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The effect of demographic variables on the assessment of cognitive ability

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Abstract

Background: This study examines the effect of parental educational levels, sex, and family structure on the WISC-V Full Scale IQ (FSIQ) and primary index scores (VCI, VSI, FRI, WMI, and PSI) in a representative sample of children from Spain (N = 1008). **Method:** Differences between demographic groups were examined using independent-samples *t-test*, ANOVA and Hochberg *post hoc* tests. A multiple regression analysis was performed to examine whether demographic variables could predict children's FSIQ score. **Results:** Results showed that the parents' educational level was a significant predictor of children's FSIQ and significant increases in mean FSIQ and primary index scores were found as the parents' educational level increased. Sex was not a significant predictor of children's FSIQ but slight sex differences were found for PSI. The family structure was a significant predictor of FSIQ but its contribution to the global model was small. Children from two-parent families obtained higher FSIQ, VCI, VSI, and FRI mean scores than children from single parent families. **Conclusions:** The results support the design of a normative sample stratified by demographic variables. Parental education levels, as a good predictor of children's FSIQ score, must be taken into account as a key stratification variable.

Keywords: Parental education level, cognitive ability, IQ, WISC-V, sex, family structure.

Resumen

El efecto de las variables demográficas en la evaluación de la aptitud cognitiva. **Antecedentes:** este estudio examina el efecto del nivel educativo parental, el sexo y la estructura familiar sobre el CI total (CIT) y los índices primarios del WISC-V en una muestra representativa de niños españoles (N = 1008). **Método:** las diferencias entre grupos demográficos se examinaron mediante pruebas t, ANOVA y tests *post hoc* de Hochberg. Se realizó un análisis de regresión múltiple para examinar si las variables demográficas podían predecir la puntuación CIT de los niños. **Resultados:** los resultados mostraron que el nivel educativo parental era un predictor significativo, se observaron incrementos significativos en las puntuaciones del CIT y de los índices conforme se incrementaba el nivel educativo parental. El sexo no fue un predictor significativo, pero se observaron ligeras diferencias en el índice de velocidad de procesamiento. La estructura familiar fue un predictor significativo, pero su contribución al modelo general fue pequeña. Los niños de familias biparentales obtuvieron puntuaciones superiores en el CIT y los índices a las de los niños de familias monoparentales. **Conclusiones:** los resultados apoyan el diseño de muestras normativas estratificadas por variables demográficas. El nivel educativo parental es un buen predictor del CIT de los niños y debe considerarse una variable de estratificación relevante.

Palabras clave: nivel educativo parental, aptitud cognitiva, CI, WISC-V, sexo, estructura familiar.

Despite the effect of genetics on cognitive ability (Haworth et al., 2009; Wright et al., 2001), environmental factors can interact with genetics and influence IQ (Marcus Jenkins, Woolley, Hooper, & De Bellis, 2013; Toga & Thompson, 2005). Environmental influences, including family rearing environment, socioeconomic status, diet, and schooling, can play a significant role in the malleability of cognitive ability (Marcus Jenkins et al., 2013; Kendler, Turkheimer, Ohlsson, Sundquist, & Sundquist, 2015; van Ijzendoorn, Juffer, & Poelhuis, 2005).

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Parental education level is a variable associated with both genetic and environmental mechanisms which influence neuro-development and cognitive ability (Lange, Froimowitz, Bigler, & Lainhart, 2010). The education level of biological parents is associated with intelligence heritability, but a portion of the IQ of adopted siblings can also be explained by the educational level of their adoptive parents (Kendler et al., 2015). Specifically, parent education can be associated with environmental factors such as socioeconomic status, schooling, community resources and variables related to cognitively enriching environments that enhance intellectual development and skill acquisition (Weiss, Saklofske, Prifitera, & Holdnack, 2006; Weiss et al., 2016). Additionally, structural equation modeling analyses in an adolescent Portuguese sample showed that parent education level predicts adolescents' intelligence regardless of family income. The authors concluded that brighter parents raise brighter children, suggesting a causal chain: parental intelligence differences are behind the educational level they reach, promoting best occupations, and greater incomes (Lemos, Almeida, & Colom, 2011).

