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Advances in Autism Spectrum Disorder (ASD) Diagnostics: From Theoretical Frameworks to AI-Driven Innovations

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Abstract: This study provides a comprehensive analysis of the evolution of Autism Spectrum Disorder (ASD) diagnostics, tracing its progression from psychoanalytic origins to the integration of advanced artificial intelligence (AI) technologies. The study explores, through scientific data bases like PubMed, Scopus and Google Scholar, how theoretical frameworks, including psychoanalysis, behavioral psychology, cognitive development, and neurobiological paradigms have shaped diagnostic methodologies over time. Each paradigm's associated assessment tools, such as the Autism Diagnostic Observation Schedule (ADOS) and the Vineland Adaptive Behavior Scales, are discussed in relation to their scientific advancements and limitations. Emerging technologies, particularly AI, are highlighted for their transformative impact on ASD diagnostics. The application of AI in areas such as video analysis, natural language processing, and biodata integration demonstrates significant progress in precision, accessibility, and inclusivity. Ethical considerations, including algorithmic transparency, data security and inclusivity for underrepresented populations, are critically examined alongside the challenges of scalability and equitable implementation. Additionally, neurodiversity-informed approaches are emphasized for their role in reframing autism as a natural variation of human cognition and behavior, advocating for strength-based, inclusive diagnostic frameworks. This synthesis underscores the interplay between evolving theoretical models, technological advancements, and the growing focus on compassionate, equitable diagnostic practices. It concludes by advocating for continued innovation, interdisciplinary collaboration, and ethical oversight to further refine ASD diagnostics and improve outcomes for individuals across the autism spectrum.

Keywords: assessment; diagnosis; autism spectrum disorders; tools; AI

1. Introduction

The conceptualization and diagnostic methodologies of Autism Spectrum Disorder (ASD) have undergone substantial evolution over the past century. This evolution reflects the integration of historical perspectives, theoretical models, and emerging innovations into a cohesive understanding of this complex neurodevelopmental condition. From its origins in psychoanalytic theories to modern approaches using advanced tools such as artificial intelligence (AI), this paper explores the development of ASD diagnostics. By tracing this trajectory, the paper evaluates the interplay of diverse methodologies, the challenges they encounter, and their implications for addressing the multidimensionality of autism.

This study investigates how theoretical models have influenced the diagnostic evolution of ASD. The progression reflects the shift toward neurodevelopmental and evidence-based frameworks that offer a more comprehensive understanding of autism. Moreover, emerging diagnostic tools and technologies aim to address critical gaps in inclusivity, particularly for underrepresented populations and diverse manifestations of ASD.

1.1. Early Theoretical Frameworks and Psychoanalytic Influence

Autism research initially emerged within the framework of psychoanalytic theories, with significant contributions from Leo Kanner and Hans Asperger during the 1940s [1]. Kanner defined

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autism with characteristics such as "autistic aloneness" and "insistence on sameness," highlighting challenges in social interaction and resistance to changes in the environment. Concurrently, Asperger's work introduced the concept of autism as a spectrum, encompassing milder cases that exhibited unique intellectual and social traits [2]. Diagnosis in this era relied on psychoanalytic tools like unstructured interviews, Rorschach Inkblot Tests and Thematic Apperception Tests (TAT) [3]. These approaches emphasized subconscious disturbances and psychological dynamics, which shaped early perceptions of autism as rooted in psychological issues. However, later advancements in understanding autism as a neurodevelopmental condition rendered these tools and theories less relevant due to their speculative nature and limited empirical support [4].

During the mid-20th century, psychoanalytic frameworks were at the forefront of diagnostic practices. Relying heavily on unstructured interviews and interpretive instruments like the Rorschach Inkblot Test and TAT, these methods aimed to delve into underlying psychological disturbances or subconscious drivers [3]. However, they faced significant criticism for their scientific limitations. These included an excessive dependence on subjective interpretation, which made results inconsistent and difficult to replicate, and the inability to produce objective diagnostic benchmarks [4]. Moreover, the lack of empirical support and the association of autism with parental behavior further diminished the credibility of this approach [5]. These shortcomings, coupled with growing demands for more evidence-based and scientific methodologies, precipitated a shift toward empirically driven neurodevelopmental approaches, marking the decline of psychoanalytic dominance.

