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Will Closing the Achievement Gap Solve the Problem? An Analysis of Primary and Secondary Effects for Indigenous University Entry.

Empirical research indicates that the choices made at school transition points are ongoing determinates of later attainment, yet considerable Inequalities in Educational Attainment (IEA) exist, internationally, for at risk groups (e.g. immigrants, minorities, indigenous populations, low socioeconomic groups; see OECD, 2011; Lucas, 2001). Within Australian educational research and policy arenas, as with other countries such as Canada, New Zealand, Norway, and the United States, there has been a long standing concern about the educational outcomes for First Peoples (i.e. for Australia, those who identify with and are accepted as being an Aboriginal and/or Torres Strait Islander person), especially when compared to their non-Indigenous counterparts (De Bortoli & Thomson, 2009). Indeed, the inequities between Indigenous¹ and non-Indigenous students extend across all schooling years, and includes not only levels of achievement outcomes, but issues of retention into the higher education sector (De Bortoli & Thomson, 2009; Department of Education, Employment, and Workplace Relations [DEEWR], 2008). Although there has been a significant improvement in educational outcomes for Indigenous Australian students over the last few decades, the continual pervasiveness of IEA means that there is a clear need to adequately determine the factors that are associated with these discrepancies (Craven & Bodkin-Andrews, 2011; Partington & Beresford, 2012). In the current research we explore the relative strength of two sources of inequality: a) achievement differentials, and b) differing cost-benefit analyses and choice related behaviours that may help to explain differences in university entry rates of Indigenous versus non-Indigenous populations in Australia.

Attainment Differentials in Indigenous Populations

The potential impact of disadvantage in educational attainment for Indigenous Australian student is reflected in research examining future educational options (DEEWR, 2008). Of some concern has been the pattern of lowered retention and progression rates for Indigenous students within education (Bourke, Rigby, & Burden, 2000; Schwab, 2006; Zubrick et al., 2006). Although there has been a significant increase in university entry rates of Indigenous youth (DEEWR, 2008), this positive finding is negated when the emphasis moves to parity of access rates weighted to the proportion of non-Indigenous students. The DEEWR report revealed that from 2001 to 2008, the percentage of Indigenous Australian students accessing university hovered between 1.58% and 1.61% of all students, suggesting little to no improvement in university participation for Indigenous Australian students when evaluated in relation to estimated parity estimates (that is an equitable Indigenous representation in the university sector) of between 2.73% in 2001 to 3.13% in 2006 (DEEWR, 2008, p.116).

Considering that education in general and university education in particular is often seen as one of the most important factors influencing a variety of future quality of life standards (Bowen, Chingos, & McPherson, 2009; Craven & Marsh, 2004; Hunter, 1997; Mellor & Corrigan, 2004; Rogot, Sorlie, & Johnson, 1992), many researchers have argued that it is imperative that an increased quality of education be recognised as a pivotal point of intervention for righting the current and future inequities suffered by Indigenous Australian students (Hunter & Schwab, 2003). The benefits of a university level of education include a greater likelihood of finding employment and remaining employed during times of economic hardship. Indeed, the movement of many Australian manufacturing jobs off shore means that it is increasingly important that young people (both Indigenous and non-Indigenous) remain in education to protect themselves from long-term economic disadvantage (Côté, 2006; OECD, 2011). With these results in mind, there is little doubt about the positive effects of further education for the future life

opportunities of Indigenous Australians.

Intervention Targets

Within the Australian literature, considerable debate has emerged as to the most appropriate and effective foundation for seeking to resolve IEA. Much of the research and policy in this area has focused on closing the achievement gap between Indigenous and non-Indigenous students. Indeed, the achievement gap is of considerable concern where a recent report into Indigenous education (DEEWR, 2008) revealed that across the government preschool system, the median rates of school readiness in terms of literacy and numeracy were significantly lower for Indigenous Australians compared to non-Indigenous Australians. This is concerning given Heckman's (2006) findings that achievement gaps that are present before schooling tend to persist throughout education. Indeed, within primary and secondary schooling, national assessments of literacy and numeracy testing revealed a substantial and consistent pattern of inequitable results to the detriment of Indigenous Australian students (DEEWR, 2008). Such findings are also consistent with the research emanating from the Program for International Student Assessment (PISA), for which Australia as a whole was consistently ranked well above the OECD average in all target academic areas. An analysis of the results for Indigenous Australian students, however, revealed that they were consistently well below the OECD average for all academic domains (De Bortoli & Thomson, 2009). Possibly the most disappointing finding from the PISA data was that across the three differing time frames (2000 to 2006), there has been no improvement in the performance of Indigenous Australian students.

