COGNITIVE GENDER DIFFERENCES CONTRIBUTE TO HORIZONTAL GENDER SEGREGATION IN EDUCATIONS AND OCCUPATIONS

EXTENDED ABSTRACT

BACKGROUND

Very few educations and occupations have an equal gender distribution (1, 2). One reason for this is that men and women make different choices, due to differences in expectations and societal traditions, encouraging women and men to choose different paths. However, the educational and occupational choices may also be based on one's cognitive strengths.

Women and men are found to differ in their performance on some but not all cognitive tasks (3, 4). For example, there is a female advantage on tasks assessing reading comprehension (3) and memory (5). Men, on the other hand, are reported to perform at a higher level than women on most visuospatial tasks (6) and on some mathematical tasks (3, 5). These cognitive gender differences have been found in many regions of the world (5, 7, 8). The gender differences in cognitive profiles are mirrored in scholastic performance, with the largest gender differences favoring girls found in language courses, and the smallest in math and science courses, although girls typically receive higher grade point average (GPA) (9).

Aim. We investigate (I) to what extent one's cognitive strengths are associated with subsequent educational and occupational choices, and (II) whether gender differences in cognitive profiles are related to the unequal gender distributions in educational and occupational choices.

METHODS

Study population. The study is based on the data from full population registers which comes from the Swedish Interdisciplinary Panel, administered by the Centre for Economic Demography at Lund University. The baseline population consists of all men and women born in Sweden in 1977-1979 who attended the 9th grade of elementary school at age 16 (1993-1995). The population is restricted to men and women who later graduated with at least a gymnasium (high-school) diploma, and went on to obtain employment and reported an occupation by the age of 32 (2009-2011). The final analysis population consists of 167,766 individuals (84,264 men and 83,512 women).

Cognitive profile. As a proxy of cognitive performance, we used teacher-assigned school grades from the last year of compulsory school (9th grade; age 16). For our cohorts, school grades were reported for 16 mandatory school subjects in accordance with a scale ranging from 5 (highest grade) to 1 (lowest grade). *Grade point average (GPA)* was calculated as a simple mean of grades in all 16 compulsory subjects, separately for each student (range 1.0-5.0).

In order to determine individual's *cognitive profile*, grades in specific school subjects were used. We focused on two cognitive domains: numerical/technical and verbal/linguistic domains. To measure each individual's attainment on numerical/technical domains, we added up their school grades in "Technics", "Physics", "Mathematics", and "Chemistry" (TEC/PHY/MAT/CHE), that is subjects in which girls' advantage was smallest or non-existent. To measure verbal/linguistic abilities, grades in which girls' advantage was largest (i.e., "Swedish language", "English language", "Religion", and "Biology"; SWE/ENG/REL/BIO) were added together. By taking a difference between the sums of grades in the two cognitive domains, (SWE+ENG+REL+BIO) - (TEC+PHY+MAT+CHE), we were able to assign each individual with a cognitive profile score, which indicates by how many grade points their overall performance in numerical/technical cognitive domains is higher than their performance on verbal/linguistic cognitive domains (or the other way around).