The pivotal transition away from psychoanalytic interpretations marked a progressive trend toward viewing autism as a biologically rooted neurodevelopmental disorder. Psychoanalysis's limitations, such as its reliance on subjective interpretations and lack of empirical rigor, highlighted the necessity for diagnostic tools that offered objective, replicable, and evidence-based assessments [6]. These tools evolved to incorporate structured observational methods and standardized metrics, marking a shift toward more scientifically grounded approaches to autism diagnosis.

1.2. The Behavioral Paradigm and Objective Diagnoses: 1960s–1980s

The mid-20th century marked a significant shift in autism research and intervention with the rise of behavioral psychology. This era emphasized observable and measurable behaviors, steering away from the subjective methodologies of psychoanalysis. Among the hallmark contributions was Ivar Lovaas's Applied Behavior Analysis (ABA), which employed operant conditioning principles to reinforce or modify behaviors in autistic individuals. However, the tools developed during this period, while revolutionary, warrant closer scrutiny regarding their application and limitations.

The **Autism Diagnostic Interview-Revised (ADI-R)** was a pivotal tool in this era, complementing the Autism Diagnostic Observation Schedule (ADOS) to create a comprehensive framework for autism diagnosis. The ADI-R is a structured, semi-standardized interview designed to gather detailed information about developmental history and behavioral patterns across three core areas of autism: social interaction, communication, and restrictive, repetitive behaviors [7]. Meanwhile, ADOS evaluates current behaviors through structured play-based activities and clinical observation [8]. Together, these tools offer a dual perspective: ADI-R provides a historical developmental context, while ADOS captures real-time behavioral data. Their combined use ensures a robust diagnostic process that integrates longitudinal and situational insights. The synergy between ADI-R and ADOS addresses a critical need for reliability and consistency in diagnosing ASD. ADI-R's detailed interview format relies on caregiver reports to trace behavioral development over time, ensuring that developmental milestones and potential delays are thoroughly documented. ADOS, in contrast, employs direct observation to assess behaviors, offering an immediate snapshot of social, communicative, and behavioral interactions. This dual-tool approach bridges the gap between retrospective insights provided by caregivers and objective, real-time clinician assessments, thus increasing diagnostic precision.

Despite their complementary nature, the ADI-R and ADOS have limitations that must be acknowledged. The ADI-R heavily depends on the caregiver's ability to recall and articulate detailed developmental histories, which may introduce biases or inaccuracies. Moreover, while ADOS

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provides direct behavioral observation, it is constrained by the artificiality of clinical settings, which may not reflect a child's natural behaviors in familiar environments. Together, these factors underline the importance of interpreting their findings within a broader diagnostic framework that includes diverse perspectives and contexts.

While tools like the ADI-R and ADOS advanced empirical rigor in autism diagnostics, behavioral methodologies of the era were not without critique. Programs like Discrete Trial Training (DTT), a component of ABA, emphasized repetitive, task-based learning, often at the expense of fostering meaningful social and adaptive skills. It is essential to distinguish that DTT is an intervention program, not a diagnostic tool. Critics have argued that such interventions reduced autism to a series of deficits to be corrected, overlooking the broader cognitive, sensory, and emotional profiles of individuals on the spectrum [9]. Additionally, behavioral approaches were often criticized for their mechanistic nature, prioritizing quantifiable outcomes over the holistic understanding of individual variability. This rigidity limited their ability to address the full spectrum of autism's manifestations, necessitating the development of alternative, more integrative frameworks.

The behavioral paradigm's emphasis on structure and objectivity marked a critical departure from earlier psychoanalytic approaches. Tools like the ADI-R and ADOS played a transformative role in standardizing autism diagnostics, providing complementary perspectives on developmental history and observable behaviors. However, their reliance on structured clinical environments and caregiver reports reveals inherent limitations that highlight the need for ongoing refinement. These critiques underscore the importance of integrating behavioral tools with broader, more inclusive methodologies that address the multidimensionality of autism. As diagnostic frameworks continue to evolve, the lessons from this era remain invaluable for ensuring that tools and methodologies reflect the complexity and diversity of autistic individuals.