On the basis of these achievement gaps, research and policy development in this area has emphasised skills development and immediate achievement orientated approaches with the view that this will necessarily lead to greater equality in educational and status attainment (see DEEWR, 2008). This raises the critical question as to whether an emphasis solely on increased achievement will have an adequate flow-on-affect to reduce the inequities in educational commitment and attainment into not only the later years of schooling, but also the higher education system itself.

Primary and Secondary Effects

The attainment differentials for at risk groups at transition points emanate, in the work of Boudon (1974), from two sources; namely achievement differentials (primary effects), but also systematic differences in rational choice behaviours (secondary effects). Primary effects refer to differences in academic achievement distributions for at risk groups when compared to their same age peers. That is, students from at risk groups tend, on average, to have lower educational achievement than their not at risk peers (Hauser, 2010). These differences may come from a number of sources including biological influences (e.g., developmental effects of prenatal and early childhood health), developmental context, education access, and resources availability (see Cunha, Heckman, Lochner, & Masterov, 2006; Lareau, 2011; Reardon, 2011, for a review). Within the Australian educational context, especially within Indigenous education, there is considerable resistance to a focus on biological influences, as they have previously been aligned with more insidious deficit orientations (Mellor & Corrigan, 2004). Although such resistance is justified, one should not ignore the often documented socio-economic disadvantages endured by many Indigenous Australians, which have been repeatedly documented to lead to poorer childhood and even perinatal health and wellbeing outcomes (Gracey & King, 2009).

Secondary effects, on the other hand, refer to the choice behaviors and resources of young people and their families at and leading up to educational transitions, and which influence young people's destinations, net of that which can be explained by academic achievement. Put simply, these are the factors which lead to at risk children choosing less ambitious transition pathways than their same age peers, even when they have similar levels of academic achievement (Jackson, Erikson, Goldthorpe, & Yaish, 2007).

While, there is considerable debate on what systemic factors contribute to these secondary effects (Nash, 2003), they at least include differences in rational choice behaviors such as relative risk aversion, credit constraint, resource availability, orientations toward the future, and personal efficacy (see Boudon, 1974;

Breen & Jonsson, 2005; Checchi, 2005; Cunha et al., 2006; Gambetta, 1989; Erikson & Goldthorpe, 2002). On this basis, secondary effects suggest that young people from at risk groups will make different educational choices even if they have the same achievement levels of their not at risk peers, largely because they do not have access to the same financial and social resources (Kerckhoff, Haney, & Glennie, 2001; Vondracek & Schulenberg, 1986).

It may be argued that secondary factors are likely to be important for explaining attainment differentials in Indigenous populations, where factors other than achievement influence the choice behaviour of Indigenous Australian students. There is a moderate research base seeking to understand such factors. For example, Parente, Craven, and Munns (2003) interviewed Indigenous Australian high school students with regards to their future aspirations and found a number of re-occurring patterns that included a preference for vocational education (also reflected in quantitative data; e.g., Craven et al., 2005; DEEWR, 2008), and a level of pessimism about education. For those aspiring to go to university, there was evidence for a lack strategic planning (e.g., knowledge of requirements to get into university, back-up plans or consideration of alternative entry strategies), a lack of effective career advice emanating from parents (although enthusiastic about education, parents were uncertain about providing necessary support) and school advisors, social and peer problems, difficulties due to location (e.g., travel), and stereotyping and racism. Additionally, research findings suggest that Indigenous students' aspirations are driven by a need to better serve the community itself more than their non-Indigenous peers (Fordham & Schwab, 2007; Parente et al., 2003).

