Ethnic enclaves in the classroom[1]

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Abstract

We use data on elementary-school students to investigate how the home language and other characteristics of a student's same-grade schoolmates influence that student's academic achievement. We exploit the availability of multiple cohorts of data within each school to control for endogenous selection by incorporating school fixed effects in the model. We also exploit the longitudinal structure of the data to estimate value-added models of the educational production function. We find that attending an "enclave" school provides a slight net benefit to Chinese home-language students and a large net cost to Punjabi home-language students. The results are consistent with a simple peer effects mechanism in which the academic achievement or behavior of peers is much more important than their home language.

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1 Introduction

The marked tendency for immigrants to settle in local enclaves in host cities may have significant costs and benefits for their economic success and ultimate integration into their new country (Borjas 1995; Edin et al. 2003). Enclave concentration may reduce the rate at which immigrants adapt to host country culture and acquire host-country-specific skills such as language proficiency (Chiswick and Miller 2005), and may worsen discriminatory attitudes and practices towards immigrants among non-immigrants (Dustmann and Preston 2001). On the other hand, enclaves may benefit immigrants by insulating them from discrimination and providing opportunities for within-group networking (Portes 1987; Lazear 1999). The net effect is clearly an empirical question and one that may vary by context.

Enclave neighborhoods tend to produce enclave schools. Recent evidence supporting the importance of peer effects in academic achievement suggests that educational peer effects may be an important mechanism through which immigrant enclaves affect individual outcomes. Schools provide immigrant children with opportunities for language acquisition and adaptation to the host culture, as well as offering skills and credentials needed for economic success. Enclave schools may adversely affect the language acquisition of immigrant students if many classmates also speak English as a second language. On the other hand, immigrant students may benefit from stronger social and support networks when there are more such students. The presence of significant numbers of newcomers may also affect the learning environment of native-born students and earlier immigrants who have already largely adapted to life in the host country.

This paper uses data from the Canadian province of British Columbia to examine peer effects on academic achievement from students whose families speak a language other than English at home. The peer group under analysis is same-grade schoolmates, and achievement is measured by the net change in standardized test scores between grades 4 and 7, as well as by test score levels in both grades. Nonrandom selection into schools is addressed by using multiple cohorts of students and including school level fixed effects. In order to characterize the relative costs and benefits of enclave schools, we allow the

effect of peer home language to vary with students' own home language.

Our approach has several valuable features in relation to previous research. Investigating enclave effects at the school level makes it possible to address the issue of nonrandom community selection, an issue that neighborhood-based studies in this literature rarely address. In this respect, our paper is most similar to Gould et al. (2009) who use a similar research design to measure the effects of immigrant peers on long-run educational outcomes for native-born students in Israel. Our paper differs in that we measure the influence of immigrant peers (more specifically peers that speak a non-English language at home) on each other as well as on other students, and that we look at short-run achievement rather than long-run outcomes. It also differs in that we separately measure the effects of two different language groups, one with above-average measured academic achievement (Chinese) and the other with below-average achievement (Punjabi). This allows us to distinguish somewhat between peer effect mechanisms that operate primarily through language (which should lead to similar spillovers from the two groups) and those that operate primarily through more standard learning spillovers (which should lead to positive effects from Chinese home-language students and negative effects from Punjabi home-language students).

We find some evidence for substantial peer effects, as well as evidence that peer effects play a role in explaining achievement differences across home-language groups. The proportion of Chinese home-language peers has a weak positive association with achievement, and the proportion of Punjabi home-language peers has a strong negative association with achievement. However, both of these effects are weaker for students within those groups. Overall, enclaves provide minor benefits to Chinese home-language students and major costs to Punjabi home-language students.

1.1 Related Literature

Research on peer effects on academic achievement dates back to the late 1960's "Coleman Report" (Coleman et al. 1966). The early research was plagued with identification problems due to endogenous assignment of students to schools and/or

classrooms (Manski 1993), while more recent work attempts to address these problems with varying degrees of success. The most common approach, and the one employed in this paper, is to exploit quasi-random variation across cohorts within schools in large multi-year administrative data sets (e.g., Hoxby 2000; Hanushek et al. 2002, 2003, 2009; Lavy and Schlosser 2010; Black et al. 2010). The empirical evidence at this point is not conclusive, but is consistent with nontrivial peer effects on academic achievement. Peer achievement is the most common explanatory variable of interest in this literature, though peer race or ethnicity, age, gender, parental education, disability, and other characteristics have also been considered.

Relatively few papers have looked specifically at the effect of immigrant peers or peers who do not speak the language of instruction at home. As described earlier, Gould et al. (2009) is one important exception that uses a school-based design with quasi-random assignment across cohorts. Using data from Israel, they find that immigrant peers (primarily from the former Soviet Union) in grade 5 reduced the pass rate of native students on a high school matriculation exam. At least some form of negative peer effect is suggested by the literature (e.g., Betts and Fairlie 2003) that finds evidence of "native flight" from public schools in areas that receive large immigrant inflows.

