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Research Article

No Flynn Effect in Jordan 2012-2021

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Abstract

There is growing evidence that the Flynn Effect, the secular rise in IQ scores that was observed across the twentieth century, has reached a plateau and has even gone into reverse in many Western countries. However, several recent studies report an ongoing Flynn Effect in developing countries, especially in those in the Arab world. Here we compare two samples from 2012 (N = 350) and 2021 (N = 1,491) of children in the Kingdom of Jordan. The children were 4, 5 and 6 years old and were randomly selected from kindergartens in the north, central and south of Jordan. They were administered the Wechsler Preschool and Primary Scale of Intelligence (WPPSI), a test which is designed for this age group. Factor analyses exhibited very similar factors loadings across samples and subtests, indicating high construct validity. Comparing effect sizes for the difference between the samples in both total and subtest scores, we find no evidence of any change in intelligence between the two samples. We explore the possible reasons for this apparent cessation of the Flynn Effect in Jordan among which may be the impact of the Covid-19 pandemic on the 2021 sample. We conclude that there is little reason to think that this would have interfered with how representative the sample was.

Keywords

Flynn Effect, WPPSI, Intelligence, Jordan

1. Introduction

The Flynn Effect refers to the secular rise in performance on tests of approximately 3 points per decade that has been observed in Western countries since widespread IQ measurement commenced in the 1930s. It has been argued that this

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was not on *g* [27], but, rather, reflected pronounced increases in sub-tests such as 'Similarities,' precipitated by developed societies causing people to think in an increasingly scientific fashion [13]. In many Western samples, this process began to slow down or reach a plateau, and even go into reverse by the end of the twentieth century [21]. Indeed, a so-called 'Negative Flynn Effect' was increasingly observed in Western cohorts around this time, implying that the environment had pushed 'Similarities' and related sub-tests to their phenotypic maximum [11, 30].

Meta-analyses indicate that the Flynn Effect is on-going in developing countries [13], consistent with the hypothesis that it is significantly a reflection of socio-economic development and has, therefore, not yet reached its peak in developing countries. Congruous with this model, there is evidence that it has reached a plateau in highly developed areas of developing countries, such as in a particularly wealthy region of Brazil [5]. A number of studies that have found negative Flynn Effects or no Flynn Effect in developing countries, specifically in the Arab world, have put these effects down to incomparable samples or changes in education policy [7-10]. The Flynn Effect, even if it is not on *g*, is reported to have a significant real world economic impact (e.g. [22]). Thus, it is crucial to document this effect, or its absence or reversal, wherever it may be found, in order to try to understand its causes in the greatest detail possible. Here, we, therefore, explore whether there is still a Flynn Effect in the Kingdom of Jordan.

Officially known as the Hashemite Kingdom of Jordan, this nation of about 10 million people borders Saudi Arabia, Iraq, Syria, Israel and Palestine. It is 95% Sunni Muslim and it gained full independence from Britain in 1946, having previously been part of the Ottoman Empire until 1916 [23]. Schooling is compulsory in Jordan between the ages of six and sixteen, and the enrollment rate is 95% [29] p. 199. As of 2015, adult literacy was 93%, with an illiteracy rate of 30% among those over the age of 55, with illiteracy being more pronounced among females [29] p. 199. In 2012, kindergarten (pre-school, 4-5 years of age) enrollment in Jordan was 59%, which is relevant as we will draw upon kindergarten samples [2]. In 2020, the rate of kindergarten enrollment was 41% [18]. Kindergarten was offered online during the Covid-19 pandemic of 2020 to 2021 [1]. In Jordan, kindergarten is free but voluntary [26]. As of 2019, the enrollment rate for pre-school was 59% [6, 14]. Unfortunately, it has not been possible to find earlier reliable statistics on this matter.

Whether or not a Flynn Effect has occurred can be measured by comparing two age-controlled samples separated by a significant period of years, with many studies comparing samples around a decade apart (see [11, 13]. The Flynn Effect, indeed, is usually measured by comparing two age-controlled samples, across a decade or more, using exactly the same instrument. This optimally permits us to see if any rise or fall in average IQ has occurred between samples. In this study, we compare two school samples in order discern if there has been any change in intelligence. To these ends, we examine possible changes in the *g*-loading of tests, because the environmental sources of higher test taking results are associated with generally lower *g*-loadings [20]. Another important use of *g*-loadings is to assess if the possible change occurs on more or less *g*-loaded subtests, as a higher *g*-loading is believed to reflect a stronger association with genotypic intelligence.

