Do birth order, family size and gender affect arithmetic achievement in elementary school?

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Resumen

Introducción. Durante décadas el orden de nacimiento y las diferencias de género han atraído la atención de la investigación.

Método. El orden de nacimiento, el tamaño de la familia y género, y la relación con el rendimiento aritmético es estudiada en 1152 alumnos de educación elemental (540 niñas, 612 niños) en Flanders. Los niños fueron seleccionados atendiendo al estatus socioeconómico de los padres y se les administró un test de cálculo mental y conocimiento de números.

Resultados. Los hallazgos favorecen a los niños y sugieren que sólo los niños y nacidos en último lugar en familias extensas se muestran menos competentes en aritmética que los nacidos primero. En contraste con la predicción de Zajonc que señalaba que en familias con tres, cinco o más niños, eran los nacidos en medio quienes lo hacían mejor.

Discusión. El estudio está parcialmente en línea con la hipótesis de confluencia y disolución. Las diferencias en función del orden de nacimiento pueden explicarse por la ventaja de la tutorización que los primogénitos realizan sobre los más pequeños ayudándoles en el procesamiento de la información. Sin embargo, nuestros datos proporcionan evidencias sobre que el orden de nacimiento explica sólo el 2% o 3% de la varianza. Los análisis muestran que los nacidos en último lugar presentan puntuaciones pobres tanto en familias pequeñas (dos elementos) como en familias grades (cinco o más elementos). Sin embargo, las desventajas de los benjamines y las ventajas de los primogénitos no están presentes en familias con tres o cuatro hijos.

Palabras Clave: orden de nacimiento, tamaño familia, género, cálculo mental, conocimiento de números, educación elemental

Abstract

Introduction. For decades birth order and gender differences have attracted research attention.

Method. Birth order, family size and gender, and the relationship with arithmetic achievement is studied among 1152 elementary school children (540 girls, 612 boys) in Flanders. Children were matched on socioeconomic status of the parents and administered a test on mental arithmetic skills and on number knowledge.

Results. Our findings tend to favor boys and suggest that it is possible that only children and lastborn children in large families are less competent in arithmetic than first born children. In contrast with the prediction of Zajonc, in families with three and five or more children middle children did best. Moreover, our dataset was not compatible with the Admixture hypothesis.

Discussion. The study was partially in line with the Confluence and the Resource Dilution hypothesis. The birth order differences might be explained by the advantage of tutoring younger children by first born or middle children, helping them to process information. However, our data provides evidence that birth order accounts for only two or three percent of the variance in arithmetic scores. Analyses of our dataset demonstrate that last borns have poorer scores in small (family size 2) and large (family size 5 or more) families. However, the last-born disadvantage and first born advantage was slight is not present in families with three or four children.

Introduction

Birth order and family size

For decades birth order attracts research attention. Since Galton (1874) elaborated on the superiority of the first born, and Adler (1870-1937) developed a theory of how later borns vary in personality depending on family size, studies provide evidence that birth order is related to intelligence (e.g., Belmont & Marolla, 1973; Kristensen & Bjerkedal, 2007).

Negative associations between birth order and intelligence have been found in numerous studies (e.g., Kristensen & Bjerkedal, 2007). Children from large families perform poorer on intelligence tests, with a gradient of declining scores with rising birth order. However also opposite results are present. Several studies fail to provide evidence that birth order is related to intelligence scores (Blake 1989, Retherford & Sewell, 1991; Rodgers, 2000, 2001). Some of these inconsistencies are explained by methodological considerations (Ernst & Angst, 1983; Sulloway, 1996, 2001; Zajonc, 1976). Earlier reported birth order effects on intelligence are attributed to factors that vary between, not within, families (Wichman, Rodgers, & MacCallum, 2006). Often there are also confounding factors in the analysis, such as the ignorance of the parental background differences and other selection biases. In general, on the one hand cross-sectional studies often reveal that the higher the birth order, the lower the IQ. On the other hand, longitudinal studies usually demonstrate no relationship between birth order and IQ. However, the tendency for large families to produce lower IQ children holds regardless of the research design (Rodgers, Cleveland, van den Oord, & Rowe, 2000).