Results from the WISC-IV US normative sample showed a significant correlation (r = .43) between children's Full Scale IQ (FSIQ) and parent education level. The difference between the mean FSIQ score of children whose parents dropped out of high school (M = 87.1, SD = 15.7) and those whose parents completed college (M = 108.7, SD = 15.0) was more than 20 points. The difference between the mean FSIQ score of children whose parents graduated from high school (M = 94.5, SD = 15.9) and those whose parents completed college was 14.2 points. The number of parents living in the home was also associated with offspring IQ differences in the WISC-IV US normative sample. In comparison with dual parent families, children of single parent families showed lower mean FSIQ scores, ranging from 0.6 to 6.5 points (Weiss et al., 2006).

The differences between children's mean FSIQ and parent education level in the WISC-V US normative sample showed the same pattern as the WISC-IV. The difference between the mean FSIQ score of children whose parents dropped out of high school (M = 88.6, SD = 16.2) and those whose parents completed college (M = 108.0, SD = 14.0) was 19.4 points. The difference between the mean FSIQ score of children whose parents graduated from high school (M = 93.8, SD = 13.4) and those whose parents completed college was 14.2 points. In this sample, parent education level explained 18.7% of variance in FSIQ scores (Kaufman, Raiford, & Coalson, 2016). Sex differences in the WISC-V US normative sample showed some significant differences; however, for all but index scores that involve processing speed, mean differences were slight. The difference between the mean Processing Speed Index score of females (M = 103.0, SD = 14.8) and males (M = 97.0, SD = 14.7) was 6.0 points, p < .01 (Kaufman, Raiford, & Coalson, 2016). The impact of the number of parents living in the home on children's cognitive ability test scores was similar to WISC-IV results. Children of dual parent families obtained higher mean FSIQ scores than single parent families by 4 to 6 points on average (Weiss et al., 2016).

The association between offspring cognitive performance and parental demographic variables has also been found in samples from Spain. FSIQ mean scores differences for children aged 2:6 to 7:3 were associated with socioeconomic status, $F(4, 1141) = 12.90$, p < .01, and parent education levels, $F(3, 1095) = 23.20$, p < .01 (Wechsler, 2009). For adolescents, the association between parental educational/occupational levels and cognitive performance on verbal, numeric, and reasoning tasks was also reported. The ratio of having a high cognitive performance (top quartile) in adolescents with high parent educational/occupational level was 1.6 to 2.4 times higher than for those with lower parent educational levels in Spain (Castillo et al., 2011).

The results of the social inclusion report in Spain (Marí-Klose et al., 2009) support the intergenerational transmission of school failure and success. This report shows a significant effect of both parent educational level and the family's educational and cultural resources on children's performance on math and reading as assessed during PISA 2006 testing.

The main purpose of the current study is to examine the effect of parent educational level, sex, and family structure on the WISC-V FSIQ and primary index scores in a representative sample of children from Spain. We expect to find significant increases in mean FSIQ and primary index scores as parent educational level increases. We expect to find separate small effect of sex and family structure on cognitive ability.

Method

Participants

A total of 1008 children from the WISC-V normative sample from Spain were included. The mean age for boys (n = 508) was 11.17 years (SD = 3.19) and for girls (n = 500) was 11.35 years (SD = 3.14). In all cases, the father, mother or a legal tutor signed a consent form.

The sample was stratified by sex, age, parent educational level, geographic region, and population density following the rates published in the Spanish population census (INE, 2011).

Parent educational level was broken down into four categories following the description provided by the census. If the child was living with only one of the parents, that parent's educational level was used. If the child was living with both parents but they differed in their educational level, the highest level was used. The four categories were: Without studies (didn't finish primary education); First grade (finished primary education or grade 6); Second grade (finished secondary education, high school diploma, vocational degree, or equivalent); and Third grade (university degree, college degree or graduate degree).

Geographic region was determined by splitting up Spain into four regions: North (Asturias, Cantabria, Castilla y León, Galicia, La Rioja, Navarra y País Vasco), South (Andalucía, Islas Canarias y Murcia), East (Cataluña, Comunidad Valenciana e Islas Baleares), and Center (Aragón, Castilla-La Mancha, Extremadura y Madrid).