Taken together, these findings suggest that Indigenous students differ from their non-Indigenous peers not only in relation to achievement but also in factors which influence costs-benefits evaluations of a university education. As such a sole focus on achievement may not be sufficient in correcting IEA between Indigenous and non-Indigenous students. It is thus critical that we carefully understand the degree to which factors, over-and-above prior achievement, drive the educational outcomes of

Indigenous students.

Current Research

Within the Indigenous education literature, there has been a considerable emphasis on either factors that may contribute to Indigenous Australian student achievement or achievement related choice behaviours, much of which highlights a series of unique factors that may have a impact on a variety of Indigenous Australian student outcomes (Craven et al., 2005; Gray & Partington, 2012; Zubrick et al., 2006). What is not present in the literature is an understanding of the relative importance of primary (i.e. achievement) versus secondary (i.e. engagement and choice) effects in educational attainment outcomes such as university entry. This is a critical gap in our understanding of IEA as Jackson and Jonsson (2013, p.2) note “disentangling primary and secondary effects is important for educational and social policy, as different policy interventions will be required to generate a reduction in [inequality in educational outcomes] depending on whether primary or secondary effects are more consequential”. The current research aims to address this issue by directly comparing the relative strength of primary and secondary effects utilising recent developments in statistical analysis.

In the current research we explored the effect of Indigenous status on university entry using a large eight year longitudinal study of Australian young people. We used this data to estimate a model in which Indigenous status predicted university entry both directly (secondary effects) and via achievement (primary effects; see Figure 1). While it was expected that differences in achievement between Indigenous and non-Indigenous youth would account for a large percentage of the difference between these groups in university entry (primary effects), it was hypothesised that after controlling for achievement differences Indigenous status would still have a significant direct effect on university entry (secondary effects).

Methodology

Participants and Measures

The current research uses the Longitudinal Study of Australian Youth (LSAY) extension of the 2003 cohort of the program for international student assessment (PISA; $N=10,370$ 15-year-old Australians)³. Australian participants from PISA were followed over the next seven years through high school and beyond (in the most recently available wave [2010] participants were aged 22). The database has a number of advantages which make it particularly well suited for the proposed research. First, the PISA data, where sampling occurs at the school level, provides access to a large sample of Australian young people including a significant group of Indigenous youth ($N = 589$). Second, young people are followed through major educational transition points allowing us to assess whether young people enter university. The LSAY project includes several cohorts covering PISA data collection periods from 2000 to 2006. In the current research we used the 2003 cohort as it was the most recent cohort which also covers a sufficient number of years after formal schooling to capture both those who went to university directly after schooling and those that took a 'gap-year' or deferment period before entering university.

Measures

Achievement. As part of the PISA 2003 study, participants sat a two hour test. This examined their 'functional ability' in reading, mathematics, and science as well as containing a problem solving skills test. The majority of test questions focused on student's skill in mathematics as this was the PISA 'major domain' in 2003, with a smaller number of items testing ability in the other areas. Answers were summarized by the survey organizers into a single score for each of the four domains using an item-response models resulting in five 'plausible values' generated for each participant. In this paper, we combined participants' scores on the four domains via a principle components analysis using the first plausible values for each of the four domains and *z-standardizing* the resulting variable. This was then used as a broad measure of participants academic achievement at age 15.

University Entry. For each year of the LSAY 2003 data participants were asked

about whether they were currently or had ever entered university education. Responses over the eight waves were then combined such that a participant was coded as one if they had entered university at any stage from 2003 to 2010. Only those who indicated they had never entered university in the 2010 wave of the study were coded as zero, indicating they had not entered university at any point. The rest were coded as missing and their status was estimated from the statistical model applied to the data (see analyses section below). Due to attrition over the eight waves of the data, information on university entry was available for a total of 5793 or 56% of the total sample (see analysis section below for how missing data was treated).

Analysis

In recent times primary and secondary effects have been defined formally within a statistical modelling perspective. Jackson et al. (2007) define a theoretical model in which 'at risk status' (in this case Indigenous status) is used to predict difference in educational transitions via academic achievement. The total effect is then decomposed into direct and indirect effects. Primary effects are given by the estimated indirect effect of at risk status on the transition outcome that is explained by achievement differentials. Secondary effects are given by the direct effect, or the effect of being a member of an at risk group, controlling for achievement (see Figure 1).

