this fixative. We conclude that in avian species there is a closer relationship between the two glucagons than is the case with mammals.

Finally, our data on the distribution of the 4 'hormones' gastrin, glucagon, secretin and VIP, in the avian gastrointestinal tract can form a basis for investigations into their physiology. This field is presently somewhat neglected.

[39] For their valuable help, in supplying peptide hormone antigens and antisera, or in raising and testing such antisera, we would like to thank Prof. V. MUTT, Drs S. R. BLOOM and S. I. SAID, and also Farmitalia. Miss C. GREEN provided excellent technical assistance. Grants from the Medical Research Council (microspectrofluorometer), the Wellcome Trust, the Ernest and Minnie Dawson Trust and the Volkswagenwerk Stiftung made the work possible.

Resumen. Estudios con immunofluorescencia realizados en al tracto gastro-intestinal de las aves (pollo y codornix) han demostrado el origen celular y la distribución de cuatro hormonas polipeptídicas: Gastrina, Secretina, Enteroglucagon y VIP. Las cuatro hormonas están presentes en células argirófilas y no en las células argentafines (células enterocromafines).

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COGITATIONES

'...We said that the offspring should come from parents in their prime.' 'True'. 'Do you agree that the period of the prime may be fairly estimated at 20 years for a woman and 30 for a man?' 'How do you reckon it?' he said. 'The women,' I said, 'beginning at the age of 20, shall bear for the state to the age of 40, and the man shall beget for the state from the time he passes his prime in swiftness in running to the age of 55.'

PLATO, (*The Republic*, Harvard University Press 1953), book V, p. 465.

On Correlation between the Generation Age of the Fathers and Grandfathers and the Intelligence of the Descendants[1]

1. *The problem.* Which prerequisites could play a rôle in the development of intelligence? Is it genetically inherited, the effect of the social environment, or something else that has until now not been considered? The following study started from the assumption that the well-known postulate of PLATO[2] and ARISTOTLE[3] that men should not reproduce before the age of 30, was probably based on extended observations. In the same context belong some data on families ascending or descending in intellectual endowment. Since a definite change of status is very often first observed after 2 generations, the generation age[4] of the grandparents should also be taken into consideration. We define therefore a characteristic '*Paternal Trinomial*' (Dreierzahl) by the formula

$$S_f = F + Z_f + Z_m$$

where F is the age of the father and Z_f, Z_m the ages of the paternal and maternal grandfathers, all at the time of corresponding generation.

Analogously the '*Maternal Trinomial*' is defined by

$$S_m = M + Y_f + Y_m$$

where M is the age of the mother and Y_f, Y_m the ages of the grandmothers, all at the time of corresponding generation.

2. *Series of investigations.* In order to avoid the influence of an intentional selection, I used first only lists of persons which were brought together by other authors, and studied the generation age of the fathers and grandfathers in these series completely and without any exception. Three of these series consist of highly gifted personalities, one series of under average endowed persons. In this way we discussed the two extreme cases of endowment. In order to consider the problem in the most general way, we then studied the interconnection between the level of endowment characterized by the intelligence quotient (IQ) and the ages of parents and grandparents, using a sample obtained specially for that purpose.

2. 1. In the series of monographs edited by ROWOHLT[5], we have a number of biographies of outstanding personalities where, however, the choice was made according to the anticipated interest of the reader. In 109 subjects we could find the age of the father in 96 cases[6], and in 39 cases the paternal trinomial could also be obtained. In the result, 15.6% of the fathers were under 30, while no paternal trinomial was under 90[7].

[1] Dedicated to ALEXANDER M. OSTROWSKI on his 80th birthday.

[2] 'The limit of the marriage-age shall be from 16 to 20 years – the longest time allowed – for a girl, and for a boy from 30 to 35.' PLATO, *Laws*, (Harvard University Press, Cambridge, Mass. 1952), book VI, p. 501.

[3] 'The body (of men) is most fully developed from 30 to 35 years of age, the mind at about 49.' ARISTOTLE, *The 'Art' of Rhetoric* (Harvard University Press, Cambridge, Mass. 1959), vol. II, p. 257.

[4] Since the fecondation age is not easy to find with some precision, we use instead the generation age that is the age of the parents at the birth of the child.