Population density was defined as Urban (population equal o higher than 50 000 residents); Medium (population between 10 000 and 49 999 residents); and Rural (population lower than 10 000 residents).

Table 1 provides demographic characteristics of the sample compared to the population in Spain.

Instruments

Escala de inteligencia de Wechsler para niños-V (Wechsler Intelligent Scale for Children-Fifth Edition); WISC-V (Wechsler, 2015)

Participants' cognitive abilities were assessed with the WISC-V Spanish version adapted and published in Spain. This version is composed of 15 subtests yielding the FSIQ, 5 primary index scores and 5 ancillary index scores. For this study, the FSIQ and the primary index scores were included: Verbal Comprehension Index (VCI), Visual Spatial Index (VSI), Fluid Reasoning Index (FRI), Working Memory Index (WMI), and Processing Speed Index (PSI).

The WISC-V Spanish showed good psychometric properties. Internal consistency coefficients were excellent for the primary indexes (from r = .88 to r = .93) and the FSIQ (r = .95). The test-retest stability coefficients were good to excellent for primary indexes (from r = .74 to r = .87), and the FSIQ (r = .89) (Prieto & Muñiz, 2000).

Confirmatory factor analysis results showed a good fit for the 5 factor structure (primary index scores) proposed in the US version, including the crossloading of Arithmetic in the Working Memory and Fluid Reasoning factors. Concurrent validity analyses and special groups studies also provide external validity for the WISC-V Spanish structure (Wechsler, 2015).

Sociodemographic Questionnaire

After the parent or legal tutor signed the consent form, they were asked to fill out a questionnaire with additional demographic variables, including parent educational level, geographic region and population density.

Family structure was defined by the number of parents living in the home. Children who were living with only one parent/tutor were considered single parent families and children living with both parents/tutors were considered dual parent families.

Procedure

The analyses conducted in this study are based on the WISC-V Spanish normative sample collected from September 2014 through May 2015. During the standardization phase, 85 examiners with assessment experience were recruited and trained to administer the WISC-V. The 15 subtests included in the WISC-V were administrated following the standard order and testing guidelines defined in the *Administration and Scoring Manual* (Wechsler, 2015).

Data collected by examiners were scored and entered into a database by the Pearson Clinical & Talent Assessment scoring team, which was trained for this purpose.

Data analysis

Differences between groups in sex and family structure were examined using independent-samples *t*-test, and effect size was computed using Cohen's *d* formula:

$$d = \frac{x_1 - x_2}{\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_1^2}{n_1 - n_2 - 2}}}$$

For interpretation purposes, values for Cohen's *d* that range from .20 to .49 are reported as small effect sizes, values that range from .50 to .79 are reported as moderate effect sizes, and values of .80 or greater are reported as large effect sizes (Cohen, 1988).

Differences in parent educational level between groups were examined with ANOVA tests. When homogeneity of variance was violated, Welch's *F* is reported. The effect size computed is omega squared (ω^2) using the formula:

$$\omega^2 = \frac{SS_M - (df_M)MS_R}{SS_T + MS_R}$$

Where SS_M is the between-group effect, df_M is the degrees of freedom for the effect, MS_R is the mean squares, and SS_T is the total amount of variance in the data. For interpretation purposes, ω^2 values of .01, .06 and .14 represent small, medium and large effects respectively (Kirk, 1996).

To analyze where the differences between parent educational level groups lie, Hochberg *post hoc* tests were computed. The effect size was computed using Cohen's *d* formula.

Finally, a multiple regression analysis was computed to examine if parent educational level could predict children's FSIQ score. Children's FSIQ score was defined as the dependent variable and sex, parent education level, and family structure were defined as predictors. A hierarchically forced entry method was used and predictors were introduced in the model in two steps. Parent education level was introduced in a first step and the rest of predictors were introduced in a second step.

Several assumptions were considered to draw conclusions from the regression analysis. The VIF values and the tolerance statistics were examined to assess multicollinearity. Partial plots, histogram and normal probability of the residuals were checked to test the homoscedasticity and linearity of the model, and the independence and normal distribution of the errors. Extreme and influential cases were also examined. It was considered that standardized residuals for 95% of the cases should lie within ±2, and 99 % of the cases within ±3. Cook's and Mahalanobis distances, the average leverage, and DFBeta and covariance ratio values were also examined to look for influential cases.