1.3. Advances in Cognitive and Developmental Frameworks (1980s–1990s)

The 1980s and 1990s brought significant shifts in autism diagnostics, framed by cognitive and developmental theories emphasizing autism as a neurodevelopmental condition. Seminal contributions, such as Simon Baron-Cohen's "Theory of Mind" deficit hypothesis, proposed that individuals with autism experience difficulties in attributing mental states to others, leading to challenges in social communication and interaction [10]. Additionally, models like "Executive Function Deficits" and "Weak Central Coherence" shed light on limitations in planning, cognitive flexibility, and information integration among autistic individuals [11, 12]. Assessment tools aligned with these theories, such as the Sally-Anne test for Theory of Mind and the Wisconsin Card Sorting Test (WCST) for executive functioning, provided insights into cognitive and developmental profiles [9, 13] This era also witnessed significant refinements to diagnostic methodologies. The publication of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III and DSM-IV) standardized criteria for autism diagnosis, focusing on identifiable behaviour patterns such as social impairments, repetitive activities, and restricted interests [13, 14]. Complementary tools, including the ADOS, introduced play-based assessments to evaluate social and communication deficits through structured yet flexible settings [8].

1.4. The Neurobiological and Genetic Paradigm (1990s–Present)

From the 1990s onward, autism research has increasingly emphasized neurobiological and genetic foundations, redefining autism as a multifactorial, heterogeneous spectrum. Advances in neuroimaging techniques, including functional magnetic resonance imaging (fMRI) and electroencephalography (EEG), have produced significant insights into neural connectivity and structural anomalies associated with ASD. For example, fMRI studies have revealed atypical connectivity in the default mode network (DMN), which is associated with self-referential thought and social cognition, while EEG has highlighted altered gamma oscillations linked to sensory processing differences [16, 17]. These findings have deepened our understanding of the neural underpinnings of ASD, providing a foundation for more targeted interventions and diagnostic refinements. Similarly, breakthroughs in genetic research, such as whole-genome sequencing, have

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identified heritable markers that influence ASD, reinforcing this neurodevelopmental perspective [18]. Assessment tools during this era included neuroimaging protocols, the Social Responsiveness Scale (SRS) for evaluating social impairments, and the Sensory Integration and Praxis Tests (SIPT) [19] to address sensory processing challenges [20]. These tools worked in conjunction with the DSM-5's updated criteria, which emphasized a unified spectrum diagnosis for a more comprehensive approach to ASD [21]. Tools and instruments developed in this era reflect a deeper biological and sensory analysis of autism.

2. Materials and Methods

ASD diagnostics have advanced significantly, encompassing evolving theoretical understandings, groundbreaking technologies such as neuroimaging techniques (e.g., fMRI, EEG) and genetic analysis, as well as innovative tools like ADOS [8] and Social Responsiveness Scale (SRS) [20]. This study examines how transitions in diagnostic frameworks, driven by integrative approaches such as AI, shape our knowledge and practices of ASD diagnosis.

The scientific data bases searched were PubMed, Scopus and Google Scholar. The key words used were "autism" OR "ASD" AND "artificial intelligence" OR "AI" AND "Assessment" AND "Diagnostic Tools for ASD". The publication time frame of the study was between 2020 - 2024.

3. Results

3.1. Emerging Directions: Artificial Intelligence and Integrative Approaches

The advent of artificial intelligence has introduced a transformative force in ASD evaluation, streamlining diagnostic procedures, enhancing precision, and increasing accessibility [22]. It represents a significant leap over conventional methodologies, which often rely on subjective analysis and small datasets. By contrast, AI leverages vast, intricate data patterns for consistent and objective assessments. These computational advancements extend across various domains within ASD evaluation.

The potential of AI systems to integrate multimodal biodata sources exhibits extraordinary promise in transforming ASD diagnostics [23]. Biodata encompasses a wide range of information, including genetic databases, clinical observations, and physiological metrics, all of which contribute to a more holistic understanding of ASD. These systems excel in consolidating diverse data streams into cohesive individual profiles, revealing previously inaccessible insights through their advanced analytic capabilities. For instance, the synthesis of genetic data and EEG metrics enables AI algorithms to identify hidden patterns, such as correlations between specific genetic markers and notable variations in brainwave activity [16, 17]. This capability has proven significant in ASD research, as it deepens our understanding of both the genetic and physiological dimensions of autism. By enriching existing databases and improving patient-specific diagnostics and interventions, AI heralds a new era of precision medicine in ASD care [16, 17].