[5] *Rowohlt Monographien*, volumes 1–116 edited 1959–1971. We did not use vol. 33, 34, 35, 55, 56, 69 and 70 since they do not contain indications about single personalities.

[6] In this series we find also personalities like THOMAS OF AQUINAS, FRANCIS OF ASSISI, ARISTOTLE and JOHN THE BAPTIST (although in the case of the latter we have in the Bible the indication of a high age of his father) but in these cases we cannot expect to find the life data of their fathers.

[7] I was privileged to submit these results in summer 1971 to Professor ADOLF BUTENANDT and Professor GUSTAV WAGNER; I am indepted to both for valuable indications concerning my future work.

2. 2. A series of persons gifted to the highest degree was collected by ADELE JUDA[8] in the twenties, using a rather complicated selection procedure. She discussed altogether 314 highly gifted personalities from the world of arts and science. With 286 fathers, whose generation age could be found, exactly 19.9% were under 30, while among the 201 paternal trinomials which could be obtained, there were only 4.4% under 90.

2. 3. In the series *Neue deutsche Biographie*[9], personalities are listed, after their death, who distinguished themselves by a particularly important achievement. In a group of 2000 persons taken from the volumes 2 and 4 of this series, we could find in 1137 cases data concerning the father: 19.4% of the father generation ages were under 30. Among the 80 paternal trinomials obtained, there were only 5% under 90. In this connection we may refer also to an article by the Russian scientists ALEKSACHIN and TKATSCHENKO[10], in which the authors indicate that, by inspection of a great number of highly gifted persons, they found that 80% of the fathers at the generation time were over 30.

2. 4. As another extreme case, the generation age of the fathers was studied in a group of under average endowed children in a certain social isolate investigated by ARNOLD[11] in another context. Among 380 children, the generation age of the father could be obtained in 163 cases and of these ages 46% were under 30[12]. In this group, however, the paternal trinomials were not available as the data were missing. Already in 1961, JÜRGENS[13] emphasized the extremely low average generation age of the fathers among socially damaged people.

2. 5. In order to attack the problem in its generality, a field investigation was carried out in october 1972 in 4 forms of a Boy's High School in Munich[14]. The pupils first underwent an intelligence test[15], and then the results were checked with the answers to a questionnaire in which the pupils were asked for the life data and professions of their parents and grandparents. These questionnaires were filled in by the pupils at home in the family. Among 137 tests, only 87 could be and were used at all, as only in these cases were the questionnaires complete, while in 13 cases there were only data from one side of the grandparents, and in 8 cases the generation ages of both grandparents were missing. One case of adoption was also discarded and 28 questionnaires were not returned.

The results of this study are given in Tables I and II. One recognizes in both tables a definite monotony in the correlation between the paternal trinomial and the IQ of the children, while this is not the case for the maternal trinomial, although of course this trinomial also at first increases. A statistical significance computation of the rank correlation also gave a positive result. The correlation was significant with $P = 5\%$, that is to say, the probability that the rank correlation observed in our sample is only due to a chance is at the most 5%. In this case the significance computation of the Spearman Test according to CONOVER[16] yielded $r = 0.223$. For a two-sided test with $P = 5\%$ and $n = 87$ the critical value of r is

$$r_{\text{crit.}} = \frac{1.96}{\sqrt{86}} = 0.211 ,$$

r is therefore greater than the critical value, and the result can be considered as significant. The completely analogous statistical significance computations were also carried through with the three different single indices which form, taken together, the paternal trinomial.

The ages of the fathers alone in correlation with the IQ of the children yielded an $r = 0.076$ which corresponds to the error probability (P) or 50%! For Z_f alone we obtained: $r = 0.220$, $P = 4\%$, while for Z_m alone the result was $r = 0.158$ and the P would then be 15%.

This suggests the attempt to assign to the three ages considered different weights, and to take the corresponding weighted mean. It is then particularly interesting that it turns out that the weight of the father ought to be taken as rather smaller than those of both grandfathers. If we assign to the ages of the father, of the paternal grandfather and of the maternal grandfather respectively the weights 1, 3 and 2, and study the corresponding mean value in the rank correlation with the IQ, we obtain $r = 0.233$ which corresponds to a P of less than 3%.

Furthermore we have also carried through the computations of other age combinations in their correlation to the IQ. In the Table III we collect all r values obtained in this way with the corresponding error probabilities P, ordered according to P.

