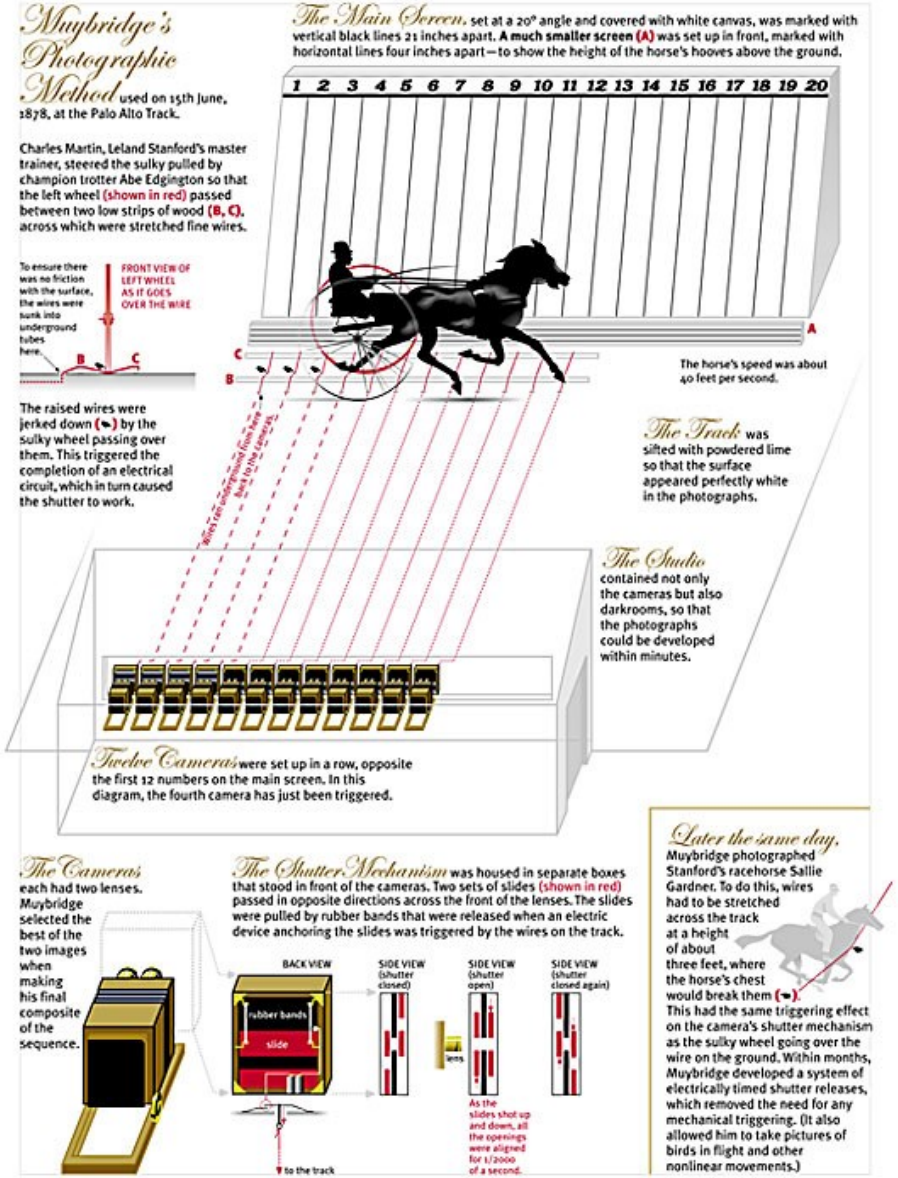
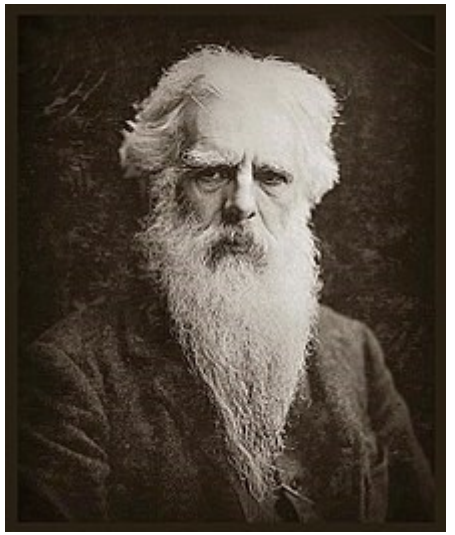
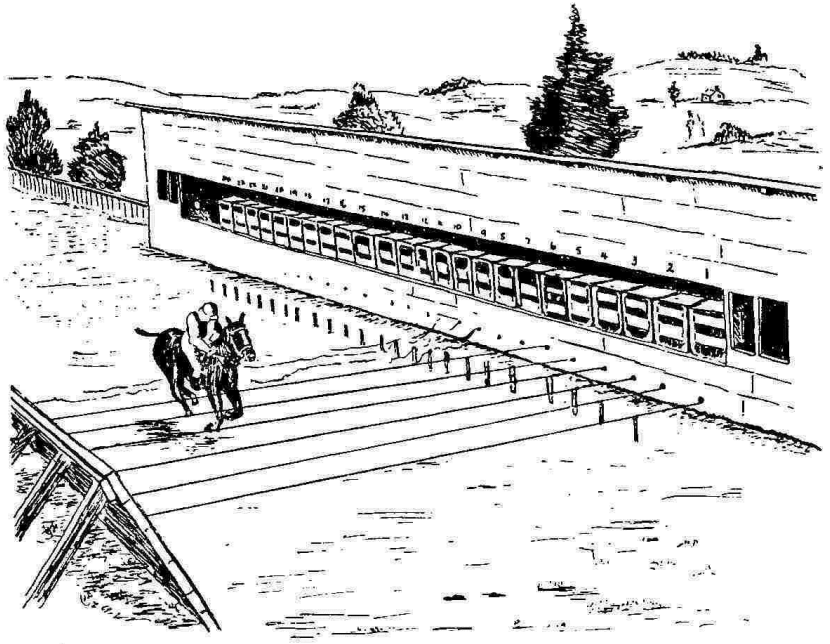
