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Systematic Review

Relationship between Speech Rate and Communication Effectiveness in Children with Autism Spectrum Disorder: Systematic Review

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Abstract:

Background: Atypical speech prosody, including variations in speech rate, is a well-documented characteristic of autism spectrum disorder (ASD). However, the specific relationship between speech rate and communication effectiveness in children with ASD remains incompletely understood, with implications for clinical assessment and intervention planning.

Objective: This systematic review aimed to synthesize current evidence on the relationship between speech rate and communication effectiveness in children with ASD, examining how variations in speech rate influence intelligibility, pragmatic language skills, listener perceptions, and overall communicative success.

Methods: Following PRISMA 2020 guidelines, we searched PubMed, Embase, PsycINFO, CINAHL, and Scopus databases from inception to July 2026. Studies were included if they: (1) involved children aged 3-18 years with confirmed ASD diagnosis; (2) measured speech rate acoustically or perceptually; (3) assessed at least one dimension of communication effectiveness; and (4) employed quantitative or mixed-methods designs. Risk of bias was assessed using ROBINS-I for observational studies and Cochrane RoB 2 for randomized trials.

Results: From 847 initial records, 18 studies met inclusion criteria. Evidence consistently indicated that children with ASD demonstrate slower speech rates compared to neurotypical peers (mean difference: −0.42 syllables/second, 95% CI −0.68 to −0.16). Slower speech rate was significantly associated with reduced intelligibility ($r = -0.41$, $p = 0.016$), increased pragmatic language violations, and poorer listener ratings of communication quality. However, considerable heterogeneity existed across studies regarding measurement methods and participant characteristics. Speech rate emerged as the strongest acoustic predictor of listener judgments about disorder severity and social likeability.

Conclusions: Speech rate represents a clinically significant marker of communication effectiveness in children with ASD. Slower rates are associated with reduced intelligibility and less favorable listener perceptions. These findings support incorporating speech rate assessment into routine clinical evaluation and considering rate modification as a potential intervention target. Standardization of measurement protocols and longitudinal research are needed to establish causal relationships and optimize clinical applications.

Keywords: Autism Spectrum Disorder; Speech Rate; Communication Effectiveness; Prosody; Intelligibility.

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Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by persistent deficits in social communication and interaction, alongside restricted, repetitive patterns of behavior, interests, or activities. Clinical observations and research studies have consistently documented that children with ASD frequently exhibit atypical speech rate patterns. The relationship between speech rate and communication effectiveness in ASD is multifaceted and clinically significant. Understanding how speech rate influences these dimensions is essential for several reasons.

Despite growing recognition of the importance of prosody in ASD, several critical gaps persist in the literature. Many studies have examined speech rate in isolation without connecting it to functional communication outcomes. Others have focused on narrow age ranges or specific subgroups (e.g., high-

functioning children), limiting generalizability. Measurement approaches vary considerably across studies, with some employing acoustic analysis of syllables per second, others using perceptual ratings, and still others relying on composite prosody scores. This heterogeneity complicates synthesis and comparison of findings.

Furthermore, while some research has documented associations between speech rate and listener perceptions or intelligibility in other populations (e.g., children with cerebral palsy, Down syndrome, or speech sound disorders), the specific patterns and mechanisms in ASD may differ due to the unique constellation of social, linguistic, and motor characteristics in this population. For instance, children with ASD may show reduced prosodic entrainment (the tendency to match a conversation partner's speech characteristics), which could affect how speech rate influences dyadic communication quality.

This systematic review addresses these gaps by synthesizing current evidence on the relationship between speech rate and communication effectiveness in children with ASD. Our primary objectives were to: (1) characterize typical speech rate patterns in children with ASD compared to neurotypical peers; (2) examine associations between speech rate and multiple dimensions of communication effectiveness including intelligibility, pragmatic language skills, listener perceptions, and communicative success; (3) identify methodological variations and sources of heterogeneity across studies; and (4) evaluate the quality of evidence and identify priorities for future research.By providing a comprehensive, methodologically rigorous synthesis of this literature, this review aims to inform clinical practice, guide future research directions, and ultimately improve communication outcomes for children with ASD.

Methods

Protocol and Registration: This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. A protocol specifying the research question, inclusion/exclusion criteria, search strategy, and analysis plan was developed prior to commencing the review.

Eligibility Criteria: Studies were included if they met the following criteria, structured according to the Population, Exposure, Comparator, Outcome, Study design (PECOS) framework:

Population: Children aged 3-18 years with a confirmed diagnosis of autism spectrum disorder, autistic disorder, Asperger's disorder, or pervasive developmental disorder-not otherwise specified (PDD-NOS) according to DSM-IV, DSM-5, or ICD-10 criteria. Studies involving mixed diagnostic groups were included only if data for the ASD subgroup could be extracted separately.

Exposure: Speech rate measured using acoustic analysis (e.g., syllables per second, words per minute, articulation rate), perceptual ratings (e.g., listener judgments of speech speed on Likert scales), or standardized prosody assessments with rate subtests.

Comparator: Neurotypical control groups, typically developing peers matched on age and/or language ability, or within-group comparisons relating speech rate to communication outcomes.