In order to meet the possible objections that the correlation which we found may be caused mainly by

Table I.

Paternal trinomials	Average IQ	No. of testees
77–89	107.3	30
90–104	110.1	43
>105	113.6	14
Total		87

Table II.

IQ	Average of the paternal trinomials	No. of testees	Average of the maternal trinomials
90– 99	90.2	11	77.6
100–109.5	91.9	33	85.1
110–119	98.0	30	86.9
120–126	100.5	13	84.5
Total		87	

[8] ADELE JUDA, *Höchstbegabung*. Ihre Erbverhältnisse sowie ihre Beziehungen zu psychischen Anomalien (Urban and Schwarzenberg, München 1953). I am very grateful to Dr. med. habil. E. ZERBIN-RÜDIN as she made it possible for me to consult the complete field material of ADELE JUDA, including the genealogical tables.

[9] *Neue Deutsche Biographie*. Herausgegeben von der Historischen Kommission bei der Bayerischen Akademie der Wissenschaften (Duncker & Humblot, Berlin 1955 and 1959), vol. II and IV.

[10] J. ALEKSACHIN and A. TKATSCHENKO, Literaturnaja Gaseta *48*, Nov. 29 (1972).

[11] HERMANN ARNOLD, *Die Neumühler*. Beschreibung einer sozial isolierten Bevölkerungsgruppe, in *Mitteilungen der Pollichia* (1967), 3. Reihe, vol. 4.

[12] I am particularly grateful to Professor H. ARNOLD for his field material in connection with this investigation.

[13] Hans W. JÜRGENS, *Asozialität als biologisches und sozialbiologisches Problem* (Enke Verlag, Stuttgart 1961), p. 56.

[14] Assisted by HANS BEAT KÖHL.

[15] HANS JÜRGEN EYSENCK, *Intelligenztest*, aus dem Englischen übertragen von EDELGARD STÖHR. Für die deutsche Ausgabe neu standardisiert und eingerichtet von GERD STÖHR (Rowohlt, Hamburg 1972), test No. VII.

[16] W. J. CONOVER, *Practical Non-Parametric Statistics* (Wiley, New York 1971), p. 245–249, 390.

the social class of the fathers, or on the birth order of the testees, we studied also the social status of the father as well as the birth order of the testees[17] in correlation with the 4 different IQ levels already used in the Table II.

In this way we obtained the results of Tables IV and V. The statistical check with the $\varkappa^2$ test[20] of Table IV shows that the $\varkappa^2$ value (2.6) lies under the critical $\varkappa^2$ value (5.99) on assumption of the error probability 5%, so that in this case there is no significance with respect to the social status of the father.

In the Table V the $\varkappa^2$ [22] shows in assumption of $P = 5\%$ the $\varkappa^2$ value (8.54) lies under the critical $\varkappa^2$ value (12.6), so that the hypothesis of a correlation between the birth order and the endowment must be considered as not significant.

Table III.

Combination of the age indices	r-Value	Error probability (%)
Age of the father	0.076	50
Age of the mother	0.090	41
Max (F. Z_f, Z_m)	0.110	33
Max (F, Z_f)	0.120	27
Binomial: F+Z_m	0.142	20
Maternal trinomial S_m	0.145	18
Z_m	0.158	15
Binomial: F+max (Z_f, Z_m)	0.179	10
Binomial: F+Z_f	0.206	6
Binomial: Z_f+Z_m	0.210	6
Z_f	0.220	4
Paternal trinomial: S_f	0.223	4
Mean value corresponding to the weights 1 of F, 3 of Z_f and 2 of Z_m	0.233	3

Table IV.

IQ	Social class of the father[18] 1	2	3	4	No. of testees
90– 99	1	1	5	4	11
100–109.5	4	3	6	18+2[19]	33
110–119	1	3	14	12	30
120–126	1	3	4	5	13
Total	7	10	29	41	87

3. *Discussion of results.* The above computations prove a definite tendency for the rank correlation of the endowment with the paternal trinomial index. Furthermore they appear also to confirm the observation mentioned above that a definite change in the social status becomes evident mainly after two generations, since the weight which has to be assigned to the paternal grandfather is unexpectedly large. The age of the grandfather alone has a rank correlation with the endowment of the child that is already significant with an error probability of 4%. This fact speaks also against the hypothesis of the strong interdependence of the endowment with the environment, since the father alone appears to play only a lesser rôle, against all expectations.