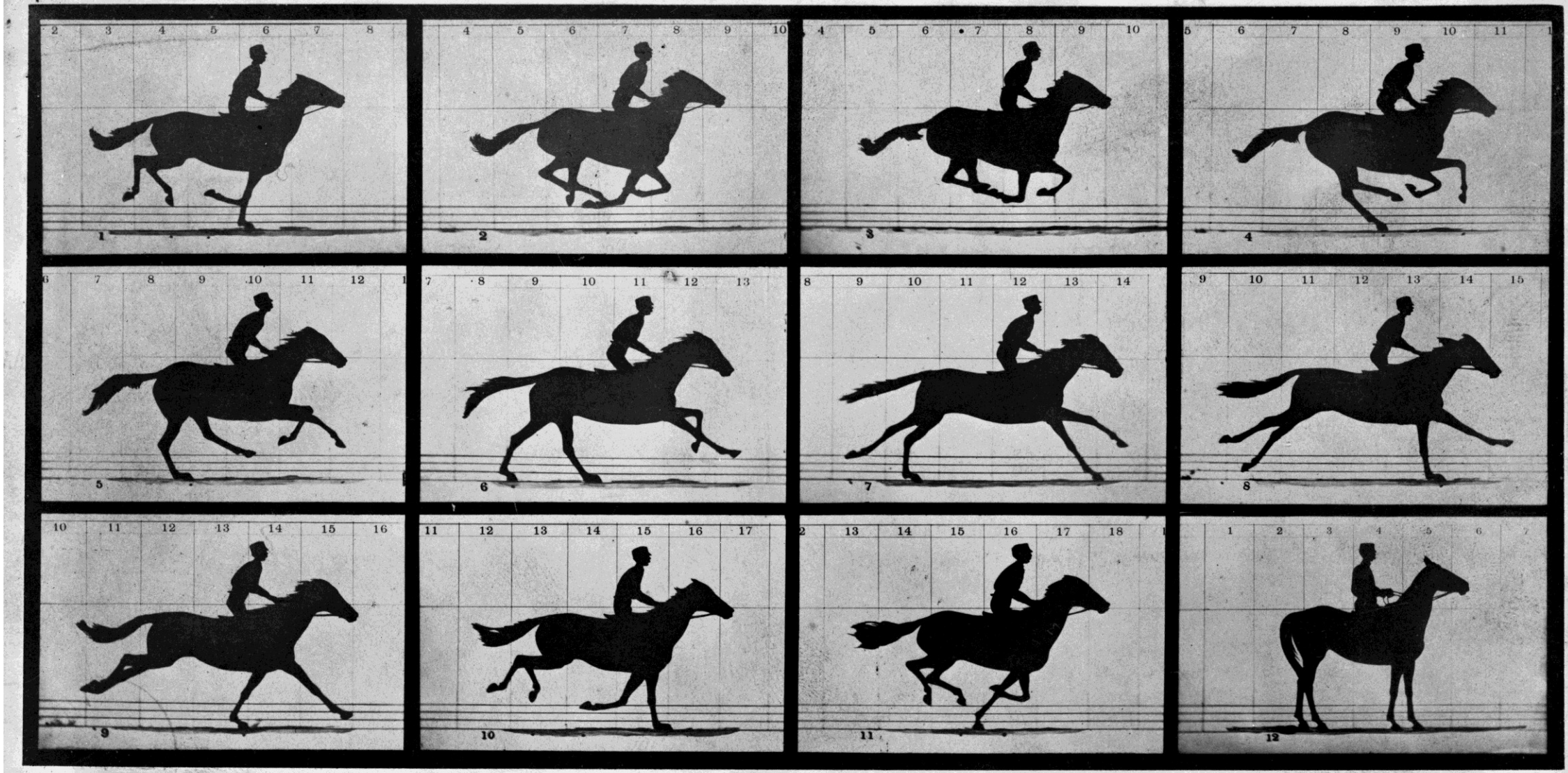
Behavioural tracking techniques
a short history
John O’Keefe