There is also a sizeable literature on immigrant residential enclaves and the formation of human capital. Most empirical papers in this literature treat the neighborhood or some higher level of aggregation as the primary peer group, and estimate the effect of community composition on wages or earnings (Borjas 1995; Edin et al. 2003), educational attainment (Borjas 1995, 1998; Betts 1998), or self-assessed language acquisition (Chiswick and Miller 2005). With the exception of Edin et al. (2003), these studies generally do not use any form of random or quasi-random assignment. The current evidence in the literature is that enclaves matter, though not always in a simple way. Edin et al. (2003) find that enclaves provide a substantial earnings benefit to low-skilled immigrants in Sweden. Borjas (1995) finds a negative effect of enclaves on the educational attainment of immigrants in the U.S., while Borjas (1998) finds that this effect depends on the average educational attainment within an individual's own ethno-

cultural group. In terms of effects on natives, Betts (1998) finds that a greater share of immigrants in a U.S. state or municipality is associated with reduced high school completion rates among native-born minorities.

2 Data and Institutional Background

2.1 School funding and organization

Elementary schools in British Columbia typically provide Kindergarten through grade 7, with secondary schools offering grades 8 through 12. The provincial Ministry of Education funds K-12 education and sets curriculum. Operating and capital grants are allocated to district public school boards according to a funding formula based primarily on total district-level enrollment, with supplementary funding based on the number of Aboriginal students, students enrolled in programs for English as a Second Language (ESL), and students with special needs. These grants are the primary funding source for public schools. Private schools receive 35-50% of the base public school rate.

School choice is an important consideration for our research design. As elsewhere, the primary determinant of a young person's school is residential location. The most populat alternatives to the local school are private schools (about 10% of students) and French immersion magnet programs within the public system (6%). In addition, a few French-language public schools offer French language programming to Francophone students, and some districts operate small alternative schools and specialized magnet programs. Finally, a student can sometimes[2] enroll in a regular public school outside his or her catchment area. By incorporating school-by-grade fixed effects, our research design allows for an extensive role for parental choice in school assignments, so long as these choices depend on stable characteristics of the school and not on the characteristics of the student's particular grade cohort within that school.

[2] Prior to 2003, individual districts had discretion on whether a student could register out of his or her catchment area. Beginning in 2003, the provincial government instituted an official "open boundaries" policy that allows any student to attend any public school if there are spaces available after local students have enrolled.

2.2 Standardized assessment

The Ministry administers a set of standardized tests known as the Foundation Skills Assessment (FSA) in May of each year to students in grades 4 and 7 in all public and provincially funded private schools. FSA testing began in the 1999/2000 school year and covers the subject areas of Reading Comprehension, Numeracy, and Writing. The Reading and Numeracy exams include both multiple-choice and open-ended questions. The Writing exam includes one short writing task and one long writing task, and is not included in this study. Accredited teachers grade all exams in a central location. All students are expected to participate, with the exception of ESL students who have not yet developed sufficient English language skills to respond to the test, and some special needs students. The FSA exams are relatively low-stakes for all parties. Students' scores do not contribute to their school grade and play no role in grade completion. The results do not affect school or district funding. However, school and district-level results are available to the public and a widely publicized annual "report card" uses FSA results along with other information to construct a ranking of elementary schools.

2.3 Data description

The underlying administrative data used in this study consist of the Ministry's enrollment database and its FSA exam database, linked across years using each student's unique identification code. Records in the enrollment database are based on Form 1701, the annual enrollment form collected for each student on September 30 of each year and used by the Ministry to determine funding. The enrollment record includes the student's current grade, school and district identifiers, year, gender, Aboriginal identity, enrollment in a language program (e.g., ESL, French Immersion), special needs designation, and self-reported language spoken at home. Records in the FSA exam database include the student's score on each exam subject, along with a flag indicating whether the student was excused from writing a given exam.

Our analysis uses a longitudinal data set constructed from an extract[3] of this administrative data. The extract includes every student who is in grade 4 or 7 during the school years 1999/2000 through 2004/2005. Three cohorts of students thus have both grade 7 and grade 4 FSA results. Wherever such information exists, the longitudinal record also includes information from the student's enrollment records in grades 5 and 6.[4] The data include both public and private school students, but does not include students in the Francophone system. A student's peer group is defined as all students attending the same grade in the same school in the same year. We treat French Immersion and regular program students as attending different schools, even if housed in the same school building. French Immersion students receive instruction mostly in French, and do not attend classes with and rarely participate in organized activities with regular program students. Finally, our regressions use only the non-Aborginal student population. The complex issues associated with Aboriginal students are beyond the scope of this paper, and are analyzed elsewhere (Friesen and Krauth 2010). Our peer group measures, however, use the full population of students.

3 Descriptive Statistics

3.1 Student characteristics

Table 1 provides descriptive statistics by home language for the population under analysis: non-Aboriginal students enrolled in a public or private school in grade 7 between 2002 and 2004. As the table shows, the student population is linguistically heterogeneous, with about 21% of students speaking a language other than English at

[3] Because of confidentiality restrictions, our extract differs from the original administrative data in the following ways: (1) enrollment records are provided only for students in grades 4 through 7; (2) student, school, and district identification codes are encrypted in such a manner as to allow for within-database linkage, but not linkage with external information; (3) language spoken at home is aggregated from the over 100 languages in the administrative data into English, Chinese (including Cantonese and Mandarin), Punjabi, and Other; and (4) both language spoken at home and Aboriginal status are provided based on the student's entire history rather than on the current year's self-report. In particular, a student is categorized as Aboriginal if he/she ever self-identifies as Aboriginal. A student is categorized as speaking English if he/she always self-reports as English, and is otherwise categorized by his/her most frequently reported home language other than English.

