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Research Paper

What happens if the same curriculum is taught in five instead of six years? A quasi-experimental investigation of the effect of schooling on intelligence

Sebastian Bergold[a,*], Linda Wirthwein[a], Detlef H. Rost[b,c], Ricarda Steinmayr[a]

[a] Technical University Dortmund, Department of Psychology, Emil-Figge-Straße 50, D-44227 Dortmund, Germany
[b] Southwest University Chongqing, Faculty of Psychology, 2 Tiansheng Road, Beibei District, Chongqing 400715, PR China
[c] Philipps-University Marburg, Department of Psychology, Gutenbergstraße 18, D-35032 Marburg, Germany

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ABSTRACT

Several studies have shown that each year of schooling has a significant positive impact on IQ. However, there is still a debate about how to explain this effect. With the German G8 school reform, the duration of school attendance in the highest track of Germany's tracked school system (Gymnasium) was shortened from 9 years (G9) to 8 (G8) while simultaneously both the curricular contents and amount of instruction should be preserved in full. In the present paper, the G8 reform was utilized as a natural quasi-experiment to examine whether the duration of school attendance would enhance intelligence test scores even when students with different numbers of years of schooling had completed the same curricular contents within the same amount of instruction. Two studies were conducted. In Study A, the performances of $n = 81$ G8 10th graders ($M_{age} = 15.16$ years, $SD = 0.37$) and $n = 80$ G9 11th graders ($M_{age} = 16.39$ years, $SD = 0.49$) on the Berlin Intelligence Structure Test were compared. In Study B, the cognitive abilities of $n = 244$ G8 10th graders ($M_{age} = 15.23$ years, $SD = 0.42$) and $n = 204$ G9 11th graders ($M_{age} = 16.33$ years, $SD = 0.47$) were measured with the Intelligence-Structure-Test 2000 R. The G9 students outperformed the G8 students on nearly all cognitive ability tests despite completing equal curricula. Thus, the impact of schooling on intelligence test scores seems to be primarily due to the fostering of intelligence-related abilities that are independent of formal curricula.

1. Introduction

Schooling has a significant impact on many areas of life, such as labor market participation and income (Schnittker & Behrman, 2012), health (Amin, Behrman, & Spector, 2013; Kemptner, Jürges, & Reinhold, 2011), and the development of social competencies (Bowles & Gintis, 2002). Previous studies have also shown that schooling influences students' intelligence test performance (e.g., Brinch & Galloway, 2012; Cahan & Cohen, 1989; Hansen, Heckman, & Mullen, 2004; Stelzl, Merz, Ehlers, & Remer, 1995). However, the processes underlying this causal relation are still a subject of debate. In the present study, we utilized the German G8 school reform as a natural quasi-experiment to shed some light on these processes. More specifically, we tried to answer the question of whether the impact of schooling on intelligence test scores is due to the teaching of specific cognitive skills and abilities that are tied

* Corresponding author.
E-mail addresses: sebastian.bergold@tu-dortmund.de (S. Bergold), linda.wirthwein@tu-dortmund.de (L. Wirthwein), rost@uni-marburg.de (D.H. Rost), ricarda.steinmayr@tu-dortmund.de (R. Steinmayr).

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to the curriculum or to the fostering of more general, intelligence-related abilities that are independent of formal curricula.

1.1. Schooling and intelligence test scores

For quite some time, it has been known that there are substantial correlations between schooling and students' intelligence test scores, mostly ranging from $r = 0.50$ to $r = 0.60$ (Ceci, 1991; Rost, 2013). However, the possibility that schooling influences intelligence has long been seen as rather unlikely. Correlations used to be explained either by selection effects (more intelligent students attend school longer) or by confounding variables that influence both schooling and intellectual development (e.g., socioeconomic status; Ceci, 1991). Meanwhile, studies have suggested that intelligence is not just a precondition but also a consequence of schooling (Brinch & Galloway, 2012; Cahan & Cohen, 1989; Cliffordson & Gustafsson, 2008; Merz, Remer, & Ehlers, 1985; Rost & Wild, 1995; Stelzl et al., 1995).

On the basis of numerous studies, Ceci (1991) suggested that every school year that is missed causes a loss of 0.25–6 IQ points. However, an accurate determination of the effect of schooling on intelligence appears difficult because schooling is confounded with a number of variables that are also relevant for intellectual development, such as physical maturation or intellectual stimulation outside of school (family climate, mass media, etc.), all of which are—just like schooling—indexed by chronological age.