Edward James Muybridge 1830-1904





MORSE'S Gallery, 417 Montgomery St., San Francisco.

THE HORSE IN MOTION.

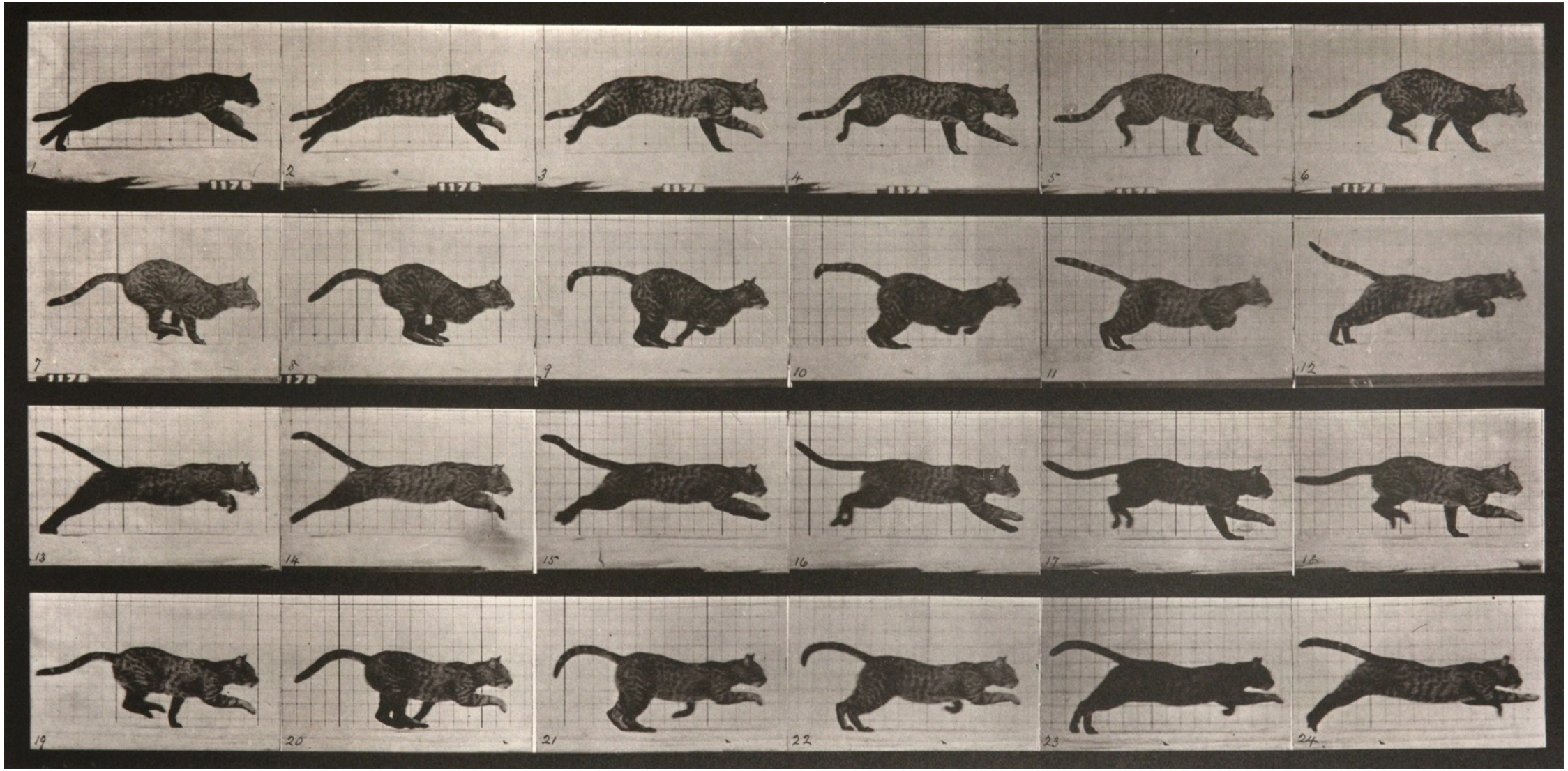
Illustrated by

MUYBRIDGE.

AUTOMATIC ELECTRO-PHOTOGRAPH.

"SALLIE GARDNER," owned by LELAND STANFORD; running at a 1.40 gait over the Palo Alto track, 19th June, 1878.

The negatives of these photographs were made at intervals of twenty-seven inches of distance, and about the twenty-fifth part of a second of time; they illustrate consecutive positions assumed in each twenty-seven inches of progress during a single stride of the mare. The vertical lines were twenty-seven inches apart; the horizontal lines represent elevations of four inches each. The exposure of each negative was less than the two-thousandth part of a second.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THE INTERNATIONAL SCIENTIFIC SERIES

MOVEMENT

BY

E. J. MAREY

MEMBER OF THE INSTITUTE AND OF THE ACADEMY OF MEDICINE
PROFESSOR AT THE COLLEGE OF FRANCE
DIRECTOR OF THE PHYSIOLOGICAL STATION

TRANSLATED BY

ERIC PRITCHARD, M.A., M.B., B.Ch. (Oxon.)

WITH TWO HUNDRED ILLUSTRATIONS

NEW YORK
D. APPLETON AND COMPANY
1895

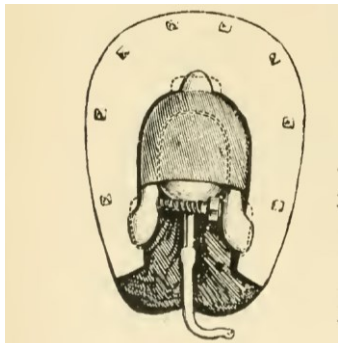


Fig. 6. — Special apparatus for recording the contacts of a horse's feet with the ground; a transmitting tube effects a communication between the air chamber and the chronographic tambour.

