Is there a linear relationship between inbreeding and mental ability?: A meta-analysis

Bachelor thesis
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Abstract

Consanguinity is the blood relationship between two individuals through a common ancestor. Although the practice of inbreeding is strongly rejected in modern Western society because of its detrimental health effects, it can be observed in all ethnic and religious groups to a varying degree (Bittles, 1994). Marriages between close biological relatives are relatively common in populations throughout the North of Africa, Middle East, South and Central Asia (Bener & Hussain, 2006), and in some migrant communities, permanently residing in Western Europe (Bittles, 2008).

The harmful effect of inbreeding on mental ability is less generally known, in spite of a large body of scientific evidence. In the current paper a linear relationship between inbreeding and depression of mental ability is hypothesized. A thorough literature search resulted in 95 studies. There were 15 studies that provided sufficient data for a meta-analysis. The studies were divided into four categories of inbreeding, showing values of an inbreeding coefficient (*f*) of .046, .063 (first cousin marriage), .125 (double first cousin marriage), and .25 (incest). The study's hypothesis of a linear relationship was strongly confirmed. Over four categories, degree of inbreeding correlated highly with average IQ depression, $r = .91$. The current meta-analysis shows that the most common type of consanguinity, first cousin marriage ($f = .063$), may lead to a depression of about six IQ points, whereas incest ($f = .25$), the most severe type of consanguinity may cause a depression of about 28 IQ points. As scores on IQ tests are by far the best predictors of work performance (Salgado, Anderson, Moscoso, Bertua, & de Fruyt, 2003; Schmidt & Hunter, 1998), and school achievement (Jensen, 1980; Neisser, et al., 1996), it may be concluded from the study's findings that the degree of inbreeding is related to IQ depression, which in turn makes it plausible that consanguinity leads to lowered work performance and school achievement. From the paper it may be concluded that any attempts to discourage consanguineous unions at the population level and to decrease considerably the frequency of consanguineous marriages are important.

Blood relationship between two individuals through a common ancestor, is known under the name consanguinity. Although consanguinity is strongly rejected in modern Western society for its deleterious health effects (Bittles, 2008), consanguineous marriages are widespread in many parts of non-Western societies. In populations throughout the North of Africa, Middle East, South and Central Asia, consanguineous marriages sometimes account for half of all marriages (Jensen, 1983; Bittles, 1994). The rates of consanguineous marriages in several non-Western countries are summarized in Table 1, showing values ranging from 16% in India and 58% in Saudi Arabia. Recent studies show that consanguineous marriages in non Western migrant communities in Western-Europe are also very common (Bittles, 2001, 2008; Gibbons, 1993; Reniers, 2001).

Several theories try to explain the differences found between groups in the prevalence of consanguineous unions. Historically, both social and economical motives are given for the popularity of consanguineous unions. For instance, cousin marriage, the most common type of consanguinity, is said to strengthen family ties. Other advantages are that people do not have to deal with uncertainties about partners from outside the family, that premarital arrangements are simplified, and that wealth in the form of a dowry or bridal price remains within the family (Bittles, 1994, 2002). Goode (1963) suggested an inverse relationship between modernization and the prevalence rate of consanguinity. Moreover, socio-demographic characteristics such as level of education, socio-economic status (SES), and urbanization are found to be inversely related to the rate of consanguinity. There are exceptions, though: in some cultures consanguinity is found to be more prevalent in the upper than in the lower socio-economic classes, as a means of preserving power and wealth within the family (Agrawal, Sinha & Jensen, 1984).

Research has shown that offspring of consanguineous parents suffer from increased risks of a number of harmful health effects compared to offspring of non-related parents. The most prevalent and well-documented health risks for consanguineous offspring are found to be increased prenatal mortality, postnatal mortality, infant mortality, birth defects, congenital malformations, mental retardation, and lowered resistance to infectious diseases (Bittles, 2001, 2002; Bundey & Alam, 1993; Durkin et al., 2000; Jensen, 1983; Stoltenberg, Magnus, Lie, Daltveit, & Irgens, 1997). The effects of consanguinity on mental ability are less generally known, although research has provided a considerable amount of empirical evidence, over the last decades, scattered over studies in a large number of scientific journals. Test scores on

mental ability are reflected in societal outcomes such as measures on educational achievement (Jensen, 1980; Neisser, et al., 1996) and work proficiency (Salgado, Anderson, Moscoso, Bertua, & de Fruyt, 2003; Schmidt & Hunter, 1998). In fact, test scores on mental ability by far seem to provide the best general predictors of educational achievement and work proficiency. From all this it may be concluded that consanguinity will probably lead to lower IQ scores, resulting in lower levels of educational and work achievement.

