Fluid reasoning skills at the high school transition predict subsequent dropout☆

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ABSTRACT

The purpose of this study is to examine the prospective association between fluid reasoning skills in seventh grade and subsequent high school dropout in an at-risk population, independent of a number of important confounders. Participants are 4962 students from one of 56 high schools in the French Canadian province of Quebec. Three quarters of participants were intentionally representative of all schools in disadvantaged areas of the province. The Standard Progressive Matrices was administered to assess fluid reasoning, defined as the requisite skills for critical thought and complex problem resolution in novel situations, regardless of task and setting characteristics. Leaving high school from eighth grade onward, as a developmental milestone, was officially tracked and recorded by government sources. Dropout status was assigned if registration in school was discontinued without returning or obtaining a diploma within the period spanning from fall of Grade 8 to two years beyond expected graduation. Lower fluid reasoning skills significantly predicted less perseverance toward high school completion. Specifically, after adjusting for potential confounders, every standard deviation decrease in fluid reasoning predicted 21% increases in odds of dropout (OR = 1.21; 95% C1 = 1.06–1.37). Youth showing below average fluid reasoning skills at the secondary transition might benefit from teacher-student support and technologically-based interventions that bolster knowledge acquisition and learning-related skills. Early approaches to screening and preventive stimulation before student trajectories become clearly characterized by indiscriminate under-achievement might circumvent high school dropout and are likely to be more cost-effective than letting the bio-psycho-social developmental risks associated with dropout take their course.

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It could be metaphorically argued that high school dropout is like a faucet leaking potable water, seeping social investments down the drain. Any country plagued with the economic misfortune of dropout becomes an ideal laboratory for studying its process. For example, over their life course, 15% of Canadian youth fail to earn their high school diploma (Statistics Canada, 2014). As a nation, Canada finds itself slightly better than the OECD average and just ahead of the United States in prevalence of high school graduation (OECD, 2014). However, some of its provinces, like Quebec, graduate their students at a similar frequency or below that of developing nations (The10and3.com, 2015; Janosz et al., 2013). Although its education system, managed under provincial jurisdiction, is meant to facilitate student graduation at a timelier rhythm by reducing the North American standard from 12 to 11 grades, it does not. In fact, one out of five girls, and one out of three boys become high school dropouts before age 20 in Quebec (Statistics Canada, 2014).

The unrelenting search for characteristics that can forecast and thus circumvent high school dropout remains an important target for any nation's economic survival.

Unfortunately, less than half of people who choose to unsuccessfully leave high school seem not that different from those do so successfully (Pagani et al., 2008). For example, an analysis of two independent Canadian longitudinal data sets found that students who abandoned school were quite heterogeneous in terms of school engagement and social integration prior to their premature departure from school (Janosz, Le Blanc, Boulerice, & Tremblay, 2000). Noteworthy is that approximately 40% showed prior levels of school engagement and psychological and behavioral profiles that were comparable to the average eventual graduate. This has been previously documented elsewhere (Kronick & Hargis, 1998).

Underachievement remains a characteristic of many students, regardless of whether they persist or drop out (Janosz, Archambault, Morizot, & Pagani, 2008). This lack of predictive exactitude adds difficulty in targeting cost efficient preventive interventions which promote school completion. Persistently poor attention and engagement skills from kindergarten onward seem to be more robust predictors of expected dropout than achievement in high risk students (Entwisle et al., 2005; Archambault, Janosz, Fallu, & Pagani, 2009) and unexpected

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high school dropout in low risk students (Pagani et al., 2008, Janosz et al., 2000). Interestingly, attention and engagement are both supported by early childhood working memory (Baddeley, 2007), which predicts a dropout trajectory from the beginning of high school (Fitzpatrick, Archambault, Janosz, & Pagani, 2015). The assessment of working memory is nevertheless no small feat in a school population of typically developing youth. Such a screening process calls for the assessment of a simpler neuropsychological factor behind knowledge acquisition (Raven, 1942, 2000).

Measures of achievement remain unreliable forecasters of schooling outcomes because they mostly measure declarative or crystalized knowledge, which reflects conceptual knowledge adapted and assimilated from previous experience (Flynn, 2009). At its very foundation, fluid reasoning ability represents a measurable capability to solve new problems, use logic in novel situations, and identify patterns during processing of complex data (Cattell, 1963). It is the ability to reason in unfamiliar situations without depending on previous knowledge (Au et al., 2015). Learning new things draws on fluid reasoning. As a precursor to crystalized knowledge, fluid reasoning ability determines ease or difficulty in learning (Raven, 1942). Yet once a task or information is learned, one can count on its storage and availability in long-term memory (Finn et al., 2014). Said differently, learning outcomes from novel problem solving become crystalized in long-term memory for later pertinent access and retrieval, as needed.

