values than the average of the purebreds ($0{\cdot}1 > P > 0{\cdot}05$). The difference between inbreds and outbreds was not significant. Most clearly, ewes which nearly a year ago produced lambs with swayback had much lower blood copper values than contemporaries which had previously had normal lambs ($P < 0{\cdot}001$). Females in-lamb for the first time had significantly lower values than ewes which had lambed previously ($P < 0{\cdot}05$).

For about 6 weeks prior to bleeding, the ewes, which ran together as one grassland flock, had access to a mineral lick containing 718 p.p.m. copper. It is possible, therefore, that sheep may have ingested different quantities of mineral, which could complicate interpretation of the results. However, the special management circumstances of the experimental flock are such that there was no segregation of the flock by breed or by the other subdivisions in the analysis. In spite of the access to a mineral lick containing copper, only two of the fifty-five sheep had blood copper values greater than the 60 μg/100 ml. whole blood, which has been accepted as a 'normal' level in the literature (for references see Barlow *et al.*[1]).

It has recently been found[3] in the same flock that the incidence of swayback in lambs in 1964 was clearly associated with breed and breed cross. The mean blood copper values of the three pure breeds ranked inversely to the percentage of lambs with swayback among these breeds in the previous year. The overall correlation between the present blood copper levels of the six breed types of ewe and the percentile incidence of swayback among the lambs of the same six breed types in the same flock a year ago was $-0{\cdot}82$ ($P < 0{\cdot}05$). The genetic implications of these findings merit further investigation in relation to the swayback syndrome.

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PSYCHOLOGY

Age, Cardiac Output and Choice Reaction Time

IN an earlier communication to *Nature*[1] it was argued that the attempt to resolve the discrepancy in data on choice reaction time in relation to age in terms of the effective duration of signals[2] must be regarded as inadequate. The observations were based on a small sample ($N = 48$) of data from a psycho-physiological study of the possible effects of ageing on professional (that is, airline, military and test) pilots. The present communication is a brief account of some of the further results obtained to date in a larger sample ($N = 201$).

The design of the psychological experiments is intended to reflect the fact that flying requires, *inter alia*, making high-speed decisions and detecting low probability signals, as well as an ability to receive and retain significant amounts of information in the course of routine control procedures. Consequently in the measurement of choice reaction times, latencies of responses are recorded not only under normal ('basic') conditions but also under those of 'information overload'—in an attempt to estimate 'reserve capacity'. For a more detailed description of the methods used in this investigation the reader is referred to the earlier reports[1,3,4]. The evidence summarized in Table 1 makes it clear that, as before, the principal age differences in our sample of some two hundred active pilots are to be found in the intercept constant of the formula for choice reaction ($RT = a + b \log_2 n$) under conditions of information overload, not in the slope constant. The b constant, however, appears to be directly related to cardiac output, as assessed on the basis of ballistocardiogram stroke volume and of heart rate, recorded after exercise. Furthermore, the results of the pulmonary physiology studies under conditions of maximum effort are also in line with this trend.

Table 1

(Response time $= a + b \log_2 n$)

Correlation r* = rate of gain of information with age and cardiac output (ballistocardiogram stroke volume and heart rate)

	Serial choice task alone		Serial choice task with overload		Difference (basic-overload)	
	r	p	r	p	r	p
Rate of gain of information						
× Age	−0·13	NS†	−0·27	0·001	0·25	0·001
× Cardiac output (pre-exercise)	0·06	NS	0·01	NS	−0·06	NS
× Cardiac output (post-exercise)	0·05	NS	0·08	NS	0·04	NS
Constant a (intercept)						
× Age	0·03	NS	0·22	0·01	0·18	0·02
× Cardiac output (pre-exercise)	−0·04	NS	0·01	NS	0·03	NS
× Cardiac output (post-exercise)	0·02	NS	−0·02	NS	−0·03	NS
Constant b (slope)						
× Age	0·02	NS	0·07	NS	0·07	NS
× Cardiac output (pre-exercise)	0·01	NS	−0·05	NS	−0·05	NS
× Cardiac output (post-exercise)	−0·08	NS	−0·26	0·01	0·23	0·01

		r	p
Cardiac output	(Pre-exercise) × age	0·15	NS
	(Post-exercise) × age	−0·17	0·05
Oxygen pulse	(Maximum effort) × age	−0·12	NS
	× Difference in rates	−0·20	0·01

* Quantitative analysis carried out with the aid of a Burroughs 5500 computer.
† NS: not significant.

It is felt that these findings raise important questions of fact and of analysis. In the first place, they confirm the general impression that age differences in physiological and psychological tests are more revealing when observed under conditions of stress than under baseline or resting conditions[5]. In the second place, they add to the slowly accumulating evidence[1,4,6–8] that the population samples in those studies of ageing in which the occupational and health status of the subjects was not clearly defined may have to be regarded in some sense as non-normal. In particular, with reference to data on choice reaction times, the present investigation suggests that those earlier investigations which reported slowing of response with age as an increase in the slope constant must have included, no doubt inadvertently, sub-clinical cases of cardiovascular disorder. Of course, studies of ageing which would be entirely free of pathology are to some extent imaginary; however, the difficulties which arise about 'unscrambling' the effects of ageing and those of minimal pathology are not the most convincing confirmation of the supposed vulnerability of function in later adulthood.

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