Several researchers have claimed that being first-born confers a significant educational advantage that persists when considering earnings (Black et al., 2005; Hertwig, Davis, & Sulloway, 2002; Kantarevic & Mechoulan, 2006; Paulhus, Trapnell, & Chen, 1999; Sulloway, 1996; Van Eijck & De Graaf, 1995; Zajonc, 2001). The study of Van Eijck and De Graaf (1995) reveals that oldest and youngest children do better at school compared with their brothers and sisters. Also Hertwig et al. (2002) expects the same pattern. Nevertheless Zajonc (2001a) shows a limited but positive impact of birth order till the age of 11 ±2 years, namely better scores for young brothers and sisters. After the age of 11 ±2 year an inverse pattern is supposed, with lower scores for high birth order or late born children. An exception on this pattern are the only children, they are expected to perform worst. There are also data revealing no effect of birth order on school results (Beer & Horn, 2000; Rodgers, 2001).

It has been show that birth order is associated with a 'theory of mind' and 'executive functioning' as preschooler (Mc Alister & Peterson, 2006), probabilities of private school attendance and grade retention (Conley & Glauber, 2006), male sexual orientation (Bogaert & Liu, 2006), depression or internalized symptoms (Asal & Abdel-Fattah, 2007; Marleau, Saucier, & Allaire, 2006), overweight in girls (Wang et al., 2007), and even with the likelihood that parents divorce (Caceres-Delpiano, 2006).

The explanation of the relationship between birth order and intelligence or educational advantage is not clear, and several hypotheses have been suggested. One family of hypotheses suggests that the relation is due to prenatal gestational factors, suggesting an effect of maternal antibody attack on the fetal brain. Maternal antibody levels tend to increase by higher bird orders in a suggested mechanism parallel to rhesus incompatibility. Another family of hypotheses suggests that the relation is due to more-favourable interaction and stimulation of low-birth order children (Kristensen & Bjerkendal, 2007). Page and Grandon (1979) have suggested the *Admixture Hypothesis*. They argue that other factors, like socioeconomic status, may be responsible for both large families and low IQ, making it especially appear in cross-sectional studies. Parents with lower socioeconomic status tend to have more children. On the other hand, the *Confluence Model* was proposed by Zajonc and Markus (1975) and Zajonc (1976, 2001). This model explains the firstborn IQ advantage in terms of the ever-changing intellectual environment within a family (Berbaum & Moreland, 1980). Firstborns do not have to share their parents' attention, so they benefit from their parents' complete absorption in the new responsibility. Later-born children never experience this advantage. Firstborn children are, according to this model, also exposed to more adult language. In addition, the act of tutoring to their younger siblings helps the older children to process information. Therefore firstborns will be more intelligent than only children, but as more children enter the family, the general intellectual environment becomes less mature. It is expected that firstborns and older children from large families have lower IQs than firstborns and older children from smaller families. Zajonc's theory has been much criticized, especially confounding birth order with both age and family size. The *Resource Dilution Model* was proposed by Blake (1981) and elaborated by Downey (2001), Hertwig, Davis and Sulloway (2002). Proponents of this hypothesis assumpt that on average, the more children the lower the quality of each child parental resources, such as money, personal attention and cultural objects such as books. Additional siblings reduce the share of parental resources received by any one child. Also parental

resources have an important effect on children's educational success. However in large families, older brothers or sisters can also enrich the environment. In these families later born children will have more advantages than middle born children.

