his visual illusion of the cabin as a fixed frame of reference may be corroborated by false evidence from his semicircular canals and all other physiological means of sensing what is horizontal. With all these senses combining to mislead him, it is no wonder that he may discredit the little glimpses of the ground through these small and distant and apparently stationary windows.

After the wheels touch, the aerodynamic drags weaken gradually, but the wheel brakes take their place and the backward acceleration may not change much. So it is reasonable that the illusion should persist sometimes nearly to the end of the run. Then, when the ship wheels around and the engines start up for taxying, the acceleration is quickly changed from backward to forward; so in the cases observed by Moore, "the phenomenon abruptly ceased."

To create this illusion, and to maintain it during the change from aerodynamic drags to wheel brakes, the ship must indeed have to be handled very smoothly. But these airline pilots are smooth!

On the practical question of the possibility of a pilot being misled by this illusion, it must be noted that experienced pilots are already disillusioned as to their sense of level, and they are also well trained on how the ground should look in a landing.

This does not mean any lack of use for the sense of level, but only that its use is not what the layman would expect. The principles applied above, to explain Moore's phenomenon, apply also to turns. In them, centripetal acceleration acts like the backward acceleration in a landing, to mislead our sense of level. The only difference is that in the turn it is not through the side windows, but ahead, that the horizon appears not horizontal. If the ship is correctly banked for the turn, however, she seems level to all senses but that of sight. So the pilot uses his internal senses of level to find the correct angle of bank, well knowing that what he senses is not really level, and he uses his eyes to find the true level.

This separation of the internal and visual senses of level, and their concurrent but independent uses for different purposes, is therefore a very important part of piloting. The ability to separate them has to be acquired in learning to fly, because flight is the only activity in which accelerations can grow so smoothly and with so little angular velocity as not to warn us of the difference between acceleration and gravity. Having acquired this ability, however, and having had to put some real effort into its acquisition, the experienced pilot can be counted on to apply it in landing on any airport that he can see. So there is no appreciable chance of his being misled by Moore's illusion.

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SPATIAL DISORIENTATION DURING LANDING FROM AIRPLANE

The type of spatial disorientation reported by Professor A. D. Moore[1] in connection with the landing of an airplane is by no means unknown to experimental psychologists, although too little attention has been paid to it in the literature on space-perception. The basic principle, as Professor Moore suggests, is that of the conflict of two spatial frames of reference, both of which reside in the visual field of the observer, but one of which is more closely related to the directional system of the observer's body. The ground, as seen through the near window, occupies a sufficiently large visual angle to dominate the perceptual process and consequently to provide a "true" system of horizontal and vertical directions. As seen through the far window it is imbedded in the framework of the interior of the plane, and is consequently seen as tilted. The underlying principles have been discussed, although with different examples, by Koffka,[2] Wertheimer[3] and others, and the phenomenon has even crept into at least one elementary text-book.[4]

Whether or not this is a newly discovered phenomenon is, however, of no importance. What is to be emphasized is that this type of "illusion," and the underlying psychological principles, may too easily be overlooked, not only in aviation but in any field of activity in which the perception of space is an important factor. In seeking for the determinants of our perception of spatial directions we are apt to concentrate on the vestibular functions to the neglect of visual organization. In the example which Professor Moore cites, the problem is essentially visual. I am inclined to think that the solution which he proposes will not prove satisfactory. It might be noted, however, that a sub-committee on problems of perception has recently been organized in connection with the program of the National Defense Research Committee. The problem might well be referred to this committee.

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THE HEAT OF SEROLOGICAL REACTIONS

The only attempt to measure directly the heat of an antibody-antigen reaction known to us is that of Bayne-Jones.[1] It is generally admitted that his result is much too high.[2] We have recently completed mea-

[1] A. D. Moore, Science, 92: 477, 1940.
[2] K. Koffka, "Principles of Gestalt Psychology," 1935.
[3] M. Wertheimer, *Zsch. f. Psychol.*, 61: 161–265, 1912.
[4] E. G. Boring, H. S. Langfeld, H. P. Weld, "Introduction to Psychology," 1939.

