Motor and sensory impairments

Damage to the cerebral cortex was what had been expected in the experiments with monkeys subjected to sudden total asphyxia at birth, and the brainstem pattern of damage came as a surprise. After further experimentation Myers (1972) found that monkeys subjected to partial disruption of placental circulation late in gestation developed cerebral palsy [5]. Thus the effect of partial disruption of oxygen delivery (hypoxia) is different from complete oxygen deprivation (asphyxia or suffocation).

Myers confirmed the finding of brainstem damage that resulted from subjecting a newborn monkey to eight minutes or more of total asphyxia. It is proposed here that autism is more likely the result of brainstem lesions, and in particular that language development may be disturbed due to impairment of the brainstem auditory pathway.

Myers, however, described the brainstem pattern as a “monotonous rank-order of subcortical nuclei” affected by a brief period of total asphyxia. The brainstem pattern clearly did not match the expected outcome. However, the inferior colliculus is at the top of a rank-order of brainstem nuclei of high metabolic rate [6]. This rank-order can clearly be seen in the data in tables 3, 4, and 5 above. The rank-order is real, and maybe should not be considered so monotonous, or minimal and insignificant.

Figure 10 (left), showing prominent damage in the inferior colliculi, is from Myers’ paper. Myers provided an excellent analysis of metabolic events that lead to this kind of brain damage, but decided this is not what happens when an infant is in distress during a difficult birth. Figure 10 (right, bottom) from Leech and Alvord (1977) does confirm that brainstem damage is found in human infants who suffer an anoxic insult, affecting the inferior colliculi most dramatically [7].

The human brain in figure 10 was from a 3-month old infant who suffocated in a crib accident, but according to Leech and Alvord was representative of the kind of injury they observed in 16 infants who suffered anoxia before, during or after birth. Leech and Alvord commented that all of their cases demonstrated injury from both brief total anoxia and prolonged partial hypoxia as described by Myers. Leech and Alvord noted that the thalamus, reticular formation, and cranial nerve nuclei were affected in over 90% of their cases. The colliculi were examined in 13 of the cases and found damaged in 11 (85%). In descending order other areas involved were the cerebral cortex and hippocampus (13/16), lateral geniculate bodies, cerebral white matter, striatum, pallidum, substantia nigra, dentate nuclei, and cerebellar cortex (6/16).

Roland et al. (1988) and Natsume et al. (1995) reported similar brainstem patterns of damage and compared their findings to those of Leech and Alvord [8, 9].

The highly active subcortical centers are more susceptible to damage during a sudden and total disruption of oxygen delivery. On the other hand, during hypoxic conditions (with partial insufficiency of oxygen) protective mechanisms ensure delivery of whatever oxygen is available.

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first to the brainstem nuclei of high metabolic rate, at the expense of the cerebral cortex and other less metabolically active structures.

Autonomic functions like breathing and heartbeat are controlled from brainstem centers, and these take priority for survival over higher cognitive function. That the auditory system has the highest metabolic rate in the brain makes it special; this cannot be denied, and deserves every effort to try to understand why.

Autism is found among children with disorders like phenylketonuria (PKU) in which abnormal and toxic metabolites are produced by faulty enzymes [10]. These endogenous toxins can damage the blood-brain barrier, then enter and disrupt metabolism in neurons, and impairment might be expected to be most severe in the brainstem nuclei of high metabolic rate, as happens with asphyxia.

Disorders of mitochondria, where aerobic production of energy takes place, are also associated with autism; and all metabolic processes are dependent upon adenosine tri-phosphate (ATP), the end-product of aerobic metabolism [11-13]. The brainstem nuclei of high metabolic rate might also be expected to be most severely affected in mitochondrial disorders.

Some children with autism are delayed in achieving some motor milestones – rolling over, sitting, crawling, standing, and walking. They usually “catch up” which is why pediatricians tell parents not to worry. Some degree of clumsiness may persist, but autism does not usually include the life-long handicaps of motor control that afflict victims of cerebral palsy. People with cerebral palsy may have language handicaps, but usually of a different nature from the echolalia of people with autism.

References
Oxygen insufficiency damages the midbrain auditory pathway in monkey and human infants as can be seen by comparing the damage in a monkey (below) with that in a human infant (right lower).

**Figure 10:**
Left – Damage of the inferior colliculi in an infant monkey subjected to asphyxia at birth. From Myers (1972).
Right – Damage of the inferior colliculi in a human infant who died of suffocation. From Leech & Alvord (1977), with permission from the American Medical Association.