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Sex differences on Raven's Standard Progressive Matrices within Saudi Arabia and across the Arab world: Females' advantage decreases from childhood to adolescence

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ABSTRACT

Sex differences in intelligence are of great importance with regard to understanding intelligence's underlying evolutionary forces. Previous research in this area has had a strong focus on Western countries and data across developmental stages are fragmented. Here, we present new data on Raven's Standard Progressive Matrices from three samples in Saudi Arabia, and combine these with nine previously published studies from other Arab countries, which also provide data for each year of age. We specifically consider Lynn's developmental theory of sex differences in intelligence, whereby a female advantage becomes pronounced due to earlier average puberty and then decreases as males enter puberty. The estimates for each age do not differ significantly from zero, and very few from each other, apparently due to large heterogeneity across studies. Nevertheless, the age trend is largely consistent with Lynn's model. Moreover, its specific predictions are seemingly borne out in many individual countries. Plausible explanations for incongruities in Sudan, Libya, Yemen and Saudi Arabia are also examined.

1. Introduction

Sex differences in intelligence are of profound theoretical importance with respect to the interactions between genetic, endocrinological, and social factors, as well as for understanding intelligence's underlying evolutionary forces. There has been much recent discussion with regard to sex differences in psychometric intelligence (hereafter IQ). Lynn (2017a) maintains that during childhood and early adolescence females tend to attain equal or higher IQ scores than males, partly because they enter adolescence at an earlier stage than do males. However, Lynn avers, males then catch up and ultimately overtake females, leaving males with a slight IQ advantage, of around 2 points. Consistent with this viewpoint, Van der Linden, Dunkel, and Madison (2017) confirmed previous findings that adult females have slightly smaller brains than adult males and that brain size robustly predicts IQ. Using detailed anatomical data from 900 individuals, they demonstrated that the sex difference in brain size did actually mediate part of the subtle male-female IQ difference. Flynn (2017) has argued that when you draw only upon large representative samples of adults using Raven's Progressive Matrices tests, in developed nations, adult male and female IQ is equal overall, although he contends that the adult female standard deviation is narrower than the male. Lynn (2017b) rejoinders that this counter-finding is due to the outlier of Argentina. In Argentina females score much higher than males for some unknown reason (Flynn, 2012, pp.149–150); possibly because it is not a fully developed country and thus has different dynamics. However, when it comes to children and adolescents, females tend to systematically outscore males in early adolescence. Thus, on one administration of Raven's Standard Progressive Matrices (SPM) in England, females aged 12 scored 0.4 SD higher than males. In New Zealand it was 0.28 SD, while in Ireland it was 0.17 (Lynn & Irwing, 2004).

These results are based on studies in developed countries and European-origin countries. Here we wish to contribute to the understanding of sex differences in IQ scores by exploring this issue in Middle Eastern countries. We will examine sex differences in IQ scores in Saudi Arabia (where we also have regional data) and compare them to sex differences in IQ scores in other Arab countries where a number of different ages are presented. This is in order to allow us to discern

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Table 1
Overview of included studies.

Country	Test	Age range	Approximate sample size per age cohort	Data collected year	Reference
UAE	CPM	8–11	200	2008	Khaleefa and Lynn (2008a)
Yemen	SPM	8–13	170	2014	Bakhiet, Al-Khadher, and Lynn (2015)
Sudan	CPM	8–25	129–366	2004	Bakhiet and Lynn (2014)
Sudan	SPM	8–19	368–559	2010	Dutton, Bakhiet, Ziada, Essa, and Blahmar (2017)
Sudan	SPM	8–19	199–408	1999	Khaleefa, Khatib, Mutwakkil, & Lynn, 2008
Libya	SPM	8–11	100	2006	Al-Shahomee and Lynn (2010)
Kuwait	SPM	8–15	674–887	2015	Ahmed, Abdel-Khalek, and Mourad (2015)
Oman	CPM	5–11	140	2008	Khaleefa, Al-Kudri, and Lynn (2012)
Syria	SPM	7–18	132–355	2004	Khaleefa and Lynn (2008b)
Riyadh	SPM	6–12	272–632	2016	Present study
Makkah 1	SPM	8–18	223–316	2010	Present study
Makkah 2	SPM	8–12	42–110	2010	Present study

patterns which may explain these differences. For the purposes of this analysis an Arab country is one whose primary language is Arabic. Thus, we do not include countries in which Arabic is a secondary language, such as Somalia.

We consider only Raven's tests, primarily because they were used in the original Lynn and Irwing (2004) study, but also because they are non-verbal, highly standardised (e.g. Simberg, 1989), and quite frequently administered across the world (Stuart-Hamilton, 1999, p. 26). Thus, in the present study, we explore the sex difference in these tests among children and adolescents with age as a group factor.