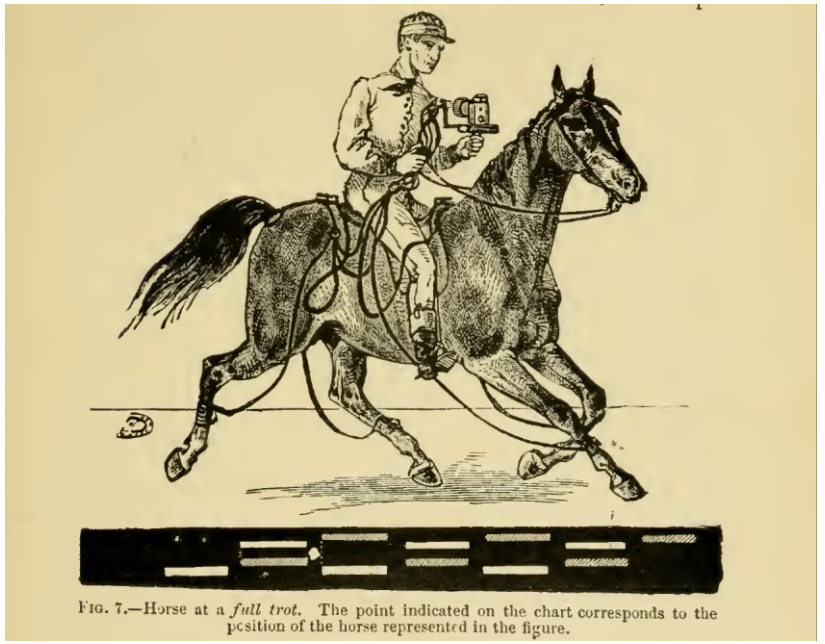


Fig. 7.—Horse at a *full trot*. The point indicated on the chart corresponds to the position of the horse represented in the figure.

Étienne-Jules Marey
1830-1904
Chronophotography

Fig. 41.—Man dressed in black, with white lines and points for the chronophotographic study of the movement of the important parts of the body.

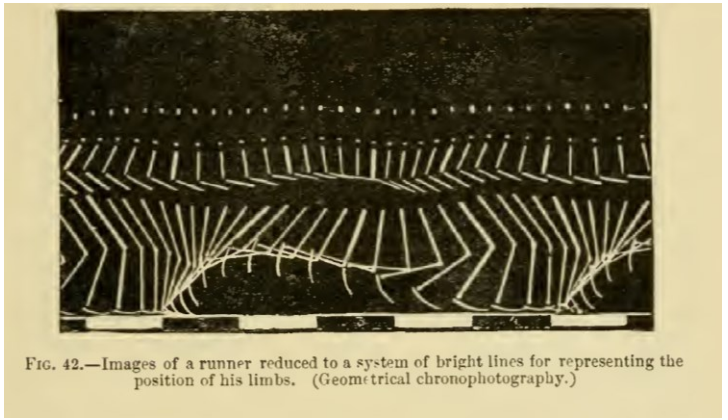
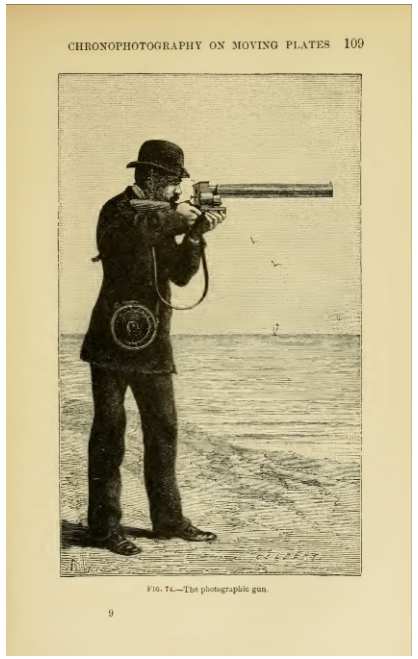


Fig. 42.—Images of a runner reduced to a system of bright lines for representing the position of his limbs. (Geométrical chronophotography.)

Nude Descending a Staircase, No. 2
Marcel Duchamp 1912



CHRONOPHOTOGRAPHY ON MOVING PLATES 109

Fig. 74.—The photographic gun.

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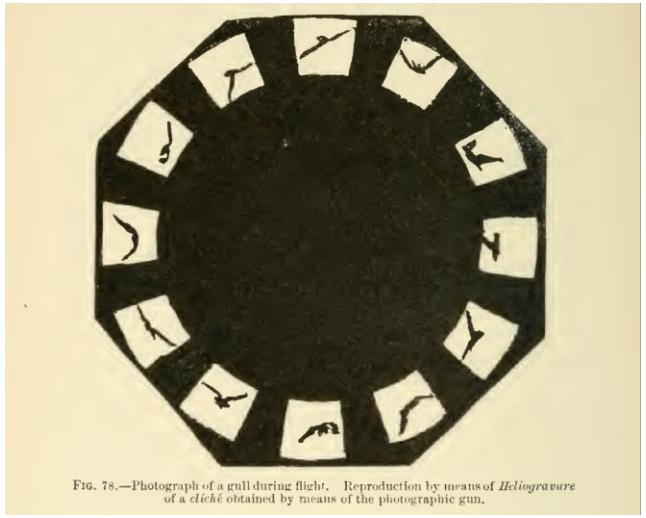


Fig. 78.—Photograph of a gull during flight. Reproduction by means of *Heliogravure* of a *cliché* obtained by means of the photographic gun.