2. Method

We compared data from two studies: an unpublished doctoral thesis that measured the intelligence of children in 2012 [3] and an article that did the same thing in 2021 ([4] published in Arabic).

Al-Mustafa administered the Jordanian version of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) to a sample of 350 Jordanian children aged between 4 and 6, with equal numbers of boys and girls in each age group. It was comprised of 174 males and 176 females [3]. These children were taken from kindergartens in north, central and south Jordan and were chosen at random in the first term of the school year 2012-2013. The validity of the test was assessed through content validity, construct validity, and convergent validity. The content validity was assessed through translation and back-translation, which was then evaluated by a group of 12 experts with specialization in measurement, evaluation, and education. The percentage of approval was high on the contents of the scale. Construct validity was assessed through correlations between the items and their subscale, and correlations between the subscales and with the total score, as well as through factor analysis. Convergent validity was assessed by the correlation with the Stanford Binet Intelligence Scales (Third Edition; SB3), which was 0.69. The split-half reliability was 0.802 for the verbal scales, 0.739 for the performance scales, and 0.874 for the total scale. Cronbach alpha was as 0.804 for the verbal scales, 0.765 for the performance scales, and 0.875 for the total scale. The second study collected data in the same manner as the first in a sample of 1,491 children about ten years later.

3. Results

Table 1 shows the factor solution for the sub-tests in the 2012 sample, across the sexes, with factor loadings for each of the performance and verbal factors as well as for the general factor. Table 2 shows the same analyses for the 2021 sample, and it can be seen that the factor structure is highly similar across the samples.

Table 1. *Sources of variance in WWPSI (3rd Ed) among the 350 children in the 2012 sample.*

Subtest	General		VS		PS		h^2	u^2
	b	***Var***	***b***	***Var***	***B***	***Var***		
Information	0.65	42.25	0.41	16.8			65.3	34.2
Vocabulary	0.63	39.69	0.42	17.6			64.5	43.7
Arithmetic	0.62	38.44	0.46	21.2			62.3	42.7
Block design	0.62	38.44	0.48	23.0			61.2	37.1
Comprehension	0.62	38.44	0.42	17.6			61.3	40.2
Animal	0.61	37.21			0.37	13.7	60.5	45.7
Picture completion	0.58	33.64			0.36	13.0	56.2	33.4
Mazes	0.57	32.49			0.36	13.0	58.7	37.5
Geometric design	0.58	33.64			0.42	17.6	54.6	41.7
Similarities	0.58	33.64			0.38	14.4	57.3	47.4
Total		35.4		4.1		3.1	53.2	38.7
Common		71.6		8.2		6.2		
ω	0.87		0.82		0.61			
ω_h	0.8		0.32		0.12			

Note. *b* = standardized factor loading; *Var* = % variance explained; h^2 = communality; u^2= uniqueness; VS= Verbal scale; PS= Performance scale; ω = omega; ω_h = omega hierarchical; factor loadings ≥ 0.30 are in bold

Table 2 shows the same results for the 2021 sample, confirming that the factor solutions are very similar for the two samples.

Table 2. *Sources of Variance in WWPSI (3rd Ed) among the 1491 children in the 2021 sample.*

Subtest	General		VS		PS		h^2	u^2
	b	***Var***	***b***	***Var***	***B***	***Var***		
Information	0.68	46.24	0.42	17.6			67.2	34.2
Vocabulary	0.66	43.56	0.43	18.5			65.3	44.3
Arithmetic	0.66	43.56	0.48	23.0			64.1	40.2
Block design	0.67	44.89	0.49	24.0			61.4	37.4
Comprehension	0.64	40.96	0.44	19.4			63.5	41.3
Animal	0.63	39.69			0.39	15.2	61.2	44.5
Picture completion	0.6	36.00			0.41	16.8	58.3	32.7
Mazes	0.61	37.21			0.38	14.4	60.4	40.4
Geometric design	0.59	34.81			0.40	16.0	57.7	49.5
Similarities	0.6	36.0			0.37	13.7	59.6	44.6
Total		36.4		4.3		3.4	55.4	46.2
Common		72.8		8.6		6.8		

