

**Autism Spectrum Disorder:
Neurodevelopment and Individualized Care**

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Autism Spectrum Disorder (ASD) is estimated to affect 1-2% of children globally (Motta et al., 2026). Understanding of ASD has shifted from seeing it as a sudden emergence in toddlers to recognizing it as a condition with origins long before birth (Motta et al., 2026). ASD is diagnosed between ages two and four, when differences in socializing and communication may become more noticeable. However, research indicates that the neurological difference associated with autism develops much earlier, at the prenatal stage of neurodevelopment. This information reframes autism as a developmental wiring difference rather than a sudden deficit, underscoring the importance of individualized intervention, including both therapy and education, at an early age. Evidence of differences in prenatal and early postnatal brain development in ASD demonstrates the importance of understanding autism as a neurological difference and providing individualized care based on each person's needs.

Genetic and Prenatal Foundations

A Multistage, Multifactorial Origin

Autism has high heritability, yet it is not caused by one single gene. Studies of highly confident risk genes for autism reveal that almost all such genes are expressed prenatally in multiple areas of the brain involved in autism spectrum disorders, and that they can be divided into two groups: genes with general regulatory functions throughout the brain and body and genes that are specific to the brain (Courchesne et al., 2020). These genes appear to act at various stages of prenatal development, interfering with cellular processes such as cell proliferation and neurogenesis before birth (Courchesne et al., 2020). These findings suggest that autism should be treated as a "multistage prenatal disorder" with sequential biological events happening in it (Courchesne et al., 2020).

However, genetics do not function independently. One recent birth-cohort study investigating various prenatal and perinatal risk factors identified multiple maternal and environmental characteristics as being linked to greater chances of receiving an autism diagnosis later on, such as high pre-pregnancy body mass index of the mother, maternal history of mental disorders before conception, selective serotonin reuptake inhibitors usage during pregnancy, exposure to tobacco smoke secondhand, vinyl flooring exposure, and socioeconomic adversity (Holland et al., 2026). Moreover, protective relationships have been identified regarding maternal nutrition, especially increased consumption of folic acid, magnesium, and iron, as well as compliance with dietary guidelines (Holland et al., 2026). These findings show that the prenatal environment may influence an individual's neurodevelopment through inflammation and oxidative stress, and interact with genetic vulnerability (Frasch et al., 2023).

The Neuroinflammatory Hypothesis

One mechanism currently under investigation includes the brain's immune cells. It has been theorized that fetal neuroinflammation, along with maternal prenatal stress, can reprogram the metabolic and immune activities of astrocytes and microglia, the support cells and the immune system of the brain, in such a way as to influence neurodevelopment, increasing the chances of developing autism in genetically predisposed children (Frasch et al., 2023).

Comparative studies across species have used gene data from rodent and sheep glial cells, the cells that support, protect, and help neurons function properly, along with genes linked to autism. These studies have uncovered common sets of stress and inflammation-related genes, supporting the thesis that prenatal biological stress may help connect environmental factors to the genetic risk profile outlined above (Frasch et al., 2023). This may be one biological link between

environmental factors and the genetic risk profile outlined above, although it remains under investigation.

What Fetal Imaging Reveals

For many years, researchers inferred direct proof of a prenatally different brain through genetics rather than through direct observation. New advances in fetal MRI have opened a way to observe brain development in the uterus. One recent narrative review found eight studies providing converging evidence that neurodevelopmental divergence in autism may begin prenatally and may be seen in structures like the insular cortex, a region of the brain involved in sensory processing and awareness of internal bodily states, and changes in the size of the brain's fluid-filled ventricles, ventriculomegaly (Motta et al., 2026). This imaging evidence sharpens the thesis by showing that prenatal differences can be observed directly.

Another line of research that stands out came from Eric Courchesne's group at UC San Diego. They studied “brain cortical organoids,” laboratory-grown models of developing brain tissue, and observed that the extent to which it overgrew during the embryonic stage corresponded to the severity of the social symptoms seen later in life. Toddlers who developed severe autism had greater overgrowth of the brain cortical organoid, whereas toddlers with lesser social symptoms had lesser overgrowth (Courchesne et al., 2024). This observation reaches back to the embryonic stage, well before the third trimester. A distinct study published in 2026 examined fetal functional connectivity, the communication between different networks of the brain before birth, and found that certain connectivity patterns, determined by the means of fetal resting-state functional MRI, were predictive of autistic traits at 3 years of age, providing some of the earliest evidence of the link between functional brain organization in utero and autism-related characteristics (Chen et al., 2026).