While this mediation approach is relatively straight forward for linear regression, the calculations of direct and indirect effects given a binary outcome variable (i.e. a logit model) are somewhat more complicated (Buis, 2008). Jackson et al. (2007) propose one solution based on using counterfactual probability estimates (we choose to work in predicted probability estimates rather than log odds as they are more easily interpretable; Morgan, 2012). In the case of the current research two observed (OP) and two *what-if* (WIP) (Morgan, 2012) probabilities relating to university entry are estimated:

- OP1: Probability of Indigenous youth entering university given their own achievement and transition properties.
- OP2: Probability of non-Indigenous youth entering university given their own achievement and transition properties.

WIP1: Probability of Indigenous youth entering university taking on the transition properties on the non-Indigenous youth but maintaining their own achievement distribution.

WIP2: Probability of non-Indigenous youth entering university but taking on the transition properties of the Indigenous youth but maintaining their own achievement distribution.

For example, WIP1 asks “what would the probability of entering university be for Indigenous youth if they had the choice behaviours of their non-Indigenous peers”.

The mathematical notation for estimating primary and secondary effects is presented in supplementary material (<http://bit.ly/RryneQ>), put simply, these equations estimate secondary effects by subtracting the counterfactual probability from the observed probability for each group. That is the secondary effects for the non-Indigenous groups equals WIP2 minus OP2. The secondary effect for the Indigenous group equals WIP1 minus OP1. Primary effects are given by subtracting the secondary effects estimated from the total effect of Indigenous status. Given primary and secondary effects must sum to the given total effect, primary effects can be more simply estimated by subtracting OP2 from WIP1 for the non-Indigenous group or OP1 from WIP2 in the Indigenous group.

Estimated uncertainty and missing data. The Jackson/Erikson approach is useful in overcoming the difficulties associated with estimating mediation effects for binary outcomes and also gives estimates which are easily interpretable for primary and secondary effects. However, this approach does not account for uncertainty in the estimates⁴. In the current research we chose to estimate primary and secondary effects using a Bayesian logistic regression model in which university entry is predicted by Indigenous status and achievement. Bayesian approaches treat parameters rather than data as random and thus have several advantages in estimating primary and secondary effects. First, Bayes models provide a distribution rather than a point estimate of the relevant parameters; as such parameter estimates and associated uncertainty can easily be estimated. Summarizing these results we used the mean estimate as a measure of central tendency (which, in our case, are proportionally equivalent to maximum likelihood

estimates) and the 2.5 and 97.5 quantiles of the parameter distribution were used to construct 95% CIs for all components in the analysis (see Ntzoufras, 2011). Second, Bayesian measures of uncertainty have a more straightforward interpretation than frequentist alternatives. For example, the above CIs in Bayesian models simply imply that given the data we can be 95% sure that the estimated parameter lies between the 2.5 and 97.5 quantiles of the parameter distribution (see Jackman, 2009). Third, Bayesian approaches also provide a useful model based approach to dealing with missing data which takes into account the uncertainty involved in imputing missing values (see Lynch, 2007). This is important as few studies to date have estimated primary and secondary effects while also accounting for attrition in a manner other than by listwise or pairwise deletion. This is problematic, as longitudinal studies including the current research often have moderate to large amounts of attrition where participants are followed over a long period of time (in this case over eight years). Simple listwise or pairwise deletion as a means of accounting for this attrition can lead to considerable bias in the results. The Bayesian model we used provided a principled model based approach where missing data on university entry were estimated from the hypothesised model thus accounting for missing data and incorporating uncertainty in the estimates that results from modelling missing values (see Gelman & Hill, 2007; Lynch, 2007). The baseline data used in this research had little missing data. As such, the research had a stronger basis for imputing missing data than typically convenience samples.

Results

Descriptives

Table 1 provides an overview of the central variables in the current research. Firstly it can be noted that considerably fewer Indigenous students transitioned to university compared to their non-Indigenous peers. Second, it can be noted that the average achievement of Indigenous students is almost one standard deviation on average lower than non-Indigenous students (Reardon, 2011, for the various socio-cultural explanations of this differential).