Table 1
Country, Percentage of Consanguineous Unions, and Reference

country	consanguineous unions (%)	reference
Egypt	40	Mokhtar and Abdel-Fattah (2001)
India	16	Banerjee and Roy (2002)
Iran	39	Saadat, Ansari-Lari, and Farhud (2004)
Jordan	55*	Khoury and Massad (1992); Sueyoshi and Ohtsuka (2003)
Morocco	29	Reniers (2001)
Oman	36	Rajab and Patton (2000)
Qatar	55	Bener and Alali (2006)
Saudi Arabia	58	El-Hazmi et al. (1995)
Turkey	23	Reniers (2001)
United Arab Emirates	51*	Bener et al. (1996); Al-Gazali et al. (1997)
Yemen	44	Gunaid, Hummad, and Tamim (2004)

Note. *Mean value of both studies.

Consanguinity may lead to a depression of mental ability caused by an increase of homozygosity of recessive genes for intelligence in inbred offspring, compared to non-inbred offspring (Jensen, 1998, pp. 189-196). The coefficient of inbreeding (*f*) is the average probability over all gene loci, that the same allele on both homologous chromosomes stems from the same ancestor (Crow & Kimura, 1970, pp. 64-65). Thus, if there is dominance of the alleles which enhance the phenotypic expression of the trait, inbreeding will lower the mean of the trait comparable to the mean of a non-inbred population, which phenomenon is known as inbreeding depression. Conversely, if the alleles that enhance the phenotype are recessive, inbreeding will raise the mean, because inbreeding directly increases the average homozygosity, permitting greater phenotypic expressions of recessive alleles (Jensen, 1983). Furthermore, the variance of the trait is increased by inbreeding (Agrawal, Sinha & Jensen, 1984), because it brings out previously hidden recessive factors that contribute to the phenotypic variance. The theory of genetic mechanisms responsible for the effects of

inbreeding on polygenic traits is thoroughly expounded by Crow and Kimura (1970) and Jensen (1978).

According to Jensen (1978) the degree of consanguinity varies, depending on the biological proximity of the relatives. In plant species such as corn and wheat, self fertilization produces a hundred percent of shared genes (f = ½). Incestuous matings, defined as matings between biological first-degree relatives (i.e. father-daughter, mother-son, brother-sister), cause the largest degree of consanguinity possible in humans (f = ¼). Although ranges of consanguinity beyond second cousins are possible, the levels of homozygosity beyond second cousin relationships ($f < .0156$) only differ to a negligible degree from those observed in random matings in the general population (Bittles, 2001). Therefore, the paper's analysis was limited to consanguineous unions ranging from incestuous matings to second cousin matings. An overview of the degrees of consanguinity and equivalent inbreeding coefficients (f) for all various matings is presented in Table 2.

A problematic feature of research on inbreeding depression of mental ability arises from the fact that inbreeding is usually negatively correlated with socio-economic status (SES) in the majority of studies. The lower mean of mental ability test scores found in inbred groups as compared to control groups is therefore in most cases partly attributable to lower socio-economic status. Determining to which degree inbreeding or lowered SES may cause depression of mental ability appears to be a major issue in inbreeding research (Agrawal, Sinha & Jensen, 1984; Jensen, 1978, 1983; Kamin, 1980; Schull & Neel, 1965).

Table 2

Percentage of Shared Genes and Inbreeding Coefficient (f) for Various Matings[a]

matings	shared genes	*f*
Self-mating	100.0	½
Parent-offspring	50.0	¼
Full siblings	50.0	¼
Half siblings	25.0	1/8
Grandparent-grandchild	25.0	1/8
Uncle-niece (or aunt-nephew)	25.0	1/8
Double first cousins	25.0	1/8
First cousins	12.5	1/16
Double half cousins	12.5	1/16
First cousins once removed	6.3	1/32
Second cousins	3.1	1/64
Second cousins once removed	1.6	1/128
Third cousins	0.8	1/256
Random mating	0[b]	0[b]

Note. [a] Table from Jensen (1978); [b] Arbitrarily set at zero though the actual value is in fact slightly higher.

Research question

In the present study the following hypothesis was examined: Is there is a linear relationship between the degree of inbreeding and the size of depression of intelligence scores? In order to test this hypothesis a meta-analysis was conducted.

Method

Searching and screening studies

Both electronic and manual searches were conducted to identify studies on inbreeding related IQ depression for inclusion in the meta-analysis. First, an electronic search was conducted for published research using PsycINFO, ERIC, MEDLINE, PiCarta, Academic Search Premier, Web of Science, and Google Scholar. Keywords used were inbred, inbreeding, incest, consanguinity, consanguineous, mental ability, intelligence, IQ, WISC, and combinations of these concepts. Second, the reference lists of various significant articles were analyzed in search of additional studies. Third, a cited reference search was conducted using Web of Science, to search for articles citing the article in question. Last, several authors were asked for additional studies on the subject. The procedure as mentioned above, resulted in 95 articles, book chapters, and reports on the topic of inbreeding depression. Only fifteen studies met all criteria for inclusion in the meta-analysis, comprising nearly all published research on the subject published in English-language research journals and books.