Gender

A comparison between the research data highlights considerable overlap in arithmetic performance of boys and girls (e.g., Cheung & Rudowicz, 2003; Desoete, 2007a&b). However, often significant differences in aritmetic performance tend to favor boys (e.g., Evans, Schweingruber, & Stevenson, 2002; Geary, 2007; Olszewski-Kubilius & Turner, 2002). Boys seem to perform better than girls, especially when it comes to solving word problems, to fast and accurate arthithmetic facts retrieval from long-term memory, and to mental representation, abstraction, estimation and spatial-mechanical skills (Casey, Nuttall, & Pezaris, 2001; Voyer, & Sullivan, 2003). Boys are also found to use more often direct retrieval and covert or unconventional solution strategies for the aritmetic problem solving than girls (e.g., Carr, Jessup, & Fuller, 1999; Geary, Bow-Thomas, Liu, & Siegler, 1996). As a group they seem more variable in their performance, meaning that the fastest boys are faster than the fastest girls but the slowest boys are slower than the slowest girls (Geary, Saults, Liu, & Hoard, 2000; Royer et al., 1999). However, there is evidence that gender differences tend to decrease (Eisenberg, Martin, & Fabes, 1996; Roebken, 2007) of even disappear (Frost, Hyde, & Fennema, 1994; Pajares & Graham, 1999). Recent analyses indicate that gender differences in mathematics during the elementary and middle school years are often no longer found when total scores are examined, although researchers using detailed process analyses of children's learning still find gender differences as early as first grade (e.g., Carr, Jessup, & Fuller, 1999). Gender differences seem especially obvious in high school children and adolescents, but no longer for the older generation (Geary et al., 2000). Nevertheless there are also studies available where boys score significantly lower on aritmetic problem solving (e.g., Freeman, 2003; Zabel & Nigro, 2001) and seem less motivated than girls (e.g., Peetsma, Roeleveld, & Stoel, 2003; Seegers & Boekaerts, 1996).

Aim and research questions

In sum, expectations are far from clear-cut and several inconsistencies remain in the relationship between performance and birth order and gender. In addition, most research on birth order has been devoted to understand the relationship with intelligence or personalities.

There is little research and certainly no consensus concerning arithmetic (Desoete, 2007b) in relationship to birth order and family size.

In the current study we focus on three major aims. First, the present study aims to investigate if elementary school children with a different birth order differ on arithmetic performances and if oldest and youngest children differ at arithmetic compared with children with a different biological rank. Elementary school children were selected to avoid a prevalence fallacy with an excess of subjects coming from small families in which firstborns make up a high proportion of all births. In addition parental background differences or socioeconomic status as potential confounding factor are controlled by matching children from small families with the children from large families. According to the Admixture Hypothesis, it is hypothezed that no birth order or family size effect will appear if we control for socioeconomic status. The second aim of this study is to investigate the impact of family size and to investigate whether firstborn children in small families are better in arithmetic compared with first born children in large families and whether firstborn children equal the performances of only children. According to the Resource Dilution Model, first born children in large families are hypothezed to do worse than first born children in small families. According to the Confluence Model, firstborns and only children will perform better than later-born children, because they benefited from their parents' complete absorption in the new responsibility, where later-born children never experienced this advantage. However, firstborns will perform better than only children, because they tutor to their younger siblings. In addition oldest and youngest children are compared with middle born children, since they are supposed to do better at school compared with their brothers and sisters. Third, the present study aims to investigate whether boys differ in performance from girls in relationship to birth order and family size. It is hypothesized that boys will have equal arithmetic performances and therefor gender will have no value added in the prediction of arithmetic performances.

Method

Participants

The initial sample (*n*=2061) was referred by us to 16 participant elementary schools. Permission for children to participate in this study was obtained from their parents. In the initial dataset 15% of the children were only child, 41.1% of the children lived in a family of two children, 33% of the children lived in a family of three children, 7.3% had three brothers of

sisters and the family size was five in 1.9% of the children (1.9%). In addition, family size was six till twelve in 1.4% of the sample. The birth order in the initial sample was 48.2% first, in 37.9% second, in 11.5% third, in 1.6% fourth, in 0.3% fifth, in 0.4% sixth, seventh or eight.

