The effect of gamma waves on cognitive and language skills in children

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New studies conducted by April Benasich, professor of neuroscience at Rutgers University in Newark, and her colleagues reveal that gamma wave activity in the brains of children provide a window into their cognitive development, and could open the way for more effective intervention for those likely to experience language problems.

"Research into the adult brain has shown that gamma activity is the 'glue' that binds together perceptions, thoughts and memories," notes Benasich. "Little research, however, has been conducted into the development of gamma activity in the infant brain and its possible connection to cognitive and language skills."

Benasich and her research team are the first to look at "resting" gamma power in the frontal cortex, the "thinking" part of the brain, in children 16, 24 and 36 months old. In an article published online and in an upcoming issue of *Behavioral Brain Research*, Benasich offers significant new insight into the likely role gamma activity plays in supporting emerging cognitive and language abilities during the first 36 months of life.

Gamma waves are fast, high-frequency, rhythmic brain responses that have been shown to spike when higher cognitive processes are engaged. Research in adults and animals suggests that lower levels of gamma power might hinder the brain's ability to efficiently package information into coherent images, thoughts and memories. However, until now little has been known about the developmental course of gamma power in

children.

Analyzing the children's EEGs (electroencephalograms), Benasich and her research team found that those with higher language and cognitive abilities had correspondingly higher gamma power than those with poorer language and cognitive scores. Similarly, children with better attention and inhibitory control, the ability to moderate or refrain from behavior when instructed, also had higher gamma power. There were no differences in gamma power based on gender or socio-economic status.

The measurements were obtained by placing a soft bonnet with 62 sensors on the heads of the children as they sat on a parent's lap and quietly played. In separate tests, children were evaluated for their emerging language and cognitive skills. The researchers looked both at children from families with normal language development and those at higher risk for problems because they were born into families with a history of language disorders. As suspected, the group of children with a family history of language impairments showed lower levels of gamma activity.

"We believe that maturation of the brain mechanisms that support gamma activity and those critical for mounting normal language and cognitive development may be occurring simultaneously," says Benasich. "We seem to have identified a window, during a period of sustained and dramatic linguistic and cognitive growth, that can help us to better determine where a child is developmentally."

Such an understanding could provide for earlier and more effective intervention. For example, if a child is found to have lower than average resting gamma, intervention and learning methods could be instituted as a preventative measure. Such early intervention possibly also could result in increasing gamma power in the frontal cortex.

In her other related research, Benasich has discovered that how well infants distinguish differences in successive rapidly occurring tone sequences is a good predictor of future language problems and that it can be determined as early as three months whether a baby will struggle with language development. These latest findings appear to show that the emergence of strong gamma activity is critical for linguistic and cognitive development and that children at risk for language impairments may lag in this process.

"Having strong bursts of gamma appears to assist the brain in making the neural connections needed for effective language development," says Benasich. "By measuring gamma activity in the frontal cortex, which is the last brain area to mature and is used to make decisions and solve problems, we may be able to tell how well the brain is developing in general."

Being able to determine a child's level of development could allow for more effective treatment at a critical point in time when the brain is laying the foundations for cognition and language and establishing efficient connections for future learning. From 16 to 36 months, there is a dramatic explosion of linguistic and cognitive growth; children rush headlong into language, rapidly developing their skills, increasing from a vocabulary of 100 words to 1,000 words, learning that words stand for objects, and that words not only are associated with a specific object but categories, such as "dog" representing not just a single animal but all dogs.

"During this intense learning period, they are little scientists in their environment putting things together and figuring things out," says Benasich. "Lower levels of gamma power in the resting brain may provide a 'red flag' indicating that a child will experience language or attentional problems. Knowing that may allow us to provide effective intervention during this critical learning period."

Source: Rutgers University