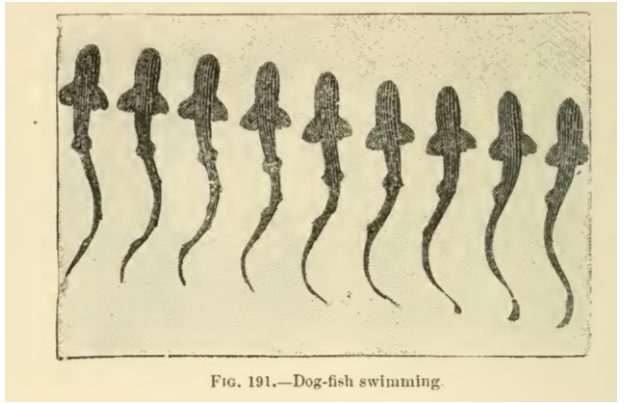


Fig. 191.—Dog-fish swimming.

Gunnar Johansson
Department of Psychology
Uppsala University
Uppsala, Sweden

Fig. 2. Outline contours of a walking and a running subject (A) and the corresponding dot configurations (B).

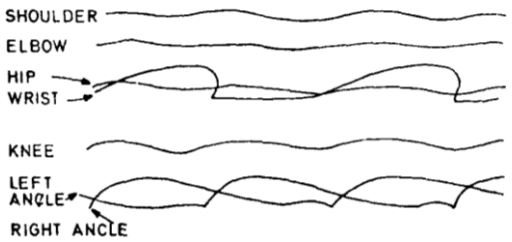


Fig. 3. Typical motion paths of seven elements representing the motions of thyright side joints plus the ankle joint of the left leg of a walking person.

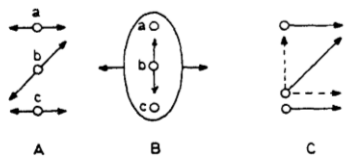
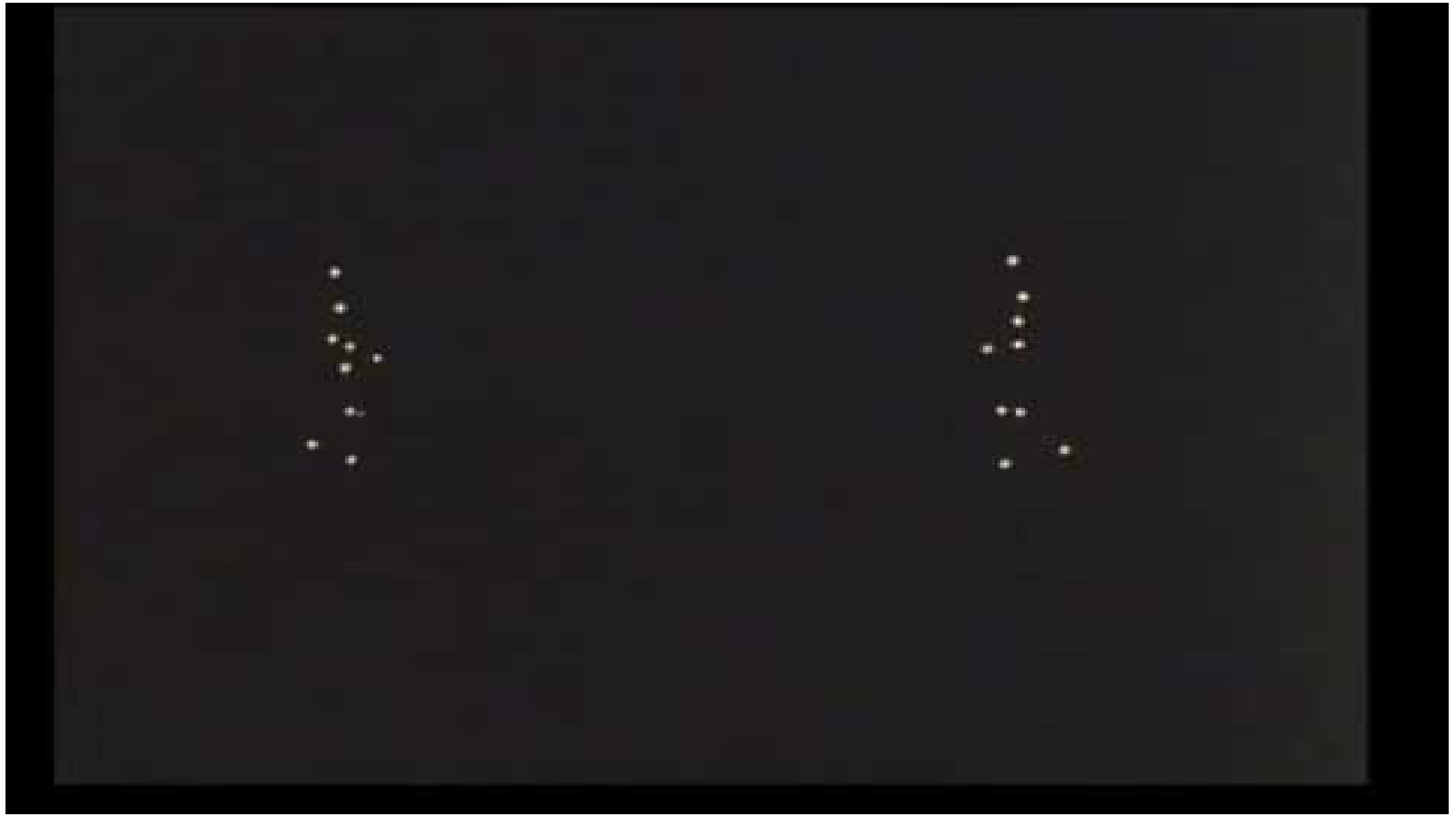
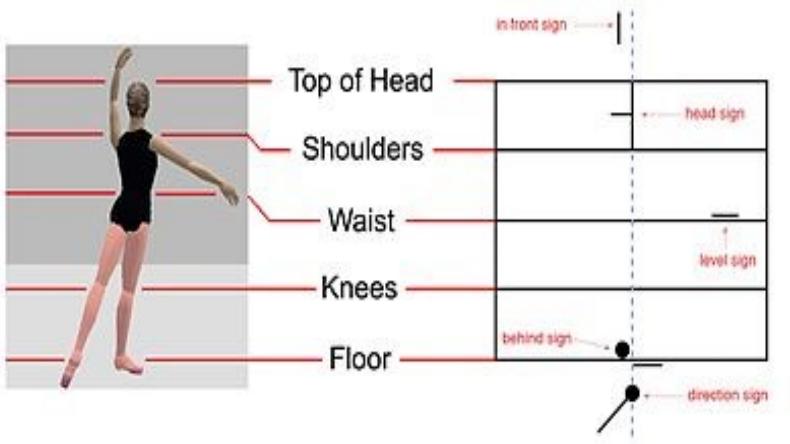