A combination of criteria (anamnesis, testing) was used to include 1152 children (612 boys, 540 girls) out of the initial sample (see Table 1). All children with family size 4, 5, 6 and more ($n = 224$) and all only-children ($n=309$) were included. In addition, children from families with two ($n=302$ out of the initial 848) or three ($n=317$ out of the initial 680) children were included, if they could be matched with one of the children from large families or with one of the only children on gender, school/group, age- , and socioeconomic status based upon not more than 3 month difference in date of birth and not more than 2 years of difference between the level of education of both parents.

Table 1. *Birth order and family size in the sample.*

	Family size												
Birth order	1	2	3	4	5	6	7	8	9	10	11	12	Total
1	309	152	116	24	6	2	0	0	0	0	0	0	609
2	0	150	100	56	17	3	4	1	1	0	0	1	333
3	0	0	101	44	10	1	1	1	1	1	1	0	161
4	0	0	0	27	3	2	0	0	1	0	0	0	33
5	0	0	0	0	4	2	1	0	0	0	0	0	7
6	0	0	0	0	0	2	3	1	1	0	0	2	9
Total	309	302	317	151	40	12	9	3	4	1	1	3	1152

Measures and statistical Analysis

The Kortrijk Arithmetic Revision Test (Kortrijkse Rekentest Revision, KRT-R) (Baudonck et al., 2006) is a 60-item Belgian mathematics test on domain-specific knowledge and skills, resulting in a percentile on mental computation, number system knowledge and a total percentile. The psychometric value has been demonstrated on a sample of 3,246 Dutch speaking children. The KRT-R measures performances on mental computation (e.g. 129+879=…) and number system knowledge (e.g. add three tens to 61 and you have …). We used the standardized percentiles based on national norms.

All subjects were assessed in February with the KRT-R (Baudonck et al., 2006). The examiners, all psychologists, received practical and theoretical training in the assessment and interpretation of mathematics. The training took place two weeks before the start of the assessment. In addition, systematic, ongoing supervision and training was provided during the assessment of the first 25 children. The training included a review and discussion of the KRT-R student profiles and involved one meeting during the assessment period.

Results

Differences in arithmetic performances relating to birth order

To investigate if children with a different birth order differ on arithmetic performances, when age, socio-economic status of the parents and family size are controlled for, four MANCOVA's (multi-variate analyses of covariance) were conducted with mental arithmetic and number knowledge (on the KRT-R) as dependent variables and gender as covariate in families with at least five children, four children, three children and two children.

Birth order in families with al least five children

The MANCOVA on families with at least five children revealed a trend for birth order (F (10, 120) = 1.591, p =.117, η^2=.117) and for gender (F (2, 60) = 1.974, p =.148, η^2=.062) but no interaction-effect (F (10, 120) = 0.793, p =.635). Tukey post hoc analyses revealed that sixth or last born children (post hoc index [a]) did worse than fourth born and first born children (see post hoc index [b] in Table 2).

Birth order in families with four children

The MANCOVA on families with four children was not significant for birth order (F (6, 284) = 0.603, p =.728; Power = 0.240) but a significant effect for gender (F (2, 142) = 3.305, p =.040, η^2=.044) and an interaction-effect F (6, 284) = 1.220, p =.025, η^2=.025) was present.

Last born girls (M=27.33; SD=21.523) did significantly worse on number knowledge than first (M=42.20; SD=33.638) and second (M=46.20; SD=28.512) born girls. The same birth effect was not found in boys (last born boys M=57.25; SD=26.206; first born boys M=42.93; SD=28.389; second born boys M=48.23; SD=35.338).

