for on-site use. GESIS Data Archive, Cologne, ZA5353 Data file Version 1.2.0, doi:10.4232/cils4eu.5353.1.2.0. Jaspers, E. & Van Tubergen, F. (2018) Children of Immigrants Longitudinal Survey in the Netherlands (CILSNL) – Wave 6. Full version v6.0.1 DANS. https://doi.org/10.17026/dans-zfa-j297

Declarations

Ethics Approval All respondents who were part of the surveys (CILS4EU wave 1 and CILSNL wave 6) provided informed consent prior to participation. Data collection was approved by an ethics committee.

Conflict of Interest The authors declare no competing interests.

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