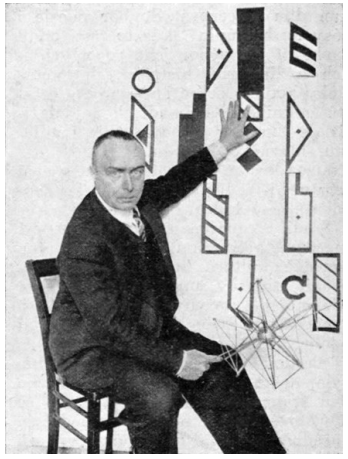
Fig. 4. Examples of the main principle in visual vector analysis. (A) Proximal pattern; (B) diagram of the percept from this stimulus combination; (C) vector analysis of the motion of the middle point corresponding to the percept. For further description see text.

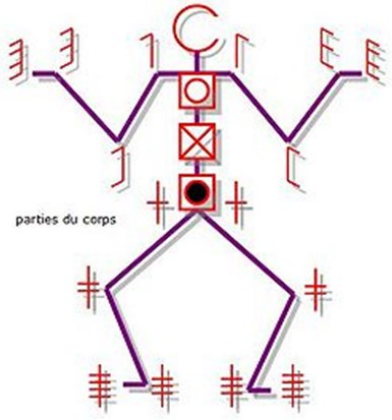


Choreology Dance Notation



•Benesh, R. and Benesh, J. (1983) *Reading Dance: The Birth of Choreology*. McGraw-Hill Book Company Ltd, ISBN 0-285-62291-9