Table 2. *Birth order in families of different size.*

		Birth order 1	Birth order 2	Birth order 3	Birth order 4	Birth order 5	Birth order 6 or more	
		$n=8$	$n=27$	$n=16$	$n=6$	$n=7$	$n=9$	$F(5, 67)=$
Family size 5 or more	Mental arithmetic	53.88[b]	38.85	29.94	65.83[a]	42.57	22.22[b]	2.687*
		(26.134)	(30.250)	(23.496)	(19.984)	(36.391)	(20.055)	
	Number knowledge	43.13	38.44	36.19	66.50	38.86	20.44	1.630
		(31.503)	(34.763)	(27.203)	(29.528)	(35.206)	(21.361)	
		$n=24$	$n=56$	$n=44$	$n=27$			$F(3, 147)=$
Family size 4	Mental arithmetic	45.79	46.71	43.43	49.44			0.251
		(32.712)	(29.177)	(26.169)	(30.173)			
	Number knowledge	42.63	47.63	40.70	40.63			0.486
		(29.974)	(31.580)	(29.775)	(27.739)			
		$n=116$	$n=100$	$n=101$				$F(2, 314)=$
Family size 3	Mental arithmetic	49.55[b]	77.29[a]	67.64				36.727*
		(27.919)	(20.243)	(23.353)				
	Number knowledge	47.41[b]	86.94[a]	69.45				98.734*
		(27.811)	(18.797)	(19.594)				
		$n=152$	$n=150$					$F(1, 300)=$
Family size 2	Mental arithmetic	74.11	57.31					35.425**
		(19.649)	(28.606)					
	Number knowledge	80.51	62.03					61.843**
		(10.500)	(26.975)					

** $p<.0005$

* $p<.05$

[ab] refer to posthoc indexes $p<.05$

Birth order in families with three children

The MANCOVA on families with three children was significant on the multivariate level for birth order ($F(4, 622) = 39.822$, $p<.0005$; $\eta^2=.230$) and gender ($F(2, 310) = 8.714$, $p<.0005$; $\eta^2=.053$) with a significant interaction effect ($F(4, 620) = 3.289$, $p<.05$; $\eta^2=.021$).

Tukey post hoc analyses revealed that all second born boys and girls (index [a]) did better than first born or oldest children (see index [b] in Table 2). Moreover, last born boys ($M=76.84$ $SD=15.656$) did significantly worse than second born boys ($M=90.96$; $SD=6.071$). Although not significant, the same birth effect was found in girls (last born girls $M=62.10$; $SD=20.405$; second born girls $M=82.92$; $SD=9.302$).

Birth order in families with two children

The MANCOVA on families with two children was significant on the multivariate level for birth order (F (2, 297) = 26.768, p <.0005; η^2=.153) but not for gender (F (2, 297) = 1.108, p =.331; Power=.244) with a significant interaction effect (F (2, 297) = 7.644, p ≤.001; η^2=.049).

All first born boys and girls did better than last born children on mental arithmetic (see Table 2). In addition, first born boys (M=83.82; SD=9.120) did significantly better than last born boys (M=58.40; SD=31.248) on number knowledge. Although not significant, the same birth effect was found in girls (first born girls M=77.21; SD=10.803; last born girls M=68.68; SD=14.588) for number knowledge.

Differences in arithmetic performances relating to family situation and family size

To investigate whether only children are better in arithmetic compared with first born children and whether first born children in small families are better arithmetic compared with first born children in larger families, two MANCOVA's were conducted with mental arithmetic and number knowledge performance (on the KRT-R) as dependent variables, gender as covariate and family situation (only child, first child) or family size (first born in families with 2, 3, 4, at least 5 children) as independent factor.

Family situation: only and first born children compared

The MANCOVA on only and first born children was significant on the multivariate level for family situation (F (2, 604) = 50.480, p <.0005; η^2=.143). No significant differences were found for gender (F (2, 604) = 2.654, p=.071; η^2=.009). No significant interaction-effect was present (F (2, 604) = 1.635, p =.196).

