Executive Functioning in Fetal Alcohol Spectrum Disorder (FASD)

Fetal Alcohol Spectrum Disorder (FASD) is used to refer to people who may have physical, mental, behavioral, and learning disabilities as a result of maternal alcohol consumption.[1] Underneath the spectrum, different classifications are made based on the severity of the deficits. The term FAS has been used to refer to those who have central nervous system (CNS) or cognitive deficits, as well as growth deficiency and distinct facial features as a result of prenatal alcohol exposure. The terms partial Fetal Alcohol Syndrome (pFAS) and Alcohol Related Neurodevelopmental Disorder (ARND) have been used to describe children who do not have all the characteristics of FAS (namely absence of some or all facial features and/or lack of growth deficiency) but still have prenatal alcohol exposure and some CNS dysfunction.

Although there are no official statistics on the prevalence of FASD in Canada, Health Canada has estimated the rate to be 9/1000 births.[2] FAS is the most common known cause of mental retardation and occurs more often than the two most common birth defects (Down syndrome and spina bifida) combined. [3] However, FASD is one of the only causes of mental retardation that is clearly preventable. FASD costs society, both socially and economically.

The cognitive deficits of FASD are not fully understood however, improved diagnosis and treatment would result if we could profile of neuropsychological deficits of these individuals. Executive function has recently been identified as a specific area of difficulty in FASD.

Executive Functioning

Executive function (EF) has been defined as higher-order cognitive processes involved in goal-oriented behavior under conscious control.[4] EF is an umbrella term for many cognitive processes including planning, inhibition, working memory, set shifting, flexible thinking, strategy employment, organized search, abstract thinking, concept formation, and fluency.[5,6]

Development of EF

EF emerges around one year of age and important developments in EF occur between 2 and 5 years. Adult-level abilities are reached on some EF tasks by 12 years, whereas other EF abilities develop till adulthood.[4]

Prenatal Alcohol Exposure, EF, and the Brain

EF is thought to be mediated by the frontal lobe of the brain. Children and adolescents with prenatal alcohol exposure show a smaller brain size and abnormal brain shape, specifically in the frontal lobe and left hemisphere.[7] In fetuses, prenatal alcohol exposure is related to a decrease in size of the frontal cortex.[8] Other researchers have found have found that rats prenatally exposed to alcohol had fewer neurons in the fontal cortex.[9] Thus it appears that prenatal alcohol exposure has a distinct negative effect on the development of the frontal cortex, however, more research is needed in this area to replicate these findings and to better understand the mechanisms involved. The impact of alcohol on the frontal lobe may result in EF deficits in those with FASD.

Research on EF in FASD

Previous research studies have found EF deficits in both children and adults with FASD. These EF deficits have been documented in the areas of cognitive flexibility, planning, strategy use,

verbal reasoning, some aspects of inhibition, set shifting, fluency, and working memory.[10] Some researchers are now differentiating between cognition-based or 'cool' EF and emotion-related or 'hot' EF. [4] Cool EF (which most previous research has been conducted on) is involved in problem solving, planning, working memory, conceptual set shifting, nonverbal and verbal fluency, and fluid intelligence. In contrast, 'hot' EF is thought to be involved in responses to reward and punishment stimuli.[11] Hot and cool EF are associated with different areas on the fontal cortex. Recently researchers have found that children with FASD also display deficits on emotion-related or hot EF.[12]

Conclusions

One common finding in the research on EF in FASD is that these EF deficits persist regardless of whether the individual has facial characteristics of FAS. This finding indicates that alcohol damage on some cognitive functions may be just as severe for those with and without full FAS, and it highlights the importance of understanding the CNS deficits that these individuals display. It is also important to note that in some studies the EF deficits were lower than what would be predicted based on the participants IQ. Thus, the EF deficits found in FASD cannot be solely attributed to a low IQ. One aspect of EF that appears to be particularly important in FASD is working memory.

More research with larger sample sizes, smaller age ranges, and consistent use of tests to measure EF is needed. Furthermore, researchers should now focus on studying the pattern of weakness in EF in individuals with FASD, which will help to identify specific areas of weakness, to enhance diagnosis and improve treatment. There is limited research on the development of EF in individuals with FASD, which can have important implications for understanding of how these deficits unfold from childhood through adulthood.

New Research

Researchers at the University of Alberta (Rasmussen & Bisanz)[13] have recently completed a study examining EF in children and adolescents with FASD. The goals of this study were to examine 1) The pattern of EF deficits in FASD, and 2) Age differences in EF abilities in FASD. Twenty-seven children with FASD aged 8 to 16 years participated in this study, in which they completed many different tests of executive functioning. The scores of the children with FASD were compared to the average scores for a sample of children without FASD. Children with FASD performed poorly on most tests of executive functioning, and a distinctive profile emerged. Children with FASD performed poorest on the test that involved problem solving, flexible thinking, and concept formation. The children did not have difficulty on executive functioning tests that involved nonverbal fluency, planning, and spatial reasoning. Compared to children without FASD, older children with FASD showed more difficulty on some verbal tests of EF than younger children with FASD. Difficulty on verbal EF appears to be more pronounced with age.

EF and LAW

These EF deficits in FASD can lead to life-long difficulties adapting to and functioning in society. Specifically, EF difficulties can result in problems with planning, organizing, and learning from past mistakes.[14] Lack of sufficient inhibitory control combined with not understanding the

consequences of their actions (cause-and-effect reasoning) could lead to devastating problems with the law. In fact, in one study of adolescents and adults with FASD it was found that 60% of the sample had been in trouble with the law.[15] Furthermore, in a Canadian study it was found that 23% of youth remanded for a psychiatric inpatient assessment had FASD.[16]

Strategies for EF Deficits in FASD

Despite the EF deficits in individuals with FASD and the potentially devastating life-long consequences related to functioning in society there has been little, if any, research examining how to deal with EF deficits in terms of improvements, treatment, and upbringing. Some researchers (Watson & Westby) have suggested various strategies for addressing EF deficits in children prenatally exposed to alcohol and other drugs. For example, for difficulties with nonverbal working memory (remembering events, information, and behaviors etc.) they suggest using visualization techniques including self-awareness training, consistent and structured environments and routines, as well as visual aides and checklists. For difficulties with self-directed speech and verbal working memory they suggest language intervention, cognitive-behavioral intervention, and linking visual cues to verbal prompts. The authors further recommend social skills training, role-playing, social stories, and teaching the vocabulary of emotions, to deal with problems with self-regulation. Lastly, for difficulties with problem solving they suggest cognitive modeling, coaching, and self-determination curricula.[17]

Research is now needed to determine the effectiveness of these EF strategies, the efficacy of intervention programs for individuals with FASD, as well as research on whether EF skills can actually be improved in those with FASD. Research in this area will allow for the development and implementation of specific programs and strategies that could improve the quality of life for those with FASD and their families. In turn, this may reduce the poor outcomes many adults with FASD experience including apprehensive for criminal activity, dropping out of school, and increased risk of addictions.

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