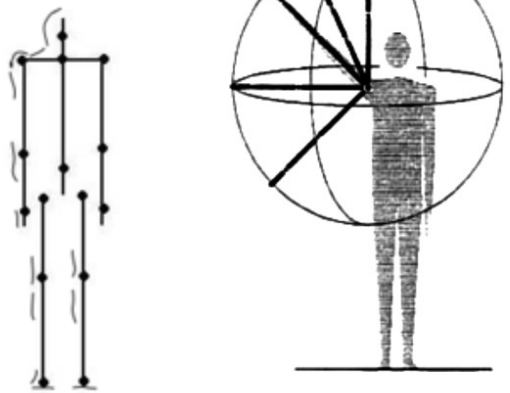


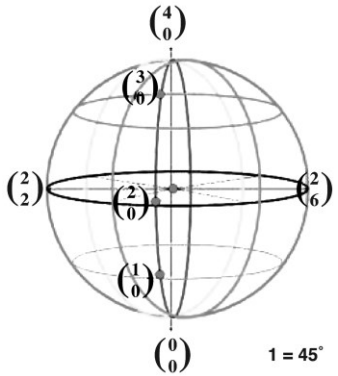


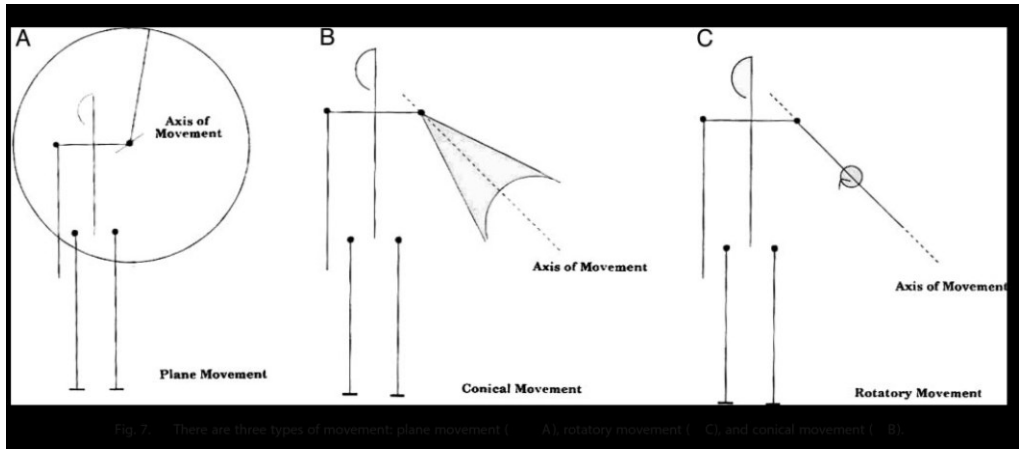
Labanotation

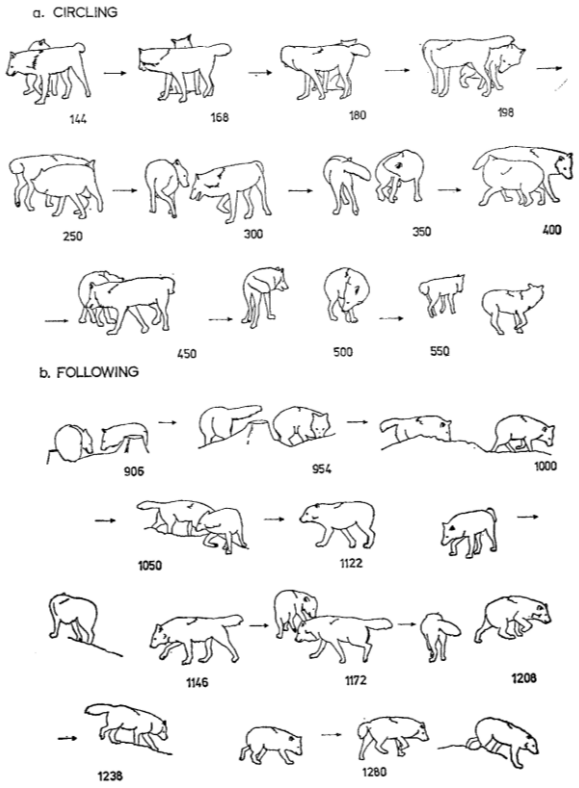
- Hutchinson-Guest, Ann. (1983). *Your Move: A New Approach to the Study of Movement and Dance*. New York: Gordon and Breach.
- Hutchinson-Guest, Ann. (1989). *Choreo-Graphics; A Comparison of Dance Notation Systems from the Fifteenth Century to the Present*. New York: Gordon and Breach.

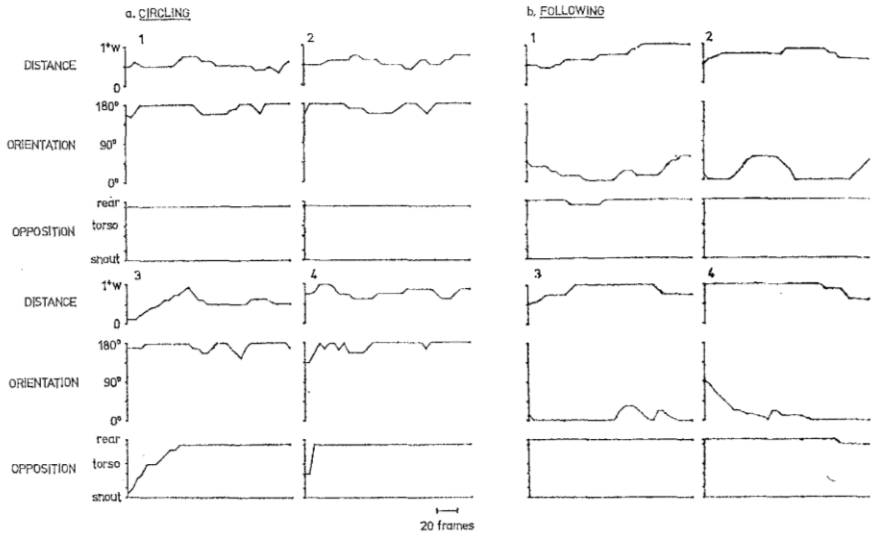
Eshkol-Wachman movement notation dance notation technique











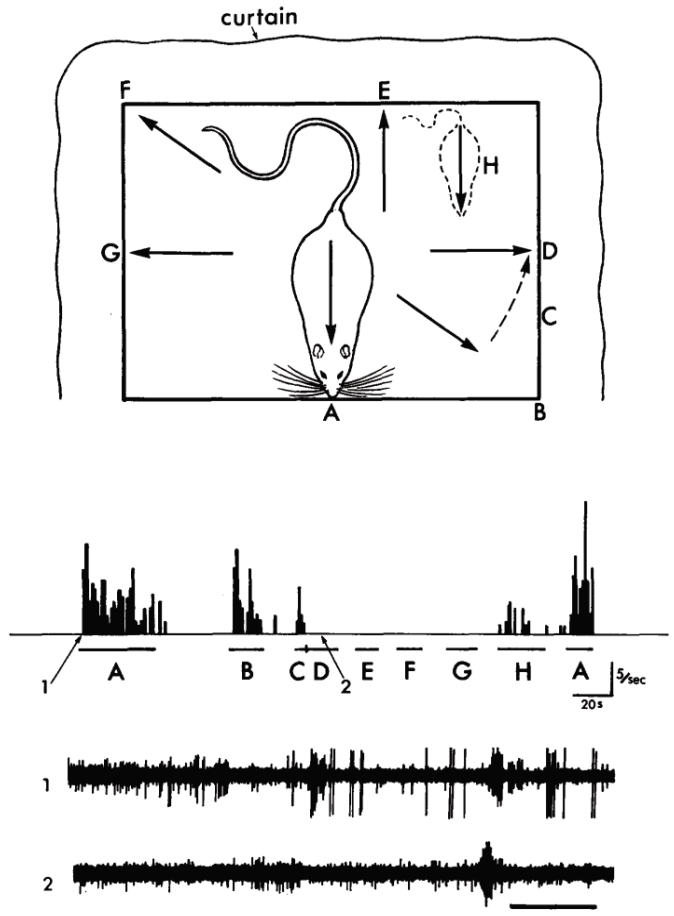
A DESCRIPTION OF RELATIONAL PATTERNS OF MOVEMENT DURING 'RITUALIZED FIGHTING' IN WOLVES