[4] A minority of students who are observed in both grades 4 and 7 during the FSA exam period repeat grades, skip grades, or are out of province for one or more of the intervening years. We keep these students in our analysis whenever possible. If the student repeats either grade 4 or grade 7, the longitudinal record is constructed from the student's last year in grade 4 and first year in grade 7.

home. The most common category of non-English home languages is Chinese (7%), followed by Punjabi (4%). All other home languages are grouped in our data as "Other." The most common languages in this group are Korean, Tagalog, Vietnamese, Spanish, and Hindi. None of these languages is spoken by more than 2% of students.

Although 21% of grade 7 students speak a non-English home language, fewer than 6% have a current ESL designation. This is primarily due to a Ministry policy of providing a maximum of 5 years of ESL funding per student. Almost all Punjabi and Chinese home language students have been designated ESL at some point in their schooling, so ESL status in grade 7 is mainly a proxy for how long a student has lived in the province.

The next few rows of Table 1 describe the peer group composition of the average student in each language category. The peer group is defined as one's same-grade schoolmates. The table shows that English home-language students are somewhat more likely than other students to have a substantial number of Aboriginal peers. Although measured disability rates vary substantially by home language, there is very little variation in the proportion of peers with identified disabilities.

The table also shows a substantial degree of segregation by home language. The typical English home-language student attends a school in which students speaking English at home form a sizeable majority (about 88%). On the other hand, the typical Chinese home-language student attends a school in which only 44% of the students speak English at home, and about 34% speak Chinese at home. The typical Punjabi home-language student attends a school in which about 50% of students are English-speakers and about 29% of students speak Punjabi at home. As one might expect, students speaking a home language other than English also have more peers in traditional[5] ESL programs.

[5] The administrative category of ESL in British Columbia encompasses two distinct groups: traditional ESL students and "English as a Second Dialect" (ESD) students. An ESD student is one whose first (and often only) language is English but whose early-childhood exposure to Standard English was very limited. Districts may count such students as ESL/ESD students for funding purposes. Although the enrollment data does not distinguish between the two categories, Aboriginal English-home-language students in ESL/ESD can be safely inferred to be ESD students, and students who speak a language other than English at home can be safely inferred to be traditional ESL students. The small population of non-Aboriginal English-home-language students in ESL includes a mix of the two. For the purposes of this study, ESL

3.2 FSA participation and outcomes

Table 1 also reports test scores in both levels and gains. Scores are standardized within each subject-year-grade to have a zero mean and unit variance, so the units reported in Table 1 and elsewhere in the paper can be interpreted directly as standard deviations. Chinese home language students score above average in all four exams, while Punjabi home language students score below average. Students speaking other non-English languages score slightly above average in grade 7 numeracy and somewhat below average otherwise. The picture is somewhat different for test score gains. All three non-English groups improve relative to English home-language students between grades 4 and 7 in both reading and numeracy. Although Punjabi home-language students do substantially worse than English home-language students in both grades, the gap narrows between grades 4 and 7.

Participation rates are important in interpreting exam results, as researchers have found that schools often respond to exam-based accountability measures by discouraging the participation of students likely to do poorly (Jacob 2005). Unlike many U.S. jurisdictions, British Columbia has not implemented exam-based accountability measures. About 91% of grade 7 students take exams compared to, for example, about 82% in Texas (Hanushek et al. 2002). Punjabi home language students are slightly more likely to participate in the exams than English home-language students, with Chinese and other home-language students slightly less likely to do so. Speakers of non-English home languages are generally more likely to be excused from the exams. Participation has been stable over the period of our data (results available in the online appendix), although it has trended slowly downward, and a higher-than-usual proportion were excused in 2001.

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students who are Aboriginal and speak English at home are categorized as ESD. All other ESL students are categorized as traditional ESL.

4 Methodology

4.1 Model specification and research design

Our overall empirical strategy for measuring peer effects is based on a panel-data extension to the standard linear-in-means model of contextual peer effects (Manski 1993). As is now well known, peer effects are not identified from cross-sectional data with nonrandom assignment of individuals to groups. Through the mechanisms of school choice described in Section 2.1, parental resources and preferences will influence the school a child attends. Correlation between those factors and observable characteristics will lead to correlation between peer group composition and unobserved school or student factors relevant to educational outcomes (what Manski calls "correlated effects").

Our research design uses individual student-level panel data from multiple cohorts of students within each school, and exploits the small but plausibly random year-to-year variation in peer group composition within a school to consistently estimate school-by-grade level peer effects, while allowing for systematic cross-school variation in school or student quality via school fixed effects. Variations on this design are quite common in the recent literature on educational peer effects (e.g., Hoxby 2000; Hanushek et al. 2002, 2003, 2009; Lavy et al. 2009; Lavy and Schlosser 2010; Black et al. 2010).

Index students by $i=1,2,\ldots,n$; schools by $s=1,2,\ldots,S$; and time by $t=1,2,\ldots,T$. Let y_i be an outcome for student i. Let $t(i)$ be the school year in which the outcome for student i is observed, and let $s(i)$ be the school attended in that year. Let X_i be a vector of student i's individual background characteristics, and let be the average value of X among student i's same-grade schoolmates in year $t(i)$. The effect (for example) of Punjabi home-language classmates may differ between Punjabi and non-Punjabi students, so we interact with selected[6] elements of X_i. The model is:

(1)

[6] To simplify notation, equation (1) interacts with all elements of X_i. The more limited subset of interactions estimated in Section 5 is equivalent to setting some elements of λ to zero.

where β and λ are the parameters of interest, δ_t is an unobserved year-specific fixed effect (treated as a parameter), a_s is an unobserved school-specific fixed effect (treated as a random variable), and u_i is an unobserved individual-and-year-specific effect. The standard linear fixed effects estimator consistently estimates β and λ under the assumption of strict exogeneity of u_i:

(2)

That is, the choice of school is sufficient to explain any relationship between a student's own unobserved characteristics and observed peer characteristics.

