EARLY STEPS IN ANALYZING TRANSMISSION OF AGGREGATE SIGNALS IN THE BRAIN.

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It is widely accepted that in the brain distinct signals are distributed among sets of dispersed neurons. This report concerns attempts to identify and analyze the transmission of aggregate signals (i.e., groups of distinct signals considered as a total or whole). Focal transmission relays allow sufficient numbers of related units to be sampled locally to provide potentially useful aggregate signal information.

Transmission of a 70 dB click produced by a 1 ms pulse to a loudspeaker was studied in cats trained to respond to the click-CS with a conditioned eyeblink response (CR). The CR was defined by averaging electromyographic activity from the orbicularis oculi muscles. The goal was to identify signals reflecting transmission of the CS and incipient generation of the CR.

A large database of CS-evoked unit activity from hundreds of single, serially recorded units was established. It is freely available for use by other investigators (c.f., http://repositories.cdlib.org/mrrc/1).

Aggregate signals were obtained by averaging the PST spike histograms from large numbers of units recorded at each of several transmission relays. Identification of the aggregate signals was based on their relationship (or not) to the raw CS or CR using Pearson correlation coefficients for data collected over 320 ms post-CS periods. Transmission was assumed when significant correlations were found between aggregate signals at pairs of different relays. Given identification of such transmissions, the direction of transmission was estimated by the onset latencies of spike discharge at the respective relays and the degree of correlation with the CS and the incipient CR. The results indicated that aggregate signals representing the CS or the incipient CR could be identified and followed during transmission through relays such as the following:

NUMBER OF CELLS	ONSET LATENCY MS	CS	LOCATION	CR	TRANSMISSION CORRELATION
182	4--6	.62	DCN	-.05*	
132	4--6	.60	IC	-.30	DCN - IC 0.66
158	4--6	.88	SDN	-.42	DCN - SDN 0.76
92	6--8	-.02*	MGN	.54	DCN - MGN 0.32
126	6--8	.14*	RT	.46	MGN - RT 0.61
302	8--12	.24[a]	A1	.18*	MGN - A1 0.61
94	8--16	-.16*	CbL	.59	MGN - CbL 0.54
152	8--16	.00*	MC	.52	RT - MC 0.63
	20 ms	(EMG)	* n. s.	[a] $p < .10$	

DCN − dorsal cochlear nucleus, IC − inferior colliculus, SDN − subcerebellar dentate nucleus, RT − rostral thalamus, MGN − medial geniculate nucleus, A1 − primary auditory cortex, CbL - lateral ansiform cerebellum, MC − motor cortex

The early onset latency and high correlation with the CS mark the DCN as the early sensory relay nucleus that it is known to be. The IC and SDN are early relays that transmit messages related to the CS and to a lesser degree the CR. The high transmission correlations suggest that these relays receive transmissions from the DCN. There is also a significant transmission correlation between DCN and MGN, but the message related to generation of the incipient CR begins to eclipse that related to the CS (a novel functional finding given the classical view of the MGN as an auditory relay nucleus). Communication between the MGN and RT is highly significant, and appears to concern generation of the CR, but the direction of transmission is not disclosed by the present results. At A1 the latencies suggest transmission from MGN to A1 (as would classically be expected), but the message seems more complex that either simply the raw CS or the incipient CR. The CbL and MC both participate in generation of the incipient CR (as expected), and receive transmission inputs from the MGN and RT, respectively, on the basis of latencies. The conclusions drawn from these approaches generally agree with earlier conclusions about transmission drawn from classical neuroanatomical and electrophysiological studies, and thus the analytic approaches seem promising for wider applications.

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