BY G MORAN*, J C. FENTRESS & ILAN GOLANI

Animal Behav., 1981, 29, 1146-1165

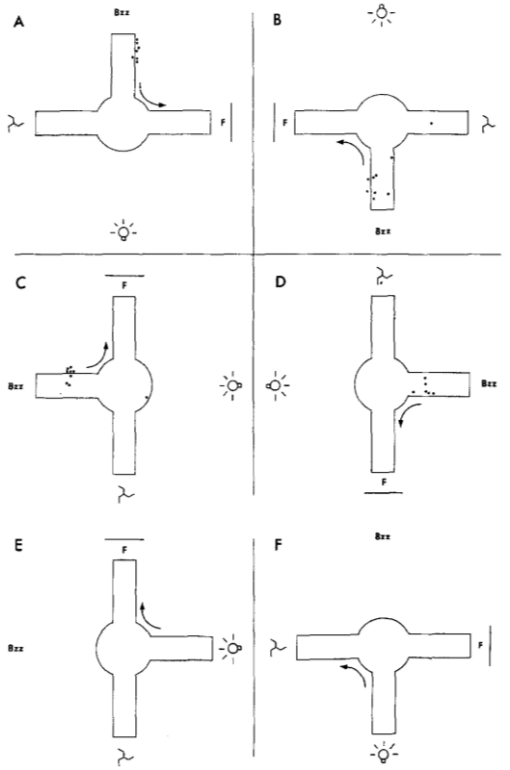
Short Communications

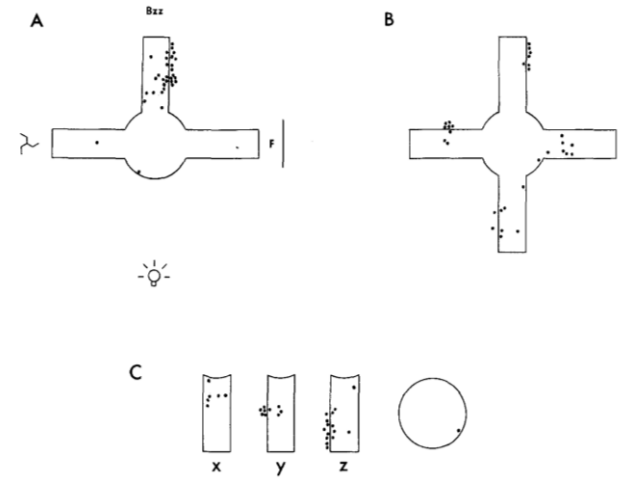
The hippocampus as a spatial map. Preliminary evidence from unit activity in the freely-moving rat



O'Keefe & Dostrovsky 1971

In order to display the relationship between the firing of a unit and the rat's position in the cue-controlled environment, we used a variation of a technique first developed by Marey (1894) and most recently used by Czopf, Karmos, Bauer and Grastyan (1964) to depict movement. In the Marey technique, the position of a bright spot or line fixed to a moving object such as a limb is periodically photographed on the same film. The resultant sequence of dots or lines represents the successive positions of the object over time. In our modification, we took the pulse from the window discriminator and fed it to a light-emitting diode on the rat's head. The spike-driven flashes were photographed on Polaroid film (Polaroid, Type 52) by a 4 x 5 camera mounted on the ceiling of the cue-controlled room. The camera shutter was left open throughout the trial. After each trial, a mask of the outline of the T-maze was placed on top of the maze and the film briefly exposed again. The resulting picture gave an accurate representation of the places on the maze where the unit fired [1]. Here we took advantage of the fact that the place units have little or no 'spontaneous' firing when the animal walks or runs outside the place field. It should be noted that it was necessary to use a relatively long voltage pulse (typically 25 msec) to produce a bright enough flash of the L.E.D. so that unit firings which occurred with an interspike interval of 25 msec or less were counted as one spike, in practice, this means that complex spikes are represented as one spike and occasionally the number of spikes shown in the place field is fewer than actually occurred.





[1] More recently we have combined this technique with the original Marey technique for depicting motion with good results. Two different coloured diodes are placed on the rat's head, one flashing at a fixed rate and representing the rat's position and the other showing the unit firing. Coloured Polaroid film is used instead of the black and white film described here

O'Keefe and Conway 1978

The Contributions of Position, Direction, and Velocity to Single Unit Activity in the Hippocampus of Freely-moving Rats
B.L. McNaughton , C.A. Barnes , and J. O'Keefe 1983

The XY coordinates of the animal's position on the maze were measured with an 8 x 8-bit video tracking system (HVS Imaging Systems, U.K.) which detected the position of a small DC lamp which was part of the headstage assembly. The animals's position was continuously sampled by the computer at a rate of 10 Hz. The resolution in the position measure was estimated at about 0.5 cm. Since instantaneous velocity was calculated from the distanced moved between sampling points its resolution was therefore about 5 cm/sec.