4.2 Identification and interpretation

Assumption (2) is common in research on educational peer effects and is usually motivated by the idea that each cohort of students in a particular school represents a random draw from some fixed school-specific distribution of students. It also requires that the random draw of students is unrelated to any unobserved common shock like a staffing or policy change. If these two substantive assumptions are satisfied, then the "correlated effects" problem (Manski 1993) is addressed by including the school fixed effect. However, there remain some important issues of identification and interpretation.

The first identification issue is the problem of distinguishing between the effect of peer characteristics (in Manski's terminology, contextual effects) and the effect of peer behavior/outcomes (what Manski calls endogenous effects). Manski (1993) shows that contextual and endogenous effects are not separately identified in a linear model without an exclusion restriction. While many papers in this literature (e.g., Hanushek et al. 2003) focus on measuring endogenous effects, we follow another branch of the literature (e.g., Hanushek et al. 2009; Lavy and Schlosser 2010; Imberman et al. 2009; Black et al. 2010) in focusing on contextual effects. Because it includes only contextual effects, equation (1) represents the reduced form of a linear structural equation in which peer characteristics both enter directly (contextual effects) and proxy for peer behavior

(endogenous effects). Identification of this reduced form is sufficient to answer many interesting counterfactual questions: a candidate reallocation of students would affect both observed peer characteristics and the unobserved peer behaviors they proxy for.

A second identification issue lies in modeling the education production function. A student's academic achievement at a given point in time is a function of both current and past inputs, and there are inevitably limited data on past inputs. Correlation over time in inputs will lead to observed current inputs acting as a proxy for unobserved past inputs. In the context of this model, our assumption of random assignment conditional on school implies that current peer characteristics are mainly a proxy for past peer characteristics, rather than for other past inputs. The coefficient on current peer characteristics from a simple "levels" regression that takes the test score as the dependent variable is thus likely to overstate the contemporaneous effect of having a given peer group in the current grade but understate the effect of having that same peer group in every grade up to the current grade. In addition to estimating levels regressions for the grade 4 and grade 7 exams, we also estimate a simple "value added" regression that treats the test score gain between grades 4 and 7 as the dependent variable. There is currently no consensus in the literature about whether the levels or value-added approach is more appropriate. The value-added approach is more commonly employed in the literature (e.g., Hanushek et al. 2003), but a number of authors including Todd and Wolpin (2005) and Rothstein (2010) have criticized it for restrictive assumptions about the persistent effects of past inputs

A third issue is identifying the relevant peer group. Our estimated peer effects will include any interaction among same-grade schoolmates, including interactions within classrooms. Any interaction outside of that group, including with other-grade schoolmates and with neighbors, appears in the school fixed effect. If we assume that all within-grade peer effects are within classroom, then the estimated within-grade effects will be the same sign as the within-classroom effect, but with some attenuation bias due to imperfect correlation between the composition of the same-grade schoolmate peer group and the same-classroom group.

5 Results

5.1 Regression results: Numeracy

Table 2 reports our main regression results for the numeracy exam. The population under analysis is non-Aboriginal students in both public and private schools who took the grade 7 exams between 2002 and 2004, and who also took the grade 4 exams in 1999 or later. Test score levels have unit variance, so all coefficients can be interpreted in units of one standard deviation in the level[7] of the test score. Peer characteristics are in decimal units, so each coefficient represents the change in outcome associated with the percentage of peers in a given category increasing from 0% to 100%. School and year fixed effects are included in all regressions, and estimated standard errors are robust to heteroskedasticity and clustering at the school-year level. For each outcome, two specifications are reported. The base specification (1) excludes interaction terms, while specification (2) allows the effect of peer language to differ between speakers of that language and others. The estimated coefficients on individual-level variables are stable across specifications, have low standard errors, and are consistent with what we see in the descriptive statistics. Neither the proportion of male peers nor the proportion of Aboriginal peers appears to have a substantial effect on the test score level or gain.

Table 2 generally shows positive effects from Chinese home-language peers, relative to the base category of English home-language peers. These effects are large and statistically significant for the grade 4 score, but small and statistically insignificant for the grade 7 score and for the change in score. The results for specification (2) provide evidence that any positive influence from Chinese home-language peers is attenuated for students who themselves speak Chinese at home. The coefficient on the interaction of Chinese and peer % Chinese is negative and at least marginally significant for both the grade 4 and grade 7 exams. The estimated overall effect of Chinese home-language peers on Chinese home-language students is the sum of the base effect and the interaction term, and so is 0.21 (standard error 0.14, statistically insignificant) for the test score gain, 0.21 (standard error 0.13, statistically insignificant) for the grade 4 exam, and -0.01 (standard

[7] To interpret coefficients in units of one standard deviation in test score gain, simply multiply by the standard deviation of the gain reported in Table 5 (i.e., 0.81 for numeracy and 0.79 for reading).

error 0.13, statistically insignificant) for the grade 7 exam.