Criteria for inclusion

Studies included in the meta-analysis had to meet two criteria. First, an empirical examination had to be performed, reporting an inbreeding coefficient. If the value of an inbreeding coefficient was not reported, the study had to provide enough detailed information to compute or estimate the value of the inbreeding coefficient. Studies that did not provide enough information for estimating the value of an inbreeding coefficient were excluded from the meta-analysis. Second, test scores on mental ability or clear verbal descriptions of IQ levels had to be provided, from which the size of the IQ depression could be computed. Ideally, studies presented IQ test scores on children from both consanguineous and non-consanguineous parents. Studies lacking sufficient information for the estimation of the IQ depression were excluded from the meta-analysis as well.

Computation of IQ depression

IQ depression was calculated by distracting the average IQ test score of the inbred group from the average IQ test score of the control group. When studies reported IQ scores for

different age groups, the weighted average of these IQ-scores was computed. Some studies only reported IQ scores for the inbred group. In order to compute IQ depression the mean IQ score was estimated of a matching control group based on all available information, such as age, SES, and parents' IQ.

Some studies categorized children (offspring) by levels of mental retardation or mental subnormality. For example, Seemanová (1971) used descriptions such as "60% of the inbred sample was severely mentally retarded". In these cases IQ scores were estimated using a classification of mental ability. In order to estimate the IQ depression between inbred and control groups as accurately as possible, three different classifications of mental ability were used. In the present study, based on type of information and time of publication the following lists were used. First, the classification from the American Association for Mental Deficiency (AAMD) as summarized in Table 3 (see Jensen, 1980). Second, Wechsler IQ Test Ratings of Idiocy as summarized in Table 4, and, third, the Mental Retardation classification from the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (1994) (DSM-IV) as summarized in Table 5.

Table 3
AAMD Retarded Classification (1933)

IQ	classification	median
85-70	Borderline retardation	77.5
69-55	Mild retardation	62
54-40	Moderate retardation	47
39-25	Severe retardation	32
<25	Profound retardation	12

Table 4
Wechsler IQ Test Ratings of Idiocy (1956)

IQ	classification	median
56-70	Borderline	63
41-55	Moron	48
26-40	Imbecility	33
11-25	Severe idiocy	18
1-10	Profound idiocy	5

Table 5
Mental Retardation Classification DSM-IV (1994)

IQ	classification	median
50-70	Mild retardation	60
35-49	Moderate retardation	42
34-20	Severe retardation	27
< 20	Profound retardation	10

The classical Seemanová study of 1971 was used to illustrate the estimation process. In her study, 161 children from incestuous matings were compared with their half-siblings from the same mother, but from other, non-consanguineous partners (N = 95). By doing so, IQ

scores could be compared from half-siblings of which one child was from incestuous parentage and the other was not. Seemanová's (1971) research design offers a comparison of inbred and non-inbred children in more or less identical environmental conditions. She did not report IQ test scores, but instead all participants were categorized in certain levels of IQ. The IQ depression score of the inbred group was computed from this detailed categorization. Nine children were diagnosed as idiotic, and 31 children as imbecile. Idiocy is a term used to refer to people with an average IQ score between 1–25 (see Table 4). The median score (13) was used to compute the IQ depression score. Determining the IQ value corresponding to imbecility is somewhat more difficult, for over five classifications assigned different IQ ranges to imbecility. We chose the highest IQ value (38), which is the median score of the IQ range 26–50. It also appeared to be the most prevalent IQ range for imbecility. By doing so, we hypothesized that our estimation of IQ depression could only be an underestimated value. The other 121 children of the inbred group were diagnosed as of normal intelligence. However, it should be mentioned that in Seemanová's opinion some children were mildly mentally retarded. The criterion was that children should be able to attend special education. Therefore, the average IQ of the remaining 121 children was estimated to be 85, which is the bottom value of average intelligence based on the AAMD classification (see Jensen, 1980).

How to deal with infant mortality?

It appeared that there was a large difference in rates of infant mortality between inbred groups and non-inbred groups in most studies. Virtually all studies report both high rates of mortality within the inbred group as compared to the non-inbred group, and high rates of imbecility, idiocy, and severe mental retardation among non-surviving inbred children. However, unless IQ test scores of deceased children were clearly reported, our analysis was based on survivors only, amongst others because of the practical limitations of estimating IQ test scores of children who died at a very young age. The estimated average IQ scores of inbred children based on survivors will presumably be an underestimation of the true average IQ score.