Results

Demographic characteristics of the sample compared to the population in Spain are presented in Table 1. These data indicate a close correspondence between the normative sample and the Spanish population census proportions.

FSIQ, VCI, VSI, FRI, and WMI mean scores didn't show significant differences by sex. The mean PSI score was higher for females (M = 102.20, SD = 14.84) than for males (M = 98.16, SD = 13.99), this difference was significant with a small effect size ($t(1006) = -4.45$, $p<.001$, $d = -.28$).

Taking into account the family structure, 9.4% of boys and 8.0% of girls from the sample were included in the category single parent family. Children from dual parent families obtained higher FSIQ, VCI, VSI, and FRI mean scores than single parent families. WMI and PSI mean scores didn't differ significantly between

Table 1
Percentages of the Spanish sample and population by sex, parent education level, geographic region, and population density

	Sample		Population[a]	
Variable	**Male**	**Female**	**Male**	**Female**
Sex	50.4	49.6	51.6	48.4
Parent education level				
Without studies	1.4	1.6	1.6	1.7
First grade	9.6	7.2	9.6	9.7
Second grade	59.8	63.0	63.8	63.5
Third grade	29.1	28.2	25.0	25.0
Geographic region				
North	16.1	16.4	18.3	18.3
South	33.1	30.2	28.7	28.7
East	27.6	30.6	29.5	29.5
Center	23.2	22.8	23.4	23.4
Population density				
Urban	52.6	55.8	50.5	50.6
Medium	27.2	23.2	29.2	29.1
Rural	19.9	21.0	20.3	20.3

[a] (INE, 2011)

children from single and dual parent families. Mean differences between single and dual parent families are presented in Table 2.

Table 3 presents the FSIQ and primary index mean scores of children in the sample by parent education level. Mean FSIQ and primary index child's scores generally increase substantially with each increase of parent education level. The mean FSIQ for children whose parents didn't finish primary education is 21.2 points lower than those whose parents completed college; children whose parents completed primary education obtained a mean FSIQ 13.6 points lower than those whose parents completed college; and children whose parents completed secondary education obtained a mean FSIQ 6.0 points lower than those whose parents completed college.

An analysis of variance showed a significant linear trend indicating that as the parent education level increase, FSIQ score of children increase proportionately Welch's F (3, 63.34) = 43.91, $p < .01$, $\omega^2 = .09$. ANOVA results also showed a significant linear trend for VCI, $F(3, 1004) = 29.70$, $p < .01$, $\omega^2 = .06$; VSI, $F(3, 1004) = 22.96$, $p < .01$, $\omega^2 = .05$); FRI, $F(3, 1004) = 34.39$, $p < .01$, $\omega^2 = .07$; WMI, Welch's F (3, 61.39) = 15.78, $p < .01$, $\omega^2 = .04$; and PSI, $F(3, 1004) = 10.42$, $p < .01$, $\omega^2 = .02$.

Hochberg *post hoc* tests to detect where differences between relevant groups lie are presented in Table 4. *Post hoc* tests didn't reveal significant differences between the Without studies and First grade parent education level groups and effect size values were small. *Post hoc* tests showed significant differences between the First grade and Second grade parent education level groups for the FSIQ and primary index scores; effect size values were moderate for FSIQ and VCI and small for the rest. *Post hoc* tests between Second and Third grade parent education level groups showed significant differences for the FSIQ and primary index scores, except for the PSI; effect size values were small.