In contrast, we generally see negative effects from Punjabi home-language peers. The effects are large and statistically significant for both the level of the grade 7 score and for the test score gain. To get a more concrete idea of the magnitude, note that the coefficient of -0.45 implies that a 25 percentage point increase in the proportion of peers who are Punjabi home-language is associated with a reduction in the student's numeracy test score gain by 11.3% (0.45*0.25=0.1125) of a standard deviation. The interaction terms in specification (2) imply that the effects are weaker for students who themselves speak Punjabi at home. The overall estimated effect of Punjabi home-language peers on Punjabi home language students is -0.47 (standard error 0.14, statistically significant at 1%) for the test score gain, 0.12 (standard error 0.19, statistically insignificant) for the grade 4 exam, and -0.20 (standard error 0.16, statistically insignificant) for the grade 7 exam.

5.2 Regression results: Reading

Table 3 reports results for the reading exam. As with the numeracy exam, the estimated coefficients on individual-level variables are stable and consistent with the descriptive statistics. Male peers have a statistically significant negative effect on reading test scores in both grades, but not on the test score gain. Aboriginal peers have no clear effect on any of the three outcomes.

The remaining patterns are similar to those for numeracy, but weaker and less frequently statistically significant. Point estimates for the effect of Chinese home-language peers are generally positive but small and statistically insignificant. There is some evidence that any positive effect of Chinese home-language peers is attenuated or even reversed for students who themselves speak Chinese at home, as the relevant interaction term is negative for all three outcomes and significant for both grade 4 and grade 7 test score levels. The overall effect of Chinese home-language peers on Chinese home-language students is estimated to be -0.02 (standard error 0.12) for grade 4, -0.09 (standard error

0.13) for grade 7, and 0.07 (standard error 0.12) for the test score gain.

Point estimates for the effect of Punjabi home-language peers are generally negative but statistically insignificant. The marginally significant effect reported in the first column implies that a 25 percentage point increase in the proportion of peers who are Punjabi home-language reduces the student's reading test score by 5.5% (0.22*0.25=0.055) of a standard deviation. The results from specification (2) do not strongly suggest that the effect of Punjabi home-language peers varies with a student's own home language.

5.3 Robustness checks

Table 5 includes a selection of results from estimating alternative specifications of the model. The baseline regression is from the first column of Table 2 or Table 3, which uses the test score gain as the dependent variable and leaves out any interaction terms.

The first alternative specification uses a modified value-added (MVA) model of the education production function. The dependent variable is the grade 7 test score and grade 4 test scores are used as a control variable. Todd and Wolpin (2005) show that this model relaxes the simple value added model's strong implicit assumption that past inputs have the same effect on both past and current achievement. This advantage comes at a cost of increased sensitivity to measurement error, which is why our main value-added regressions use the simple value added model. The table shows using the MVA model has little effect on the relevant parameter estimates, though the coefficient on "Peer % Punjabi" for reading moves from marginally significant to marginally insignificant.

Next, we drop the school fixed effects. These results are not reported as a robustness check – the specification without fixed effects is more restrictive than the baseline – but rather to show that school fixed effects are an important element of the research design and their omission yields very different results.

The next alternative specification includes a fixed effect for each principal-school

combination. Principals often change schools in British Columbia, and principal quality may be an important time-varying determinant of school quality. This modification does not change the general pattern but has some effect, in particular raising the estimated effect of "peer % Chinese" on reading achievement and making it marginally statistically significant.

The next two alternative specifications use average peer characteristics over grades 5 through 7 as the explanatory variable. Our baseline results use grade 7 peers only, in part because students may change schools and separate school fixed effects in each grade are not feasible. To address school changes, we estimate the model only on the subset of students who do not change schools between grades 5 and 7. For this subsample, there is no need for separate fixed effects for each grade. We also estimate the model on the full sample, including a single fixed effect based on the school attended for grade 7 and using grade 7 peers as an instrumental variable for grade 5-7 peers. In both cases, the estimated negative impact of peer % Punjabi on numeracy scores is larger than in the baseline estimates, while the estimated impact of peer % Punjabi on reading scores becomes statistically insignificant.

The remaining specifications consider alternative sample definitions. The first uses the pooled sample of Aboriginal and non-Aboriginal students, with own Aboriginal status included as an explanatory variable. The results here are almost identical to the baseline, suggesting that the choice to leave out the Aboriginal students was not a critical one. We also estimate separately by gender, with gender-specific school and year effects. The point estimates suggest that peers have stronger influence on girls than on boys, though the differences are not large or statistically significant.

6 Conclusion

This study finds the language spoken at home by one's peers has a substantial association with numeracy achievement, but the association varies substantially by the peers' specific home language. Punjabi home-language peers have a strong negative association with math test scores, while Chinese home-language peers have a weak positive association

with math test scores. Previous studies in the immigration literature consider mostly long-run outcomes such as educational attainment and earnings, and larger peer groups such as neighborhoods or cities. These differences prevent a quantitative comparison with our results. However, our results are comparable to prior estimates of contextual peer effects on elementary school achievement, as reported in Table 4. Our estimated negative effect of Punjabi home-language peers on math achievement is at the high end of the range of estimates for male peers, and around the middle of the range for Black peers in the U.S. Interestingly, the within-group effect in our study is generally weaker than the across-group effect. One explanation for this result could be that the school fixed effects essentially condition on any family and neighborhood effects, and the influence of (for example) a Punjabi home-language classmate is weaker when one already has many Punjabi home-language peers outside of school. Our result that within-group effects are weaker than across-group effects contrasts with the opposite findings for Black students in the U.S. (Hoxby 2000; Hanushek et al. 2009).