Means and Standard Deviations are presented in Table 3. First born children did better than only-children.

Table 3. *Arithmetic in only- and first born children.*

	Only-child	First born Child	
	$n = 309$	$n = 300$	$F (1, 300) =$
Mental Arithmetic	43.06 (29.224)	61.81 (27.395)	66.649*
Number Knowledge	41.49 (28.419)	63.68 (27.188)	96.857*

* p<.0005

Family size: first borns in small and large families compared

The MANCOVA on all first born children was significant for family size ($F (8, 580) = 21.718$, $p <.0005$; $\eta^2 = .239$) and gender ($F (2, 290) = 6.643$, $p <.005$; $\eta^2 = .044$) with a significant interaction-effect ($F (6, 582) = 2.955$, $p <.01$; $\eta^2 = .030$). Girls did worse then boys on all arithmetic measures.

Table 4. *Arithmetic in first born children.*

	Family size 2 ($n=152$)	Family size 3 ($n=116$)	Family size 4 ($n=24$)	Family size 5 ($n=6$)	Family size 6 ($n=2$)	$F (4,295) =$
Mental Arithmetic	71.11[a] (19.649)	49.55[b] (27.919)	45.79[b] (32.712)	50.33 (29.323)	64.50 (13.435)	600.104
Number Knowledge	80.51[a] (10.500)	47.41[b] (27.811)	42.63 (29.974)	38.00[b] (33.094)	58.50 (28.991)	449.471

* p<.0005

[ab] refer to posthoc indexes p<.05

Tukey post hoc analyses revealed that first born children in small families ([a] index family size 2) did better than first born children in families of size 3 on mental arithmetic and number knowledge ([b] index family size 3), than first-borns in families of size 4 on mental arithmetic ([b] index family size 4), and than first-borns in families with five children on number knowledge. Perhaps due to the very small number of first-borns with family size 6 ($n=2$),

no significant differences were found between first born children in families with two and six children in our dataset.

Relationship between arithmetic, birth order, family size and gender

To investigate the relationship between mental arithmetic, number system knowledge, birth order, and family size in the sample (*n*= 1152) controlling for the age of the children partial correlations were computed.

A non significant correlation of *r* =.017 (*p* = .559) was found between mental arithmetic and birth order, controlling for family size and age. Another non significant correlation of *r* = .032 (*p* = .273) was found between number knowledge and birth order, controlling for family size and age. A trend of *r* = -.042 (*p* = .151) was found between mental arithmetic and family size, controlling for birth order and age. A very small but significant correlation of *r* = -.057 (*p* = .053) was found between number knowledge and family size, controlling for birth order and age.

Since all variables were normally distributed and did meet the assumptions for multiple regressions, two regression analyses were conducted to evaluate how well these factors predicted number knowledge and mental arithmetic in elementary school children. All variables were included simultaneously as predictor variables: birth position or family situation (oldest, middle, and youngest), birth order, family size and gender.

The linear combination of the factors was significantly related to number knowledge in elementary school, $F (4, 1147) = 19.934$, $p < .0005$. R^2 was .062, meaning that only a very small proportion (6.2%) of variance could be explained by these parameters (see Table 5).

Birth position or family situation ($F (1, 1150) = 30.809$, $p < .0005$) predicted 2.5% of the variance, whereas birth order ($F (2, 1149) = 35.001$, $p < .0005$) predicted 3.1% of the variance, and gender ($F (3, 1148) = 26.486$, $p < .0005$) predicted 0.8% of the variance.

Table 5. *Prediction of number knowledge by birth order, family situation, and gender.*

Variable	Unstandardized Coefficients	β	t	p
Constant	53.426		24.118	**
Birth order	-9.151	-.285	-5.315	**
Family situation	3.534	0.368	8.172	**
Family size	0.515	0.022	0.570	
Gender	5.188	0.086	3.002	*

** *p<.0005*

* *p<.005*

The second multiple regression analyses pointed out that the linear combination of the factors was also significantly related to mental arithmetic in elementary school children, F (4, 1147) = 12.021, p < .0005. R² was .040, meaning that only a very small proportion (4%) of variance could be explained by these parameters (see Table 6).