Statistical analyses

The fifteen included studies yielded sixteen data points. First, the values of inbreeding depression (f) and IQ depression (d_{IQ}) were used to compute Pearson correlation coefficients between f and d_{IQ}. The next step involved computations for each of the four categories of inbreeding: incest, double first cousins; first cousins; and a combination of first cousins, first cousins once removed, and second cousins. The mean values for each category were computed. The variance of average d_{IQ} scores within the four categories is fairly high. By calculating the

correlation between the average scores of the studies within the four categories, the influence of outliers is reduced. Over the four categories, Pearson correlations between *f* and d_{IQ} were computed.

The sample sizes of the fifteen studies vary strongly, with values ranging from N = 13 to N = 3203. To limit the influence of systematical errors in the large studies, the sample sizes of each study were logarithmically transformed and Pearson correlations between *f* and d_{IQ} were computed. The outcomes using logarithmical transformation of sample sizes were then compared to the outcomes using untransformed sample sizes.

Results

The hypothesis of a linear relationship between inbreeding and mental ability was examined. The results of the fifteen studies on the relation between the inbreeding coefficient and IQ depression scores are presented in Table 6. The large overall sample size of 9328 participants can be looked upon as a solid contribution to the findings of the present study. The results show that when the value of the inbreeding coefficient goes from low to high the value of the IQ depression goes from small to large. Indeed, inbreeding coefficient *(f)* and IQ depression (d_{IQ}) values are significantly correlated: $r = .72$ ($p < .01$).

Table 6

Reference, Total Sample Size, Inbred and Control Group, Inbreeding Coefficient (f), IQ Depression (d_{IQ}), and Background

reference	*N*	n_i	n_c	*f*	d_{IQ}	background
First cousins, first cousins once removed, second cousins						
Jensen (1983)[d]	1854	865	989	.046	3.7	Japanese children 1-10 years
Badaruddoza (2004)	1426	976	450	.046	9.2	North Indian Children 6-14 years
First cousins						
Bashi (1977)[c]	3203	970	2108	.063	1.2[b]	Arab children, in Israel 10-12 years
Slatis and Hoene (1961)	159	87	72	.063	2.6	US children
Cohen et al. (1963)	85	38	47	.063	3.8	Immigrant Jews, into Israel from Kurdistan
Böök (1957)	271	166	105	.063	4.5[a]	Swedes 0-69 years
Pandey, Jha, and Das (1994)	330	160	170	.063[a]	7.4	Indian Muslim children 8-12 years
Agrawal, Sinha, and Jensen (1984)	186	86	100	.063	8.0	Indian Muslim boys 13-15 years
“A study of parental consanguinity” (1988)	80	46	34	.063[a]	9.5	Indian children 5-9 years
Badaruddoza and Afzal(1993)	100	50	50	.063	11.2	Indian Muslim children 6-11 years
Afzal (1988)	1314	566	748	.063	11.4	Indian Muslim children 9-12 years
Double first cousins						
Bashi (1977) [c]	3203	125	2108	.125	5.1[b]	Arab children, in Israel 10-12 years
Incest						
Adams and Neel (1967)	36	18	18	.25	11.2	US children
Carter (1967)	13	13	n.a.	.25	20.1	UK children
Seemanová (1971)	256	161	95	.25	28.0[b]	Czech and Slovak children
Jancar and Johnston (1990)	15	15	n.a.	.25	54.3	UK children

Note. [a] estimated value; [b] weighted average; [c] Bashi (1977) reported scores on first cousins, and double first cousins. Both groups are categorized separately. [d] Data derived from original study by Schull and Neel (1965). n.a. = not available; *N* = total sample size; n_i = sample size of inbred group; n_c = sample size of non-inbred control group.

Table 7 reports the mean IQ depression scores for each category of consanguinity. These data are graphically shown in Figure 1. The correlation of *f* and the unweighted average IQ depression per category is $r = .91$, ($p < .05$, one-tailed). The correlation of *f* and the weighted average IQ depression per category is $r = .91$, ($p < .05$, one-tailed). Because the large

variance in sample size between the studies might bias the findings, we logarithmically transformed sample sizes. After these transformations the correlation between the four categories of inbreeding, and IQ depression $r = .91$, ($p < .05$). The fact that the correlation between inbreeding and IQ depression is unaffected by logarithmically transformed sample size values, strongly suggests that the large variance in sample size does not influence the outcomes.