The pattern of our results, combined with the variation in achievement levels by language group, suggests that language is acting as a proxy for other aspects of learning behavior. The result that the effect on achievement of attending school with more same-language peers varies with the achievement level of one's own language group suggests that linguistic or ethno-cultural similarity to peers does not in itself play a significant role in immigrant success, but rather that human capital and cultural norms of peers is what matters. These results mirror the findings of other recent studies (e.g., Borjas 1995, 1998; Gang and Zimmerman 2000; Edin et al. 2003; Cutler et al. 2007) that the effect of living in an immigrant or ethnic enclave depends critically on ethnic group characteristics such as the average level of human capital.

Although the administrative data in this setting provide limited direct information on mechanisms, a recent qualitative study finds an oppositional subculture and negative attitudes about academic work among some Punjabi youth in British Columbia (Frost 2010). Recent research suggests that disruptive behavior in the classroom may be an important underlying mechanism through which particular subpopulations generate

negative peer effects. Lavy and Schlosser (2010) find from student and teacher reports that a higher proportion of girls in a class reduces disruption, noise and violence, as well as teacher fatigue, primarily through a composition effect: girls are less likely to be disruptive or violent. Imberman et al. (2009) find that Katrina evacuees in Houston had an above-average rate of absenteeism and disciplinary infractions, and were associated with increased absenteeism and disciplinary infractions among peers. Both of these studies, like ours, find that peers have a more pronounced effect on math achievement than on reading, suggesting that the classroom environment may play a larger role in the acquisition of math skills. Black et al. (2010) find that a higher percentage of grade 9 peers who are female has a positive effect on academic outcomes in the short-run, but is associated with poorer long-run outcomes among young men.

An important limitation in this study is that random cohort-to-cohort variations in composition are generally small, so we are unable to capture any potentially important nonlinearity. Sociological research on enclaves (e.g. Portes 1987) emphasizes "critical mass" mechanisms that are nonlinear in nature. In addition, our approach isolates peer effects at the same-grade schoolmate level, and provides no direct information about social interactions at a higher level of aggregation like the school or neighborhood. However, our within-grade findings are consistent with those of earlier studies that consider higher levels of aggregation at the cost of stronger identifying assumptions.

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Tables

Table 1: Summary statistics, grade 7 non-Aboriginal students 2002-2004.

Variable	English	Chinese	Punjabi	Other	Total
# of observations	110,310	9,865	5,076	14,359	139,610
as % of total	79.0	7.1	3.6	10.3	100.0
% male	51.1	51.5	52.9	52.3	51.3
% currently in special education	10.5	6.2	5.4	6.0	9.5
% gifted	2.6	2.7	0.5	1.2	2.4
% disabled	7.9	3.5	4.9	4.8	7.1
% in ESL now (grade 7)	0.5	24.8	14.2	26.9	5.4
% in ESL in grade 4	1.9	73.6	69.8	55.8	13.2
% in ESL ever	4.5	93.4	92.4	76.6	21.5
Mean % Aboriginal peers	8.3	3.2	5.7	5.0	7.5
	(10.0)	(5.0)	(6.9)	(6.9)	(9.5)
Mean % disabled peers	7.9	7.5	7.6	7.7	7.8
	(6.6)	(6.0)	(5.6)	(6.5)	(6.5)
Mean % English-language peers	87.8	43.9	49.7	54.7	79.9
	(17.6)	(23.8)	(28.5)	(27.9)	(25.1)
Mean % Chinese-language peers	3.6	33.8	6.1	13.2	6.8
	(9.1)	(21.5)	(11.9)	(16.7)	(14.0)
Mean % Punjabi-language peers	2.0	3.2	29.1	5.3	3.4
	(6.0)	(6.4)	(26.3)	(11.2)	(9.8)
Mean % other-language peers	6.5	19.2	15.1	26.8	9.8
	(9.4)	(11.6)	(11.8)	(22.9)	(13.6)
Mean % peers currently in (traditional) ESL	3.2	15.4	13.6	10.8	5.2
	(6.0)	(12.2)	(21.8)	(10.7)	(9.2)
Grade 4 numeracy score	0.06	0.40	-0.32	-0.14	0.05
	(0.98)	(1.02)	(0.93)	(0.99)	(0.99)
Grade 4 reading score	0.09	0.13	-0.41	-0.21	0.05
	(0.98)	(0.97)	(0.87)	(0.96)	(0.98)
Grade 7 numeracy score	-0.00	0.71	-0.19	0.07	0.05
	(0.96)	(1.02)	(0.99)	(1.04)	(0.99)
Grade 7 reading score	0.08	0.23	-0.36	-0.15	0.06
	(0.97)	(0.98)	(0.96)	(1.00)	(0.98)
Gain in numeracy score	-0.08	0.29	0.16	0.14	-0.03
	(0.79)	(0.83)	(0.91)	(0.82)	(0.81)
Gain in reading score	-0.02	0.20	0.09	0.16	0.01
	(0.79)	(0.77)	(0.78)	(0.79)	(0.79)
% taking grade 7 numeracy exam	91.0	91.3	92.6	87.1	90.7
% taking grade 7 reading exam	92.4	89.5	93.4	86.1	91.6
% excused from grade 7 numeracy exam	3.6	5.8	4.1	7.3	4.2
% excused from grade 7 reading exam	3.2	7.7	4.0	9.0	4.2
% without numeracy gain data*	11.8	13.1	12.8	17.8	12.4
% without reading gain data *	10.2	13.2	11.5	16.3	10.9

Standard deviations are in parentheses

* As a proportion of grade 7 students who also attended a British Columbia school during grade 4.

