The Influence of Paradoxical Sleep Deprivation
on Glycogen Content and Phosphorylase Activity
in Various Brain Structures of the Rat

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Introduction

Previous investigations from our laboratory have shown that paradoxical sleep (PS) deprivation leads to a fall of glycogen content in certain regions of the brain of cats [6] and rats [3, 7] and that the changes in the glycogen concentration do correspond to the degree of PS deprivation. Evidently, PS deprivation is a specific type of stress to which the central nervous system (CNS) responds selectively and in widely distributed areas. Furthermore, the data indicated that probably both cholinergic and adrenergic mechanisms participate in the glycogenolytic effect of PS deprivation; the first triggering off the second [7]. The work reported here was initiated to confirm our previous findings on glycogen content and to extend the earlier experiments by including measurements of phosphorylase activity as additional parameter.
The experiments were carried out on adult Wistar rats. The animals were either deprived of PS for 72 h by the method described elsewhere or subjected to ‘controlled’ stress [3]. The animals (5 in each group) were sacrificed immediately after deprivation. Glycogen was extracted from the frozen brain tissue by the method of Le Baron [4] and from the peripheral tissues by the method of Montgomery [5]. Glycogen was assayed for glucose using a glucose oxidase method based on the procedure described by Huggett and Nixon [2] with reagents available in kit form (Boehringer, Mannheim). The results are expressed as mg glycogen/100 g tissue, wet weight (mg %).

Glycogen phosphorylase activity was measured by the method of Bennett and Nakada [1]. The activities of ‘total’ phosphorylase and ‘active’ phosphorylase (phosphorylase ‘a’) were expressed as /μm (TPNH) min/mg. The activity of phosphorylase ‘b’ was assumed to correspond to the difference between ‘total’ and phosphorylase ‘a’ activities. In table II the activity of phosphorylase ‘a’ is expressed as a percentage of ‘total’ phosphorylase.

Results and Discussion

Our results (table I, II) indicate that PS deprivation affected not only brain structures but some peripheral tissues as well. A significant decrease of glycogen concentration and an increase of phosphorylase ‘a’ activity were detected in subcortical brain structures and skeletal muscle, whereas in heart there was a significant increase of glycogen content and decrease of phosphorylase ‘a’ activity. However, in the cerebral cortex and in the liver the content of glycogen and the activity of phosphorylase ‘a’ and ‘b’ were unaffected by PS deprivation.

In turn, the content of glycogen and of the phosphorylase activity were unchanged during the ‘control’ stress situation. Evidently the CNS

Table Ia. The effect of PS deprivation on glycogen content in different tissues.

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<th>Brain structures</th>
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Table Ib. The effect of PS deprivation on glycogen content in different tissues.

| Peripheral tissues |

Table IIa. The effect of PS deprivation on glycogen phosphorylase activity in different tissues. Brain structures, ‘active’ phosphorylase (%)

Table IIb. The effects of PS deprivation on glycogen phosphorylase activity in different tissues. Peripheral tissues, ‘active’ phosphorylase (%)
and peripheral tissues respond differently to different types of stress, as far as the glycogen content and phosphorylase activity are concerned. As cyclic 3,5-adenosine monophosphate (cyclic AMP) is known to control both glycogen phosphorylase and glycogen synthetase systems, our results suggest that during PS deprivation there is an increase in activity of adenyl cyclase and an elevation of cyclic AMP as compared to control conditions. Finally, the data obtained suggest that PS deprivation is a specific type of stress to which the CNS as well as various peripheral tissues respond selectively.

References

1 Bennett, R. jr., and Nakada, I. N.: Comparative carbohydrate metabolism of marine moluscs. Comp. Biochem. Physiol. 24: 787-797 (1968);

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