Table 7

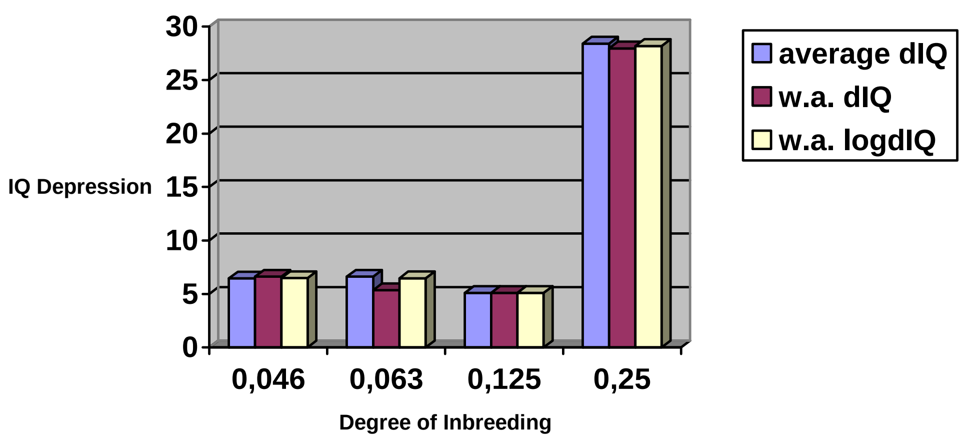
Average IQ Depression scores per Category of f, Before and After Logarithmically Transforming d_{IQ}

f	d_{IQ} [a]	d_{IQ} [b]	log d_{IQ} [c]	N
.046	6.45	6.62	6.47	1841
.063	6.62	5.35	6.46	2169
.125	5.10	5.10	5.10	125
.250	28.40	27.95	28.18	207

Note. [a] unweighted average of IQ depression. [b] weighted average of IQ depression. [c] the logarithmic transformation of $f = .063$ is ∑ dIQ.logN / ∑logN = 86.19 / 14.29 = 6.03, and the logarithmic transformation of $f = .25$ is ∑ dIQ.logN / ∑logN = 162.10 / 5.75 = 28.18.

Figure 1

Average IQ Depression scores per category of f, before and after logarithmically transforming d_{IQ}



Note. w.a. = weighted average.

Discussion

The main question of this meta-analytical study is whether there is a negative linear relationship between the degree of inbreeding and scores on mental ability tests. The outcomes of our analyses strongly support the hypothesis. As the degree of inbreeding increases, the scores of mental ability show a linear decrease. The mean decrease among children from cousin marriages is about six IQ points, and the decrease for children from incestuous relationships is about 28 IQ points.

IQ depression

The most common type of inbreeding, resulting from consanguineous marriages between first cousins produces an overall mental ability depression of about six IQ points. The most severe form of inbreeding, resulting from incest (first degree consanguinity) reduces IQ with 28 IQ points.

In the present study sixteen data points were used that show an overall correlation between inbreeding and IQ depression of $r = .72$. With respect to the four categories of inbreeding, it appeared that the correlation between weighted average IQ depression and inbreeding is $r = .91$. After the sample sizes were transformed logarithmically to reduce the influence of the systematical errors in the larger studies, the values of the correlations were identical. One of the results was not in line with one hypothesis, i.e. the IQ depression for double first cousins was smaller than the IQ depression of first cousins, but this effect was based on one study only.

Most results of the estimates of the value of f in this study were based on the inbreeding coefficients of the present generation. However, in many societies with a tradition of consanguineous unions, inbreeding is found to be quite usual, which might lead to a cumulative inbreeding effect. This effect could be accounted for by multiplying the f value calculated for the current generation by the term $(1+F^a)$, in which F^a is the inbreeding coefficient of the ancestor, i.e., it represents the probability that the common ancestor carries two identical genes at any particular locus (Bittles, 2002, 2003). Studies on inbreeding depression usually do not provide sufficient data to make such calculations. Nevertheless, it can be hypothesized that long-lasting inbreeding over many successive generations diminishes the gene pool of deleterious genes.

All in all, it may be concluded that the mean f value reported in the studies in our meta-analysis seems to be a little too low, which in turn means that the study's computation of IQ depression resulting from consanguineous matings is very likely slightly underestimated.

Practical Implications

The present study makes a strong empircal contribution to the important discussion of how to interpret the relationship between inbreeding and mental ability. Our findings suggest that as the degree of inbreeding increases test scores of mental ability decrease linearly. However, legislating close-kin marriages in order to attenuate these adverse effects on mental ability might have counterproductive side effects (Gibbons, 1993). According to University of London geneticist Alan Bittles: “laws banning close-kin marriages might prevent related couples to undergo genetic screening. In Western nations the goal should be to encourage immigrants or others in close-kin marriages to seek prenatal care.” Therefore, a discussion on how to discourage the practice of close-kin marriage should be handled with the utmost care.

Limitations of the study

Some of the studies this meta-analysis is based on, did not report IQ test scores but used qualifications such as “imbecility” or “severe retardation.” Starting from these qualifications IQ scores were computed. However, there are some limitations to this approach, for it involves making arbitrary choices. The result of the computation of the estimated IQ scores are reported in the Appendix.

Another methodological problem results from infant mortality. In nearly all studies mortality rates are found to be much higher within inbred groups, as compared to non-inbred groups. Also, the average mental ability of children who died prematurely is reported to be strongly below average. It could be argued that the effect sizes reported in our meta-analysis are most likely underestimates. However, the current study is based on living participants, because of the impossibility to estimate the IQ score of stillborn children.

