# Understanding Individual Differences in Autism Spectrum Disorder Through a Trait-Based Approach: A Literature Review

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## ABSTRACT

Autism Spectrum Disorder (ASD) shows substantial heterogeneity in social communication, sensory processing, and cognitive functioning that categorical diagnostic systems struggle to capture. This review examines the extent to which a trait-based approach, conceptualising autistic characteristics as continuously distributed dimensions, accounts for individual differences in ASD. It traces the historical and psychometric basis of the trait perspective and integrates behavioural-genetic and neuroimaging evidence across three domains: social communication, sensory processing, and cognitive flexibility. It then considers domain-targeted interventions addressing these dimensions, before critically examining limitations concerning social camouflaging, environmental influences on trait expression, and developmental change. The review concludes that the trait approach offers considerable explanatory and clinical value, but functions best as a complement to, rather than a replacement for, categorical diagnosis, with future research needing to test trait-informed intervention models directly.

**Keywords:** Autism Spectrum Disorder; Trait Approach; Individual Differences; Camouflaging; Executive Functioning

## 1. INTRODUCTION

Autism Spectrum Disorder (ASD), referred to in some frameworks as Autism Spectrum Condition (ASC), is a neurodevelopmental condition characterised by persistent differences in social communication and interaction, alongside restricted, repetitive patterns of behaviour, interests, or activities [1]. Since Kanner's [2] earliest clinical descriptions, autism has been recognised as a profoundly heterogeneous condition: individuals who share the same formal diagnosis can differ markedly in developmental trajectory [3], sensory experience [4], cognitive style [5], and long-term outcome [6]. This heterogeneity poses a fundamental challenge for categorical diagnostic systems, which classify individuals as either meeting or not meeting a fixed set of criteria, but do not fully describe the continuous and multidimensional nature of the underlying individual differences [7].

A wide range of perspectives have been proposed to explain this heterogeneity, spanning cognitive theories of theory of mind and executive function [8,9], neurobiological accounts of atypical brain development [10,11], and perceptual models of autistic cognition [12]. However, comparatively few reviews have systematically synthesised these findings through the specific lens of the trait approach, which treats individual differences not as competing single explanations but as continuously distributed dimensions in their own right. This review therefore focuses specifically on the trait perspective, drawing together psychometric, genetic, and neurobiological evidence rarely integrated within a single dimensional framework.

The trait approach offers a complementary descriptive framework with a long history in autism research, dating to Wing's [13] proposal that autistic characteristics differ from typical development in degree rather than in kind. Alongside asking whether an individual meets diagnostic criteria, the trait approach asks where an individual falls along one or more continuously distributed dimensions of behaviour and cognition, such as social communication ability, sensory reactivity, or cognitive flexibility [14]. This reframing allows researchers and clinicians to capture meaningful variation both within the diagnosed population and in the wider, non-diagnosed population [15,16]; it explains why individuals with the same diagnosis present so differently, since trait-based models allow multiple, partially independent dimensions to vary within a single individual [17]; and it has direct clinical relevance for more personalised assessment and intervention [18,19]. In this review, continuous trait profiling describes an individual's relative levels across these dimensions to complement categorical diagnosis; it does not redefine diagnostic criteria or replace diagnostic categories.

Taken together, the persistent heterogeneity of ASD and the long tradition of dimensional thinking in autism research point to a genuine gap in the existing literature. Psychometric research on trait measures such as the Autism-Spectrum Quotient (AQ) and the Social Responsiveness Scale, behavioural-genetic studies of heritability, neuroimaging work on brain correlates of trait variation, and intervention research targeting specific autistic characteristics have each developed substantially as largely separate literatures, with little work drawing these strands together within a single dimensional framework; moreover, the assumption that trait-matched intervention selection outperforms diagnosis-general treatment has rarely been tested directly rather than simply asserted. This fragmentation leaves it unclear how strongly the trait approach is supported once evidence across levels of explanation is considered jointly, and whether individually tailored, trait-matched intervention is empirically justified or remains largely aspirational. A focused, integrative review of the trait perspective is therefore both timely and necessary. This review proposes that a trait-based approach can substantially advance understanding of individual differences in ASD by unifying psychometric, genetic, and neurobiological evidence, while also informing more individually tailored intervention; at the same time, it anticipates that this approach cannot fully substitute for categorical diagnosis, given limitations examined later. The review accordingly traces the historical development and evidence for trait-based thinking across three domains, considers how trait profiles inform targeted intervention, and finally evaluates key limitations and future directions.

