Determination of the Neural Responses During Visual Fixation by use M. Fasciularis

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Abstract-*Eye movement refers to the voluntary or involuntary movement of the eyes, helping in acquiring, fixating and tracking visual stimuli. Specific systems are used in maintaining fixation, when reading and in music reading. A special type of eye movement, rapid eye movement, occurs during REM sleep.*

The eyes are the visual organs of the human body, and move using a system of six muscles. The retina, a specialised type of tissue containing photoreceptors, senses light. These specialised cells convert light into electrochemical signals. These signals travel along the optic nerve fibers to the brain, where they are interpreted as vision in the visual cortex.

Primates and many other vertebrates use three types of voluntary eye movement to track objects of interest: smooth pursuit, vergence shifts[1] and saccades.[2] These movements appear to be initiated by a small cortical region in the brain's frontal lobe.[3][4] This is corroborated by removal of the frontal lobe. In this case, the reflexes (such as reflex shifting the eyes to a moving light) are intact, though the voluntary control is obliterated.[5]

Keywords-1. M. fascicularis(male monkey)2. REM(rapid eye movement)

I. INTRODUCTION

Muscle relaxants are routinely used to immobilize the eyes in experiments to study the receptive fields of visual neurons in anesthetized animals. Despite this, the eyes move. These movements have been studied systematically in the cat [6]Accompanied By cervical sympathectomy (the cat, unlike the monkey, has Sympathetic innervation of orbital muscle), muscle relaxants can Reduce eye-movements to ca. 10 min arc over periods of minutes because the cat has large receptive fields, these residual movements will seldom be consequential for visual physiology. Receptive fields in the monkey's visual system are much smaller than those in the cat, and physiological measurements are correspondingly more vulnerable to small eye-movements[7]. In making unpublished measurements of the optical linespread function of the monkey's eye using the method of Robson and Enroth Cugell (1978), A.M. Derrington and P. Lennie found that, even with the eye firmly stabilized by attachment to a ring, movements associated with pulse and respiration occurred with experiments using stationary images to study neurons in macaque V1, Müller et al. [8].

Methods:

Male monkeys (M. fascicularis) weighing between 3.75 and 5.45 kgWere prepared for single-unit recording, as described in Mülleret al. (2001).

Awell-fitting opaque contact lens, to which a fragment of coverslip had been glued (total weight 25 mg), was placed on one eye.

Several minutes were allowed to elapse while the lens became firmly attached to the eye. The beam from a diode laser (635 nm)was reflected off the coverslip on to the surface of UDT DLS-4 position sensing detector placed about 14 cm in front of the eye. This detector, coupled to its amplifier, provided continuous output voltages proportional to the X and Y positions of the centroid laser spot on its 4 3 4 mm sensing surface[9]. The device had arelative accuracy limited only by noise—in practice it could resolve a 2-sec arc change in gaze. X- and Y-position signals were low-pass filtered (30 Hz) then sampled continuously by a Macintosh computer at 100 Hz with 16-bit resolution, and saved for later analysis. We usually recorded eye-position for 10 min.

We recorded the position of one eye in each of nine anesthetized monkeys. In five of these, the recordings were made shortly after the monkey had been paralyzed with vecuronium bromide(Norcuron; loading dose of 50 mg0kg, followed by a continuous infusion at 100 mg0kg0h); in the remaining animals measurements Were made 3 or 4 days later, when we had finished single-unit recording. For two animals, measurements were made both at beginning and the end of recording[10]. We found no difference in character of the measurements made early and late, and have not distinguished these in the Results. In several monkeys, we also attempted to record eye-position before the infusion of muscle relaxant we were able to obtain adequate records of eye-position in only two because frequent large eye-movements tended to move the laser spot off the sensor.

Neuroanatomy:

Neuroanatomy is the study of the anatomy and stereotyped organization of nervous systems. In contrast to animals with radial symmetry, whose nervous system consists of a distributed network of cells, animals with bilateral symmetry have segregated, defined nervous systems, and thus we can make much more precise statements about their (M.fascicularis) neuroanatomy[11]. In vertebrates, the nervous system is segregated into the internal structure of the brain and spinal cord (together called the central nervous system, or CNS) and the routes of the nerves that connect to the rest of the body (known as the peripheral nervous system, or PNS) [12]. The delineation of distinct structures and regions of the nervous system has been critical in investigating how it works. For example, much of what neuroscientists have learned comes from observing how damage or "lesions" to specific brain areas affects behavior or other neural functions[13].