Finally, pregnancies of incestuous origin tend to be accompanied by specific adverse factors, such as mental stress, and attempts at an artificial interruption, as compared to pregnancies of non incestuous unions. The influence of such factors on mental ability of incestuous offspring is not consistently accounted for in the studies of the present meta-analysis.

The studies show a strong variety with respect to the way they value the effect of several confounding variables such as SES, age of the mother at childbirth, and parents’ IQ. Obviously, the parents of incestuous offspring are not a representative sample of the general population. Some cases of mentally subnormal children may partly be attributable to the mental condition of the parents.

Conclusion

Scores on IQ tests are by far the best predictors of work performance, and school achievement. The findings of the present study show that the degree of inbreeding is related to IQ depression. Offspring from consanguineous relationships may thus face adverse consequences for work performance and school achievement. In view of these adverse effects on mental ability, a discussion on ending the practice of consanguineous marriage should be encouraged.

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Appendix

We report a detailed description of the computation of each IQ depression score by study. The same order is used as in Table 6, i.e. from the smallest *f* value to the largest.

Jensen (1983)

A study on 1854 Japanese children was performed. Jensen clearly describes both the average degree of inbreeding ($f = 1/22$), and the IQ depression score (3.7 IQ points) (p.77). No further computations were necessary to perform our analyses.

Badaruddoza (2004)

A study on 1,426 children from the Aligarh district, Uttar Pradesh in North India was performed. Ages ranged from 6 to 14 years. The total sample had an average degree of inbreeding (*f*) of .046. The values in Table 1 are derived from Table 2 (p. 315). The IQ depression score was computed by subtracting the combined sexes weighted average IQ score of inbred from the combined sexes weighted average IQ scores of non inbred children.

Table 1
Degree of Inbreeding and Mean IQ Scores

Degree of inbreeding	IQ		
	Male (N=810)	Female (N=616)	Combined Sexe (N=1426)
Inbred (N=976)	99.23 (N=555)	97.30 (N=421)	98.40 (N=976)
Non inbred (N=450)	108.47 (N=255)	106.37 (N=195)	107.56 (N=450)
			9.16

Bashi (1977)

A study on 3203 children from the Arab educational system in Israel was performed. Verbal IQ test scores, and IQ test scores using Raven's Progressive Matrices were used. The values in Table 2 are derived from Figure 1 (p. 441). The IQ depression scores were computed by subtracting the combined scores from grade 4 and 6 from the scores of the control group, and then calculating the mean score of first cousins, and double first cousins, respectively (see Table 3).

Table 2
Degree of Inbreeding and Mean IQ Scores

degree of inbreeding	verbal *IQ*	RPM
Grade 4		
First cousins	99.2	99.5
Double first cousins	97.5	97.4
Unrelated	100.4	100
Grade 6		
First cousins	99.2	99
Double first cousins	91.5	94.7
Unrelated	100.4	100.8
Grade 4 and 6 combined		
First cousins	99.2	99.3
Double first cousins	94.5	96.1
Unrelated	100.4	100.4

Note. RPM = Raven's Progressive Matrices

Table 3
Degree of Inbreeding, Drop in Verbal IQ and RPM Score, and Mean IQ Depression Score

degree of inbreeding	drop in verbal *IQ*	drop in *IQ* (RPM)	mean *IQ* depression
First cousin	1.2	1.1	1.2
Double first cousin	5.9	4.3	5.1

Note. RPM = Raven's Progressive Matrices

Slatis & Hoene (1961)

A study on 159 US children was performed. A group of 87 children from first cousin marriages was compared to a control group of 72 children from unrelated parents. The mean scores were subtracted to compute the IQ depression score. The mean scores are summarized in Table 4.

Table 4
Degree of Inbreeding and Mean IQ Scores

degree of inbreeding	*m*
First cousin	101.5
Unrelated	104.1
	2.6[a]

Note. [a] IQ depression score; *m* = mean IQ score.

Cohen (1963)

A study on 85 children was performed. A group of 38 children from first cousin marriages was compared to an unrelated control group of 45 children. The data from which the value of IQ depression was computed are summarized in Table 5. The IQ depression score was computed by subtracting the mean first cousin score from the mean unrelated score.

Table 5
Degree of Inbreeding, Mean IQ Score, and Sample Size

degree of inbreeding	mean IQ	*N*
First cousin	77.1	38
Unrelated	80.9	47

Böök (1957)

A study on 271 Swedes was performed. A group of 166 children from first cousin marriages was compared to an unrelated control group of 105 children. Böök derived intellectual capacity from school performance, school records, and the author's own clinical examination. We computed an estimated IQ depression score by subtracting the weighted average IQ score of first cousins from the weighted average IQ score of unrelated children. Böök provides ranges of IQ scores, and detailed information on the categorization he used. The data from which the IQ depression score was computed are summarized in Table 6.