One of the most promising applications of AI in ASD evaluation lies in video analysis [24]. Machine learning-based computational models have demonstrated remarkable capabilities in identifying subtle behavioral indicators of autism. These models effectively analyze facial expressions, gaze patterns, and hand movements to detect irregularities. For example, analyzing home videos enables these systems to flag nuanced markers such as reduced eye contact or atypical gestures, which might be overlooked by traditional observational methods. This innovative approach has proven particularly effective in detecting atypical behaviors that evade less sensitive techniques, thereby enhancing the diagnostic process.

Digital behavioral monitoring presents another critical avenue for advancing ASD evaluations. By examining patterns in children's digital interactions, these platforms collect and analyze data on variables like facial expressions, gaze directions, and reaction times [25]. This process generates digital biomarkers—quantitative indicators of social engagement, attention, and stress levels—which complement traditional diagnostic methods. The use of real-time data allows clinicians to gain insights into behavior in diverse settings, enriching the overall assessment process. However, challenges remain, particularly regarding the risk of misinterpreting complex behavioral data and the need for robust cross-cultural validation to ensure these tools are applicable and effective across diverse populations.

Automated screening applications constitute an essential advancement in ASD diagnostics by seamlessly integrating into pediatric care settings. These tools analyze responses from digital questionnaires to flag potential cases requiring further medical attention. Predictive analytics, supported by machine learning algorithms, offer even deeper insights by processing extensive datasets that include genetic, environmental, and behavioral inputs [26, 23]. For instance, these analytics can identify ASD cases by detecting subtle data patterns typically unnoticed by human evaluators. Such advancements not only foster earlier detection but also inform timely intervention strategies. Yet, concerns about the variability in accuracy, stemming from biases in input data, highlight the ongoing need for refinement and quality assurance in these systems.

Natural Language Processing (NLP) is another transformative application in ASD diagnostics, particularly in the analysis of communication patterns. NLP algorithms analyze both verbal and non-verbal cues, including irregular intonation, atypical language usage, and inconsistent speech pacing, which are often linked to ASD traits [27]. For example, during structured interviews or conversations, these tools proficiently transcribe and assess dialogue, flagging potential diagnostic markers. Additionally, healthcare researchers can apply NLP to unstructured data, such as clinician notes, converting free-text narratives into structured formats. This process unlocks valuable insights into symptom progression and diagnostic complexity, enabling earlier detection and more precise treatment planning.

In addition, remarkable proficiency has been demonstrated in identifying early indicators of ASD through biodata analysis. Wearable biometric devices, including smartwatches and specialized medical sensors, enable continuous monitoring of physiological parameters like physical activity, heart rate variability, and sleep patterns over extended periods [28]. The data generated by these devices is examined by AI algorithms to uncover subtle patterns and anomalies associated with ASD. This predictive capability offers the potential to identify ASD risks as early as infancy, facilitating timely intervention strategies tailored to individual developmental needs. Early interventions during sensitive developmental stages can leverage the brain's plasticity, significantly enhancing long-term outcomes and quality of life for individuals diagnosed with ASD.

Advanced diagnostic tools, including those powered by artificial intelligence, have revolutionized ASD evaluations by improving both precision and accessibility [29]. These technologies not only complement established methodologies, such as the ADOS [8], but also address gaps in traditional approaches. Mobile applications designed for the early detection of autism provide caregivers and clinicians with user-friendly platforms for immediate assessments. For instance, apps like Cognoa and Autism & Beyond have streamlined early screening processes by leveraging AI-driven algorithms to analyze behavioral data and provide actionable insights [22]. These applications not only enhance clinical evaluations but also empower parents and caregivers by facilitating timely interventions and reducing delays in accessing professional care. These tools enhance clinical evaluations by streamlining the diagnostic process, reducing delays, and increasing accessibility for populations in under-resourced diagnostic settings.

