

to be recalled the greater the difference, overall, between the first and second half-spans.

These findings make it seem quite unlikely that differences in motivation can explain such changes in short-term storage with age. It is not easy to conceive how overall changes in motivation as people grow older could make them respond accurately to one ear but not to the other.

It could, however, be maintained that the impairment shown by elderly subjects in the recall of dichotic digits might be due to a failure to hear, or a failure to attend to, the second half-spans on which they showed most errors of report. We have accordingly carried out a further experiment in order to evaluate these possibilities; a preliminary report of our results is offered here.

One hundred and twenty subjects between 11 and 20 years of age were tested. There were 20 people in each decade group: 10 male and 10 female. They were required to recall dichotic digits under three conditions; these being: (1) when the order of recall was left to the free choice of the subject; (2) when the ear order of recall was specified before; (3) after these digits had been delivered.

Condition (1) was used in order to provide a further repetition of the experiments carried out on similar groups by Inglis and Caird² and Mackay and Inglis³. It can be seen that no control was exercised by this condition over the laterality of the order of recall. The results of this part of the experiment were in accord with previous findings.

In condition (2) the side to be recalled first was indicated by means of a signal panel set in front of the subject simply bearing the printed words 'right' and 'left'; a red light was switched on above the appropriate word by the experimenter, in this case immediately before each span of the dichotic digits was delivered. This condition was used in the experiment recorded here to evaluate the notion that the changes with age which had previously been shown on this task might be due, for example, to an age-related hearing loss in one ear as compared with the other. If it were the case that as people grow older they tend to suffer such a differential loss in auditory acuity then the apparent deficit in the ear recalled second under conditions of free response might be explained by this kind of peripheral difficulty. If, however, an increased order effect were to appear with age regardless of ear-specification, then this hypothesis would not be supported.

The results obtained under this condition refute the notion that any unilateral decrease in auditory acuity could account for the appearance of the order effect noted under conditions of free recall. A marked age-related recall order effect appears which is relatively independent of ear laterality.

In condition (3) the side to be recalled first was again specified by means of the light signals, in this case immediately after the dichotic digits were delivered. This procedure provided a control for the possible effects of differences in attention between the different age groups. It might be argued, for example, that previous findings were due to the fact that as people grow older they will, in the dichotic digit experiment, only pay attention to the material coming into one ear. If, however, the subjects only know after the digits have been delivered which side they have to report first and, further, if they only attend to one side, then the ear order effect should vanish, or at least be greatly diminished, since they cannot know beforehand to which ear they should have paid most attention.

Under this condition the age-related order effect was again clearly shown; the main decline with age being in the half-sets recalled second. This means that the order effect cannot be entirely explained by the notion that older subjects only attend to the material presented to one ear.

In conclusion, therefore, it may be said that the results of this experiment confirm, once again, that the responses

made to dichotic stimulation under conditions of free recall are affected by age. Since it is the order effect which is exaggerated in older subjects this finding lends support to the view that some short-term storage mechanism is affected by advancing years. This finding cannot be explained in terms of differences in motivation with age. The results obtained in this experiment when the order of recall was specified before delivery of dichotic digits are similar to the results from free recall. Since the age-related order effect still appears regardless of which side is specified for recall first, this finding is quite incompatible with the notion that changes in responses to dichotic listening with age might be due, for example, to some unilateral hearing loss which gets worse as people grow older. This finding cannot, therefore, be explained in terms of differences in sensation or perception. The results obtained when order of report was specified after the delivery of the digits are also very similar to the results obtained under conditions of free recall. This outcome runs completely counter to the view that the changes observed with age might be due, for example, to the fact that older individuals only attend to the material from a single channel under conditions of simultaneous stimulation. This finding, therefore, cannot be explained in terms of differences in attention.

All these findings are, however, compatible with the hypothesis that the age-related impairment shown in recall under the three experimental conditions is due to a decline in the efficiency of some short-term memory storage process.

The work described was supported by grant 25 of the Ontario Mental Health Foundation; the testing was carried out by Mrs. Mary Ankus.

JAMES INGLIS

Department of Psychiatry,
Queen's University,
Kingston, Ontario.

¹ Broadbent, D. E., *Perception and Communication* (London: Pergamon Press, 1958).

² Inglis, J., and Caird, W. K., *Canad. J. Psychol.*, **17**, 98 (1963).

³ Mackay, H. A., and Inglis, J., *Gerontologia*, **8**, 193 (1963).

MISCELLANEOUS

Shape of Small Particles

I REGRET that the index 2 was omitted from one of the β 's in the denominator of equation (19) in my article published in *Nature* under the above title¹; this was due to an error in the analysis which escaped me and was later detected by Mr. J. Cartwright of the Safety in Mines Research Establishment when applying the method to coal dust. As a result, the figures given in Table 3 were in error and the Table should read as follows:

Axial ratio β	$F(\beta) =$	$1/\beta^{1/2} F(\beta)$	$2\sqrt{F(\beta)}$	$\beta^{1/2}\sqrt{F(\beta)}$
	surface area $4\pi a^2$			
1.0	1.0	1.0	2.0	1.0
1.1	0.986	0.952	1.986	1.025
1.3	0.862	0.975	1.856	1.013
1.5	0.787	0.989	1.774	1.016
2.0	0.690	0.914	1.662	1.046
3.0	0.604	0.796	1.554	1.121
4.0	0.567	0.700	1.506	1.195
6.0	0.535	0.566	1.462	1.329
8.0	0.522	0.479	1.444	1.445
10.0	0.515	0.418	1.436	1.547
20.0	0.500	0.272	1.414	1.919
50.0	0.500	0.147	1.414	2.604
100.0	0.500	0.093	1.414	3.282
500.0	0.500	0.032	1.414	6.612
1,000.0	0.500	0.020	1.414	7.071

C. N. DAVIES

London School of Hygiene and Tropical Medicine,
Keppel Street, London, W.C.1.

¹ Davies, C. N., *Nature*, **201**, 905 (1964).