Table 6
Degree of Inbreeding, Intellectual Capacity, Sample Size, and Weighted Average IQ score

	mental deficiency 0-70[a] 44.1[c]	borderline 70-85[a] 78[b]	backward 90 [b]	normal 100 [b]	gifted 110 [b]	*N*	*IQ*
First cousin	12	11	28	108	7	166	93.2
Unrelated	3	5	9	75	13	105	97.7
Total	15	16	37	183	20	271	4.5[d]

Note. [a] value from Böök (1957); [b] estimated value; [c] the mental deficiency category was subdivided into a more detailed categorization, from which the average value of 44.1 was computed (see Böök, 1957, Table 10, p. 199). [d] IQ depression score computed by subtracting the first cousin IQ value from the unrelated IQ value.

Pandey, Jha, & Das (1994)

A study on 330 Indian children was performed. A group of 160 children from first cousin marriages was compared to a control group of 170 children from unrelated

parents. The data from which the IQ depression score was computed are summarized in Table 7.

Table 7
Degree of Inbreeding, Intellectual Capacity (IQ), Mean IQ score, Standard Deviation, and Sample Size

inbreeding	IQ										*N*	*M*
	45	55	65	75	85	95	105	115	125	135		
Inbred	0	6	15	21	38	30	24	25	1	0	160	90
Unrelated	0	5	10	18	35	30	25	10	22	15	170	97.4
Total	0	11	25	39	73	60	49	35	23	15	330	7.4[a]

Note. [a] IQ depression score computed by subtracting the weighted average IQ scores of inbred from unrelated children.

Agrawal, Sinha, and Jensen (1984)

A study on 186 Indian Muslim school boys was performed. A group of 86 children from first cousin marriages was compared to a control group of 100 children from unrelated parents. The authors report a *"Group Statistics on Matrices Raw Scores and Scores Adjusted for Age and SES*" Table (see Agrawal, Sinha, and Jensen, 1984, Table II, p. 583). This Table reports a "σ difference" value of .55. This value is equivalent to a depression of 8 IQ points (1 σ = 15 IQ points).

"A Study of parental consanguinity" (1988)

A study on 80 Indian children was performed. A group of 46 children from first cousin marriages was compared to a control group of 34 children from unrelated parents. The mean intellectual ability scores of both groups were reported (see p. 30). The IQ depression score was computed by subtracting these two values. An overview is presented in Table 8.

Table 8
Intellectual Ability of Consanguineous Versus non-Consanguineous Children

inbreeding	*M*	*SD*	*N*
First cousin	89.6	12.9	46
Unrelated	99.1	14.4	34
	9.5[a]		

Note. [a] IQ depression score; M = Mean IQ score. SD = Standard deviation. N = Sample size.

Badaruddozza and Afzal (1993)

A study on 100 Indian Muslim children was performed. A group of 50 children from first cousin marriages was compared to a control group of 50 children from unrelated parents. Full-scale IQ scores were computed from verbal IQ scores and performance IQ scores. The mean scores were subtracted to compute the IQ depression score. The mean scores are summarized in Table 9.

Table 9
Degree of Inbreeding and Mean IQ Scores

inbreeding	*m*
First cousin	88.4
Unrelated	96.6
	11.2[a]

Note. [a] IQ depression score; *m* = mean IQ score.

Afzal (1988)

A study on 1314 Indian Muslim children was performed. A group of 566 children from first cousin marriages was compared to a control group of 748 children from unrelated parents. Full-scale IQ scores were computed from verbal IQ scores and performance IQ scores. The mean scores were subtracted to compute the IQ depression score. The mean scores are summarized in Table 10.

Table 10
Degree of Inbreeding and Mean IQ Scores

inbreeding	*m*
First cousin	73.71
Unrelated	85.07
	11.36[a]

Note. [a] IQ depression score; *m* = mean IQ score.

Adams and Neel (1967)

A study on 36 US children was performed. A group of 18 children from incestuous parents were compared to a matched control group of 18 children from unrelated parents. Mothers in the control group were matched on seven variables. Despite these efforts the estimated mean IQ score of the matched control mothers was five IQ points higher in the control group as compared to the IQ score of mothers in the incest group (IQ scores of 93.7, and 98.7 respectively). To counterbalance this effect, we decided to subtract five IQ points from the mean IQ score of the unrelated control group. The IQ scores of the incestuous group, and the unrelated group are summarized in Table 11. The mean IQ scores are 85.7 and 101.9 respectively. After subtracting five IQ points, the average IQ score of the unrelated group becomes 96.9. This leads to an IQ depression score of 11.2 points. The value of the adjusted mean IQ score of the unrelated group is used to compute IQ depression in other incest studies, where no control group was administered.