Evaluation of Primary and Secondary Effects

We next estimated a logistic regression in WinBUGS with university entry predicted by Indigenous status and achievement (see online Appendix). Both the \hat{R} and inspection of the iteration plots suggested convergence of the model.^{5,6} Using the output of this model we first calculated the observed and *what if* probabilities of university entry for both groups (see Table 2). All results are presented as predicted probabilities. These counterfactual probabilities were then used to calculate primary and secondary effects. From Table 3 it can be seen that the average difference between the Indigenous and non-Indigenous group in the probability of entering university was .32. Put simply, an Indigenous youth with an achievement level equal to the average for the Indigenous sample would be predicted to have a 32 percentage points lower likelihood of entering university than a non-Indigenous youth with an achievement level equal to the average for the non-Indigenous sample. This total effect was then decomposed into primary and secondary effects. Taken together, secondary effects accounted for an average of 25% to 28% of the total effect. This suggested that if Indigenous youth maintained their own achievement levels but took on the transition properties of a non-Indigenous youth their probability of entering university would increase by approximately .08. Put simply, this estimate suggests that Indigenous student probability of entering university would increase from .29 to .37 if they had the same choice influences and behaviours of their non-Indigenous peers. Likewise, if the non-Indigenous youth maintained their own achievement profiles but took on the transition properties of the Indigenous youth then their probability of entering university would decrease by approximately .09.

As Jackson et al. (2007) show, the relative strengths of primary and secondary effects can also be visualised by plotting the estimated achievement distributions of the two groups and the estimated probability ogives of both groups derived from the above model on a single graph (see Figure 2). From this graph various counterfactual scenarios can be easily seen. Most importantly for the current research, it can be noted that if Indigenous students maintained their own achievement profile but took on the transition probabilities of the non-Indigenous sample, they would be more likely to enter

university (the difference between the grey ogive versus the black ogive given the Indigenous achievement distribution).

Discussion

The results of the current research suggest that there is an approximately 32 percentage point difference between Indigenous and non-Indigenous youth in Australia in university entry, which is broadly consistent with the often cited inequity in Year 12 completions of Indigenous and non-Indigenous students (DEEWR, 2008, p.58). Findings indicated that much of this inequality in university entry was due to achievement differentials apparent during schooling. While the achievement gap did explain a substantial amount of the inequality in university entry, secondary effects still consisted of approximately 25% of the gap in university entry. As such the current research suggests that both achievement differentials and differences in choice behaviours are consequential and that future research and policy will need to consider both issues in order to reduce IEA for Indigenous youth.

Primary effects: Achievement differentials

The findings of the current research support, to some degree, the research focus in Australia on identifying the factors that result in lower average school achievement for Indigenous youth. The problem of achievement gaps is one in need of considerable attention, yet research on when the gap emerges and how it develops is relatively scarce in Australia. What is available suggests that gaps in achievement are present during early schooling and that early intervention is important (Bradley, Draca, Green, & Leeves, 2007). The early occurrence of significant achievement gaps between Indigenous and non-Indigenous children is consistent with research on other disadvantaged groups. Heckman (2006) and Reardon (2011) in their reviews suggest that much of the achievement gap between advantaged and disadvantaged youth is present by the age of four. Indeed, Heckman (2006) goes further to suggest that programs aimed at raising academic achievement in disadvantaged youth need to be focused very early on in children's educational careers if widespread and meaningful change in achievement

levels and school preparedness is to occur. While a focus on closing the achievement gap and targeted interventions aimed at children and their families are important, two caveats must be made. First, a focus on closing the achievement gap is unlikely to be effective if research and policy does not address the wider sociopolitical, moral, economic, and historical context in which such gaps emerge (Ladson-Billings, 2006). Second, while primary effects (i.e., achievement differentials) were found to be very strong in this research, the results also suggest that closing the achievement gap may not be sufficient for addressing IEA for Indigenous youth unless differences in choice influences and behaviours are not also taken into account.