Table 2
Means differences for FSIQ and primary index scores, by family structure

	Single		Dual				
	Mean	**SD**	**Mean**	**SD**	***t*(1006)**	***p***	***d***
FSIQ	95.16	13.50	100.45	13.64	-3.48	<.01	-.39
VCI	96.10	13.39	100.27	13.86	-2.70	<.01	-.30
VSI	96.81	14.14	100.12	14.26	-2.09	<.05	-.23
FRI	94.83	14.65	100.45	14.55	-3.46	<.01	-.39
WMI	98.14	13.46	100.17	14.25	-1.29	.20	-.14
PSI	100.07	12.50	100.17	14.74	-0.75	.94	-.01

Table 3
Means and standard deviations for FSIQ and primary index scores, by parent education level

	Without studies (*n* = 15)	First grade (*n* = 85)	Second grade (*n* = 619)	Third grade (*n* = 289)
	Mean (*SD*)	**Mean (*SD*)**	**Mean (*SD*)**	**Mean (*SD*)**
FSIQ	83.9 (8.2)	91.5 (16.5)	99.1 (13.0)	105.1 (12.2)
VCI	86.9 (10.3)	92.4 (16.1)	99.3 (13.2)	104.2 (13.2)
VSI	88.2 (10.7)	94.0 (15.2)	98.8 (13.9)	104.4 (13.7)
FRI	85.1 (11.7)	93.0 (15.4)	98.8 (14.3)	105.3 (13.3)
WMI	91.5 (13.2)	92.9 (16.3)	99.4 (14.1)	103.7 (12.6)
PSI	91.6 (13.3)	94.3 (15.5)	100.3 (14.5)	102.0 (13.9)

Table 4
Post hoc tests for FSIQ and primary index scores between parent education level groups

	Difference	***SE***	***p***	***d***
Without studies vs. First grade				
FSIQ	-7.66	3.66	.199	-.49
VCI	-5.43	3.76	.618	-.36
VSI	-5.80	3.89	.583	-.40
FRI	-7.88	3.95	.246	-.53
WMI	-1.43	3.88	.999	-.09
PSI	-2.66	4.03	.986	-.18
First grade vs. Second grade				
FSIQ	-7.61	1.51	<.001	-.56
VCI	-6.89	1.55	<.001	-.51
VSI	-4.78	1.61	.018	-.34
FRI	-5.75	1.63	.003	-.40
WMI	-6.53	1.60	<.001	-.45
PSI	-6.06	1.67	.002	-.41
Second grade vs. Third grade				
FSIQ	-6.00	0.93	<.001	-.47
VCI	-4.93	0.96	<.001	-.37
VSI	-5.62	0.99	<.001	-.40
FRI	-6.55	1.00	<.001	-.46
WMI	-4.31	0.99	<.001	-.32
PSI	-1.70	1.03	.461	-.12

The correlation between parent education level and FSIQ score of children was $r = .31$, $p<.001$. Table 5 presents the results for hierarchic multiple regression analysis. Parent education level was a significant predictor for FSIQ in the first step of the model and explained 9.5% of the variance; with each increase of parent education level, the FSIQ score increased 6.66 points. In the second step of the model, along with parent education level, sex and family structure were included as predictor variables. This model explained 10.1% of the variance in FSIQ score, which represents a small but significance increase ($\Delta R^2 = .006$, $p = .03$). The sex contribution to the model was not significant, whereas the family structure contribution was small and significant ($\beta = .08$; $p = .01$). ANOVA results showed that models from step 1 and 2 fit the data significantly ($p < .001$); however, model from step

Table 5
Results for hierarchic multiple regression analysis (*N* = 1008)

	R²	***B***	***SEB***	***β***
Step 1	.095**			
Constant		85.52	1.47	
Parent education level		6.66	0.65	.31**
Step 2	.101*			
Constant		79.56	3.23	
Parent education level		6.49	0.65	.30**
Sex		-0.59	0.82	-.02
Family structure		3.77	1.46	.08*

* *p*< .05
** *p*< .001

1 (F = 105.38) is a better predictor than model from step 2 (F = 37.67).

The inspection of assumptions of multicollinearity, homoscedasticity, linearity of the model, and the independence and normal distribution of the errors indicate that regression results could be generalizable to the population.

Eight extreme cases were identified, the analyses of Cook's and Mahalanobis distances, the average leverage, and DFBeta and covariance ratio values didn't indicate that these cases might be influencing the regression model. The model was tested removing the eight extreme cases and the model explained the 10.4% of the variance in Step 1 and 11% of the variance in Step 2 (R^2 = .104 for Step 1, p < .001; ΔR^2 = .007 for Step 2, p = .03).