## 2. UNDERSTANDING INDIVIDUAL DIFFERENCES THROUGH TRAIT-BASED APPROACHES

Before considering specific domains, it is useful to trace why a trait-based conceptualisation of autism developed. Autism was first identified as a categorical clinical entity by Kanner [2], a view substantially revised by Wing and Gould [20], whose epidemiological work showed that difficulties in social interaction, communication, and imagination, later termed the "triad of impairments", occurred in far more children, and in far more variable combinations, than Kanner's criteria implied. Wing [13] then proposed the conceptual shift underlying the trait approach: that autistic characteristics form a continuum extending into the general population. This perspective was operationalised through instruments including the AQ [14], the Social Responsiveness Scale [15], and the Social and Communication Disorders Checklist [21]. Happé and Frith [22] trace how the concept of autism has since shifted from a narrow category towards a broad, dimensional spectrum.

### 2.1 Social Communication

Social communication difficulties represent one of the two core diagnostic domains of ASD, yet individuals show substantial variability in the type and severity of difficulty. Building on Wing's [13] premise, Baron-Cohen et al. [14] developed the AQ, a self-report measure later cross-culturally validated in Dutch samples [23], finding that although diagnosed individuals scored significantly higher, autistic traits were measurable and continuously variable across every group tested. This is corroborated by behavioural-genetic evidence: using the Social Responsiveness Scale in a large twin sample, Constantino and Todd [15] demonstrated that autistic social impairment is continuously and normally distributed and substantially heritable regardless of diagnostic status. At the neurobiological level, Pelphrey et al. [11] propose that this heterogeneity reflects variable disruption to a distributed "social brain" network, while Schultz [10] implicates the amygdala–fusiform system in individual differences in face processing. Understanding social communication as a trait allows individual differences in eye contact and conversational reciprocity to be linked across behavioural, genetic, and neural levels of explanation.

### 2.2 Sensory Processing

Sensory processing differences were formally incorporated into the diagnostic criteria for ASD only in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), yet are now recognised as a core, highly variable feature [1]. Robertson and Baron-Cohen [4] describe substantial variability: some individuals show hyper-reactivity, others hypo-reactivity, and many a mixed pattern varying by modality and context. Neuroimaging supports this: Green et al. [24] found that youth with sensory overresponsivity show heightened, slower-habituating amygdala and sensory-cortex responses to mild stimulation than autistic youth without overresponsivity. Baranek et al. [25] similarly show hyporesponsiveness varies continuously with developmental level and predicts joint attention and language outcomes. Enhanced performance has also been documented in some domains, consistent with Mottron et al.'s [12] "Enhanced Perceptual Functioning" model, framing superior low-level discrimination as a further trait dimension rather than a uniform deficit. This heterogeneity is well captured by a trait-based approach representing an individual's sensory profile as distinct scores across modalities rather than one unitary symptom.

### 2.3 Cognitive Flexibility

Cognitive flexibility, the ability to shift between mental sets or perspectives, is another domain of pronounced individual difference. Ozonoff et al. [9] provided early evidence that executive function and theory-of-mind performance are impaired, on average, but far from uniformly, in autistic samples. Hill's [26] review similarly finds no single executive profile characterises the condition, with wide variation across planning, inhibition, and set-shifting. Geurts et al. [27], reviewing evidence across sites, subtypes, ages, and cognitive levels, found no consistent evidence for a uniform flexibility deficit. Kenworthy et al. [28] further note that laboratory measures often diverge from real-world functioning, underscoring that a single label cannot capture everyday flexibility difficulties. Treating cognitive flexibility as a continuous trait helps explain why restricted and repetitive behaviours present so differently, from circumscribed interests to rigid routine adherence.