Secondary effects: Choice Behaviours

In the current research, secondary effects were estimated as abstract qualities that affect educational choices after controlling for achievement. Such results do not give insight into what the nature of these differences in choice behaviours consist of nor the processes involved. Nevertheless, this research is an important first step in bringing to attention the need to study and shape policy around an understanding of inputs into young people's educational choices (e.g., access to information) and the processes they go through in order to make their decisions (e.g., evaluating costs and benefits of a university degree). Such research will require an interdisciplinary focus on the economic, socio-political, pedagogical, and intrapsychic factors involved in educational choices.

From an economic perspective secondary effects are likely to be influenced by government policies that aim to promote education and labor market participation of Indigenous and non-Indigenous youth. Government and educational policies are also of importance as they affect the balance between the human capital advantages versus the direct and opportunity costs of remaining in education for longer periods (see Checchi, 2005). From a sociological perspective, the application of research by Schneider and Stevenson (2000), Gambetta (1989), and Lareau (2011) on the effect of culture on factors such as educational aspirations, parental orientation to education, educational habitus, and access to information on educational pathways

needs to be extended to research on Indigenous youth. Parente et al. (2003) and Craven et al. (2005) have made some progress in this area but more work is needed. From a pedagogical perspective, although international meta-analytic research suggested that ethnic identification may play only a minor role in promoting higher levels achievement (Hattie, 2009), linking culture to the educational environment has been long recognized as a critical factor in student engagement (Ladson-Billings, 2006). Indeed, advances in culturally inclusive educational practices within Australia, including family and community partnerships directed towards the education of Indigenous perspectives, have been argued to be strongly linked to the future aspirations of Indigenous Australian students (AECG & DET, 2004; Halse & Robinson, 2011; Lester & Munns, 2011).

However, further research is needed to explore how higher education policies may be modified to address the legitimate costs of university education perceived by Indigenous youth (e.g. a desire to remain within and contribute to their community). Finally, from a psychological perspective, developmental frameworks such as Eccles and Wigfield (2002) model of achievement related choices is likely to be critical in assessing systematic differences in the choice behaviours of Indigenous and non-Indigenous youth and their families. Indeed, existing research indicates there are small differences in academic self-concept between Indigenous and non-Indigenous youth (e.g., Bodkin-Andrews, Ha, Craven, & Yeung, 2010), yet more research in quantifying and understanding these differences is needed particularly on differences in importance, cost, utility, and intrinsic value of a university education.

Morgan (2012) suggests an important extension to research such as the present is to directly model the actual choice based processes involved in educational transitions, rather than inferring them as is done here. Future research will need to consider this; however, Morgan (2012) noted that there is a lack of information on young peoples' actual choice behaviours which means that direct estimation of secondary effects is likely to be difficult with currently available data. This is particularly the case for Indigenous youth. In the introduction we do note several pieces of important qualitative research

which do provide an insight into Indigenous youths actual choice behaviours, yet, this needs to be coupled with rigorous quantitative research which controls for primary effects and can provide insight into causal structures involved in educational choice behaviours in order to guide policy. This will require the development of new longitudinal databases and new instruments aimed directly at measuring young people's choice behaviours at critical educational transitions.

Limitations

Morgan (2012) indicated that a focus on secondary effects is needed in social research. Yet Morgan also notes that there are important limitations to the approach taken in this research. First, while the work of Jackson et al. (2007) use terms such as effect and counterfactuals, there are clear limits in the ability to make causal inferences when evaluating primary and secondary effects as was done here. Most pertinently, it is possible, that students reduce effort on achievement tests due to a decision earlier in their school careers that university entry is not important for them and thus apply less effort in achievement tests (see Gambetta, 1989). Furthermore, these achievement tests were low stakes (i.e., results of the test did not affect any future outcomes for the participants) and thus may have been associated with less effort. This presents a potentially dangerous confound to the Jackson/Erikson model. Jackson et al. (2007) evaluated these so called “anticipatory decisions” to reduce effort and found that while they are a potential concern, their effect on transition probabilities are likely to be relatively small. Nevertheless, caution needs to be used when interpreting the current results where anticipatory decisions may result in the under estimation of secondary effects. Alternatively, achievement in the current research, and in most real-world research, is measured with error. From this perspective, the effect of achievement on the educational outcome may be attenuated and thus the relative size of the secondary effects may be overestimated.

