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Intelligence and school grades: A meta-analysis

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ABSTRACT

Intelligence is considered as the strongest predictor of scholastic achievement. Research as well as educational policy and the society as a whole are deeply interested in its role as a prerequisite for scholastic success. The present study investigated the population correlation between standardized intelligence tests and school grades employing psychometric meta-analysis (Hunter & Schmidt, 2004). The analyses involved 240 independent samples with 105,185 participants overall. After correcting for sampling error, error of measurement, and range restriction in the independent variable, we found a population correlation of $\rho = .54$. Moderator analyses pointed to a variation of the relationship between *g* and school grades depending on different school subject domains, grade levels, the type of intelligence test used in the primary study, as well as the year of publication, whereas gender had no effect on the magnitude of the relationship.

1. Introduction

Intelligence is the strongest predictor of academic achievement with correlations ranging from .30 to .70 (e.g., Chamorro-Premuzic & Furnham, 2005; Colom & Flores-Mendoza, 2007; Deary, Strand, Smith, & Fernandes, 2007; Gottfredson, 2002; Gustafsson & Undheim, 1996; Jensen, 1998; Kuncel, Hezlett, & Ones, 2004; Kyttälä & Lehto, 2008; Laidra, Pillmann, & Allik, 2007; Lemos, Abad, Almeida, & Colom, 2014; Neisser et al., 1996; Primi, Ferrão, & Almeida, 2010; Rosander, Bäckström, & Stenberg, 2011; Taub, Keith, Floyd, & Mcgrew, 2008). Well known and much-quoted reviews (e.g., Gottfredson, 2002; Gustafsson & Undheim, 1996; Neisser et al., 1996; Sternberg, Grigorenko, & Bundy, 2001) refer to a mean correlation of .5, but none of them cites a study in which this was investigated. This is not surprising, since there was (and is) no current comprehensive meta-analytic examination of the association between *g* and scholastic achievement. Previous meta-analyses (see the following section) present data assessed before 1983, focus only on natural sciences and specific countries and do not correct for artifacts which might lower the correlation (i.e., unreliability, range restriction). Moreover, scholastic achievement is measured by achievement tests instead of school grades as a direct measure of scholastic success. However, school grades are crucial for accessing further scholastic and occupational qualification, and therefore, have an enormous influence on an individual's life (Sauer, 2006; Tent, 2006). With this study we try to close this research gap by integrating the extensive body of knowledge concerning the correlation between *g* and scholastic achievement measured by school grades. The main goals of the study were the following: (1) Consideration of all available studies presented in the international literature, (2) presentation of the mean correlation only weighted by sample size as well as the true score correlation corrected for unreliability and range restriction, (3) consideration of moderator variables which might influence the correlation.

1.1. Results of previous meta-analyses

1.1.1. Boulanger (1981)

This study dealt with the correlation of cognitive ability assessed by different standardized intelligence tests and school achievement in natural sciences in grade levels 6 to 12. Included were 34 studies between 1963 and 1978 yielding 62 correlations (total *N* not reported). The correlations were integrated by computing the mean correlation and corresponding standard deviations. For the complete sample, a mean correlation of $M(r) = .48$ with a standard deviation of $SD(\mathrm{r}) = .15$ was found. Furthermore, the mean correlations on different levels of a set of potential moderator variables were computed and compared using a *t*-test. Among several tested moderator variables, only the reliability of the outcome measure [$r < .80$: $M(r) = .42$ vs. $r \geq .80$: $M(r) = .55$; $p = .01$] had a significant influence on the strength of the relationship between cognitive ability and school achievement.

1.1.2. Fleming and Malone (1983)

The meta-analysis of Fleming and Malone (1983) analyzed correlations of different student variables (among others general ability, verbal and mathematical ability) and scholastic achievement in natural sciences. It was based on 42 correlation coefficients (number of studies

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and total N not reported) between 1960 and 1981. Grade levels ranged from kindergarten to grade level 12. Intelligence was assessed by verbal and mathematical scholastic aptitude tests (SAT), scholastic achievement by standardized tests. The meta-analysis was based on the strategy of Glass, McGaw, and Smith (1981). For all studies, the mean true effect was $\rho = .43$ with a standard deviation of $\sigma_\rho = .22$. Analyses of moderator variables revealed a partially moderating effect of different grade levels (Elementary School: $\rho = .25$; $\sigma_\rho = .20$; Middle School: $\rho = .59$; $\sigma_\rho = .12$; High School: $\rho = .47$; $\sigma_\rho = .36$).

1.1.3. Steinkamp and Maehr (1983)

This meta-analysis integrated correlations between affect, cognitive ability and scholastic achievement in natural sciences. Since a central goal of this study was to analyze gender effects, only studies reporting gender-specific correlations were considered. For cognitive ability, 60 coefficients between 1965 and 1983 were found (number of studies and total N not reported), which were based exclusively on anglophone individuals. Grade levels ranged from elementary school to high school. Cognitive ability was assessed by standardized intelligence tests, scholastic ability by standardized and unstandardized tests. The authors employed the meta-analytic strategy of Glass (1977). For all studies, the mean true effect was $\rho = .34$ (σ_ρ not reported), with no significant effect for gender.