Figure 1. Cognitive profile score distribution in the study population

A. Cognitive profile: frequencies

B: Cognitive profile: gender distribution
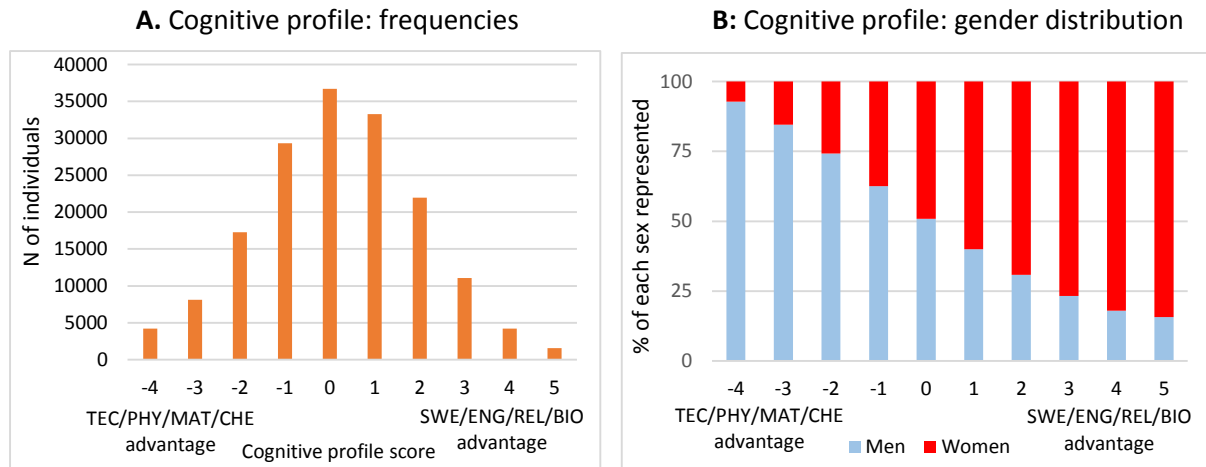
Negative values of the score indicate that the sum of grades assigned in TEC/PHY/MAT/CHE subjects is greater than the sum of grades assigned in SWE/ENG/REL/BIO subjects. According to Figure 1A, the cognitive profile score is approximately normally distributed in the population. Whereas a lot of students report comparable grades in both sets of school subjects, there is also a significant number of participants exhibiting clear cognitive profiles: some students have an advantage in TEC/PHY/MAT/CHE subjects, whereas others exhibit an advantage in SWE/ENG/REL/BIO subjects.

As indicated in Figure 1B, there is a clear gender gradient in the distribution of the cognitive profile score. Negative values of the score, signifying higher grades on TEC/PHY/MAT/CHE subjects are predominantly found in boys. In contrast, girls outnumber boys at the other end of the distribution which indicates higher grades in SWE/ENG/REL/BIO subjects.

Female-to-male proportion in education and occupation. We calculated the proportion of women in 325 educational fields for each year between 1993 and 2011 using the entire population of 16-64 year-olds in Sweden. We then matched the highest-attained educational field of every participant in the study population with the nationally-estimated female proportion in the corresponding year and field of education. The resulting measure indicates the proportion of women in the entire population of Swedish adults, who graduated from the same educational program as each of our study participants.

Similarly, we measured the proportion of women in 355 occupational roles in Sweden using the entire adult population of Sweden. We then matched each study participant's occupational title at age 32 with the corresponding occupation's female proportion estimated using the national data. The resulting measure indicates the country-wide proportion of females who were employed in the same occupation as our study participants were.

Ratings of cognitive demands of educations and occupations. We also generated the ratings of cognitive demands exerted by each of the 325 educational programs and 355 occupational titles. Psychology students, blind to the purpose of the study, rated to what extent each of the 325 educations and 355 occupations demanded numerical/technical skills (scale: 1 (low) - 7 (high)). They were also asked to rate, separately, to what extent each of the educations and occupations demanded language/verbal skills and technical/numerical skills. Student ratings were highly

correlated with each other (range of correlations for numerical/technical skills: 0.51-0.81; language/verbal skills: 0.45-0.75; Cronbach's alpha: 0.94 and 0.96, respectively).

Statistical analysis. Ordinary least square models were fitted separately for men and women. All models were adjusted for birth-year, parental education, and parental age at index person's birth. The effects of each level of cognitive profile score (-4 to +5) were estimated relative to the value of zero, which indicated identical grades in SWE/ENG/REL/BIO and TEC/PHY/MAT/CHE subjects. We adjusted for GPA in the analysis of the effects of cognitive profile in order to ensure that average performance is kept constant across the levels of the cognitive profile score. We then repeated the analysis substituting the female proportion with the mean standardized values of the student estimates of how much were numerical/technical and language/verbal skills demanded as part of the educations and occupations.

RESULTS

The aim of our analysis was to investigate if selection into educational and occupational roles, characterized by varying levels of female participation and the type of cognitive demands exerted, was associated with cognitive profile.

Female share in education/occupation. In Figure 2, predicted values of the female proportion in education and occupation according to the cognitive profile score, estimated from the OLS models, are presented. Men exhibiting a strong TEC/PHY/MAT/CHE cognitive profile select into educational (2A) and occupational (2B) careers characterized by the lowest proportion of women. Men with a cognitive profile more in favour of SWE/ENG/REL/BIO subjects, respond by selecting educational and occupational careers characterized by a higher proportion of women. For women, while the pattern is generally similar, the magnitude of the effect is weaker. Women do not appear to respond to cognitive profile as readily as men, and females with a clear TEC/PHY/MAT/CHE cognitive advantage are, nevertheless, found in heavily female-dominated educational and occupational careers.