Across all three domains, converging behavioural-genetic evidence indicates this picture is not an artefact of any single measure. Reviewing more than thirty twin studies, Ronald and Hoekstra [29] conclude that autistic traits are consistently heritable across instruments and ages, while remaining continuously distributed. Large cohort studies reinforce this: Sandin et al. [30] estimate heritability above 80% using Swedish register data, replicated by Bai et al. [31], and consistent with Tick et al.'s [32] meta-analysis reporting 64–91% heritability alongside modest shared-environmental effects at lower prevalence. Piven et al. [33] documented elevated but subclinical traits among non-autistic relatives, a broader phenotype now measured using the Broad Autism Phenotype Questionnaire [34]. Notably, Ronald et al. [17] found only modest genetic overlap between social, communication, and repetitive-behaviour domains at population extremes, suggesting the combination of traits required for categorical diagnosis is itself a product of correlated but genetically separable dimensions.

## 3. DOMAIN-TARGETED INTERVENTIONS

If autistic traits are continuously distributed and only partially correlated across domains, intervention might reasonably be tailored to an individual's specific trait profile rather than applied uniformly to all diagnosed individuals regardless of presentation. This section considers domain-targeted, behaviourally grounded interventions corresponding to each of the three domains introduced above, before considering a more mechanism-based, biological approach.

For social communication, Laugeson et al. [35] evaluated the University of California, Los Angeles (UCLA) Program for the Education and Enrichment of Relational Skills (PEERS), a manualised, parent-assisted social skills intervention for adolescents with ASD delivered through didactic instruction, modelling, and coached homework assignments; participants showed significant improvements in social skills knowledge, social responsiveness, and frequency of peer interaction relative to a waitlist control group, with gains maintained at follow-up. More broadly, Schreibman et al. [36] describe Naturalistic Developmental Behavioral Interventions (NDBIs), a family of approaches that combine applied behavioural techniques with developmental science within natural settings and shared child–therapist control, and which have accumulated empirical support across multiple independent research groups for improving social-communicative outcomes in young autistic children. Both approaches illustrate interventions addressing social-communication needs at different developmental levels, from foundational joint attention to the more complex peer-relationship skills targeted by PEERS.

For sensory processing, Schaaf et al. [37] conducted a randomised controlled trial of occupational therapy following Ayres Sensory Integration principles in children with autism and clinically significant sensory difficulties, finding significantly greater improvement on individually defined functional goals relative to usual care, consistent with targeting sensory-related functional needs in treatment planning. More recently, non-invasive brain stimulation has been investigated as a targeted, mechanism-based intervention for sensory and behavioural symptoms: in a systematic review of randomised controlled trials, Salehinejad et al. [38] report that anodal transcranial direct current stimulation (tDCS), a technique that applies a weak electrical current via scalp electrodes to modulate cortical excitability, produced improvements in behavioural symptoms across several trials in children and adolescents with ASD, although trial numbers remain modest and further replication is required. Because tDCS can in principle be targeted to brain regions implicated in specific trait dimensions, such as sensory-processing or social-cognitive circuitry, this approach illustrates how a trait-based conceptualisation of autism could eventually inform mechanism-specific, rather than diagnosis-general, treatment selection.

For cognitive flexibility, Kenworthy et al. [39] conducted a randomised controlled effectiveness trial of Unstuck and On Target, a school-based executive function intervention targeting insistence on sameness, flexibility, and goal-setting in children with ASD; children receiving the intervention showed significantly greater gains in flexibility and goal-setting than those receiving a social skills comparison intervention, delivered by ordinary school staff rather than specialist

researchers, indicating that domain-targeted intervention can be feasibly implemented outside highly controlled research settings.

Taken together, these interventions illustrate domain-targeted approaches to social, sensory, and executive needs, rather than demonstrating that trait-profile matching improves outcomes. The partial correlation of autistic traits across domains [17] provides a rationale for testing such matching, but none of the trials reviewed here explicitly stratified participants by trait profile before assigning treatment, a gap addressed further in the Discussion below.

## 4. DISCUSSION

The evidence reviewed across the preceding sections lends considerable support to a trait-based account of individual differences in ASD. Across all three domains examined, social communication, sensory processing, and cognitive flexibility, autistic characteristics were shown to be measurable using validated psychometric instruments [14,15,21], continuously distributed within the general population rather than confined to diagnosed individuals [16], substantially heritable across large twin and cohort studies [29, 30, 32], and associated with identifiable neurobiological correlates, from social-brain network disruption [11] to atypical amygdala and sensory-cortex reactivity [24]. This trait-based structure also carries practical value: because autistic traits are only partially correlated across domains [17], domain-targeted interventions, including social skills training, sensory integration therapy, and executive function coaching, address distinct areas of need, as illustrated in Section 3; whether matching treatment to an individual's trait profile improves outcomes remains to be tested directly.