However, the field does not always agree on this topic, making it a legitimate unresolved scientific controversy. According to a study conducted in 2025 involving two prospective cohorts, the Human Connectome Project and the Cambridge Human Imaging and Longitudinal Development study, brain scans of infants shortly after their birth revealed no evidence of brain overgrowth. On the contrary, brain volume, gray matter, and white matter at the beginning of life had been inversely correlated to autistic traits at 18 months in one of the two prospective cohorts (Tsompanidis et al., 2025). The same research group has also provided some evidence that a subgroup of people with autism could be characterized by the phenomenon of brain undergrowth, especially before 6 months old (Tsompanidis et al., 2025). This contradiction in the literature reinforces the idea that autism is biologically heterogeneous, meaning different children could reach the same behavioral profile through different pathways of neurodevelopment.

Postnatal Trajectories: From Overgrowth to Divergence

The most well-established postnatal model is derived from several decades of MRI studies, some of which have revealed that the brains of autistic children develop faster than those of non-autistic children in the first year or two of life. Brain size then either stabilizes or declines rapidly during adolescence and adulthood, a phenomenon termed "early overgrowth with premature arrest of growth" (Courchesne, 2004; Courchesne et al., 2011). The brain areas most affected by such overgrowth include the cerebral cortex, cerebellum, and limbic system, regions responsible for cognitive, social, emotional, and linguistic functions, respectively (Courchesne et al., 2011). These findings support the thesis that early brain development helps explain later autism-related differences.

More refined longitudinal neuroimaging work has also been done with infant subjects who are genetically predisposed to developing autism, often the younger siblings of children with autism. The image has become even clearer: there is hyper-expansion of the cortical surface area in the first year of life, followed by overgrowth of brain volume in the second year, which is the same period in which autism's characteristic social-communication problems manifest themselves in behavior (Piven et al., 2017). The conceptual framework offered posits that the process starts with excessive proliferation of neural progenitor cells, early cells that develop into different types of brain cells, and leads to hyper-expansion of the cortical surface area, which in turn causes disruption in early visual attention and sensorimotor experience and prevents the experience-dependent development of brain circuitry, resulting in abnormal development of the social-brain circuitry (Piven et al., 2017). Because these brain changes occur before behavioral characteristics develop, this period is believed to be relevant for intervention programs (Piven et al., 2017). This timing suggests that individualized care may be most useful when started early, if reflective of a child's developmental course.

Again, like the findings from the prenatal period, this is currently being tested rather than being considered definitive. As mentioned earlier, when analyzing 2025 data from the developing Human Connectome Project (dHCP) and the Cambridge Human Imaging and Longitudinal Development (CHILD) study, researchers did not identify any signals of overgrowth among the earliest months of life. Instead, they observed that the associations were reversed in one sample group. This shows that head circumference and total brain volume are incomplete and perhaps overly simplistic measures for the very different regional and circuit-level brain characteristics of autism (Tsompanidis et al., 2025). Overall, based on the existing body of scientific knowledge, a few major points can be made rather than one story: (1)

genetic risk factors have effects during the prenatal period, while also influenced by environmental and immune factors; (2) certain brain differences can be observed even before birth among some children; (3) many but not necessarily all autistic children experience a specific pattern of excessive brain growth during infancy, associated with further emergence of social and communicative deficits; and (4) autism is heterogeneous, meaning that there is no single pattern applicable to all people with autism. Taken together, these findings show that autism reflects multiple developmental pathways, which in turn implies a need for individualized understanding and support.

Tools to Support Autistic Individuals

Understanding autism as a neurological difference rather than a deficit allows for the development of individualized care that addresses each person's needs. Various resources exist, and they have proven to be effective.

Communication Support

Many autistic individuals, particularly those who are non-verbal or minimally verbal, use Augmentative and Alternative Communication (AAC), which includes anything from low-tech picture exchange communication systems to high-tech speech-generating devices and even special AAC applications on a smartphone or tablet (Ability Psychological Services, 2024). Even verbally autistic individuals can receive additional support through text-to-speech or speech-to-text software (Ability Psychological Services, 2024).