For information about the composition of animal nervous systems, see nervous system. For information about the typical structure of the human nervous system, see human brain or peripheral nervous system. This article discusses information pertinent to the study of neuroanatomy. [14]

Visual cortex:

The visual cortex of the brain is the part of the cerebral cortex responsible for processing visual information. This article addresses the ventral/dorsal model of the visual cortex. Another model for the perceptual/conceptual neuropsychological model of the visual cortex was studied by Raftopolous.[15] In Russian neuropsychology, yet another model was discussed by Alexander Luria for the anterior/posterior approach to understanding the visual cortex.[16] The visual cortex is located in the occipital lobe (one of the four major lobes of the cerebral cortex) which is in turn located at the back of the head or skull. The visual cortex is made up of Brodmann area 17 (the primary visual cortex), and Brodmann areas 18 and 19, the extrastriate cortical areas.[17]The primary (parts of the cortex that receive sensory inputs from the thalamus) visual cortex is also known as V1, Visual area one, and the striate cortex. The extrastriate areas consist of visual areas two (V2), three (V3), four (V4), and five (V5). Both hemispheres of a brain contain a visual cortex; the left hemisphere visual cortex receives signals from the right visual field, and the right visual cortex from the left visual field

II. NEURONAL RESPONSES DURING VISUAL FIXATION

Neural Recordings:

Impulse activity of single neurons was recorded extracellularly from area 7a and the proximal arm area of the motor cortex (left hemisphere) (for details, see Merchant et al., 2001b). All isolated neuronal potentials were recorded regardless of their activity during the task, and the recording sites changed from session to session. The presentation of the visual stimuli, behavioral control and data collection were carried out by a personal computer. Online raster displays were generated on a computer monitor. [18]

III. DATA ANALYSIS

General:

An analysis of covariance (ANCOVA) was performed for each neuron, using the motion condition and stimulus speed as factors and the discharge rate (based on spike counts) during the last 500 ms of the control-holding period as the covariate. The frequency of discharge during the TET was the dependent variable. The spike counts were square-root transformed to stabilize the variance (Cox and Lewis, 1966; Snedecor and Cochran, 1989). The program 2V of the BMDP/Dynamic statistical package (BMDP Statistical Sotfware Inc., Los Angeles, CA) was used to execute the ANCOVA. In addition, for those neurons that did not show statistically significant effects on the ANCOVA, we performed a one-way analysis of variance (ANOVA) between the discharge rate during the control period and TET, to identify the cells that showed general changes in their activity during interception. The level of statistical significance to reject the null hypothesis for all statistical analyses was set at $\alpha = 0.05$. The results of the ANCOVA and the ANOVA were consistent between monkeys and were combined. Cells were included in the analysis if they were recorded during the interception, the NOGO and the center → out tasks for at least four repetitions. In addition, the neurons required to have a mean firing rate >0.6 impulses/s. Of a total of 910 cells recorded in area 7a, 766 fulfilled the criteria above and analyzed further. In motor cortex, 1112 cells were recorded and 776 fulfilled the criteria and analyzed further[19]. [20]

Spike Density Functions:

The spike trains for each trial in the task were converted to 1 ms spike density functions using the fixed kernel method with a Gaussian pulse of 20 ms (Richmond and Optican, 1987).

Activation Periods:

An activation period was defined as the interval during the TET where the mean spike density function for a particular stimulus speed and motion condition exceeded the mean + 3 SD of the control spike density function during the 500 ms before stimulus onset.

Multiple Linear Regression with an Autoregressive Error Component:

We investigated the relations between the time-varying cell activity during the interception task and the stimulus position, the time-to-contact, and the vertical hand force and hand force velocity (see below). However, since during the interception task the monkeys could move their eyes freely, it was necessary to account for the neural signals related to eye position, before performing an analysis of the stimulus and hand movement parameters. For that purpose, we carried out a multiple linear regression analysis between the time-varying single cell activity and eye position. An autoregressive component was added to the regression model to take in to account the correlation between residuals that occurs in time series regression. [21]

