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Mini Review

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Brain Mechanisms in Blood Glucose Mobilization and Absorption: The Role of the Left and the Right Frontal Regions in the Regulatory Control of Blood Glucose Levels

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With the ravaging effects of glucose related diseases (such as diabetes) on the rise, an increased understanding of the central mechanisms involved in glucose mobilization and absorption, and the potential development of the metabolic syndrome, is becoming increasingly important. Although, substantive efforts have been expended to better understand the peripheral mechanisms involved with the systemic processing of glucose, there remains a paucity of research dedicated to the central neural aspects largely involved in the mobilization and absorption of blood glucose. Despite this lack of research, the relationship between emotional states of anger or fear and those oppositional processes associated with quiescent states or digestive uptake have been clearly related to blood glucose levels.[1-3] Moreover, and perhaps most relevant here, is that the differential emotional states just described have been established with origins in cerebral laterality and with regulatory control mechanisms largely relegated to the frontal lobes and executive brain systems.[4-6]

We have provided evidence with the potential to bridge this gap between brain theory and research on peripheral mechanisms with specializations of the right brain for intense emotional states and sympathetic drive[7-10] and with somewhat oppositional specializations of the left brain for quiescent states and perhaps parasympathetic drive. Functional cerebral systems theory[11-14] demonstrates the regulatory control over sympathetic drive by the frontal lobe executive regions, where incremental blood pressure, heart rate, sweating, cholesterol levels, and blood glucose levels may provide the biological resources and reserves for the fight with relevance to insure success in meeting the potentially coercive threat or challenge. Furthermore, cerebral balance theory[7] supports oppositional mechanisms with quiescent states and the establishment of resource reserves largely by left cerebral systems. This brief review of current neuropsychological research will present a theoretical foundation, based upon Alexander Luria's functional cerebral systems theory, for the preferential activation of glucose metabolism by the right cerebral hemisphere (Figure 1).

Fundamental to the presented argument is the theoretical construct, that the majority of emotional processing, particularly intense emotions such as anger or fear, are lateralized to the right hemisphere.[15] Research in our lab looking at violent-prone individuals has consistently supported this theory by showing decreased frontal lobe regulation of right posterior anger and negative emotionally responsive brain regions.[4,16] Of further import to the theory of right hemispheric glucose mobilization is evidence showing sympathetic response is substantially under right hemispheric control and that overall cardiovascular recruitment is driven by right hemispheric activation. Current research efforts,[17] comparison studies of the left-versus-right sided cerebrovascular accidents,[18] and unilateral intracarotid sodium amobarbital injections (UISAI) [Wada technique][18] all support the relative role of the right hemisphere in sympathetic response.

Given the integral role of blood glucose as the major fuel source for the brain, it follows

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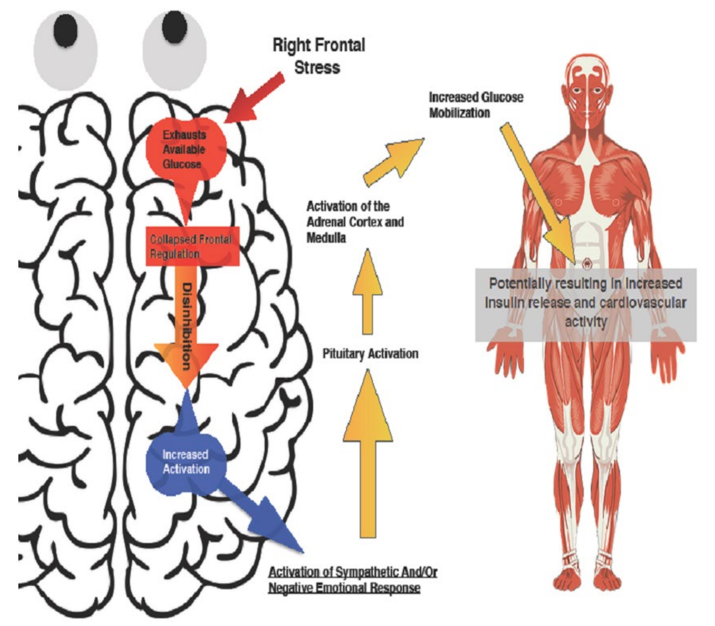
Figure 1: Right Frontal Regulatory Role Over Glucose Mobilization Depicting Capacity Limitations.



that processes such as intense emotion or increased sympathetic drive would require increase levels of glucose for mobilization of action.[2] To help illustrate how glucose may be regulated (or deregulated in certain cases), our lab has proposed the quadrant theory of neural functioning. Anatomically, the anterior and posterior "quadrants" of the brain communicate within each hemisphere *via* the longitudinal tract. Similarly, the anterior and posterior regions of each hemisphere communicate with the parallel region across the corpus callosum.[19] Given this general wiring of the various regions, each quadrant appears to compete for cerebral resources, specifically glucose, for a given function. Due to the overall regulatory role of the frontal lobe, if the right frontal region were to exhaust the general supply of glucose available, posteriorly there would be an "unbridling" or cortical release of processes typically under frontal control. Right posterior release or activation has been shown to result in increased sympathetic response and heightened emotional intensity with underlying sympathetic nervous system activation.[20] These more intense and often negatively valenced emotional responses further result in an overall increase in blood-glucose levels.[21] Chronic or pervasive stress or negatively valenced emotional biases appear to have far reaching health implications, possibly including the development of diabetes and the metabolic syndrome. Systematic research efforts in our laboratory have provided evidence that inadequate capacity for right frontal regulatory control over negative or intense emotions and over sympathetic activation is sufficient for the reactive elevation of blood glucose levels.[2,3] This is apparent in high hostile violent-prone men with chronic effects connected to the increased likelihood of developing metabolic syndrome.[3]

While a good amount of research is still needed, the evidence for the role of the right hemisphere in glucose mobilization and the potentially opposition role of the left hemisphere in glucose absorption, digestive advance, and quiescent emotional states cannot be ignored. With the increasing costs and health risks associated with glucose related diseases, efforts must continue to be made to both determine the specific role of the right hemisphere in both glucose mobilization and gluconeogenesis. With greater understanding of these processes within lateralized brain regions, cause specific treatment methodologies can be identified and utilized.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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