Table 2: Regression results, numeracy exam.

Variable	Change in score		Grade 4 score		Grade 7 score	
	(1)	(2)	(1)	(2)	(1)	(2)
Male	0.02***	0.02***	0.10***	0.10***	0.13***	0.13***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Chinese spoken at home	0.24***	0.23***	0.31***	0.35***	0.54***	0.57***
	(0.013)	(0.021)	(0.016)	(0.026)	(0.017)	(0.026)
Punjabi spoken at home	0.07***	0.08***	-0.30***	-0.36***	-0.19***	-0.23***
	(0.016)	(0.023)	(0.017)	(0.024)	(0.018)	(0.026)
Other language at home	0.15***	0.15***	-0.16***	-0.16***	-0.04***	-0.04***
	(0.011)	(0.011)	(0.013)	(0.013)	(0.013)	(0.013)
% male peers	0.00	0.00	-0.08	-0.08*	-0.04	-0.04
	(0.056)	(0.056)	(0.047)	(0.047)	(0.054)	(0.054)
% Aboriginal peers	0.04	0.04	-0.10	-0.10	-0.02	-0.02
	(0.093)	(0.093)	(0.086)	(0.086)	(0.088)	(0.088)
% Chinese-language peers	0.17	0.15	0.32**	0.37***	0.09	0.12
	(0.132)	(0.133)	(0.127)	(0.130)	(0.127)	(0.130)
% Punjabi-language peers	-0.45***	-0.45***	-0.11	-0.18	-0.34**	-0.38***
	(0.152)	(0.155)	(0.176)	(0.177)	(0.137)	(0.138)
% other-language peers	0.03	0.03	-0.12	-0.12	-0.09	-0.09
	(0.103)	(0.103)	(0.096)	(0.096)	(0.103)	(0.103)
Chinese*peer % Chinese		0.06		-0.16**		-0.13*
		(0.063)		(0.075)		(0.078)
Punjabi*peer % Punjabi		-0.02		0.30***		0.18*
		(0.101)		(0.087)		(0.106)
Observations	112,569	112,569	112,569	112,569	112,569	112,569
R^2	0.131	0.131	0.140	0.140	0.170	0.170

Cluster-robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

School and year fixed effects in all regressions.

Table 3: Regression results, reading exam.

Variable	Change in score		Grade 4 score		Grade 7 score	
	(1)	(2)	(1)	(2)	(1)	(2)
Male	-0.09***	-0.09***	-0.18***	-0.18***	-0.27***	-0.27***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Chinese spoken at home	0.15***	0.17***	0.01	0.05*	0.15***	0.21***
	(0.012)	(0.019)	(0.016)	(0.025)	(0.015)	(0.024)
Punjabi spoken at home	0.05***	0.05**	-0.38***	-0.41***	-0.32***	-0.33***
	(0.015)	(0.021)	(0.017)	(0.025)	(0.018)	(0.027)
Other language at home	0.12***	0.12***	-0.24***	-0.24***	-0.15***	-0.15***
	(0.011)	(0.011)	(0.013)	(0.013)	(0.013)	(0.013)
% male peers	-0.03	-0.03	-0.07*	-0.08*	-0.11***	-0.11***
	(0.046)	(0.046)	(0.040)	(0.040)	(0.044)	(0.044)
% Aboriginal peers	-0.06	-0.06	0.01	0.01	-0.02	-0.02
	(0.078)	(0.078)	(0.074)	(0.074)	(0.080)	(0.080)
% Chinese-language peers	0.13	0.15	0.07	0.11	0.09	0.14
	(0.111)	(0.111)	(0.111)	(0.113)	(0.113)	(0.113)
% Punjabi-language peers	-0.22*	-0.22	-0.18	-0.21	-0.08	-0.09
	(0.133)	(0.134)	(0.137)	(0.141)	(0.124)	(0.127)
% other-language peers	0.00	0.00	-0.13*	-0.13*	-0.14*	-0.15*
	(0.082)	(0.082)	(0.073)	(0.073)	(0.083)	(0.083)
Chinese*peer % Chinese		-0.07		-0.13*		-0.23***
		(0.062)		(0.072)		(0.074)
Punjabi*peer % Punjabi		-0.01		0.14		0.04
		(0.094)		(0.103)		(0.100)
Observations	114,486	114,486	114,486	114,486	114,486	114,486
R^2	0.063	0.063	0.110	0.110	0.131	0.131

Cluster-robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

School and year fixed effects in all regressions.

Table 4: Comparison of results with other research.