Moreover, AI-driven systems have played a crucial role in addressing disparities in ASD diagnostic access, particularly in geographically or resource-constrained areas. By enabling remote evaluations powered by advanced analytics, these technologies minimize barriers to obtaining timely and precise diagnostic assessments [30]. Despite their advantages, challenges persist, including the need to implement reliable infrastructure, train local experts, and equitably distribute these tools to ensure universal access. These practical considerations highlight the importance of sustained investments to realize the potential of AI-based systems in global healthcare contexts.

The integration of AI and clinical expertise continues to redefine ASD diagnostics. These advanced tools enhance both the precision and accessibility of evaluations by augmenting human judgment. By fostering a more holistic approach, AI-driven diagnostics enable early interventions and improve outcomes for individuals on the autism spectrum. This synthesis of technological innovation and clinical acumen exemplifies the future direction of autism assessment practices.

At the forefront of redefining ASD diagnostics, advanced tools underscore critical considerations regarding ethical standards, inclusivity, and data security.

3.2. Ethical Considerations in AI-Based Diagnostics for Autism Spectrum Disorder

While AI-based diagnostic tools represent monumental advancements in ASD assessment, they raise pertinent ethical considerations critical to their integration into clinical practice. One of the foremost challenges pertains to data privacy and security. AI systems depend on large datasets—often containing sensitive biodata, genetic information, and behavioral records. The potential misuse or unauthorized access to such data poses risks to patient confidentiality and raises legal and ethical concerns. To mitigate these risks, robust data anonymization protocols, secure storage infrastructure, and strict adherence to regulatory frameworks are essential.

Algorithmic transparency is another pressing concern in the development and application of AI for ASD diagnostics. For example, efforts like Explainable AI (XAI) frameworks aim to enhance the interpretability of AI-driven diagnostic tools by providing clear rationales for their predictions [31]. These advancements enable clinicians to better understand and trust AI outputs, fostering more informed decision-making in clinical practice. The "black box" nature of many AI systems—where decision-making processes remain opaque even to their developers—limits their clinical trustworthiness. Physicians and practitioners often demand clear, interpretable outcomes to base diagnostic decisions on, highlighting the need for explainable AI models. Addressing this requires interdisciplinary collaboration between AI developers, clinicians, and ethicists to foster systems that not only offer accurate predictions but also provide transparent reasoning.

Inclusivity is equally critical in shaping ethical AI frameworks for ASD diagnostics. Algorithmic biases that arise from unrepresentative datasets risk exacerbating existing healthcare disparities. In particular, populations historically underrepresented in autism research—such as individuals from racial minorities and women on the spectrum—may receive suboptimal care if biases in AI systems are not actively addressed. Ethically developed algorithms must be rigorously tested across diverse populations to ensure equitable diagnostic accuracy, regardless of cultural or demographic differences.

Lastly, ethical frameworks should respect and integrate the perspectives of the neurodiverse community. This includes prioritizing assessments that reflect the lived experiences of individuals on the autism spectrum rather than strictly deficit-oriented models. Co-designing tools and technologies with autistic individuals, advocacy groups, and caregivers ensures that diagnostic processes are sensitive to varying needs and avoid perpetuating stigmatization.

3.3. Constraints

The integration of AI systems in diagnosing ASD presents substantial challenges that require careful resolution to ensure effective implementation. A paramount constraint lies in the necessity for high-quality, meticulously curated datasets. The precision and dependability of AI models are intrinsically tied to the accessibility of such data, where any deficit in quantity or quality can result in less-than-optimal diagnostic accuracy. Establishing and maintaining these datasets demand significant investments in resources, infrastructure, and collaborative efforts, frequently creating obstacles in resource-constrained environments [30].

Financial and technical barriers pose additional challenges to the integration of AI-powered diagnostics. Healthcare systems, particularly those in low-income or resource-constrained settings, often face deficits in the requisite expertise and funding for ongoing operations and maintenance of sophisticated AI tools. This inequality underscores concerns about fair access, risking the marginalization of disadvantaged communities that arguably have the most urgent need for advanced diagnostic solutions [29].