Subtest	General		VS		PS		h^2	u^2
	b	***Var***	***b***	***Var***	***B***	***Var***		
ω	0.91		0.87		0.64			
ω_h	0.82		0.38		0.13			

Note. *b* = standardized factor loading; *Var* = % variance explained; h^2 = communality; u^2 = uniqueness; VS = Verbal scale; PS = Performance scale; ω = omega; ω_h = omega hierarchical; factor loadings ≥ 0.30 are in bold

We also performed confirmatory factor analyses for both samples, the main results of which are listed in Tables 3 and 4.

Table 3. *Goodness of fit statistics for CFA in the 2012 sample (n=350).*

Model	X^2	*Df*	*p*	*CFI*	*RMSEA*	*SRMR*
Ages 4.00 to 6.6						
General factor	875.54	87.11	0.01	0.88	0.08	0.07
General verbal and performance factor	487.44	76.1	0.01	0.93	0.07	0.05
BiFactor	154.22	167.22	0.01	0.95	0.06	0.06

Table 4. *Goodness of fit statistics for CFA in the 2021 sample (n=1,491).*

Model	X^2	*Df*	*p*	*CFI*	*RMSEA*	*SRMR*
Ages 4.00 to 6.6						
General factor	940.54	90.23	0.01	0.89	0.06	0.06
General verbal and performance factor	501.44	86.11	0.01	0.95	0.05	0.03
BiFactor	189.22	190.22	0.01	0.97	0.05	0.03

Again, we can see that both samples exhibit excellent model fits. As regards the differences in magnitude between the samples, Al [3] does not report a breakdown by sex and we must, therefore, compare the weighted means across the sexes. Table 5 reports descriptive statistics for each sub-test in the 2012 sample, and Table 6 for the 2021 sample.

Table 5. *Descriptive statistics for the 2012 sample.*

Chronological age	Indicator	Comprehension	Similarities	Arithmetic	Vocabulary	Information
4 (*N* = 498)	*M*	17.04	14.91	10.79	24.73	15.39
	SD	4.35	3.89	3.12	8.08	2.88
5 (*N* = 495)	*M*	19.26	15.65	13.79	29.61	16.72
	SD	4.53	3.32	3.03	7.20	3.15
6 (*N* = 498)	*M*	24.07	17.40	17.60	34.80	19.04

	SD	4.76	4.21	2.57	7.18	3.06
Total verbal	*M*	20.12	15.99	14.06	29.72	17.05
	SD	4.55	3.81	2.91	7.49	3.03
	Indicator	Block design	Geometric design	Mazes	Picture completion	Animal house
4 (*N* = 498)	*M*	9.50	12.05	11.61	14.68	27.95
	SD	3.44	3.37	3.582	3.19	8.08
5 (*N* = 495)	*M*	11.31	16.58	16.25	16.01	33.67
	SD	4.24	3.74	4.491	3.22	11.07
6 (*N* = 498)	*M*	15.18	21.14	19.810	19.11	41.16
	SD	3.56	4.76	4.126	3.60	10.66
Total performance	*M*	12.00	16.59	15.89	16.60	34.26
	SD	3.75	3.96	4.07	3.34	9.94

Table 6. *Descriptive statistics for the 2021 sample.*

Chronological age	Indicator	Comprehension	Similarities	Arithmetic	Vocabulary	Information
4 (*N* = 498)	*M*	16.06	13.83	11.50	23.71	14.40
	SD	4.22	3.72	3.32	7.34	2.8
5 (*N* = 495)	*M*	18.99	15.88	14.33	28.54	15.45
	SD	4.43	3.11	3.22	7.11	3.32
6 (*N* = 498)	*M*	25.33	18.66	18.22	33.54	20.33
	SD	4.21	3.55	2.44	7.28	3.22
Total verbal	*M*	20.13	16.42	14.68	28.60	16.73
	SD	4.29	3.46	2.99	7.24	3.11
	Indicator	Block design	Geometric design	Mazes	Picture completion	Animal house
4 (*N* = 498)	*M*	9.87	12.43	10.89	13.43	26.44
	SD	3.44	3.37	3.58	2.99	8.11
5 (*N* = 495)	*M*	12.32	18.22	16.22	16.33	32.43
	SD	4.21	3.66	4.21	3.12	12.44
6 (*N* = 498)	*M*	16.32	22.34	20.12	21.43	42.44
	SD	3.65	4.12	4.12	3.22	9.34
Total performance	*M*	12.84	17.66	15.74	17.06	33.77
	SD	3.77	3.717	3.97	3.11	9.96