Figure 2. Effects of cognitive profile score on female ratio in education and occupation. OLS models – predicted values estimated at variable means

A: Education – predicted values   **B:** Occupation – predicted values
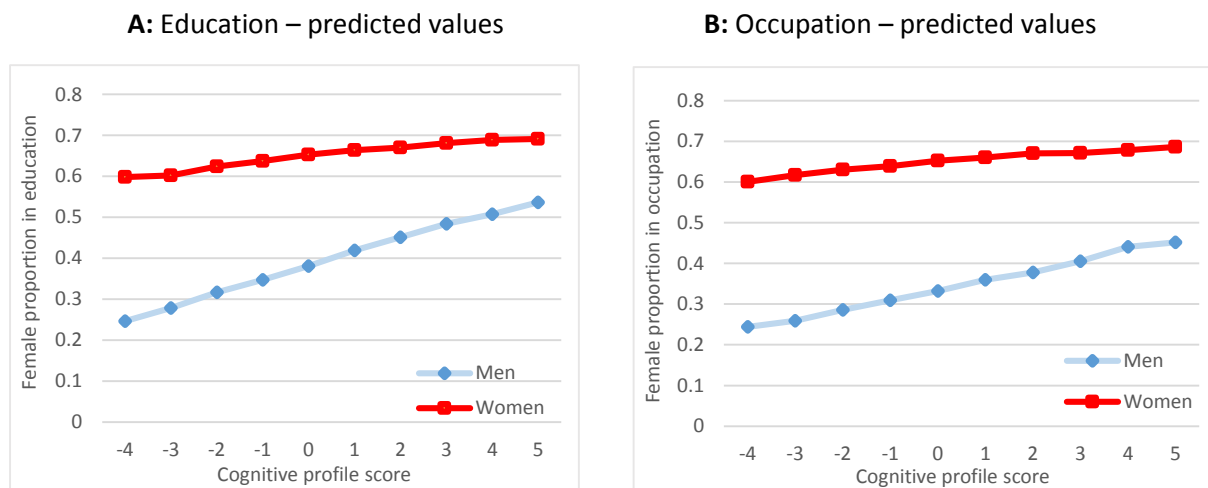
Cognitive demands of education/occupation. As can be seen in Fig. 3, our subsequent analyses demonstrate that women select into educations and occupations that are perceived to require more language skills, whereas men, in general, select into educations and occupations that are perceived to require more numerical/technical skills. Importantly, both genders make career choices reflective

of their cognitive strengths; men and women who have strengths in language and life science choose educations and occupations perceived to require such skills. Similarly, both men and women with a relative advantage in technical/numerical subjects choose educations and occupations perceived to require numerical/technical skills

