Imaging Evidence of Eating Disorders

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Eating disorders are considered a relatively common diagnosis, especially for the adolescent population. The *Diagnostic and Statistical Manual of Mental Disorders,* fourth edition (DSM-IV) classifies eating disorders on a spectrum ranging from anorexia nervosa to bulimia nervosa, and a middle category called eating disorders not otherwise specified (EDNOS).[1]

Each classification of eating disorder has different diagnostic criteria, but the appearance of restrictive behavior is a common trait among them. Individuals with anorexia nervosa are classified by low weight, fear of gaining weight, a desire for total-body thinness, and body dysmorphia. Anorexia nervosa also has the highest mortality rate among psychiatric disorders.[2] Bulimia nervosa, on the opposite end of the spectrum, is characterized by episodes of uncontrolled eating of a substantial amount of food in a limited time frame[3]; inappropriate compensatory actions, such as purging, occur after binging to avoid weight gain.[4] In the middle of the spectrum, EDNOS is a nonspecific diagnosis given when characteristics of anorexia nervosa and bulimia nervosa are present or when the individual shows traits without the main symptomology.

The standard protocol for diagnosing an eating disorder has been to observe feeding behaviors, choice of food, calorie intake, and total body weight in relation to height.[2,3] These were the sole indicators of an eating disorder. However, physicians and researchers now use magnetic resonance (MR) imaging to compare brain matter measurements of individuals who are believed to have an eating disorder with measurements of healthy individuals.[3]

Advancements in MR Imaging Technology

MR imaging is a noninvasive and nonionizing method used to image internal structures of the body.[5] Strong magnetic fields and radio frequency are used to create cross-sectional images of the body without exposure to radiation. The strong magnetic fields that circulate the patient and the presence of a radio frequency cause hydrogen atoms in the body to align.[5] This alignment creates density for the machine to detect; different tissues and structures create different densities in relation to their atomic number.[5] These basic principles have advanced into other magnetic imaging techniques such as echo-planar imaging, volume imaging, MR angiography, and chemical shift imaging.[5]

Functional MR (fMR) imaging is a branch of neuroimaging that uses the principles of MR imaging to link the functions in the brain with specific regions.[5] It also is used in conjunction with hemodynamics to measure the amount of brain activity when a subject is presented with various stimuli.[6] Hemodynamics describes the local control of blood flow and oxygenation in the brain. During imaging, a subject is presented with a stimulus. It could be a visual stimulus such as a picture, or an audible stimulus such as sirens. Researchers image the brain as the stimuli are presented and monitor for regions of increased blood flow in response. Echo-planar imaging is used with fMR imaging to create videos from single tomographic images.[5]

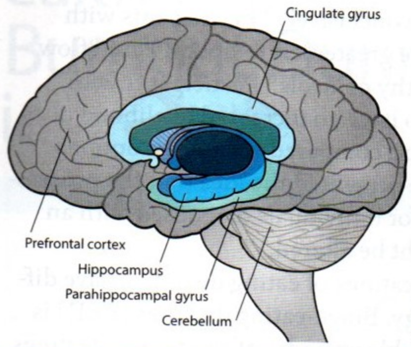

Figure. *Anatomy of the brain. © 2023 ASRT.*

In addition to imaging technology, there is new analytical technology available to researchers. Voxel-based morphography (VBM) is a technique used to analyze MR images when there is more than 1 image or subject to compare.[7] VBM allows for the automated comparison of neuroimages for brain atrophy without the need for lengthy measurements and manual structural assessments.[7] Usually, the structural changes in the brain must be manually measured by a radiologist. This is a lengthy process, especially in clinical trials with thousands of images and multiple subjects. VBM takes the images, then measures and compares each one. The program creates a statistical analysis of the data. The analyzed data can then be used by researchers to draw evidence-based conclusions in a shorter period.[7]

