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Sex differences in fluid intelligence: Some findings from Bosnia and Herzegovina

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ABSTRACT

This study has been conducted with the aim of analyzing sex differences in fluid intelligence of schoolchildren of different ages. Three samples of schoolchildren participated in this study. Fluid intelligence was measured by Raven's Standard Progressive Matrices (SPM), Raven's Standard Progressive Matrices Plus (SPM Plus), Raven's Advanced Progressive Matrices (APM), Culture fair intelligence test, Scale II, (CFIT), D-70 and Problem solving test, (PT). Results obtained in our study indicate that at ages of 12.6 and 16 effect sizes of sex difference in performance on tests of fluid intelligence were small. At age of 17.2 boys scored almost one standard deviation higher than girls. Gender stratification could have led to different experience of boys and girls, which, in turn, could have caused investment of cognitive resources in different domains.

1. Introduction

The last century ended with the almost generally accepted statement that there are no sex differences with regard to intelligence, or, at least that existing differences are of no practical or theoretical significance. A few years later, long standing questions re-emerged, partly as a reaction to findings of Lynn and Irwing (2004) and Irwing and Lynn (2005), who had reported that men scored on average 5 IQ points higher than women did on Raven's Progressive Matrices.

The most conclusive reports about sex differences in intelligence came from meta-analytical studies. Hyde and Linn (1988) analyzed 165 studies of gender differences in verbal ability. The results they obtained indicate that gender differences in mean verbal ability are extremely small (a tenth of a standard deviation) and that such a magnitude of difference has little or no practical or theoretical significance. Linn and Petersen (1985) analyzed 172 measures of the effect size of gender differences on various measures of spatial ability, among which they distinguished three different abilities: spatial perception, mental rotation and spatial visualization. They obtained a mean effect size of .44 for spatial perception, .73 for measures of rotation, and .13 for measures of visualization, all of them indicating that males scored better than females on measures of spatial abilities. Hyde, Fennema, and Lamon (1990) analyzed 259 comparisons between males and females in mathematics performance based on the testing of close to 4 million subjects. The results they obtained show a mean effect size of .20, indicating that males scored approximately one-fifth of a standard deviation better than females. The three meta-analyses of gender difference in ability mentioned above find evidence of secular trends of decreasing gender differences in performance.

The issue of whether there are any sex differences on the general factor underlying all cognitive abilities has frequently been discussed especially with regard to usage of Raven's Progressive Matrices as one of the best measures of g. One of the first systematic reviews of evidence regarding sex differences in intelligence was presented by Court (1983), who analyzed 118 studies that had provided information on sex differences on Raven's Progressive Matrices. He found that the majority of studies suggested that there was no difference and that a review of studies suggested no difference between men and women regarding intelligence. In his analysis of the research literature on sex differences on Raven's Progressive Matrices, Mackintosh (1998) argued that the sex differences are generally small, amounting to no more than 1–2 IQ points in favor of males or females. More recently, Anderson (2004) reviewed the literature and concluded that on the Wechsler intelligence tests, and Raven's Progressive Matrices, no significant differences occurred between males and females. However, Lynn and Irwing (2004) and Irwing and Lynn (2005) argued that there had been to date no actual statistical meta-analysis of sex differences in general intelligence. Lynn and Irwing collected data from 57 studies of sex differences in general population samples on the Standard and Advanced Progressive Matrices and 15 studies of child samples on the Colored Progressive Matrices. The results showed that there are no sex differences up to the age of 15. Males obtain higher means from the age of 15 through to old age. Among adults, the male advantage is 5 IQ points. A meta-analysis of studies of child samples showed that among

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children aged 5–11 years boys have an advantage of 0.21d equivalent to 3.2 IQ points.

Halpern, Beninger, and Straight (2011) briefly summarized three origins of sex differences: sex-differentiated biological mechanisms, socialization practices and their interaction.

In biological explanation structure, organization and function of the brain and sex hormones are considered as explanatory factors for sex differences. The results of some studies suggest that males differ from females in respect of spatial abilities due to the way the brain is organized and operated. The sex hormones are the most solid biological explanatory factor that contributes to understanding the sex differences in intelligence. There is strong evidence that at various stages of life, sex hormones play an important role in brain development and subsequently in cognition (e.g., Halpern & Tan, 2001; Kimura, 1996). External factors, such as intensive exercise, stress and nutrition affect hormones, which could have consequences on behavior and emotions, which, in turn, could have short and long term effects on cognitive development. Lynn (1994, 1998, 1999) has proposed a developmental theory of sex differences in general intelligence that states that development of intelligence follows the same trend as physical maturity during childhood and adolescence. Maturation of boys and girls is at the same rate up to the age of around 7 years, after which girls begin a growth spurt in which there is an acceleration of their physical growth in respect of height, weight, and brain size. Growth rate of girls slows at the age of 14 and 15, while the growth of boys continues.