Discussion

This study examines the effect of parent educational level, sex, and family structure on the WISC-V FSIQ and primary index scores in a representative sample of children from Spain. As expected, results showed an association between parent educational level and children's scores with significant increases in mean FSIQ and primary index scores as parent educational level increases.

Mean differences for FSIQ between the lowest and the highest parent educational level were around 20 points, higher than 1 *SD* (15 points) and similar to differences reported in WISC-IV and WISC-V US normative samples (Kaufman et al., 2016; Weiss et al., 2006; Weiss et al., 2016). The correlation between parent education level and FSIQ score of children in the Spanish sample was moderate (r = .31). This result is similar to the correlation reported in Sweden between IQ scores of siblings and their biological parents' educational level, who also reared them (r = .34; Kendler et al., 2015) but lower than the correlation reported in the WISC-IV US normative sample (r = .43; Weiss et al., 2006).

Results showed that parent education level was a significant predictor of children's FSIQ supporting the association of parent education level with intelligence heritability and cognitively-enriching rearing environments. Parent education level explained 9.5% of variance FSIQ scores in the Spain sample vs. the 18.7% of FSIQ in the US sample (Kaufman et al., 2016). Variability across countries in the access to community resources, differences in the relationship between parent education level and socioeconomic resources, and the level of uniformity for public and private schools could explain the lower effect of parent education level on FSIQ scores in the Spanish sample.

The pattern of differences between the lowest and the highest parent educational level was similar across the primary index scores. The WMI and the PSI showed the smallest mean difference between children whose parents didn't finish primary education and children whose parents completed college, these results are in line with the expected lower contribution of WMI and PSI to the g factor.

Post hoc tests between pairs of groups showed that differences between children whose parents didn't finish primary education and children whose parents completed primary education were not significant. Differences were significant between children whose parents completed primary education and children whose parents completed secondary education and, in general, the differences between this pair of groups showed the highest effect size. Mean differences between children whose parents completed secondary education and children whose parents completed college were also significant except for the PSI. Significant differences found between groups highlight the relevance to represent properly the parent education level in normative samples.

Sex was not a significant predictor of FSIQ score. In general, mean differences by sex were not found in FSIQ and primary index scores, only the PSI mean was significantly higher for females than for males with a small effect size. Similar processing speed sex differences were previously reported in the WISC-V US normative sample (Kaufman et al., 2016).

The family structure was a significant predictor of FSIQ but its contribution to the global model was small. Children from dual parent families obtained higher FSIQ, VCI, VSI, and FRI mean scores than children from single parent families. In the WISC-IV and WISC-V US normative sample, children from single parent families also showed lower FSIQ mean scores relative to children from dual parent families. It may be that the reduced household income for single parents, in turn reduces the access to quality schools and other cognitive enrichment environments, and the reduction of time available to engage in cognitively stimulating activities (Weiss et al., 2006; Weiss et al., 2016).

The results of the present study must be interpreted with consideration of the methodological limitations. First, the analyses were performed with a stratified general sample and the results cannot be generalized to clinical populations. Second, this study is based on cross-sectional data and we consider out of scope of this study to establish causal relationships between demographic variables and cognitive ability.

In summary, the results of this study provide support for the association between parent educational level and children's cognitive ability scores. From an applied point of view, current results support the design of a normative sample stratified by demographic variables closely approximated to census data. Parent education level, as a good predictor of children's FSIQ score, must be taken into account as a key stratification variable. Percentages for First grade (finished primary education or grade 6); Second grade (finished secondary education, high school diploma, vocational degree, or equivalent); and Third grade (university degree, college degree or graduate degree) must be closely represented, as they represent about 98% of the sample. Under-representation of the Without studies group implies a trivial impact on norms, as it represents a low percentage of the sample (1.1 to 2.6%). Additionally, parent education level is more reliably reported than household income or other related indicators of socioeconomic status, and is a variable associated with intelligence heritability and cognitively-enriching rearing environments which influence cognitive ability.

References

Castillo, R., Ruiz, J. R., Chillón, P., Jiménez-Pavón, D., Esperanza-Díaz, L., Moreno, L. A., & Ortega, F. B. (2011). Associations between parental educational/occupational levels and cognitive performance in Spanish adolescents: The AVENA study. *Psicothema, 23*(3), 349-355.