1.1.4. Summary of previous results

Ranging between $\rho = .34$ and .48, the mean correlation between cognitive abilities and scholastic achievement investigated in previous meta-analyses was slightly lower than generally assumed in the literature (e.g., Neisser et al., 1996). A wide range of possible moderator variables was analyzed, with significant effects only for grade level (Fleming & Malone, 1983) and the reliability of the outcome measure (Boulanger, 1981). As there was a strong focus on achievement in scientific school subjects, the bulk of primary studies addressing the impact of cognitive abilities for school achievement in other subject domains was not considered, nor were potential differences in the mean correlation between g and school grades across these subject domains analyzed.

1.2. The present study

Our goal was to identify the empirical estimate of the population correlation between g and scholastic success. We argue that school grades have a much stronger effect on an individual's subsequent school and occupational career than alternative measures of school achievement (e.g., teacher ratings, school achievement tests). Therefore we focus on scholastic success in a strict sense which means that we use school grades as a criterion exclusively.

The current study aims at investigating the population correlation between g and school grades in general and without restrictions on a specific subject domain or grade level as well as the country where the data were collected and the year the study was published. Moreover, we illustrate the moderating effect of third variables on the relationship between g and school grades.

1.3. Moderator hypotheses

To analyze moderating effects, we formulated hypotheses about potential moderating variables. We derived our assumptions from the previous meta-analyses by Boulanger (1981), Fleming and Malone (1983), and Steinkamp and Maehr (1983) as well as from the general literature on the topic. Thus, we identified five potential moderators which are presented below (details on the coding process for moderator variables will be presented in the method section).

1.3.1. Type of intelligence test

According to Gaedike (1974) and Sauer (2006), the performance in verbal intelligence tests is related more strongly to scholastic success than is the achievement in nonverbal ones. To test the moderating effect of the verbal or nonverbal character of intelligence tests, we built subgroups for either completely verbal or nonverbal intelligence tests as well as for such measurement instruments consisting of both verbal and nonverbal scales.

1.3.2. Subject domains

Previous meta-analyses (Boulanger, 1981; Fleming & Malone, 1983; Steinkamp & Maehr, 1983) concentrated on the mean correlation between g and school achievement in scientific school subjects. There are other school subjects beyond mathematics and science, which have not been considered in meta-analyses before. Hence we aimed at covering these and estimating the population correlation between g and school grades in a range of different school subjects. To reduce complexity and to reach a clear overview, we clustered the school subjects considered in the included primary studies into the following subgroups: Mathematics and Science (including e.g., mathematics, biology, and physics), Languages (including e.g., English, German, reading, and literature), Social Sciences (including e.g., social studies, history, and geography), Fine Art and Music, as well as Sports.

1.3.3. Grade level

The moderating effect of grade level on the correlation between general mental ability and school grades was analyzed by Boulanger (1981), Fleming and Malone (1983), and Steinkamp and Maehr (1983). Apart from that, Brody (1992) and Jensen (1998) point out the variation of the predictive value of g for scholastic success against the background of different grade levels. Jensen (1998) refers to correlations between g and grades which decrease from elementary school (.60 to .70) throughout high school (.50 to .60), college (.40 to .50) and graduate school (.30 to .40). As a consequence of the increasing drop-out of individuals with lower abilities during secondary school they expect a reduction in variance in g and hence a lower correlation between g and scholastic achievement in higher grade levels. In order to investigate the influence of grade level and to make the results of our analysis comparable to the previous meta-analytic findings, we clustered grade levels into the subgroups Elementary School, Middle School, and High School.

1.3.4. Gender

The meta-analysis by Steinkamp and Maehr (1983) did not reveal a significant difference between boys and girls in the correlation between g and scholastic achievement. In the current study, we tested gender as a variable moderating the relationship between g and school grades. We based the analysis on those samples that consisted of either male or female participants.

1.3.5. Year of publication

In order to investigate a potential change in the population correlation between g and scholastic achievement since the previous meta-analyses by Boulanger (1981), Fleming and Malone (1983) and Steinkamp and Maehr (1983), we separated the primary studies into two subgroups including primary studies published before 1983 and those published afterwards.

2. Method

2.1. Inclusion criteria

In this meta-analysis we considered primary studies that fulfilled the following inclusion criteria: (1) The independent variable general mental ability was measured either by standardized intelligence tests or highly comparable tests [e.g., Differential Aptitude Tests (Bennett, Seashore, & Wesman, 1947), Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy, & Kirk, 1974)]. We included primary studies with author-created measures, if it was possible to clearly classify them as