From the sociocultural perspective, there are a few theoretically grounded and empirically proven factors that could serve as an explanatory construct for sex differences in intelligence, among which the central one is gender stereotypes (e.g. Halpern & LaMay, 2000; Halpern & Beninger, 2011). Research shows that stereotypes are related to intelligence in children's toy choice (Dorval & Pepin, 1986; Levine, Vasilyeva, Lourenco, Newcombe, & Huttenlocher, 2005; Subrahmanyam & Greenfield, 1994), while parentś stereotypical views about their own intelligence might influence stereotypes of their sons and daughters about their own intelligence (Furnham, 2001; Furnham & Bunclark, 2006; Furnham & Petrides, 2004). More evidence was found about stereotypes and sex differences in intelligence within education. Halpern and LaMay (2000) suggest that there is a large distinction in sex choices in science subjects and to some extent in mathematics with respect to what comprises a positive or negative subject choice. The positive subject choice (for science subjects) among male students starts the process which in the end leads to improvement of spatial abilities, while the negative subject choice and consecutive rejections of science subjects leads to female students being absent from learning situations that involve the development of spatial abilities. Further, self-fulfilling prophecies are another explanatory construct on sex differences in intelligence (Plucker, 1996).

In sum, concerning sex differences in intelligence, there are findings that have been replicated in many studies. Firstly, females, on average, score higher than males on verbal abilities like spelling, language and perceptual speed (Feingold, 1988; Hedges & Nowell, 1995; Hyde & Linn, 1988; Kimura, 1993; Torres et al., 2006). Secondly, males score higher than females on spatial abilities, especially on those that require mechanical reasoning, mental rotation and spatial perception (Feingold, 1988; Hedges & Nowell, 1995; Hyde, 2005; Torres et al., 2006; Voyer, Voyer, & Bryden, 1995). Thirdly, there is a small effect for males over females on measure of general intelligence in some studies (Lynn & Irwing, 2004), but many other scholars consider that there is no average sex difference in intelligence (Anderson, 2004; Bartholomew, 2004; Butterworth, 1999; Geary, 1998; Haier, 2007; Halpern, 2000; Hines, 2007; Speke, 2007).

1.1. Overview of current study

Few studies conducted in Bosnia and Herzegovina have reported results concerning sex differences in cognitive abilities. In the TIMSS 2007 Report for Bosnia and Herzegovina (2008) only the sex difference for science is reported. Results show that there is no sex difference in total performance on science. Differences were found in respect of physics but the effect size was very low ($d = .065$). In the study conducted by Djapo and Lynn (2010) on subjects with age range between 15 and 18, females obtained higher means than males on Standard Progressive Matrices, but with lower variability. Effect size were large ($d = .699$).

This study has been conducted with the aim of analyzing sex differences in fluid intelligence in schoolchildren of different ages. Fluid intelligence refers to the processing of information and the ability to reason with the aim of understanding relationships and abstract propositions (Stankov, 2000). According to Gustafsson (1988), general mental ability (g) can be equated with general fluid ability. Sex differences are obtained for children average ages of 12.5, 16 and 17.2 years. In line with the results of the above mentioned study, we expect that girls at age of 12.5 years will perform better on a measure of fluid intelligence than boys the same age. Differences in the opposite direction are expected for subjects age of 16 and 17.2.

2. Methods

2.1. Participants

Three samples of schoolchildren participated in this study. Sample 1 was composed of 207 students of the sixth grade of five elementary schools. Of the total number of participants 44.4% were male. Average age of the participants was $M = 12.6$ (SD = 0.60). Sample 2 was composed of a group of 253 students of the first and second grade of one high school. Of the total number of participants 40.7% were males. The average age of participants was $M = 16.00$ (SD = 0.68). Sample 3 was composed of a group of 139 students of the third grade of three high schools which have different academic curricula. In the Secondary Electrotechnical school the curriculum is focused on technical and mathematical subjects. The curriculum of the "Obala" grammar school is focused on language and social science subjects. The "3rd" grammar school curriculum is focused on mathematics, natural and social sciences. The subsample from the Electrotechnical secondary school ($N = 43$) consists predominantly of boys (90%), the "Obala" grammar school ($N = 50$) is mainly girls (89%) and in the 3rd grammar school ($N = 46$) there are slightly more girls (57%). Of the total number of participants in sample 3, 46% were males. The average age of participants was $M = 17.21$ (SD = 0.58). All samples were drawn from Bosnian-speaking public schools from Sarajevo, Bosnia and Herzegovina.

2.2. Measures

Raven's Standard Progressive Matrices, SPM (Raven, Court, & Raven, 1994) measure fluid intelligence. SPM was constructed to measure the eductive component of g. According to Carpenter, Just, and Shell (1990) Raven's Progressive Matrices measure analytical intelligence, that is the ability to reason and produce a solution for problems involving new pieces of information, without extensive use of an explicit store of declarative knowledge. Work-time was not limited. SPM was available for sample 1 only.

Raven's Standard Progressive Matrices Plus (SPM Plus). Raven's SPM Plus (Raven, Raven, & Court, 2000) like SPM, measures fluid