At the same time, this trait-based picture is qualified by several notable limitations. The most consequential concerns social camouflaging: autistic individuals, particularly women, learn to mask or compensate for autistic traits in social situations [40,41], a phenomenon now directly quantified by the Camouflaging Autistic Traits Questionnaire [42] and shown to vary by context and be associated with poorer mental health [43,44,45], such that an observed or self-reported trait score may reflect camouflaging effectiveness as much as underlying trait level. Trait expression is also shaped by environmental context, since most measures rely on behavioural report within a specific setting and aetiological evidence indicates environmental and maternal factors contribute meaningfully to autism risk alongside genetics [31], meaning trait scores are not purely intrinsic to the individual. Relatedly, autistic trait profiles change developmentally: cross-sectional research obscures this "chronogeneity" [46], a concern substantiated by Fountain et al.'s [3] identification of six distinct developmental trajectories, so that a single trait score cannot represent an individual's developmental course. Finally, taxometric evidence questions whether autism is best represented dimensionally at all, with Frazier et al. [47] and James et al. [48] both finding evidence for qualitatively distinct latent categories within clinical and AQ-based samples respectively, rather than a single smooth continuum. A further, more practical limitation concerns diagnostic thresholds: because categorical systems such as DSM-5 [1], operationalised through instruments like the Autism Diagnostic Observation Schedule [49], require a fixed cut-off for service allocation, a purely trait-based model does not itself specify where clinical need begins, and individuals below threshold may still fail to qualify for support [50,51].

Given both this support and these limitations, the trait approach is best positioned not as a replacement for categorical diagnosis, which continues to serve essential practical functions in service allocation, but as a complementary framework that enriches understanding of, and intervention for, individual differences in ASD. Realising this potential, however, requires research that moves beyond demonstrating that autistic traits are dimensional towards directly testing whether trait-informed intervention selection improves outcomes. Priorities for future work include stratified or factorial randomised trials assigning participants to interventions such as PEERS-style social skills training, Ayres Sensory Integration therapy, or Unstuck and On Target executive function training based on their dominant trait profile rather than diagnostic status alone; larger, sham-controlled trials pre-stratifying participants by sensory-reactivity profile to clarify whether neuromodulation approaches such as tDCS [38] benefit specific trait subgroups; longitudinal, multi-timepoint designs combining behavioural trait measurement with neuroimaging, extending the cross-sectional work of Pelphrey et al. [11] and Green et al. [24], to disentangle genuine developmental change from the emergence of camouflaging; and genetic and neuroimaging studies that explicitly model social, sensory, and executive traits as separable dimensions, given the modest genetic overlap Ronald et al. [17] report between them, rather than aggregating them into a single composite phenotype that may obscure domain-specific mechanisms and intervention targets.

## 5. CONCLUSION

This review has examined the extent to which a trait-based approach can account for individual differences in Autism Spectrum Disorder. Tracing its roots from Wing and Gould's [20] epidemiological work through contemporary psychometric, genetic, and neuroimaging research, considerable evidence supports its application: autistic traits in social communication, sensory processing, and cognitive flexibility are continuously distributed, heritable, and only partially correlated with one another, and provide a rationale for domain-targeted interventions such as social skills training, sensory integration therapy, and executive function coaching. These findings suggest ASD is better understood as a profile of graded individual differences than a single homogeneous category. At the same time, the trait approach faces meaningful limitations, particularly the instability of trait measurement under social camouflaging, the influence of environmental context, developmental change across the lifespan, and taxometric evidence suggesting clinical-level autism may retain genuinely categorical features. These limitations indicate the trait approach, while valuable, cannot fully replace categorical diagnosis, which continues to serve essential practical functions in service allocation. Overall, the trait approach is best regarded as a complementary framework that enriches understanding of, and intervention for, individual differences in ASD, rather than a standalone alternative to categorical diagnosis, with future progress depending on directly testing trait-informed intervention models within longitudinal, multi-method research.

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