Visual Support

Because many autistic individuals understand visual messages better than real-time instructions, many use visual schedules, choice boards, social stories, and checklists to provide routine predictability and help them understand written social norms (Building Blocks Therapy,

2025). Visual supports fall under a broader category called "low-tech assistive technology," along with token boards and checklists (Building Blocks Therapy, 2025).

Sensory aids

Sensory challenges are common among people with autism; aids like noise-canceling headphones, weighted blankets, flexible lighting, fidget items, and quiet or calm areas help prevent sensory overload and the stress or shutdown caused by this condition (Key Autism Services, 2025; Building Blocks Therapy, 2025).

Therapies

Language and speech therapy supports receptive and expressive language development, as well as social and pragmatic communication. Occupational therapy supports fine motor skills, sensory integration, and activities of daily living (Ability Psychological Services, 2024). These therapies function as related services and are provided alongside educational interventions.

Routines and reinforcements

Personalized reinforcement programs have proven effective for many autistic individuals, especially children (Mastermind Behavior Clinical Team, 2025).

Schooling Frameworks Which Support Success

Structured Teaching (TEACCH)

TEACCH is based on the assumption, well supported by scientific literature, that autism is defined by a specific information-processing style rather than emotional or interpersonal difficulty, and that many individuals with autism process information visually and respond well to visual cues (Above and Beyond Therapy, 2025).

The key components of the Structured Teaching methodology are the following: organization of physical environment, minimizing of distractors and clearly marked visual

boundaries of different spaces; use of individualized visual schedules; development of "work systems" that involve information about what task the person has to perform, for how much time they have to do it, when it ends and what is next; and introduction of visual structure into tasks and materials (Autism CRC, n.d.). According to systematic reviews and meta-analyses of controlled trials conducted in 2025, TEACCH-based structured teaching programs have shown evidence of effectiveness in some areas for children with autism, although results vary across outcomes (Zhu et al., 2025; Mastermind Behavior Clinical Team, 2025). Moreover, a 2025 study showed the effectiveness of TEACCH programs in a structured clinical setting with parental involvement (Li et al., 2025).

Individualized Education Programs and Legal Policies

In the USA, most school-related assistance for students diagnosed with autism takes the form of an Individualized Education Program (IEP), a legal document under the special education legislation that connects goals directly to services (PAAutism.org, n.d.). Because autism differs from person to person, IEP teams should avoid standardized planning and develop plans based on individual data gathered during the student's evaluation (PAAutism.org, n.d.). Typical IEP services may include speech and language therapy, occupational therapy, AAC support and training, sensory adjustments to the classroom, and "Specially Designed Instruction" (SDI). SDI is instruction designed specifically to the needs of the child, such as use of word prediction software, seating modification, and behavior management (PAAutism.org, n.d.; Ability Psychological Services, 2024). If a student does not require specialized instruction but still qualifies for disability-related accommodations, they may receive a 504 plan, such as extended time, seating modification, and sensory breaks (Undivided, 2026).

Building a Comprehensive School Approach

In the existing literature on the subject, a few themes have emerged in terms of educational models that are effective for autistic learners: Sensory-appropriate physical environment with lower levels of sound and lighting; constant visual cues included in the regular schedule instead of being sporadic; social skills training that explains instead of assumes social behavior; adjustable scheduling that allows for breaks when necessary; and continuous professional development of the staff so that accommodations are provided in accordance with the recommendations (Building Blocks Therapy, 2025; Ability Psychological Services, 2024; Undivided, 2026). None of these items is used as an all-encompassing checklist; the consistency lies in the fact that support must be customized to the learner's individual needs (Holland et al., 2026; Undivided, 2026).

Conclusion

There has been a great shift in the scientific view of autism, from seeing it as a disorder that develops in childhood to viewing it as a neurodevelopmental difference. Autism is characterized by genetic and prenatal environmental factors and, for some individuals, rapid brain development leading to differences in social and communicative development. Nonetheless, the issue that remains unsettled is the question of whether this phenomenon of "overgrowth" is true for all individuals diagnosed with autism or only some. Ultimately, these different developmental trajectories can result in a different, rather than a deficient, way of experiencing the world. Individuals thrive when their environment acknowledges and supports this difference through visual, sensory, and communication tools, alongside tailored teaching strategies like structured teaching and individual education planning.

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