

5 February 1932.

Major L. Darwin, Sc.D.,
Cripps's Corner,
Forest Row, Sussex.

Dear Major Darwin:

I. On regression.

Regression, as the word was used by Galton and the Biometers, i.e. regression to the mean, must have at least three contributory causes:-

(a) If the relation of the child to only one parent is considered regression is due to the contribution of the other parent for the reason that tall men will on the average have not so tall wives, reckoning tallness in each sex from the mean of that sex, and in the same sense a selected group of short men will have wives who may be below the average, but will be not so short as their husbands. To avoid this obvious cause of regression Galton was led to use the "mid-parent".

(b) Non-inherited fluctuations due to environment will cause a group of parents selected for height above the average to have more than their share of those whose stature has been

enhanced, and less than their share of those whose stature has been stunted, by environmental circumstances. Their children, therefore, if reared on the average in an average environment, will be shorter than their parents for this reason. As far as I can judge this makes a very unimportant contribution to the regression observed.

(c) The main regression from the "mid-parent" in man seems to be due to dominance, which may be regarded as similar in its effects to environmental fluctuations, seeing that it, like them, disguises to some extent the genetic nature, so that we select a little amiss, and do not find the whole of what we saw in the parents reproduced in the children.

II.

I take your term "double-recessives" to mean homozygotes who have received a recessive gene from both parents. The term is often used for individuals who are homozygous recessives for two different factors, but this does not so well fit your context. When two homozygous recessives mate, there will be no regression in that factor. The regression of offspring of recessive parents is due to the cases where they mate with homozygous dominants, and the offspring are all dominant, instead of half dominant and half recessive, as would be a fair blind expectation, and as occurs when the recessive mates with a heterozygote. On the other hand the regression of offspring of dominants towards the mean is due to the cases where two heterozygotes mate producing a quarter recessives unlike both

their parents, a type of mating which occurs more frequently than the mating of pure dominant with pure recessive.

The whole business is rather intricate as expressed in words and I think of a table of all the possible matings for a single factor is useful to bring it out clearly.

		MOTHERS 100				
		16% Recessive		48% Heterozygotes		36% Dominants
FATHERS.	16 per cent. Recessives	2.56% R		3.84% R	3.84% D	5.76% D
	48 per cent. Heterozygotes	3.84% R	3.84% D	5.76% R	17.28% D	17.28% D
	36 per cent. Dominants		5.76% D		17.28% D	12.96% D
	Total	6.4 % R	9.6 % D	9.6 % R	38.4 % D	36.0 % D

The offspring have been classified according to their appearance, heterozygotes and dominants alike being represented as D. If we do the same with the parents we have

		Mothers			
		16% R		84% D	
FATHERS	16% R	2.56% R		3.84% R	9.6% D
	84% D	3.84% R	9.6% D	5.76% R	64.8% D
	Total	6.4 % R	9.6% D	9.6 % R	74.4% D

For illustration I have taken 40 per cent. Recessive genes to 60 per cent. Dominants, one can see that an excess (over blind expectation) of dominants occurs in the D x R

matings, and a corresponding ^{excess of} recessives in the D x D matings. Blind expectation would have given

2.56% R		6.72% R	6.72% D
6.72% R	6.72% D		70.56% D
9.28% R	6.72% D	6.72% R	77.28% D

that is 2.88% less dominants among the offspring of the recessives, and 2.88% less recessives among the offspring of dominant mothers. From this point of view the regression is not unbalanced, and indeed the one excess must balance the other, if the frequency ratio of recessives to dominants is to be the same in successive generations.

III.

I believe rather strongly that there are in most characters recessives on both sides, on the ground that, for most characters of most species the mean has long been near the optimum. I do not think one could base the belief on the asymmetry of regression as this is obtained from calculations involving only the squares and products, i.e. functions of the second degree of the measurements. There are some third degree statistics which I am rather hopeful about. I mentioned one in my book (p. 116) and have been trying it out and others on maize data, where, owing to the enormous number of recessive defects maintained by constant cross-fertilisation, and the constant efforts of the breeders to increase the yield, dominance is very much

biased indeed.

IV.

I don't feel that we can reject the notion that some qualities making for genius have been harmful. Some geniuses have had so much common sense that one can feel pretty sure that had they been born a medieval serf or a primitive hunter they would have made a very good job of it. But without a lot of ballast I should certainly guess that there are qualities, such as introspection, or an excessive concentration on apparent logical contradictions, which may make for greatness in a musician or a mathematician, but which at the same time may have been harmful during the greater part of human evolution. But I do feel these weigh rather light in the balance against the great qualities which make a mind energetic, persevering and penetrating, and I should guess that these had only been disadvantageous in very exceptional circumstances. I suppose the great difficulty is to allow for the enormously greater facilities which civilisation offers for utilising special and limited gifts, so that if they hit off the temper of the age they are appreciated, like those of Praxiteles or Nelson.

V.

I like this paragraph enormously, especially if you apply it to force of character rather than intelligence. Intelligence might take a step further and judge when to take the lead.

VI.

I don't see VI at all.

Returning to I have we any right to say that the
genuses stray further from the pile than they ought to do by
chance. In the stone age I suppose your father might have
been a great trapper, perhaps no one would have selected
his flints for chipping more carefully, but if carving
goddesses in ivory had been all the rage would he have been able
to do much more for his tribe than to leave a few level-headed
aphorisms for them to ponder over?

I am returning your manuscript notes with this typed
so that I can keep my copy and am keeping your main paper
for a time. Is it to be the Romanes lecture?

Yours sincerely,

P.S. I am enclosing a talk I gave a week ago to the
Royal Society of Dublin, which bears a little on your subject.

R.A.F.