Figure 3. Effects of cognitive profile score on the perceived demands of numerical/technical and language/verbal skills of the subsequently selected educations and occupations. Predicted values from the OLS models
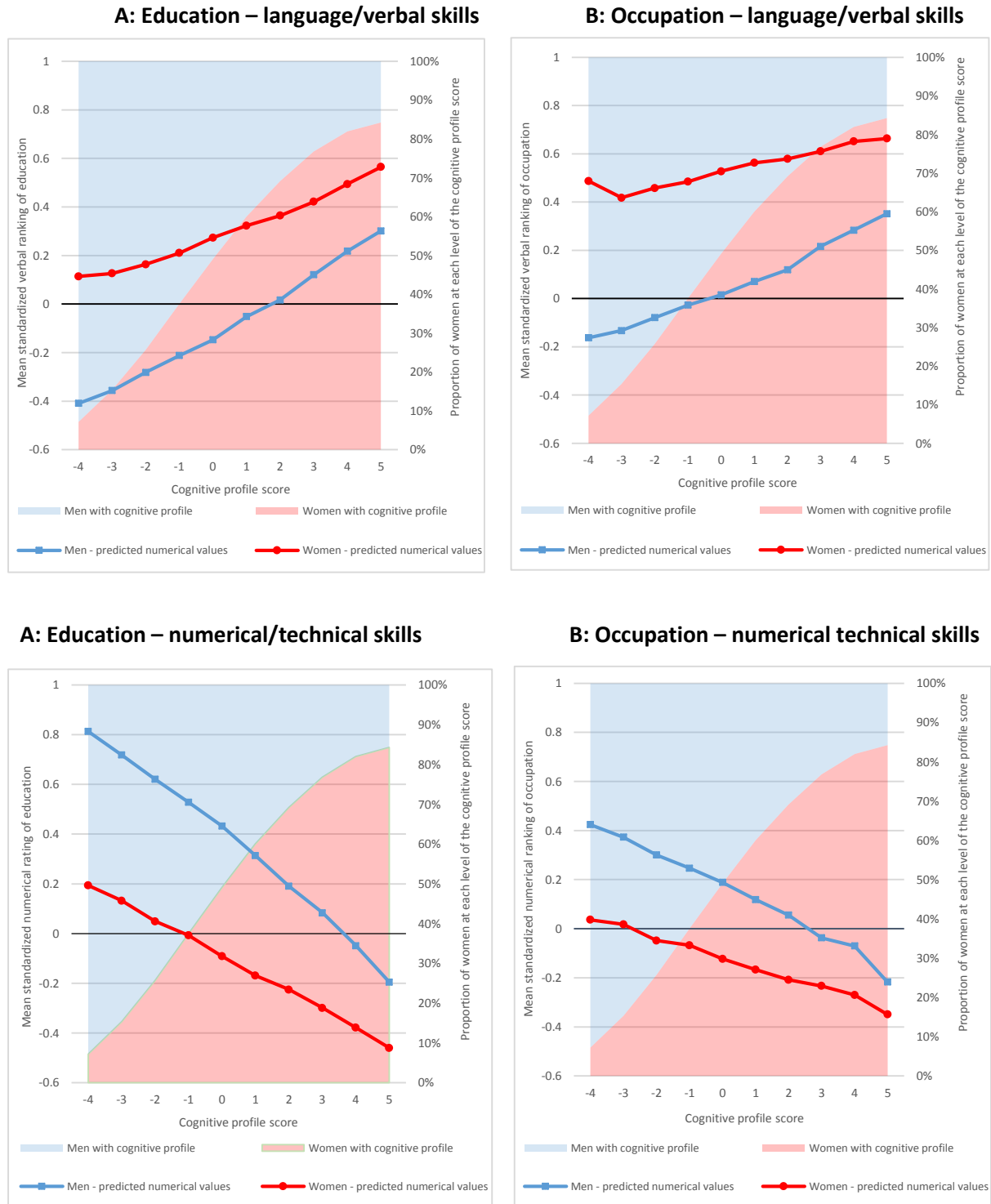
Notes: The secondary vertical axis plots the proportion of men (blue) and women (red) at each level of the cognitive profile score.

PRELIMINARY CONCLUSIONS. Although it has previously been shown that boys and girls to some extent have different cognitive strengths and that there is substantial gender segregation in educations and occupations, we demonstrate longitudinally that cognitive strengths are associated with subsequent educational and occupational choices among men and women. Both men and women with a strength in language and life science choose educations and occupations perceived to require language abilities and in which the proportion of women is relatively high. At the same time, both men and women with a cognitive strength in technical and numerical subjects choose educations and occupations perceived to require technical and numerical skills – careers that also tend to have a higher proportion of men. Furthermore, as there are gender differences in cognitive strengths, with more women than men having an advantage in language/life science and more men than women having an advantage in technical/numerical subjects, there will be more women choosing careers perceived to require language related skills, and more men choosing paths judged to require numerical/technical skills. Taken together, we demonstrate that gender differences in cognitive strengths directly contribute to gender segregation in educations and occupations, thereby having an impact on society.

Notably, our results also demonstrate that men and women with the same cognitive profile select different educations and occupations. Thus, men, regardless of their cognitive strengths, pursue careers with a higher proportion of men and which are perceived to demand more technical/numerical skills, as opposed to the careers selected by women. In addition, men make educational and occupational choices that are in line with their cognitive strengths to a greater extent than women. These findings demonstrate that in addition to cognitive factors, other influences, such as traditional gender roles and stereotypes, may influence women's and men's choices

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