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This Week's Citation Classic

Goff W R, Rosaer B S & Allison T. Distribution of cerebral somatosensory evoked responses in normal man. *Electroencephalogr. Clin. Neuro.* **14**:697-713, 1962. [West Haven Vet. Admin. Hosp. and Yale Univ. Sch. Med., New Haven, CT]

This paper describes the distribution over the scalp of electrical potentials generated in the brain of normal alert humans by median *nent* or finger stimulation. The complex series of potentials was divided into components which had different scalp distributions, and by inference different neural origins. [The *SCI*® indicates that this paper has been cited over 145 times since 1962]

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"When I came to West Haven VA Medical Center in 1959, Burt Rosner (now at the University of Pennsylvania) and Truett Allison were developing a device for averaging the electroencephalogram (EEC) to derive stimulus evoked neuroelectrical potentials from the human scalp. They were pursuing Dawson's[1] demonstration that the signal averaging technique could be used to extract brain potentials occurring with a fixed temporal relationship to repeated stimuli from the higher-voltagt EEC. These evoked potentials' (EPs) presumably reflected the brain's processing of sensory information. The exciting significance of Dawson's report was that such brain activity could be studied in man by a non-invasive technique.

"Dawson's averager was mechanical. Its memory was capacitors fed from a rotating switch. Rosner's idea was to use a loop of FM magnetic tape as a memory. The EP to the first stimulus was tape-recorded. When the loop came full circle, the first potential was played back into a summing amplifier synchronous with a newly evoked potential. The sum of these was rerecorded and the process repeated until reproducible potentials appeared on an oscilloscope. Simple in principle, but in practice, synchronizing the Nth and Nth + 1 potentials was difficult, and we spent nearly a year working out that and other technical problems.

"We christened the resulting Rube Goldberg apparatus 'ERA' (evoked response averager)[2] and showed that it properly summated square wave pulses. Nonetheless, we were uneasy about the validity of the complex waveforms we recorded to median nerve stimulation. Another EP computer, ARC-1,[3] had been developed at MIT by a group headed by Walter Rosenblith, a friend of Rosner's. We recorded somatosensory EPs (SEPs) from Allison on ERA in West Haven and on ARC-1 in Cambridge. The SEPs matched, and earned Allison the nickname 'calibrated brain '

"Convinced by this curious validation that ERA worked —what to do with it? Preliminary recordings revealed that the total SEP was a complex series of potentials which iasted about 400 msec, and varied at different scalp locations. An obvious question was whether the topographic differences might tell us something about the location of the neural generators.

"Probably the resulting paper has been cited frequently because: 1) It first described SEP morphology and topography for the entire duration of the response. 2) With a companion paper,[4] it parceled the SEP into components and suggested that they arose from different neuroanatomical sources. 3) Scalp topographic studies continue to be one of the best methods of inferring the location of generators of EPs in humans,[5] in whom there are but few opportunities to record intracranially.[6]

"As co-workers for over 20 years, Allison and I have been afforded a privilege uncommon among scientists. Beginning with a home-built gadget early in the investigation of human EPs, we have witnessed an area of basic research develop into a clinically valuable procedure for evaluating a variety of neurological dysfunction."[7]

1. **Dawson G D.** A summation technique for the detection of small evoked potentials. ***Electroencephalogr. Clin. Neuro.* 6**:65-84, 1954.
2. **Rosmer B S, Allison T. Swamson E & Goff W R.** A new instrument for the summation of evoked responses from the nervous system. ***Electroencephalogr. Clin. Neuro.* 12**:745-7, 1960.
3. **Clark W A, Jr.** ***Average response computer (ARC-1).*** Cambridge, MA: Research Laboratory of Electronics. Massachusetts Institute of Technology, 15 April 1958, Quarterly Progress Report, p. 114-17.
4. **Allison T.** Recovery functions of somatosensory evoked responses in man. ***Electroencephalogr. Clin. Neuro.* 14**:331-43, 1962.
5. **Wood C C.** Application of dipole localization models to the source of identification of human evoked potentials**.** ***Ann. NY Acad. Sci.*** In press, 1981**.**
6. **Goff W R, Allison T A Vaughan H G, Jr.** The functional neuroanatomy of event related potentials. (Callaway E, Tueting P & Koslow S H, eds.) *Event-related brain potentials in man.* New York: Academic Press, 1978. p. 1-79.
7. **Desmedt J E**, ed. *Progress in clinical neurophysiology. Vol Clinical uses of cerebral, brainstem and spinal somatosensory evoked potentials.* Basel: Karger, 1980. 352 p.