[1] S. Bayne-Jones, *Jour. Immunol.*, 10: 663, 1925.
[2] F. C. Smith and J. Marrack, *Brit. Jour. Exp. Path.*, 11: 494, 1930.

surements of the heat evolved when an antigen (hemocyanin of *Busycon canaliculatum*) reacts with an immune serum containing the corresponding antibody. In the region of antibody excess, where no precipitate is formed, a value of about 3.0 calories per gram of antigen nitrogen was found (measured at 31° C.). Since the molecular weight of the antigen is 6,800,000, this corresponds to about 3,300,000 calories per mol of antigen. It is believed that this value is probably accurate to about 20 per cent. By extrapolation from analyses of specific precipitates, it was calculated that the above result corresponds to about 40,000 calories per mol of antibody. The magnitude of the result would presumably be different when the antibody and antigen were mixed in different proportions, and would probably be different for antigens of different molecular weights, on account of the different numbers of specific combining groups. Details will be published elsewhere.

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LINNAEUS ON MAN'S NATURAL HISTORY

I HAVE just received, from Miss R. E. Dosé, from the Department of Agriculture, dated October 23, 1940, the note given below, which may be of general interest. It is an extract from a book containing correspondence of John George Gmelin with Carl Linnaeus and others, edited by Dr. William Henry Theodore Plieninger, and published at the order and expense of the Royal Academy of Sciences of St. Petersburg, Stuttgart, 1861.

On page 55 of this book there is a letter written by Linnaeus to Gmelin from Upsala on February 14, 1747. Here is a translation of a part of this letter:

> It would not please, if I placed the man among the anthropomorphous; but man knows himself. Let us abandon words, I do not care what words we use; but from thee, and from the whole world I want an answer to this: What is the difference between man and ape, difference which would be based on natural history? Most definitely I see no difference. I wish some one could show me even one distinction! Should I call a man "ape" or an ape "man," all the theologians would be after me. Yet, for the sake of science, I should have done it.

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RESIGNATION OR EQUANIMITY?

THE system of weights shared by the English-speaking world is often regarded as a cross to be borne with resignation. In our opinion it should be borne with cheerful equanimity: its minutiae test the memory and sharpen the wit. The table we have prepared may be useful to the student of science who is trained to think in terms of the metric system within the laboratory and in the English system elsewhere. Though not very useful to foreign students visiting our laboratory, this table at least entertains them. They are presented with a copy but are not asked to memorize it.

ORDINARY SYSTEM OF WEIGHTS

	1 grain (pearls)	50	mg.
1.296 grains (pearls)	= 1 grain (ordinary)	64.8	mg.
3.086 grains (ordinary)	= 1 carat (m.)	200	mg.
1.027 carats	= 1 carat (1877)	205.6	mg.
6.30 carats (1877)	= 1 scruple (apothecary)	1.296	g.
1.200 scruples (apoth.)	= 1 pennyweight (Troy)	1.355	g.
1.140 pennyweights (Troy)	= 1 dram (avoirdupois)	1.772	g.
2.194 drams (av.)	= 1 dram (apothecary)	3.888	g.
7.29 drams (apoth.)	= 1 ounce (av.)	28.350	g.
1.097 ounces (av.)	= 1 ounce (Troy & apoth.)	31.103	g.
12.00 ounces (Troy & apoth.)	= 1 pound (Troy & apoth.)	373.241	g.
1.215 pounds (Troy & apoth.)	= 1 pound (avoirdupois)	453.59	g.
14.00 pounds (av.)	= 1 stone	6.350	kg.
2.00 stones	= 1 quarter	12.701	kg.
2.68 quarters	= 1 flask (mercury)	34.019	kg.
1.333 flasks (Hg)	= 1 keg (nails)	45.359	kg.
1.00 keg (nails)	= 1 short hundredweight	45.359	kg.
1.120 short hundredweight	= 1 long hundredweight	50.802	kg.
1.607 long hundred weight	= 1 small barrel (lime)	81.65	kg.
1.089 small barrels (lime)	= 1 barrel (flour)	88.90	kg.
1.020 barrels (flour)	= 1 barrel (fish)	90.72	kg.
1.400 barrels (fish)	= 1 large barrel (lime)	127.00	kg.
3.571 large barrels (lime)	= 1 kip	453.59	kg.
2.00 kips	= 1 short ton	907.00	kg.
1.120 short tons	= 1 long ton	1016.04	kg.

Inspection shows that with few exceptions the definers of our units have successfully avoided the monotonous uniformity of the metric system by allotting no more than an equitable share of zeroes to the ratios between successive units. In order to bring into line the few exceptions which did slip by we suggest that the simple change of redefining a stone as 13 5/7ths pounds instead of 14 would make the stones and quarters accord more closely with the rest of the system, leaving only the ounces, the keg and the kip to be dealt with.

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