Table 11

IQ Scores of Offspring of Incestuous Matings and of Unrelated Parents with Mothers Matched for IQ and SES[c]

case number	IQ	
	Incest	Unrelated
1	-[a]	101
2	-[a]	100
3	-[a]	104
4	32[b]	107
5	32[b]	93
6	64	100
7	64	133
8	64	109
9	85	103
10	68	81
11	92	108
12	98	108
13	110	91
14	112	105
15	113	91
16	114	85
17	118	121
18	119	95

Note. [a] died prematurely; [b] value estimated using AAMD Retarded Classification (1933), because the child was untestable due to severe retardation; from Adams, Davidson, and Cornell (1967), in Jensen (1978).

Carter (1967)

This study describes the physical impairments and mental ability of thirteen UK children of incestuous parentage. No control group was administered. In order to compute an IQ depression score for this study, we estimated the mean IQ score of a matched control group. Therefore, we used the value of the adjusted mean IQ score of the unrelated control group from Adams and Neel (1967). The data from which the mean IQ score of the incest group was computed are summarized in Table 12. The mean IQ score of 76.8 leads to an IQ depression score of 76.8 – 96.9 = 20.1 IQ points.

Table 12

IQ scores and Background on 13 Incestuous Children

case number	*IQ*	background
1	-	died, no IQ score reported
2	-	died, no IQ score reported
3	70	died
4	33[a]	severely subnormal, untestable at age 4
5	67[b]	educationally subnormal
6	59	educationally subnormal
7	65	educationally subnormal
8	76	educationally subnormal
9	95	normal
10	95	normal
11	95	normal
12	95	normal
13	95	normal

Note. [a] estimated value; [b] estimated by computing the average IQ score of the three given IQ scores of educationally subnormal children.

Seemanová (1971)

A study on 256 Czech and Slovak children was performed. A group of 161 children of incestuous parentage was compared to 95 of their half-siblings, from the same mother, but from genetically unrelated fathers. Seemanová did not report IQ scores, but there was sufficient information to compute an IQ depression score. The inbred group consisted of 9 children diagnosed as idiotic, and 31 children diagnosed as imbecile. Idiocy is a term used to refer to people with an average IQ score between 1–25. The median score (13) was used to compute the IQ depression score. Determining the IQ value corresponding to imbecility is somewhat more difficult. More than five classifications all assigned different IQ ranges to imbecility. We choose the highest IQ value (38), which is the median score of the IQ range 26–50. This was also the most prevalent IQ range for imbecility. By doing so we hypothesize that our estimation of IQ depression is an underestimate. The remaining 121 children of the inbred group were diagnosed as of normal intelligence. However, Seemanová stated that some children were mildly mentally retarded. The criterion used was that children had to be able to function normally in special education. Therefore, the average IQ of the remaining 121 children was estimated to be 85, which is the bottom value of average intelligence based on the AAMD classification (see Jensen, 1980).

This leads to the following formula for the computation of the IQ score of the incest group:

$$9x13 + 31x38 + 121x85 = 72$$

The mean IQ score of the control group was estimated to be 100. This leads to an IQ depression score of 28 points.

Jancar en Johnston (1990)

This study reported IQ scores on fifteen children of incestuous parentage. No control group was used. Therefore, we used the value of the adjusted mean IQ score of the unrelated control group from Adams and Neel (1967). The data on which the mean IQ score is based are summarized in Table 13. The mean IQ score is 42.6. The IQ score of a control group based on Adams and Neel (1967) is 96.9. this leads to an IQ depression score of 54.3.

Table 13

IQ scores and Background on 15 Incestuous Children

case number	*IQ*
1	38
2	64
3	30
4	20[a]
5	25[b]
6	20[a]
7	20[a]
8	20[a]
9	77
10	70
11	38
12	60
13	53
14	57
15	47

Note. [a] estimated value; these children were unable to be tested, because of developmental retardation. Jancar & Johnston assigned a mental age of two years. [b] This child was assigned a mental age of three years.

Darwin, C. R., & Huxley, J. (2003). The origin of species. 150th Anniversary Edition. A Mentor Book.

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"in the first place, I have collected so large a body of facts, and made so many experiments, showing, in accordance with the almost universal beliefs of breeders, that with animals and plants, a cross between different varieties, or between individuals of the same variety but of another strain, gives vigour and fertility to the offspring, and on the other hand, **that close interbreeding diminishes vigour and fertility;** that these facts alone incline me to believe that it is a general law of nature that no organic being fertilises itself for a perpetuity of generations".

Darwin, C. R. (1859). The origin of species by means of natural selection, or the preservation of favoured races in the struggle for life. London: John Murray.

P. 256.
"I have made so many experiments and collected so many facts, showing on the one hend that an occasional cross with a distinct individual or variety increases the vigour and fertility of the offspring, and on the other hand that very close interbreeding lessens their vigour and fertility, that I cannot doubt the correctness or this conclusion."