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Footnotes

¹Within this paper, we use the label Indigenous Australian is used to represent people of Aboriginal and Torres Strait Islander descent. We stress that readers should recognise that the label Indigenous Australian the label Indigenous Australian obscures the distinctiveness between not only Aboriginal and Torres Strait Islander Peoples, but also the immense diversity of language groups and cultural values across Aboriginal and Torres Strait Islander peoples (Purdie, Dudgeon, & Walker, 2010). We simply retain the label of Indigenous Australian to avoid confusion with previous research and policy.

³The LSAY data base consists of only those Australian PISA participants database ($N=12,500$) that were successfully followed up for a telephone interview in 2003.

⁴Buis (2008) has extended this approach to provide standard errors as estimates of uncertainty. Likewise, other approaches to causal mediation with binary outcomes have been developed by Imai, Keele, and Yamamoto (2010).

⁵This model was also estimated in using a robust maximum likelihood estimator and a probit link function. This model was estimated both without and with sampling weights to account for non-response and a sandwich estimator to account for the nested nature of the data. In both cases results provided similar estimates to those reported in Table 3 with the exception that secondary effects were slightly stronger accounting for 27.5% and 33% of the total effect. This is slightly larger but still very similar to the 25% identified using the Bayes perspective developed here. We also reran the models using two stage logistic regression with both a logit link (following Jackson et al., 2007) and a probit link using the mediation package in R (following the logic Imia et al., 2010). The results from these models were also highly consistent with the results presented in Table 3.

⁶ We re-estimated the models taking into account the interaction between Indigenous status and achievement using both the Bayes perspective and the robust maximum likelihood approach. In both cases the credibility intervals for Bayes and the confidence intervals for maximum likelihood covered zero and thus we choose to focus on the more parsimonious model. However, the results did tend to suggest that secondary effects were slightly larger in non-Indigenous than Indigenous youth. This is consistent with the findings of Bodkin-Andrews, Craven, Parker, Kaur, & Yeung (in press) that non-cognitive factors were more weakly related to academic outcomes in Indigenous than non-Indigenous youth.

Table 1
Descriptives

| | University Entry ^a | | Academic Achievement | |
|----------------|-------------------------------|---------------|----------------------|------|
| | No | Yes | Mean | SD |
| Non-Indigenous | 33% (N = 1846) | 67%(N = 3763) | .03 | .91 |
| Indigenous | 56% (N = 103) | 44%(N = 81) | -.80 | 1.01 |

Notes: Results are estimated using the sample weights developed by PISA.

^aBased on observed results with missing values excluded.

Table 2
Conditional University Entry Probabilities

| | Non-Indigenous | | Indigenous | |
|----------------|----------------|-------------|------------|-------------|
| | Est. | 95% CI | Est. | 95% CI |
| Non-Indigenous | .62 | (.60 - .63) | .53 | (.45 - .62) |
| Indigenous | .37 | (.35 - .39) | .29 | (.23 - .37) |

Notes. The diagonal cells in the table represent the predicted probabilities of University entry for Indigenous and non-Indigenous youth evaluated for the group's achievement distribution and transition properties. The upper off diagonal element gives the "what if" university entry probabilities of the non-Indigenous sample evaluated using the groups achievement distribution but taking own the transition properties of the Indigenous sample. The lower off diagonal element gives the "what if" university entry probabilities of the Indigenous sample evaluated using the group's achievement distribution but taking own the transition properties of the non-Indigenous sample. Central tendency estimates give the probabilities evaluated at the mean achievement levels of the relevant group.

Table 3
Primary and Secondary Effect Probabilities

| | Primary | | Secondary | | Total | |
|-------------------|---------|---------------|-----------|---------------|-------|--------------|
| | Est. | 95% CI | Est. | 95% CI | Est. | 95% CI |
| NI-I ^a | -.24 | (-.26 - -.22) | -.09 | (-.16 - -.00) | -.32 | (-.39 - .25) |
| I-NI ^b | .25 | (.23 - .26) | .08 | (.00 - .14) | .32 | (.25 - .39) |

^aCondition: non-Indigenous to Indigenous.

^bCondition: Indigenous to non-Indigenous.

Figure Captions

Figure 1. Tested Model

Figure 2. Primary and Secondary Effects