However, the sources of error are of course rather large. For instance, we had to use in our study the well-known formulation of the Roman law: 'Pater est quem nuptiae demonstrabant', while the other Roman sentence 'Pater semper incertus est' had to be left aside. Further, there may be some probability of false data about the ages of the grandfathers.

4. *Future studies.* We intend to pursue the correlation, which we believe to have proved rather probable, also in other directions since this point of view may be of consequence in the investigation of ethnic and social groups as well as of different religiously distinct communities. For the Theory of Evolution too, there may be some relevance.

Furthermore, it would be of general interest to initiate a corresponding series of tests with animals, since in

[17] I owe this observation to Prof. F. Vogel, Humangenetisches Institut der Universität Heidelberg.

[18] The assignment of the parents to the social class was taken using Morris Janowitz' article *Soziale Schichtung und Mobilität in Westdeutschland*, in Kölner Z. für Soziologie und Sozialpyschologie, *1958*, p. 36. The numbers 1 to 4 in the table signify: 1, the lower status of the lower class; 2, the upper status of the lower class; 3, the lower status of the middle class; 4, the upper status of the middle class.

[19] The numbers 18+2 have the following significance: We had 18 fathers who definitely belonged to the upper middle class, further 1 father with social status above 4 and another whose social status could not be determined.

[20] Erna Weber, *Grundriss der biologischen Statistik*, 7th edn. (VEB Gustav Fischer, Jena 1972), p. 624. In this computation of the IQ values, the 1st and the 2nd line as well as the 3rd and the 4th line were taken together; the 1st and 2nd columns corresponding to the social classes 1 and 2 were collected into 1 column, since the sample sizes are relatively small.

[21] In this table we characterize the birth order of the testees in their families with the fraction m/n if it is the m^{th} child in a family of n children.

[22] Erna Weber, *Grundriss der biologischen Statistik*, 7th edn. (VEB Gustav Fischer, Jena 1972), p. 515. In this computation the columns corresponding to 3/3, 3/4 and 4/4 were collected into 1 column.

Table V.

IQ	Birth order of the testees in the family[21] 1/1	1/2	1/3	1/4	1/5	2/2	2/3	2/4	3/3	3/4	4/4	No. of testees
90– 99	2	1			1	2		2	3			11
100–109.5	7	8	5	4		4	2	1		2		33
110–119	7	7	1			9	1		2	1	2	30
120–126	2	2	2			4	2		1			13
Total	18	18	8	4	1	19	5	3	6	3	2	87

this case the use of the discutable IQ, which is finally rather subjectively defined, can be replaced by much more precisely formulated data in the labyrinth experiments. The sequence of the generations can also be thoroughly checked in this case. But, in the first instance, it would be particularly important to carry out future investigations on a considerably larger sample of persons.

5. *Final remark.* It is hardly necessary to emphasize that our findings are only concerned with correlation and the overall situation, but say nothing whatever about the 'mikro-caused' background, which ought to be investigated by biological methods.

Zusammenfassung. Zur Erhärtung der oft formulierten Vermutung, dass hochbegabte Kinder meistens von älteren Eltern abstammen, wurde eine Serie von Untersuchungen durchgeführt an verschieden zusammengestellten Listen hervorragender Persönlichkeiten. Dabei stellte sich als wertvoll heraus, neben dem Alter des Vaters auch die Alter der beiden Grossväter heranzuziehen und die Summe dieser 3 Alter, die «väterliche Dreierzahl» zu benutzen. Im Resultat ergibt sich, dass die Alter der Väter unter 30 nur in weniger als 20% aller Fälle und zugleich «Dreierzahlen» unter 90 in weniger als 5% aller Fälle vorkommen. Die Hypothese, dass allgemein der IQ im Durchschnitt monoton mit der «Dreierzahl» wächst, wurde an einer Gruppe von 87 Schülern eines Gymnasiums getestet und durch den «Spearman rank correlation test» als signifikant mit der Fehlerwahrscheinlichkeit unter 4% nachgewiesen. Eher unerwartet, scheint das Alter des väterlichen Grossvaters stärkeres Gewicht zu haben als das des leiblichen Vaters.