Table 6. *Prediction of mental arithmetic by birth order, family situation, and gender.*

Variable	Unstandardized Coefficients	β	*t*	*p*
Constant	51.811		23.464	**
Birth order	-6.824	-.216	-3.977	**
Family situation	0.537	0.023	0.595	
Family size	2.641	0.280	6.126	**
Gender	4.865	0.082	2.824	*

** p<.0005

* p<.005

Birth position or family situation (F (1, 1150) = 18.632, p < .0005) predicted 1.6% of the variance, whereas birth order (F (2, 1149) = 19.793, p < .0005) predicted 1.7% of the variance, and gender (F (3, 1148) = 15.9193, p < .0005) predicted 0.07% of the variance.

Discussion

Since although there is popular belief that birth order is a determinant of success, there is little empirical research on the relationship between arithmetic and birth order and there are different models explaining the declining intelligence and educational scores with rising birth

order. We investigated in 1152 elementary school children matched on socioeconomic status of the parents the effects of birth order and family size on children's mathematical knowledge.

Separate analyses were conducted in cohorts with the same family size. The analysis on families with at least five children revealed that last born or youngest children did worse than fourth born children. The analyses on families with four children were not significant, but the power of this analysis was very low, with a risk of type 2- or β-mistakes (concluding from the cohort that there were no differences although in reality there were differences in the population). Moreover, last born girls did worse than first born girls on number knowledge in our dataset. A totally unexpected advantage for middle borns was present in families with three children. The analysis on families with two children revealed oldest children performing better than youngest children. However, all birth order differences were of a very limited practical importance due to the small effect sizes.

Furthermore, our dataset did not validate the "admixture hypothesis", arguing intelligence differences among children are attributable to parent's socioeconomic status and not to birth order differences. According to this model socioeconomic status, may be responsible for both large families and low IQ. Proponents of this hypothesis would not expect decline in arithmetical performance by birth order in our dataset, since children were matched on socioeconomic status of the parents. In line with this hypothesis no differences by birth order were found in families with four children. However, in contrast with this hypothesis, significant differences were found between children with first and second birth order in families with two or three children and between children with fourth and sixth birth order in families with at least five children. Proponents of this hypothesis might argue that other factors, like parental IQ may be responsible for birth order differences in this sample.

On the other hand, the Confluence Model explains a firstborn IQ advantage in terms of the ever-changing intellectual environment within a family. It is evident that the data from the present study are partially in line with this hypothesis, since first born children did better than only children and the middle children did better than last born children in families with three and five or more children. However, in contrast with the hypothesis, no birth size effect was found in families with four children in our dataset. In addition, it is never easy to pinpoint the causes of results. For example in our dataset the results might indicate that first born children with one younger brother or sister may be favoured regarding gaining advantages from teach-

ing younger children. This can explain the difference between only children and firstborns and the difference between firstborns and second borns in families with two children. However in families with three or four children no such first born-advantage is found. In addition, only children had a high probability of coming from broken families. Therefore lower arithmetic performances might be explained due to situational causes and the lack of enthusiasm for school rather than birth situation. Parental interaction problems might have affected the attention and motivation of those only children for learning. Additional research on this other explaining factor of the presumed association instead of the older siblings teaching hypotheses certainly seems indicated.

Finally the Resource Dilution Model assumes that the more children the lower the quality of each child parental resources and the lower the performances of children. In line with the Model first born children in families with two children did better than first born-children in families with three children on mental arithmetic and number knowledge. In addition, first-borns in families with two children did also better than first-borns in families with four children on mental arithmetic and than first-borns in families with five children on number knowledge. However, not compatible with the model, but perhaps due to the very limited sample size, no significant differences were found between first born children in families with two and six children in our dataset.