Once the eye position regression was performed, we computed a multiple linear regression in order to evaluate the relations between the cell activity and the stimulus position (angle θ), the time-to-contact (τ), and the vertical hand force and its rate of change. An autoregressive component was added again to the regression model .where ft is the SDF or the residual (with respect to eye position) at time t, b0 is a constant, and b1–b5 are the regression coefficients, ρ is the first-order autoregressive coefficient, and εt is an uncorrelated, normally distributed random error with variance σ2 and mean = 0. This regression was performed separately for the real and apparent motion conditions and for different lags (Δ1, Δ2 and Δ3) between the SDF and the stimulus and movement parameters. The time lag Δ1 was the stimulus angle lag and varied from –160 to +160 ms, Δ2 was the time-to-contact lag and also varied from –160 to +160 ms, and finally, Δ3 was the hand force lag and varied from 0 to +160 ms. These three time lags were utilized so that the time shifts of the stimulus, the time-to-contact and the hand force could be assessed independently, and were shifted in 40 ms intervals. Therefore a total of 405 regression models were performed for each motion condition in every cell. The regression with the largest R2 in the real and apparent motion conditions was used as the final model for each neuron. [23]

IV. CONCLUSION

We are conclude that is analyses the Neuronal responses during visual fixation by use M. fascicular is . These analyses were carried out for both areas in the real and apparent motion conditions. An analysis of covariance (ANCOVA) was performed for each neuron, using the motion condition and stimulus speed as factors and the discharge rate (based on spike counts) during the last 500 ms of the control-holding period as the covariate. The frequency of discharge during the TET was the dependent variable.

REFERENCES

[1] Pierrot-Deseilligny, Charles; Milea, D.; Muri, R. M. (2004). "Eye movement control by the cerebral cortex". Current Opinion in Neurology 17 (1): 17–25. doi:10.1097/00019052-200402000-00005. PMID 15090873.

[2] Krauzlis RJ (Apr 2005). "The control of voluntary eye movements: new perspectives" (PDF). The Neuroscientist 11 (2): 124–37. doi:10.1177/1073858404271196. PMID 15746381.

[3] Heinen SJ, Liu M (Sep–Oct 1997). "Single-neuron activity in the dorsomedial frontal cortex during smooth-pursuit eye movements to predictable target motion". Vis Neurosci 14 (5): 853–65. doi:10.1017/s0952523800011597. PMID 9364724.

[4] Tehovnik EJ, Sommer MA, Chou IH, Slocum WM, Schiller PH (April 2000). "Eye fields in the frontal lobes of primates". Brain Res. 32 (2-3): 413–48. doi:10.1016/s0165-0173(99)00092-2. PMID 10760550.

[5] "Sensory Reception: Human Vision: Structure and function of the Human Eye" Encyclopaedia Britannica, 1987

[6] Barlow, H.B., Blakemore, C. & Van Sluyters, R.C. (1974). Measurementof residual eye movements during the analysis of disparity receptive fields of visual neurones. Journal of Physiology (London)242, 38–39.

[7] Berg, H.C. (1983). Random Walks in Biology. Princeton New Jersey:Princeton University Press.

[8] Blakemore, C. & Vital-Durand, F. (1986). Organization and post-natal development of the monkey's lateral geniculate nucleus. Journal of Physiology (London) 380, 453–491.

[9] Atta, H. M. "Edwin Smith Surgical Papyrus: The Oldest Known Surgical Treatise". American Surgeon, 1999, 65(12), 1190-1192.

[10] Rose, F., "Cerebral Localization in Antiquity". Journal of the History of the Neurosciences, 2009, 18(3), 239-247.

[11] Ginn, S. R., & Lorusso, L., "Brain, Mind, and Body: Interactions with Art in Renaissance Italy". Journal of the History of the Neurosciences, 2008, 17(3), 295-313.

[12] Neher, A., "Christopher Wren, Thomas Willis and the Depiction of the Brain and Nerves". Journal of Medical Humanities, 2009, 30(3), 191-200.

[13] Anastasios Raftopolous, Cognition and Perception, Oxford University Press, 2009.

[14] Alexander Luria (1961). Higher Cortical Functions in Man, Basic Books.

[15] Ungerleider LG, Mishkin M (1982). "Two Cortical Visual Systems". In Ingle DJ, Goodale MA and Mansfield RJW. Analysis of Visual Behavior. Boston: MIT Press. pp. 549–586

[16] Cavada C, Goldman-Rakic PS (1989b) Posterior parietal cortex in the rhesus monkey. II. Evidence for segregated corticocortical networks linking sensory and limbic areas with the frontal lobe. J Comp Neurol 287:422–445.

[17] Andersen RA, Buneo CA (2002) Intentional maps in posterior parietal cortex. Annu Rev Neurosci 25:189–220.

[18] CrossRefMedlineWeb of Science

[19] Andersen RA, Snowden RJ, Treue S, Graziano M (1990) Hierarchical processing of motion in the visual cortex of monkey. Cold Spring Harb Symp Quant Biol 55:741–748.

[20] CrossRefMedlineWeb of Science