2. Method

Bakhiet et al. (2018) conducted a systematic literature review of all known administrations of Raven's matrices in Arab countries that have been published in English-language academic journals and theses. These administrations involved the Standard Progressive Matrices (SPM) and the Coloured Progressive Matrices (CPM). The SPM is a usually 60 item multiple choice test which measures abstract reasoning as a dimension of fluid intelligence. The CPM is presented on a coloured background to make it easier to follow. It is specifically designed for children, the elderly, and the mentally impaired (see Domino & Domino, 2006).

Whereas Bakhiet et al. aggregated sex differences in order to compare countries we went back to the original sources which they uncovered and acquired data separate by sex. In addition, we present both original data and data previously not published in English from Saudi Arabia.

With regard to the new data or data published in Arabic, the first Makkah sample (Makkah 1) consisted of 3209 Saudi students aged between 8 and 18 years from the Makkah region. This region includes the major cities of Mecca, Jeddah and Taif and it was from these cities that samples were taken. The sample was composed of 1613 (50.2%) males and 1596 (49.8%) females. The total sample was divided into 11 age groups aged 8 to 18 years, and the sample was stratified, selected from state schools. Each city was divided into 4 units. Parents' consent was taken to examine their children and to collect some demographic data. As for the economic level, the neighbourhoods were identified in each of the four units and classified into three levels of socio-economic status; high, medium and low. The data collection process took place between 24th April and 23rd June 2010. An analysis of these data has been published, in Arabic, in Batterjee (2014). The second Makkah sample (Makkah 2) is from Batterjee (2013) and is also a stratified sample from Mecca, Jeddah, and Taif, that was half male and half female. It was comprised of 1682 young people aged between 8 and 18 and was taken in the year 2010.

The Riyadh sample consisted of 2945 school students composed of 1562 (53%) males and 1383 (47%) females, aged 6 to 12 years, attending state schools in Riyadh, the capital of Saudi Arabia. The sample was stratified selected from schools in the north, south, east, west, and center of Riyadh, to represent all economic and social levels in the city, classifying it into three levels of the socio-economic status; high, medium and low. The data collection process took place between February and June 2016. These data were collected by a number of the present authors. We have not analyzed those below the age of 8 years because we do not have these for the other Saudi samples, leaving 1125 females and 1261 males. Accordingly, we have commenced at age 8 for the other national samples as well, totaling 13,173 females and 13,364 males.

Though children schooled in rural areas are not included in these samples, they are comparable as in all cases we are dealing with children living in and schooled in cities. Saudi state schools are non-selective and entirely single-sex (Issa, 1979). The overwhelming majority of Saudis attend state schools. There is no evidence that boys or girls are more or less likely to attend private schools. The school leaving age in Saudi Arabia is 18 and in the cities both sexes will, in practice, remain in school until this age (Al-Haqail, 1999).

3. Results

Table 1 lists the studies analyzed, their year of data collection and age and sample size ranges. Detailed data for each study and age group are listed in Table A1.

As can be inferred from Table 1, the combination of 11 age cohorts and 12 samples provides a total data set with 86 sex contrasts, 73 for Raven's SPM and 13 for Raven's CPM. The Syrian sample lacked data for the 10 year-old females, so this contrast could not be computed. All effect sizes were based on the male minus female means, yielding a negative value when females performed better and a positive value when males performed better. In summary, 40 of these contrasts were statistically significant within each sample, 32 favouring females and 8 favouring males (see Table A1).

As we want to compare sex difference effect sizes for each age group across different samples and studies, meta-analysis is the most appropriate method. Fixed-model analysis exhibited significant Q-values (Cochran's Q) from 9.8 to 217 for all but the 14 years age group (6.46), indicating substantial heterogeneity across studies. To explore whether that could be attributable to differences between the SPM and CPM, the analysis was redone on SPM data only, which decreased the Q sum total from 992.3 to 685.1, and the mean Tau-squared (T^2) marginally from 0.146 to 0.136. As a result, both the 12- and 14-year old groups exhibited homogeneity when CPM data were excluded. Concluding that a fixed model was inappropriate, Table 2 lists the heterogeneity parameters (Q, p for Q, and T^2) and the mixed-model estimates of effect size (ES), its 0.95 confidence intervals, and the *Z*- and *p*-values for the ES. The upper half of Table 2 does this for the nine samples that employed the SPM, and the lower half for the seven samples that employed the SPM and included all ages between 8 and 17 years. Thus, excluding the samples that had only 8–13 year-old children (Yemen), 8–12 (Riyadh), 8–11 (Oman and UAE), and 8–9 (Sudan 2014 and Sudan 2017)