For ethical reasons, it is of course not possible to conduct randomized experiments in which the duration of school attendance is the grouping variable. However, there have been some well-designed quasi-experimental studies that have held chronological age constant in order to isolate the effect of schooling. Cut-off dates for school enrollment allow for an estimation of the schooling effect because students of roughly the same chronological age but with different durations of school attendance can be directly compared on their intelligence test scores (e.g., Merz et al., 1985). Other studies have used the regression discontinuity design (Cahan & Cohen, 1989) in which the intelligence test score is separately regressed on age in each of at least two successive grades. Thus, the slope indicates the age effect, whereas the difference between the predicted values of the oldest students in the initial grade and the youngest students in the subsequent grade represents the schooling effect. Other studies have spread intelligence assessments across an entire school year in order to separate the schooling effect from the age effect as well as from their interaction (Rost & Wild, 1995). Whereas these methodologically sophisticated studies consistently found that schooling has a noteworthy impact on intelligence test scores, they varied with regard to the size of the effect, even within similar age groups and when studying the same intellectual ability. For example, Stelzl et al. (1995) found that one year of schooling accounted for 5.9–8.6 IQ points in fourth graders, depending on the intellectual ability under study. For general intelligence, the effect was 7.6 IQ points (see also Merz et al., 1985). Rost and Wild (1995), also studying general intelligence and drawing on a large sample of third graders, found that every month of schooling accounted for about 0.4 IQ points (which resulted in about 4 IQ points per school year). In a comprehensive review, Rindermann (2011) estimated the average schooling effect on intelligence at 5.6 IQ-points.

However, even though these studies found differing sizes of the effect of schooling, they commonly showed that the effect of schooling was at least twice as large as the effect of chronological age. Some methodologically sound studies even found that chronological age had no noticeable effect on intelligence test scores. In the study by Rost and Wild (1995), the effects of both chronological age and its interaction with duration of school attendance were negligible. Merz et al. (1985) and Stelzl et al. (1995) compared their estimated effects of one year of schooling with the total increase of IQ scores in one year calculated from the norm tables of the intelligence tests they had used. With regard to fluid intelligence, the IQ increase was completely due to schooling. Cliffordson and Gustafsson (2008) examined the magnitudes of both the schooling effect and the age effect on intelligence on the basis of a sample of 48,269 Swedish men. Participants were tested in one of several possible testing sessions for enlisting in military services. Several possible testing sessions were offered across the year in which participants turned 18. The participation date was chosen randomly and was therefore independent of exact age. Thus, both age (as measured by the number of days before and after the 18th birthday, respectively, within this year) and schooling (as measured by the number of days of schooling within this year) varied independently from one another. Whereas the average schooling effect turned out to be 2.7 IQ points, the average age effect was 0 IQ points. These effects remained unchanged even when numerous confounding variables (e.g., socioeconomic status, educational level, ethnicity, or school achievement) were controlled for.

1.2. What underlies the causal link between schooling and intelligence test performance?

As noted above, previous research has convincingly shown that schooling enhances performance on intelligence tests. However, there is still an ongoing debate about why this is the case (i.e., what the processes underpinning this causal relation are). Empirical findings are scarce and partly inconsistent.

On the one hand, there is the hypothesis that the teaching of rather specific abilities that are closely linked to curricula (such as content-specific knowledge or reading ability) is the driving factor behind school causing higher scores on intelligence tests because those abilities can help a person complete an intelligence test successfully (see Ceci, 1991; Neisser et al., 1996; Van de Vijver & Brouwers, 2009). Thus, better scores would be achieved indirectly via those abilities and would therefore not be a consequence of a "real" enhancement of intelligence (although some specific abilities such as reading ability might contribute to intellectual development in the long term; see Ritchie, Bates, & Plomin, 2015). Several studies have shown that schooling indeed fosters specific abilities that are tied to the curriculum, such as reading ability, certain specific mathematical skills, and specific knowledge (Alexander & Martin, 2004; Baltes & Reinert, 1969; Bisanz, Morrison, & Dunn, 1995; Blair, Gamson, Thorne, & Baker, 2005; Crone & Whitehurst, 1999; Cunningham & Carroll, 2011; Naito & Miura, 2001). Cliffordson and Gustafsson (2008) found that, at least in part, there were differential effects of schooling in the academic tracks they investigated, thus suggesting a nontrivial role of the