To aggregate across the subtests in order to provide a fair assessment of a possible Flynn Effect, Cohen's effect sizes were computed for each subtest (10) and age group (3), using the maximum likelihood estimator method [15] with the pooled SD calculated according to [19]. The means of these effect sizes across the five subtests in each domain of abilities (verbal vs. performance) are plotted in Figure 1. Positive values means higher scores in 2021 than in 2012, so Figure 1 suggests a trend that in 2021 the 4-year-olds perform worse, the 6-year-olds perform better, and there is no difference for the 5-year-olds. These differences were not statistically significant, however (t = 1.005 (4 years), t = 0.024 (5 years), t = -1.095 (6 years), df = 164-170, according to the Welch–Satterthwaite equation).

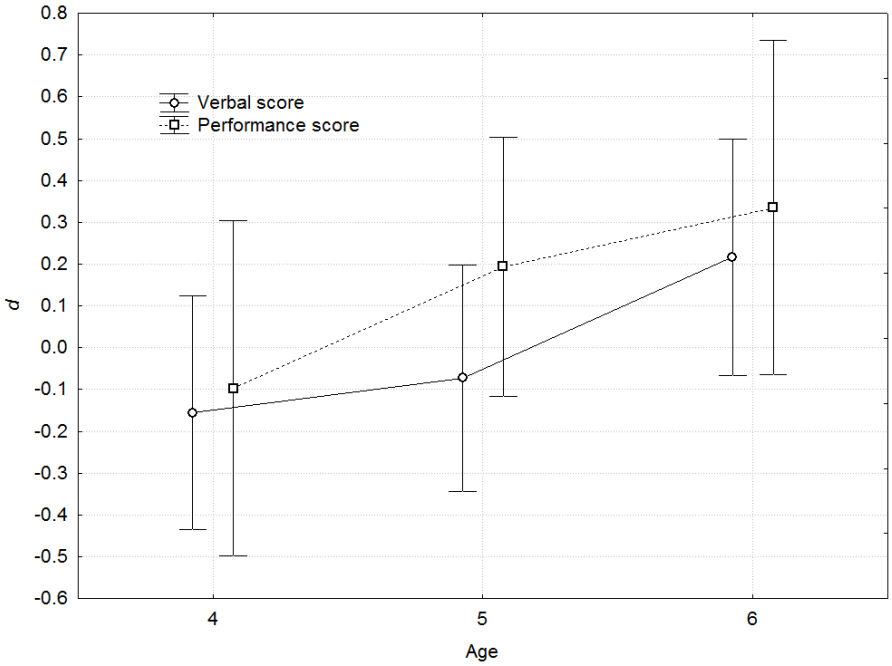

Figure 1. *Effect size for the sample difference (2021 – 2015) as a function of age and verbal or performance sub-scores.*

Further partitioning the results by sub-test, we note that there are several fairly large differences across the samples. As many comparisons are made, we need to adjust for multiple comparisons, in the sense that 30 comparisons together have a higher risk of false positives. Bonferroni correction yields a critical *t*-value of 3.39 at alpha 95 and 100 degrees of freedom (*df*), which surpasses the actual *df* that vary between ~156 and 191, according to the Welch–Satterthwaite equation. There were only five out of the 30 subtest sample differences that had higher *t*-values than this, namely picture completion for the 4-year-olds (negative), comprehension (positive) and information (negative) for the 5-year-olds they, and information and picture completion for the 6-year-olds (both positive). Positive means that they perform better in 2021. Aggregating across age or across subtests renders no differences between 2012 and 2021 statistically significant, however.