Analyses on whether oldest and youngest children did better than middle born children, as suggested by Van Eijck and De Graaf (1995), revealed an inverse profile. In families with three and five or more children, middle children did better than oldest and youngest children. In families with four children, in line with data from Beer and Horn (2000) and Rodgers (2001) no birth order differences were found.

In our dataset no significant correlation was found between both arithmetic measures and birth order, controlling for family size and age. A trend was found between mental arithmetic and family size and a very small but significant correlation was found between number knowledge and family size, controlling for birth order and age. These results indicate that relative to other variables birth order and family size are consistently not very important in explaining children's arithmetical achievement in elementary school.

In line with the data Evans et al. (2002), Geary et al. (2000) and Olszewski-Kubilius and Turner (2002) in our arithmetic data several gender differences were found, favoring boys. To investigate the impact of gender in relation to birth order and family size, two regression analyses were performed. Only a very small proportion of the variance in number system knowledge of elementary school children could be explained by family situation, birth order, family size and gender. Family situation predicted less than three percent of the variance, whereas birth order predicted about three percent, and gender predicted less than one percent of the variance. Mental arithmetic could be predicted for only a very small proportion by the same parameters. Family situation and birth order predicted both less than two percent, whereas gender predicted nearly nothing of the variance in mental arithmetic. To conclude, the difference between boys and girls is not likely to matter much.

A number of options for future research can be pursued. Additional research is certainly needed involving a larger number of children, increasing the Power of the analyses. There is no doubt that in many respects also more in-depth research is needed as to a broader range of arithmetic skills in elementary school children, controlling for differences in child-spacing and birth order intervals, social rank in the family and factors as intelligence in the parental background. Also, the relationship between arithmetic, birth order and family size has to be investigated in older children, controlling for the intelligence of the subjects, loss of siblings and the stability of families. We believe that research data derived from such studies could improve our understanding of the mechanism of arithmetical attainment.

Nevertheless, our findings suggest that it is possible that only children and lastborn children in large families are less competent in arithmetic than first born children. This might be explained by a lack of tutoring younger children helping them to process information. This can perhaps also explain the good results of first born children in families with two children, but also the performances of middle children in families with three and five or more children. When considering the educational implications of the present findings, teachers might become more sensitive to only children and last born children in big families and learn to facilitate and encourage those children to teach peers or and act as mentor for younger children. In some schools children get a younger 'reading friend' every week. Here perhaps it might be an idea to work with 'arithmetic friends' where children have the opportunity to tutor younger children in the area of arithmetic and teach them basic arithmetic information. Perhaps then only children and youngest children in large families can start with greater equity. It is widely-

accepted that teaching consolidates learning; therefore it might be interesting to look at the effect of such programs and to evaluate if they can enhance the arithmetic performances of the tutoring pupils and their younger 'arithmetic friends'. However we should not exaggerate the differences in arithmetic, since the differences appeared to be shrinking in families of four children, even without specific interventions in classrooms or extra sessions to improve tutoring skills. In addition, there are several reasons why this finding, if true, may not be very important. First, our data suggest that birth order, family size and even gender were not the most important factors in the achievement of arithmetic. There are far better predictors of mathematical success lying in the kind of learning processes that should be elicited to facilitate and support children in the progressive acquisition of arithmetic competence (De Corte, 2007; Vosniadou & Vamvakoussi, 2006). Birth order accounted for only two or three percent of the variance in arithmetic scores. Second, analyses of our dataset demonstrated that last borns had poorer scores in small (family size 2) or large (family size 5 or more) families. However, the lastborn disadvantage and firstborn advantage was slight and not present in families with three or four children. Therefore the challenging popular beliefs that all firstborns are smarter and better in arithmetic and that all big families produce children that are less good in arithmetic are hardly compatible with the empirical data of this study and might perhaps be considered rather as myths than as facts.

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