Fluid reasoning has an interdependent relationship with working memory, information processing speed, and attention (Allen, Baddeley, & Hitch, 2014; Hu, Hitch, Baddeley, Zhang, & Allen, 2014; Unsworth, Fukuda, Awh, & Vogel, 2014). These individually predict academic performance (Blair & Razza, 2007) and school engagement (Fitzpatrick & Pagani, 2012; Fitzpatrick et al., 2015). Fluid reasoning especially draws upon working memory, which supports both information processing and attention (Barbey, Colom, Paul, & Grafman, 2014). Most remarkably, it remains an aspect of measured intelligence that appears to have potential malleability over time, both naturally and experimentally (e.g., Dickens & Flynn, 2001; Stankov, 1986). It is also quite predictive of professional and educational attainment (Gottfredson, 1997) and emotional intelligence (Goleman, Boyatzis, & McKee, 2013). Consequently, it represents an optimal target of intervention (Au et al., 2015). Measurement of fluid reasoning ability early in the high school transition could help predict later difficulty acquiring the requisite declarative knowledge for a successful departure from high school. Thus, what might circumvent dropout is early identification and treatment of at-risk youth before their academic developmental trajectories become clearly characterized by indiscriminate underachievement.

Deemed the most robust measure of fluid reasoning (Flynn, 2009), the Standard Progressive Matrices (SPM) measures the requisite skills for critical thought and complex problem resolution skills in novel situations, regardless of task and setting characteristics (Finn et al., 2014; Downey, Lomas, Billings, Hansen, & Stough, 2014). The SPM captures reasoning capacity without the influence of language, education, and cultural factors. The SPM has a long history of use since its inception prior to the Second World War (Burke, 1958). Internationally, it has been commonly used by the military for assignment and ranking (Rindermann, Flores-Mendoza, & Woodley, 2012). Until relatively recently, testing military conscripts with the SPM was common practice throughout the world (Burke, 1958). Today, it is frequently used to predict a person's potential for success in professional, management and high-level technical posts that require clear thinking, problem identification, holistic situation assessment, and monitoring of tentative solutions while considering all available information (Flynn, 2009). In youth, performance on the SPM predicts academic achievement (Di Fabio & Busoni, 2007; Di Fabio & Palazzeschi, 2009; Laidra, Pullmann, & Allik, 2007) above and beyond socioeconomic status, parental intelligence, income, and level of education (Colom & Flores-Mendoza, 2007) and personality (Downey et al., 2014; Farsides & Woodfield, 2003; Furnham, Monsen, & Ahmetoglu, 2009). Because it identifies individual

differences in the effort required to learn novel material, the SPM might help identify dropouts before they begin the disengagement process from school.

To our knowledge, fluid reasoning at the high school transition has yet to be used to predict chances of perseverance or desistence toward the developmental milestone of completing high school. The presence of such a link might offer a window of opportunity where preventive intervention could serve as a protective factor. Thus, the purpose of this paper is to examine the prospective association between early high school SPM performance and subsequent dropout in a high risk population, independent of a number of important confounders.

1. Method

1.1. Participants

Participants were followed throughout the five years of high school (grade 7 to grade 11) and two years beyond, as part of the evaluation of the New Approaches New Solutions (NANS) dropout prevention program (Janosz et al., 2010). The present sample was based on NANS cohort 1, which included 6576 participants from 56 French-speaking schools in the province of Quebec (Canada) who entered grade 7 in 2002 (average age 12.2). Three quarters of participants attended a high school exposed to NANS. These schools were sampled to be representative of all schools in disadvantaged areas of Quebec (Janosz et al., 2010). The remainder of participants attended schools of average socio-economic status and were not exposed to the program. Written informed consent from participants and IRB approval from the University of Montreal were obtained. Consent was provided by 77% of eligible participants. Representative of provincial demographics, the sample was mostly Caucasian (86.2%) and roughly equally-represented by gender (52.56% females). For this study, we included participants who completed all Grade 7 assessments (n = 4962). No participant had missing dropout information. Few participants had missing data on fluid intelligence (2.1%) and potential confounders (0–7.3%).

1.2. Measures

1.2.1. School dropout

Leaving high school was annually assessed from Grades 8 to 11 using official data from the Provincial Ministry of Education, Leisure, and Sports. Participants were assigned a dropout status (=1) if they stopped being registered in school without returning or earning a diploma in the period spanning from fall of Grade 8 to two years beyond Grade 11 (which corresponds to the expected grade for compulsory high school completion in Quebec).

1.2.2. Fluid reasoning abilities

In grade 7, the Standard Progressive Matrices (SPM) was administered to assess the requisite skills for critical thought and complex problem resolution skills in novel situations, regardless of task and setting characteristics (Finn et al., 2014; Downey et al., 2014). This test comprises five sets of 12 visual geometric "matrix" problems of increasing difficulty (Raven, 1942). All five sets draw upon a specific combination of information processing characteristics (De Lemos & Raven, 1989): (a) continuous patterns, (b) analogies between pairs of figures, (c) progressive alterations of patterns, (d) permutations of figures, and (e) resolution of figures into constituent parts. The final, most difficult set requires intense coordination of working memory and other executive functions, which suggests significant compensatory strength in problem resolution great and potential for remedial learning (Burke, 1958; Unsworth et al., 2014). Each "matrix" problem has a missing part, creating a problem to solve, with responses offered in multiple-choice formats. Below each problem are either six (sets A and B) or eight (sets C through E) alternative pieces to complete the figure, only one of which is correct. Deemed as the most robust measure of fluid ability,