Structural Brain Differences Related to Anorexia Nervosa

Although fMR imaging has been used in multiple clinical trials, few have included an adolescent population. VBM research on eating disorders have focused primarily on the adult population though anorexia nervosa has the highest diagnosis rate among adolescents aged 15 to 19 years.[8] Research on eating disorders in adults has found an overall reduced amount of gray matter in the appetite-control region, cerebellum, and hypothalamus (see **Figure**).[8] The cingulate cortex, striatum, and parahippocampal gyrus form part of the neural reward system that influences appetite control. Dorsolateral prefrontal cortex (DLPFC) is activated in patients with anorexia nervosa when presented with food stimuli. The DLPFC is linked to working memory and when stimulated with food has been linked with restraint and obsessive behaviors.[1]

Other research also concluded that there was a reduction in the cingulate and insular cortex regions.[9] This research was conducted on adults after the long-term effects of eating disorders occurred. Researchers were unable to compare structural changes from before the diagnosis. Although some information has been discovered about the adult brain, little is known about the adolescent brain before the detrimental effects take place.

Researchers at a department of child and adolescent psychiatry in Sweden conducted a study to determine whether structural changes in the brain correlated[1] with eating disorders.[1] Patients were evaluated and excluded from the study based on these traits: left handedness, metallic implants, other psychiatric disorders (eg, obsessive-compulsive disorder, anxiety), and the use of medications.[1] The researchers chose 15 newly diagnosed girls from an eating disorder unit. All 15 participants underwent multiple MR scans. As the scans were being completed, the participants were asked to complete a working memory task. Each participant was asked to recall a letter that was presented in a previous trial. Between the letters, participants were presented with blue squares and images of high-calorie foods.[1] Research has shown a cognitive bias toward high-calorie foods in individuals with eating disorders. The food stimuli acted as a mechanism to test whether the DLPFC was affected in working memory.

The scans were entered into VBM software and compared by region with a template from a healthy control. The cingulate cortex, insular cortex, and the DLPFC were identified as regions of interest.[9] The study concluded that there was a positive correlation between anorexia nervosa and gray matter volume in the left insular cortex.[1] Reaction times from the memory task were compared with brain volume measurements. Findings showed that slower reaction times were related to smaller volume in the lingual gyrus.[1]

Structural Brain Differences Related to Bulimia Nervosa

Few structural studies have been completed on bulimia nervosa subjects. Pituitary abnormalities and cerebral atrophies have been suggested as an indication of the disorder, yet no research has been able to demonstrate this conclusively.[9] Participants with bulimia nervosa have greater left temporal blood flow compared with healthy controls.[9] Participants with bulimia nervosa also have an increased likelihood of choosing a sweet food compared with other options. These findings have presented the idea that the processing of taste stimuli for individuals diagnosed with an eating disorder might be altered.[9]

Different classifications of eating disorders have different symptomology. Binge-eating disorder (BED) is noted as uncontrollable episodes of eating with feelings of guilt and compensatory behaviors. Researchers at the University of Padua in Italy enrolled 42 participants and divided them into 2 groups based on BED behaviors. The study aimed to compare gray matter volume and impulsivity of participants with BED with healthy controls.[3] The study used numerous self-reporting questionaries to divide the subjects into BED and non-BED groups. The subjects then received fMR imaging scans. The scans were analyzed using VBM software. Researchers concluded that the BED group differed in regional gray matter volume.[3] Specifically, the BED group had higher gray matter volume in the DLPFC, which is critical to behavioral control and regulation of impulsive behaviors.[3] A lack of impulse control is a key trait associated with BED and weight gain. This is consistent with other research that reported that structural changes in the DLPFC are associated with overeating and obesity.[3]

Conclusion

Regardless of diagnosis, there are similarities related to brain function and structure throughout the eating disorder spectrum. Patients diagnosed with anorexia nervosa have been noted to have a reduced amount of brain matter volume in critical regions associated with restrictive and obsession control. Patients with bulimia nervosa have an increased amount of brain volume in regions associated with impulse control as well as the pituitary gland. None of these studies would have been possible without advancements in imaging technology, such as fMR imaging, that allows researchers to identify specific regions in the brain that respond differently to stimuli compared with the traditional method of imaging that produces stagnant images. For individuals diagnosed with an eating disorder, the use of regular imaging scans can be a vital part of the recovery process.

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