Paper	Country	Grades	Peer Group	Effect on math score (in SD units)
This paper	Canada	7	Punjabi HL	-0.45
Hoxby (2000), Table 5	U.S. (Texas)	6	Male	-0.24 (females) to -0.31 (males)
Lavy-Schlosser (2010), Table 5	Israel	5	Male	-0.22 (males) to -0.37 (females)
Lavy-Schlosser (2010), Table 5	Israel	8	Male	-0.36 (males) to -0.77 (females)
Hoxby (2000), Appendix Table 7A	U.S. (Texas)	6	Black	-0.25 (Hispanic) to -0.75 (Black)
Hanushek et al. (2009), Table 1	U.S. (Texas)	4-6	Black	-0.10 (White) to -0.20 (Black)
Hoxby (2000), Appendix Table 7A	U.S. (Texas)	6	Hispanic	-0.08 (Black) to -0.72 (Hispanic)
Imberman et al. (2009), Table 3	U.S. (Houston)	3-5	Katrina evacuees	-0.91

Table 5: Selected regression coefficients under alternative model specifications.

	Change in Numeracy score		Change in Reading score	
Description	**Coefficient On Peer % Chinese**	**Coefficient On Peer % Punjabi**	**Coefficient On Peer % Chinese**	**Coefficient On Peer % Punjabi**
Base specification	0.17	-0.45***	0.13	-0.22*
(Table 2, column 1)	(0.13)	(0.15)	(0.11)	(0.13)
Modified value-added	0.14	-0.42***	0.11	-0.17
(MVA) model	(0.11)	(0.13)	(0.10)	(0.11)
No school fixed effects	0.38***	0.50***	0.16***	0.15
	(0.05)	(0.18)	(0.04)	(0.09)
Principal and school	0.09	-0.29**	0.23*	-0.11
fixed effects	(0.15)	(0.14)	(0.12)	(0.16)
Grade 5-7 peers	0.18	-0.70***	0.14	-0.07
(non-movers only)	(0.17)	(0.24)	(0.15)	(0.20)
Grade 5-7 peers	0.19	-0.72***	0.16	-0.35
(grade 7 peers as IV)	(0.18)	(0.24)	(0.15)	(0.21)
Aboriginal students included	0.18	-0.41***	0.13	-0.22*
	(0.13)	(0.15)	(0.11)	(0.13)
Boys only	0.15	-0.41**	0.13	-0.14
	(0.15)	(0.17)	(0.13)	(0.15)
Girls only	0.18	-0.48***	0.16	-0.28*
	(0.16)	(0.16)	(0.14)	(0.16)

Cluster-robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Regressions include school and year fixed effects unless stated otherwise

Online Appendix

A.1 Additional results mentioned in paper

Table A.1 shows the district funding formula in British Columbia as referred to in Section 2.1 of the main text. Table A.2 shows trends in exam participation, as referred to in Section 3.2 of the main text.

A.2 Details for Table 4

General comments: The outcome variable is math achievement in elementary school. If achievement was measured in multiple grades, we used the closest grade to grade seven. Papers varied in terms of whether they used levels or some form of value-added. Results are reported for the "baseline" specification, i.e., one that has all control variables and fixed effects emphasized by the authors, but includes as few interactions as possible.

Lavy and Schlosser (2010): We used Lavy and Schlosser's results for the richer specification (1) in Table 5. Results were reported for peer % female, so we reversed the sign to get a coefficient for peer % male.

Hoxby (2000): The test scores are not standardized, so we divide by the standard deviation to get standard deviation units. In the case of the grade 6 math score, Appendix Table 2 reports a standard deviation of 2.9 for the first year of the sample (1993-1994) and of 2.4 for the last year (1998-1999), so we use the midpoint of 2.65. Hoxby's Table 5 reports a coefficient of 0.640 for females and 0.808 for males. Results were reported for peer % female, so we reversed the sign to get a coefficient for peer % male. In measuring the effect of black peers, Hoxby's Table 7A reports a coefficient of -2.000 for blacks, -0.662 for Hispanics, and -0.940 for Anglos. In measuring the effect of Hispanic peers, Hoxby's Table 7A reports a coefficient of -0.224 for blacks, -1.915 for Hispanics, and -0.457 for Anglos.

Hanushek et al. (2009): Results are from the model with lagged test scores included as a control variable, specification (3) or (4). This is identified by the authors as their preferred specification on page 367.

Imberman et al. (2010): Results are from column (1) of panel C (Houston, TAKS exams, elementary).

Table A1: Per student funding to public school districts in Canadian dollars, by funding category.

Category	before March 2002	after March 2002
Base amount	3,042	5,308
Aboriginal supplement	755 – 1,030*	950
ESL supplement (maximum 5 years per student)	1,230 (Year 1) 1,060 (Years 2-5)	1,100
Special needs supplements:		
Dependent	31,910	30,000
Low incidence/high cost	12,460	15,000
Severe behavior	6,014	6,000
High incidence/low cost	3,132	0
Gifted	341	0

Source: British Columbia Ministry of Education (2002). *2002/03 Operating Grants Manual to British Columbia School Boards*, page 4.

*Amount per student increases with total number of Aboriginal students in the district during this period.

Table A2: Trends in numeracy exam participation, grade 4 and 7 non-Aboriginal students 1999-2004.

Year	Grade 4 Numeracy		Grade 7 Numeracy	
	% Taking	% Excused	% Taking	% Excused
1999	91.7	4.6	92.4	4.3
2000	92.2	4.2	91.7	4.1
2001	90.9	5.9	90.8	5.7
2002	90.8	4.5	91.1	4.4
2003	90.0	4.5	90.0	4.4
2004	89.9	4.3	89.9	4.0