Haworth, C. M. A., Wright, M. J., Martin, N. W., Martin, N. G., Boomsma, D. I., Bartels, M., …, & Plomin, R. (2009). A twin study of the genetics of high cognitive ability selected from 11,000 twin pairs in six studies from four countries. *Behavior Genetics*, *39*(4), 359-370. doi: 10.1007/s10519-009-9262-3

Kaufman, A. S., Raiford, S. E., & Coalson D. L. (2016). *Intelligent testing with the WISC-V.* Hoboken, NJ: John Wiley & Sons.

Kendler, K. S., Turkheimer, E., Ohlsson, H., Sundquist, J., & Sundquist, K. (2015). Family environment and the malleability of cognitive ability: A Swedish national home-reared and adopted-away cosibling control study. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(15), 4612-4617. doi: 10.1073/pnas.1417106112

Lange, N., Froimowitz, M. P., Bigler, E. D., & Lainhart, J. E. (2010). Associations between IQ, total and regional brain volumes and demography in a large normative sample of healthy children and adolescents. *Developmental Neuropsychology, 35*(3), 296-317. doi: 10.1080/87565641003696833

Lemos, G. C., Almeida, L. S., & Colom, R. (2011). Intelligence of adolescents is related to their parents' educational level but not to family income. *Personality and Individual Differences*, *50*(7), 1062-1067. doi: 10.1016/j.paid.2011.01.025

Marí-Klose, P., Marí-Klose, M., Granados, F. J., Gómez-Granell, C., & Martínez, A. (2009). Informe de la inclusión social en España 2009 [Social inclusion report in Spain 2009]. Barcelona: Fundació Caixa Catalunya.

Marcus Jenkins, J. V., Woolley, D. P., Hooper, S. R., & De Bellis, M. D. (2013). Direct and indirect effects of brain volume, socioeconomic status and family stress on child IQ. *Journal of Child and Adolescent Behavior*, *1*(2), 100-107.

Prieto, G., & Muñiz, J. (2000). Un modelo para evaluar la calidad de los tests utilizados en España [A model to evaluate the quality of tests used in Spain]. *Papeles del Psicólogo, 77,* 65-71.

Toga, A. W., & Thompson, P. M. (2005). Genetics of brain structure and intelligence. *Annual Review of Neuroscience*, *28*, 1-23.

van Ijzendoorn, M. H., Juffer, F., & Poelhuis, C.W. (2005). Adoption and cognitive development: A meta-analytic comparison of adopted and non adopted children's IQ and school performance. *Psychological Bulletin, 131*(2), 301-316. doi: 10.1037/0033-2909.131.2.301

Wechsler, D. (2009). *Escala de inteligencia de Wechsler para preescolar y primaria-III* [Wechsler preschool and primary scale of intelligence-Third edition]. Madrid: TEA Ediciones.

Wechsler, D. (2015). *Escala de inteligencia de Wechsler para niños-V* [Wechsler intelligent scale for children-Fifth edition]. Madrid: Pearson Educación.

Weiss, L. G., Harris, J. G., Prifitera, A., Courville, T., Rolfhus, E., Saklofske, D. H., & Holdnack, J. A. (2006). WISC-IV interpretation in societal context. In L. G. Weiss, D. H.Saklofske, A. Prifitera, & J. A. Holdnack (Eds.), *WISC-IV: Advanced Clinical Interpretation* (pp. 1-58). Burlington, MA: Elsevier Academic Press.

Weiss, L. G., Locke, V., Pan, T., Harris, J. G., Saklofske, D. H., & Prifitera, A. (2016). WISC-V use in societal context. In L.G. Weiss, D. H. Saklofske, D. H., J. A. Holdnack & A. Prifitera (Eds.), *WISC-V Assessment and Interpretation* (pp. 123-185). San Diego: Academic Press.

Wright, M., De Geus, E., Ando, J., Luciano, M., Posthuma, D., Ono, Y., …, & Boomsma, D. (2001). Genetics of cognition: Outline of a collaborative twin study. *Twin Research, 4*(1), 48-56.