Table 7. *Mean test scores for year and age, across subtests.*

	2012		2021	
Age	**M**	**SD**	**M**	**SD**
4	15.86	6.03	15.25	5.51
5	18.89	7.09	18.87	6.46
6	22.93	8.41	23.87	8.11

We conclude that these effects constitute normal sample variation, as they exhibit no systematic trend across years. In fact, the grand total means are almost identical at 19.23 (SD = 7.58) for 2012 and 19.33 (SD = 7.46) for 2021. Future research may explore the reality of the age trend suggested here in other samples. The means for each age and year across subtests are listed in Table 7. Otherwise, there were no significant differences between the two samples.

Finally, we computed the correlation between *g* and *d* across the 10 subtests, which was -.368 for the 2012 sample and -.295 for the 2021 sample. This result should be interpreted with caution, because the correlations are not statistically significant, given the small *N* of 10 and that the variability in *g*-loadings was very small (.57-.68), as seen in Tables 1-2.

4. Discussion

We assessed whether any increase in intelligence has occurred across this nine year period. This was not the case, in terms of overall means across subtests. There were some interactions with age and with subtest, but they were inconsistent. In particular, we did not find any systematic relationship between time and the performance and verbal sections of the test, respectively. A Flynn effect is typically associated with a larger increase in performance subtests than in verbal subtests [24].

As the Flynn effect is seemingly mainly environmental in nature, an increase across time should be negatively correlated with *g*. The negative correlation between *g* and *d* across the 10 subtests is therefore consistent with the Flynn effect.

More specifically for the present results, the negative correlation means that subtests whose scores increased were less *g*-loaded than those that decreased, even though there was no overall change. In other words, inasmuch as some scores increased, they tended to do this for more *g*-loaded subtests, opposite to what is predicted for the Flynn effect (for a review, see [12]).

There are several limitations to be considered. First, the data were not broken down by sex, so we could not assess possible different trends for boys and girls. Future studies should address this issue. Second, the data might have been impacted by an apparent decline in kindergarten participation across the period, seemingly due to the effect of the Covid-19 pandemic during the time of the second administration. It is true that kindergartens in Jordan offered online learning during the period in which pre-schools were closed [1]. But it is evident that many parents simply withdrew their children from kindergarten participation. If this disproportionately impacted lower socioeconomic status Jordanians, who we would predict to have lower average IQ (see [17]), perhaps due to their lacking internet access, then we might predict a Negative Flynn Effect, but there is no clear Negative Flynn Effect according to these data. However, the parents would have been relatively young and thus very likely to have had internet access. On the other hand, it may be that wealthier Jordanians were more inclined to keep their children away from pre-school during the pandemic. But this is just speculation, as we can find no evidence for it in newspaper reporting. Other educational trends in Jordan across the period also gives us little reason to conclude that the two data sets are not comparable. The percentage of primary school-aged children not enrolled in school was 25% in 2013 and 20% in 2020, a relatively small difference [16]. There was no significant difference across this period in the percentage of children attending kindergarten [28], something that is further congruous with these two datasets being comparable. Across the period of study, unemployment rose significantly in Jordan [25] which might lead to be more impoverished environments for children, interfering in a moderate fashion with intellectual development but, even if this is so, it does not appear to be reflected in our results.

We conclude that the simplest interpretation of these data is that the Flynn Effect has ceased among children in the Kingdom of Jordan. This is consistent both with the naught overall difference and with the negative correlation between *g* and *d*, since the Flynn effect is mainly environmental in nature, in which case a higher Flynn Effect across time would be negatively correlated with *g*. This aligns with the model that has been proposed wherein developing countries should lag behind developed countries in reaching their phenotypic maximum on subtests that are more susceptible to the Flynn Effect, just as was observed in a number of European countries a few decades ago [13].

The reported limitations warrant further examination of more samples, with their being sex separated, as the performance in this age range can differ to some extent, contributing to error variance. Further, there are some indications that the Flynn effect may operate differently upon the performance of boys and girls [5].

Highlights

1) Flynn Effects are ongoing in many developing countries
2) In some, they have plateaued or reversed
3) In a number of developing countries, this reversal is due to artifacts
4) We find no Flynn Effect in Jordan nor any clear evidence of artifacts

Abbreviations

BMI Body Mass Index

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Conflicts of Interest

The authors declare no conflicts of interest.

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