Scalability remains a significant challenge in AI implementation. While AI systems may exhibit strong performance in controlled environments, their ability to consistently deliver reliable results across varied real-world populations often falls short. This discrepancy underscores the cultural and demographic variability in ASD manifestations and highlights the need for ongoing refinement of AI models to address the complexities of diverse populations [25].

Lastly, the integration of AI systems with the expertise of human clinicians is imperative. These advanced tools are designed to complement and enhance clinical judgment, rather than to replace it, ensuring balanced and effective healthcare outcomes. Promoting a collaborative synergy between AI-enabled solutions and healthcare professionals is essential to unlocking their full potential, while preserving the human-centric foundation of patient care [27].

3.4. Neurodiversity-Informed Approaches in ASD Diagnostics

Advancing ASD diagnostics through the lens of neurodiversity aims to redefine how we conceptualize and assess autism by integrating specific diagnostic tools and practices. For example, frameworks such as the AASPIRE Healthcare Toolkit emphasize self-advocacy and personalized evaluation, aligning with neurodiversity principles to create inclusive and adaptive assessment methods [32]. Instead of focusing solely on deficits or impairments, neurodiversity emphasizes understanding autism as a natural variation in human cognition and behavior, advocating for acceptance and inclusivity [33].

AI tools, when aligned with neurodiversity principles, have the potential to revolutionize assessments by capturing and celebrating individual strengths alongside challenges. Programs inspired by neurodiversity frameworks emphasize assessing unique adaptive skills, problem-solving capabilities, or creative abilities that traditional diagnostic measures often overlook [9]. For instance, integrating markers of visual-spatial skills or pattern recognition evident in some autistic individuals into diagnostic models provides a more comprehensive understanding of their cognitive profiles.

Holistic diagnostic strategies informed by neurodiversity also account for environmental and contextual factors that shape autistic experiences. For instance, strengths-oriented approaches assess how traits like sensory sensitivities, often pathologized in traditional models, may contribute to unique perceptual insights or coping mechanisms. Practical applications include environmental modifications tailored to an individual's sensory preferences, which have been shown to enhance well-being and social participation [34]. For example, strengths-oriented frameworks assess how sensory sensitivities, often pathologized in mainstream models, may contribute to unique perceptual insights or coping mechanisms [34]. Rather than mitigating these traits, assessments can focus on optimizing environments to suit the sensory preferences of autistic individuals, fostering enhanced well-being and participation.

The adoption of neurodiversity-informed approaches also prioritizes collaboration with individuals on the spectrum throughout the diagnostic process. This includes incorporating self-advocacy and self-assessment tools to provide firsthand insights into personal experiences of autism [32]. These tools empower individuals to actively contribute to their evaluations, creating a partnership between clinicians and patients. Furthermore, tools like the AASPIRE Healthcare Toolkit exemplify efforts to foster inclusivity by tailoring diagnostic instruments to individual needs [35].

By embedding neurodiversity within the diagnostic framework, assessments transcend medicalized models to allow for a deeper appreciation of autistic individuals' unique contributions and lived realities. This shift plays a pivotal role in developing more compassionate, meaningful, and equitable diagnostic practices that align with the broader goals of acceptance and inclusion within society.

4. Discussion

The persistence of outdated diagnostic frameworks for Autism Spectrum Disorder (ASD), despite significant shifts in theoretical understanding and technological advancements, can be examined through the lens of Imre Lakatos's philosophy of science. Lakatos's concept of research programmes, characterized by a "hard core" of fundamental assumptions surrounded by a "protective belt" of auxiliary hypotheses, provides a valuable hermeneutic framework for understanding the gradual evolution of ASD diagnostics [36, 37].

In this context, the "hard core" of ASD research programmes may represent the fundamental commitment to understanding autism as a distinct neurodevelopmental condition. Over time, the "protective belt" has adapted, incorporating new diagnostic tools, methodologies, and theoretical models to address emerging empirical challenges. However, the persistence of tools like the ADOS or the Vineland Adaptive Behavior Scales reflects the stability and utility of certain elements within the protective belt, even as theoretical frameworks evolve. This durability often arises from the extensive validation, familiarity, and reliability of these tools, which continue to inform clinical practice despite the emergence of innovative approaches [8, 38].