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[23] I should like to express my gratitude to Professor EDUARD BATSCHELET, Biomathematisches Institut der Universität Zürich, and Professor ALEXANDER M. OSTROWSKI, Mathematisches Institut der Universität Basel, who both helped me in a very kind way with the significance computations and made many useful observations.

PRO EXPERIMENTIS

An Improved Giemsa C-Banding Procedure for Plant Chromosomes

The Giemsa banding techniques that have been developed for animal and human chromosomes are in general not directly applicable to plants. In the former systems they made possible the recognition of constitutive heterochromatin (C-banding) as well as allowing a discrimination between other chromosome regions (G-banding). In some monocotyledonous plant species of the genera *Trillium* and *Fritillaria*, a simple method consisting of 4 steps has been developed for the preferential staining of heterochromatin[1]. However, this technique gave variable results or failed when applied to other species, such as *Vicia faba* or *Pisum sativum*.

A method has now been developed which is an improvement on the earlier technique and adds as an essential stage a pretreatment of the preparations with hot barium hydroxide. This step has been introduced in a method for demonstrating human centromeric heterochromatin[2]. The new procedure was tested with pea and rye and then successfully applied to *Anemone* and *Hepatica*[3].

Colchicine pretreated root tips were employed and several alcoholic fixatives commonly used for plant chromosomes[4] were found to be compatible with Giemsa C-banding. Fixed root tip meristems were placed in 45% acetic acid on a slide previously coated with a thin layer of HAUPT's adhesive dried with ethanol[5]. 'Subbing' with HAUPT's adhesive is superior to albumen-glycerine because there is less material loss during subsequent steps. Root tip meristems were crushed and dispersed into a very fine suspension and squashed in 45% acetic acid, applying gentle heat to the slide. The coverslip was prised off using the dry ice method or liquid nitrogen. The slide was plunged into 2 changes of 90% ethanol followed by two changes of absolute ethanol prior to air drying. Preparations were then usually stored for a day or more at room temperature. For pretreatment, slides were placed in a ridged coplin jar in a waterbath and a freshly prepared prewarmed aqueous solution of barium hydroxide was added. Optimal barium hydroxide concentration and temperature were determined in a preliminary experiment; incubation time was varied only within the range of 10 to 20 min. The alkali treatment was stopped by adding distilled water to the coplin jar so that the skin of $BaCO_3$ which had formed was washed away. After thorough rinsing with distilled water, preparations were then incubated at 65 °C for 1–2 h, or in a few instances overnight, in 2 × SSC (0.3 *M* NaCl plus 0.03 *M* trisodium citrate, pH 7.0). Preparations were washed briefly with distilled water and stained in buffered Giemsa (G. T. Gurr's R66 'improved' stock solution diluted about 50 × with *M*/15 Sörensen phosphate buffer, pH 6.9). Precipitated stain on the squashes is largely avoided by tilting the staining jar so that the preparation is on the underside of the slide. Staining was repeatedly monitored; the time required for optimum differential staining varied widely between preparations. Fine detail was often best seen in slowly developing preparations which were left in stain overnight. Lastly preparations were rinsed with distilled water, air dried and mounted directly in DePeX (G. T. GURR; Searle Scientific Services, High Wycombe, Bucks., England).

Two main difficulties arise in using the Giemsa C-banding technique on plants. Firstly, a method of fixation and preparation has to be found which yields cytologically acceptable chromosome figures and which is compatible with the subsequent Giemsa procedure. Secondly, modifications of the known Giemsa techniques may have to be devised to take into account the properties of the particular plant used and the conditions created by the fixation/preparation method employed.

Direct preparation of fixed root tips as conventional 45% acetic acid squashes[6] led to good chromosome

[1] D. SCHWEIZER, Chromosoma *40*, 307 (1973).
[2] A. T. SUMNER, Expl. Cell Res. *75*, 304 (1972).
[3] G. E. MARKS and D. SCHWEIZER, Chromosoma *44*, 405 (1974).
[4] C. D. DARLINGTON and L. F. LA COUR, *The Handling of Chromosomes*, 5th edn. (Allen & Unwin, London 1969), p. 145.
[5] A. W. HAUPT, Stain Techn. *5*, 97 (1930).
[6] T. CASPERSSON, L. ZECH, E. J. MODEST, G. E. FOLEY, U. WAGH and E. SIMONSSON, Expl Cell Res. *58*, 128 (1969).