It was observed that chicks which had been reared with the foam object often pecked at and pressed against it to the accompaniment of contentment chirps, while the others generally showed less positive activity when contacting the box. This suggested that the foam provided an intrinsically more satisfying object of attachment than the box. We tested this by comparing the proportions of the two groups which approached and which contacted their original object in the test (for this analysis the chick which approached both objects was excluded as furnishing ambiguous data). Of the 15 box-reared chicks, 6 approached the box and 4 touched it; while of 16 foam-reared chicks, 12 approached and 11 contacted the foam. The proportions test by Brown[6] shows these differences both in approach and in contact to be significant beyond the 0·05 level.

It could be argued that this result was due to chance differences in the general liveliness of the chicks, rather than to differences in the strength of attachments to the two objects. To test this we compared the mean latency times of the two groups, excluding those subjects which did not move at all. For box-reared chicks this was 2·7 min (range 0·8–4·7), for foam-reared it was 2·1 min (range 0·6–4·8). Clearly there is no significant difference between these means nor, in so far as may be inferred from latency times, in the reactivity of the two groups.

Our main result supports the hypothesis that chicks can form attachments of the kind classified as imprinting to static objects forming a part of their environment from the beginning, as well as to objects introduced into, and so disturbing, their familiar world. Although this attachment was demonstrated by our subjects in a novel situation it must have been established previously in their home environment. Nor can this be explained in terms of conventional reinforcement, since food and water were available in the corners of the pens away from the objects and temperature was constant in all areas.

It was noted, however, that the chicks appeared to seek contact with the box or the foam during the two-day period of rearing. They were often discovered sitting pressed against the object or even, in the case of the foam, actually inside it. Consequently the normally stationary objects did move when pushed, and it is possible that both contact and the movement which this produced had reinforcement value which increased the likelihood or the strength of the attachment. But chicks of this age are not particularly mobile, so that while movement of an object might occasionally have been produced by random floundering against it, systematic or frequent movement would have been unlikely unless the bird had specifically sought contact with it. Movement would therefore have been a concomitant rather than a cause of imprinting. The fact that the foam elicited stronger attachments than the box suggests that some variable akin to Harlow's 'contact comfort'[7] may have been of importance in our experiment. Further work on this question is now in progress in our laboratory[8]. We thank Prof. S. G. Lee and Dr. W. Sluckin for advice.

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[1] Ramsay, A. O., *Auk*, **68**, 1 (1951).
[2] Thorpe, W. H., *Learning and Instinct in Animals* (Methuen, London, 2nd ed., 1963).
[3] Hess, E. H., in *Nebraska Symposium on Motivation*, edit. by Jones, M. R. (Univ. Nebraska Press, Lincoln, Neb., 1959).
[4] Gray, P. H., *Science*, **132**, 1834 (1960).
[5] Abercrombie, B., and James, H., *Anim. Behav.*, **9**, 205 (1961).
[6] Brown, J., *Occup. Psychol.*, **30**, 169 (1956).
[7] Harlow, H. F., and Zimmermann, R. R., *Science*, **130**, 421 (1959).
[8] Taylor, K. F., and Sluckin, W., *Bull. Brit. Psychol. Soc.*, **17**, No. 54, 10A (1964).

STATISTICS

Epidemics and Rumours

Goffman and Newill[1] have directed attention to the analogy between the spreading of an infectious disease and the dissemination of information. We have recently examined the spreading of a rumour from the point of view of mathematical epidemiology and wish to report very briefly here on work to be published in detail elsewhere[2]. In particular, we must emphasize that a mathematical model for the spreading of rumours can be constructed in a number of different ways, depending on the mechanism postulated to describe the growth and decay of the actual spreading process. In all these models the mathematical techniques familiar in mathematical epidemiology can be applied, but even the qualitative results so obtained need not necessarily be as expected on the basis of the formal analogy with epidemics.

To illustrate this point (but not to advance the model *per se*), let us divide the (finite, closed, homogeneously mixing) population into three mutually exclusive and exhaustive classes:

Class	No.	Rumour interpretation	Epidemic interpretation
X	x	Has not heard rumour	Susceptible to disease
Y	y	Actively spreading rumour	Infectious case
Z	z	No longer spreading rumour	Dead, isolated, or immune

If we assume that the only transitions are: (1) 'infections' $(x, y, z) \rightarrow (x-1, y+1, z)$, at a rate proportional to xy; (2) 'removals' $(x, y, z) \rightarrow (x, y-1, z+1)$, at a rate proportional to y; then we obtain the deterministic Kermack–McKendrick epidemic[3] in which an initial trace of infection will generate an appreciable epidemic if, and only if, the initial number $x(0)$ of susceptibles exceeds a certain 'threshold' value ρ. In this formulation the decay of spreading is due to a process of 'forgetting'. Another plausible hypothesis is that an active 'spreader' stops telling the rumour because he learns that it has lost its 'news value'; if this happens as soon as he meets another individual knowing the rumour (that is, a member of Z or another member of Y), then transitions from Y to Z occur as a result of YZ and YY encounters (with a double transition in the latter case), and hence at a rate proportional to $yz+2[\frac{1}{2}y(y-1)] = y(y+z-1)$.

If this assumption is made, however, the behaviour of the system is strikingly different from that of a Kermack–McKendrick epidemic, and could not have been predicted from familiarity with the latter. The fraction f of the population which ultimately learns the rumour (corresponding to the fraction of the population which succumbs to the disease) is always about 0·80, almost irrespective of the value of $x(0)$, so that the familiar threshold effect has disappeared. A stochastic analysis yields very similar results; we find that f (now a random variable) has an expectation of about 0·80 and essentially a variance of approximately $0{\cdot}31/N$, where $x(0) = N$.

'Reluctance to tell stale news' can be incorporated into the model in other ways, some of which we have investigated by similar methods, and the results are then correspondingly modified. However, the object of this communication is not to urge the appropriateness of any one model of rumour-telling; but to stress the danger of transferring formulæ designed for epidemiological use without a thorough re-examination of the hypotheses, which may not always be appropriate in the new situation.

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[1] Goffman, W., and Newill, V. A., *Nature*, **204**, 225 (1964).
[2] Daley, D. J., and Kendall, D. G. (unpublished).
[3] Bailey, N. T. J., *The Mathematical Theory of Epidemics* (Griffin, 1960).