The shifting notions of ASD, as evidenced by successive editions of the DSM, further illustrate Lakatos's distinction between "progressive" and "degenerative" research programmes [13, 14]. Each edition of the DSM reflects the incorporation of novel insights—such as the transition from categorical diagnoses like Asperger's Syndrome to the unified spectrum model in the DSM-5 [21]. These revisions signify a progressive trend, whereby theoretical advancements and empirical findings are integrated into the evolving diagnostic framework.

The advent of AI represents the next potential paradigm shift in ASD diagnostics. AI tools, such as machine learning algorithms for behavioral analysis and biodata integration, offer unprecedented precision and accessibility. These innovations challenge the current frameworks by introducing novel methodologies capable of capturing the multidimensional nature of autism [22, 23]. Just as neurobiological and genetic insights necessitated the revision of earlier DSM editions, the integration of AI into clinical practice may catalyze another significant reevaluation of ASD diagnostic criteria.

Despite these advancements, the coexistence of redundant frameworks with cutting-edge technologies underscores the complexities of scientific evolution. Lakatos's emphasis on the adaptability of research programmes provides a lens to understand why older tools persist alongside emerging innovations. The enduring utility of traditional diagnostic instruments, combined with the transformative potential of AI, highlights the dynamic interplay between stability and change in the scientific study of autism. This perspective advocates for an inclusive approach, where established methodologies are integrated with innovative tools to refine and expand our understanding of ASD.

The criteria for diagnosing and understanding ASD are expected to undergo significant transformations as AI continues to mature and reshape the boundaries between physical and virtual realities. Current diagnostic frameworks rely heavily on behavioral observations in structured or naturalistic environments, as well as traditional cognitive and social assessments. However, the integration of AI-enabled tools—such as real-time digital monitoring, virtual reality simulations, and wearable devices—will expand the contexts in which autistic behaviors and traits are observed and interpreted [24, 28].

As AI merges physical and virtual realities, diagnostic practices will no longer be constrained by physical settings or static evaluations. For instance, virtual environments can simulate complex social scenarios, allowing clinicians to assess social communication, sensory sensitivities, and adaptive behaviors in ways previously unattainable. AI systems will also analyze data collected from these virtual experiences, correlating it with biodata and real-world behaviors to provide a multidimensional view of autism. This shift could redefine the thresholds and markers for inclusion within the ASD spectrum, identifying individuals who might not meet current criteria but exhibit significant challenges or strengths that align with broader neurodiversity perspectives [23, 9].

Moreover, as AI tools become more adept at detecting subtle patterns in communication, interaction, and sensory processing, the boundaries of the autism spectrum may expand to encompass previously underrepresented populations. This includes individuals with atypical profiles, such as those with highly specialized skills or sensory modalities, who might currently fall outside traditional diagnostic frameworks. The fusion of virtual and physical diagnostic realities, coupled with AI's precision and scalability, will likely force a reevaluation of what constitutes ASD, shifting focus from deficits to a broader spectrum of cognitive, social, and sensory traits [32, 33].

In this evolving landscape, the role of clinicians, researchers, and neurodiverse individuals themselves will be critical in guiding these changes. The criteria for ASD diagnosis must not only accommodate the advancements enabled by AI but also uphold ethical standards and inclusivity, ensuring that new frameworks reflect the diverse lived experiences of autistic individuals. This transformative period offers an unprecedented opportunity to align scientific innovation with compassion and equity, paving the way for a more nuanced and holistic understanding of autism.

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Abbreviations

The following abbreviations are used in this manuscript:

ASD	Autism Spectrum Disorders
AI	Artificial Intelligence
TAT	Thematic Apperception Tests
ADI-R	**Autism Diagnostic Interview-Revised**
ADOS	Autism Diagnostic Observation Schedule
DTT	Discrete Trial Training
ABA	Applied Behavior Analysis
fMRI	Functional magnetic resonance imaging
EEG	Electroencephalography
DMF	Default Mode Network
SRS	Social Responsiveness Scale
SIPT	Social Integration Praxis Test
DSM	Diagnostic Statistical Manual
NLP	Natural Language Processing

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