FS-ESB interaction rejected: A reply to Schwartzbaum and Gustafson*

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A note is offered in response to a procedural critique (Schwartzbaum & Gustafson, 1970) of a recent report from our laboratory. The study at issue (Brunner, Rossi, Stutz, & Roth, 1970) involved successive presentation of grid-delivered footshock (FS) and electrical stimulation of the brain (ESB) via bipolar electrodes chronically implanted at various loci. The results suggested that retrograde amnesia for a one-trial passive avoidance task may be produced by short-duration posttrial electrical stimulation of the hippocampus but not necessarily by stimulation of anatomically related areas (i.e., cortex or septum). Similar observations have been made in other laboratories (Wyers, Peeke, Williston, & Herz, 1968; Barcik, 1969). Schwartzbaum & Gustafson's (1970) criticism centered on the possibility that our study contained a potential electrical artifact: cross-talk between the ESB and FS circuits. It was suggested that the behavioral consequences of such cross-talk could have been responsible for our results. The following procedural and interpretative additions are offered here, lest these results be summarily dismissed as artifactual.

Because of the brief format of this journal, considerable detail was omitted from the method section of the original manuscript. We have been aware of Schwartzbaum & Donovan's (1965) initial warning about simultaneous administration of brain stimulation and footshock, and in previous studies we have taken precautions to minimize this artifact (Brunner & Rossi, 1969). Such precautions were employed by Brunner et al (1970) but were not defined in the report. The brain-shock generator consisted of a variable transformer which supplied an adjustable voltage to a step-down transformer, which in turn served to isolate the circuit from line voltage fluctuations. A 1-megohm variable potentiometer and a microammeter were placed in series with one lead of the step-down transformer, permitting current observation and adjustment when the circuit was closed. Resistive coupling to ground was eliminated at this point in the circuit by breaking

both leads from the stimulator through a double-pole/double-throw relay. An interval timer controlled the duration of closure of the relay. Following the suggestion of Davis, McIntire, Kreithen, & McCullough (1969), the relay was located as near to the animal as feasible. Short leads connected the relay to a mercury swivel, which was in turn connected to the animal via a flexible cable. Davis et al (1969) indicate that capacitive coupling to ground is virtually eliminated by this technique of using a double-pole/double-throw relay and short cables. The footshock and scrambler source was an electromagnetic mechanical type, similar in construction to that described by Phillips, Blum, & Longmore (1967). Again following the suggestions of Davis et al (1969), a double-pole/double-throw relay was inserted between the step-up isolation transformer and the scrambling unit. This relay broke the resistive and capacitive couplings of the FS circuit and insured that the ESB did not ground through the animal's body. Brain stimulation was thus confined to those structures at the electrode tips.

In addition to and independent of the procedural details which are set forth in this paper, there are two interpretative points that lend credence to the experiment and conclusions of Brunner et al (1970). First, Schwartzbaum & Donovan (1965) and Cox & Valenstein (1965) report that rewarding brain stimulation attenuates the punishing properties of grid-delivered shock. If it is assumed that the precautions taken by Brunner et al (1970) did not effectively eliminate crosstalk and that a stimulating current could have been generated at the electrode tips during grid-shock delivery, then the ability of the generated stimulation to attenuate the aversive properties of the FS should have been most pronounced in the group of animals with electrodes implanted in the septum, an area with higher reward potential than either the cortex or hippocampus (Olds & Olds, 1963). However, no significant differences in postshock step-down latencies were reported between septal and control groups, indicating that the

procedures used to eliminate crosstalk were effective at this level. Second, the suggestion by Schwartzbaum & Gustafson (1970) that *unwanted* hippocampal afterdischarges were responsible for our results seems to miss the point of our interpretation of our finding. It was clearly stated in our paper that ESB was delivered in order to produce interference with normal hippocampal functioning. Such interference, in the form of afterdischarges, was observed by Barcik (1969) following ESB. We attributed the observed changes in passive-avoidance behavior to this presumed hippocampal disruption and drew parallels between the disruption and the seizures induced by electroconvulsive shock.

While we must accept the responsibility for failing to acknowledge the above precautions in our original report, we feel that the results obtained and the interpretations placed on them should preclude their being dismissed as artifactual.

REFERENCES

- BARCIK, J. D. Hippocampal afterdischarges and memory disruption. *Proceedings, 77th Annual Convention, APA*, 1969, 185-186.
- BRUNNER, R. L., & ROSSI, R. R. Hippocampal disruption and passive avoidance behavior. *Psychonomic Science*, 1969, 15, 228-229.
- BRUNNER, R. L., ROSSI, R. R., STUTZ, R. M., & ROTH, T. G. Memory loss following posttrial stimulation of the hippocampus. *Psychonomic Science*, 1970, 18, 159-160.
- COX, V. C., & VALENSTEIN, E. S. Attenuation of aversive properties of peripheral shock by hypothalamic stimulation. *Science*, 1965, 149, 323-325.
- DAVIS, H., MCINTIRE, R. W., KREITHEN, M., & MCCULLOUGH, T. A. A procedural note on the simultaneous use of electrical brain stimulation and grid-delivered shock. *American Journal of Psychology*, 1969, 82, 136-138.
- OLDS, M. E., & OLDS, J. Approach-avoidance analysis of rat diencephalon. *Journal of Comparative Neurology*, 1963, 120, 259-295.
- PHILLIPS, M. I., BLUM, R. W., & LONGMORE, M. D. An inexpensive electro-magnetic shock scrambler. *Physiology & Behavior*, 1967, 2, 453-454.
- SCHWARTZBAUM, J. S., & DONOVICK, P. J. An artifact in the use of brain stimulation with shock-motivated behavior. *Psychonomic Science*, 1965, 2, 183-184.
- SCHWARTZBAUM, J. S., & GUSTAFSON, J. W. Peripheral shock, implanted electrodes and artifactual interactions: A renewed warning. *Psychonomic Science*, 1970, 20, 49-50.
- WYERS, E. J., PEEKE, H. V., WILLISTON, J. S., & HERZ, M. J. Retroactive impairment of passive avoidance learning by stimulation of the caudate nucleus. *Experimental Neurology*, 1968, 22, 350-366.

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