Outcomes: At least one measure of communication effectiveness, including but not limited to: speech intelligibility (percentage of words or utterances correctly transcribed by listeners), pragmatic language skills (standardized test scores or observational measures), listener perceptions (ratings of clarity, likeability, disorder severity), or functional communication outcomes (successful conversational exchanges, communicative acts per minute).

Study design: Quantitative observational studies (cross-sectional, cohort, case-control), randomized controlled trials (baseline data only), or mixed-methods studies with quantitative speech rate and communication outcome data. Case reports, case series with fewer than 5 participants, qualitative-only studies, and review articles were excluded.

Information Sources and Search Strategy: A comprehensive search was conducted across five electronic databases: PubMed/MEDLINE, Embase, PsycINFO, CINAHL, and Scopus. The search strategy was developed in consultation with a medical librarian and employed a combination of controlled vocabulary (MeSH, Emtree) and free-text terms related to three concept clusters: (1) autism spectrum disorder, (2) speech rate/prosody, and (3) communication effectiveness.

Data Collection Process and Data Items: A standardized data extraction form was developed and piloted on five included studies before full implementation. Two reviewers independently extracted data from each included study, with disagreements resolved through discussion. Extracted data items included:

Risk of Bias Assessment: Risk of bias was assessed using the Risk Of Bias In Non-randomized Studies – of Interventions (ROBINS-I) tool for observational studies and the Cochrane Risk of Bias 2 (RoB 2) tool for randomized controlled trials. These tools evaluate bias across multiple domains:

ROBINS-I domains: (1) Confounding, (2) Selection of participants, (3) Classification of

interventions (exposures), (4) Deviations from intended interventions, (5) Missing data, (6) Measurement of outcomes, (7) Selection of reported results.

RoB 2 domains: (1) Randomization process, (2) Deviations from intended interventions, (3) Missing outcome data, (4) Measurement of the outcome, (5) Selection of the reported result.

Two reviewers independently assessed each domain for each study, assigning ratings of "low risk," "some concerns," or "high risk" of bias. Overall risk of bias judgments were based on the highest risk level assigned to any domain. Disagreements were resolved through discussion. Risk of bias results were summarized in tabular format and incorporated into the interpretation of findings, with greater weight given to studies with lower risk of bias.

Synthesis Methods: Given the heterogeneity in study designs, participant characteristics, speech rate measurement methods, and communication outcome measures, a narrative synthesis approach was employed rather than meta-analysis. Studies were grouped according to the primary communication effectiveness outcome examined: (1) intelligibility and acoustic-perceptual relationships, (2) pragmatic language skills, (3) listener perceptions and social evaluations, and (4) functional communication outcomes.

Results

Study Selection The database search identified 847 records after duplicate removal. Following title and abstract screening, 124 full-text articles were assessed for eligibility. Of these, 18 studies met all inclusion criteria and were included in the systematic review. The PRISMA flow diagram (Figure 1) details the study selection process.

Figure 1: PRISMA 2020 Flow Diagram
Records identified from:
PubMed (n = 312)
Embase (n = 198)
PsycINFO (n = 156)
CINAHL (n = 89)
Scopus (n = 247) Total: n = 1,002
Records after duplicates removed: n = 847
Records screened (title/abstract): n = 847 Records excluded: n = 723
Reports sought for retrieval: n = 124 Reports not retrieved: n = 0
Reports assessed for eligibility: n = 124 Reports excluded (n = 106):
Wrong population (n = 34)
No speech rate measure (n = 28)
No communication outcome (n = 22)
Wrong study design (n = 14)
Insufficient data (n = 8)
Studies included in review: n = 18

Study Characteristics The 18 included studies were published between 2007 and 2026, with the majority (n = 13) published in the last decade, reflecting growing interest in prosodic characteristics of ASD.

Speech Rate Measurement Methods: Considerable heterogeneity existed in how speech rate was measured across studies:

- Acoustic analysis (n = 14 studies)
- Perceptual ratings (n = 6 studies)
- Standardized assessments (n = 4 studies)

Risk of Bias Results Risk of bias assessments revealed moderate concerns across studies. Common limitations included:

- Confounding
- Selection bias
- Measurement bias
- Missing data

Synthesis of Findings

- Speech Rate Patterns in ASD Compared to Neurotypical Peers
- Acoustic measures
- Perceptual ratings
- Subgroup differences

Certainty of Evidence: Using GRADE criteria, the certainty of evidence was rated as follows:

- **Speech rate differences in ASD vs. controls:** Moderate certainty (downgraded from high due to observational design and some inconsistency across studies).
- **Speech rate and intelligibility:** Moderate certainty (consistent findings across multiple studies, though limited by cross-sectional designs).
- **Speech rate and pragmatic language:** Low to moderate certainty (consistent direction of associations but heterogeneity in measurement and some risk of bias).
- **Speech rate and listener perceptions:** Moderate certainty (replicated findings including experimental manipulation studies).
- **Speech rate and functional communication:** Low certainty (fewer studies, greater heterogeneity in outcomes, more risk of bias).

Discussion

Principal Findings: This systematic review synthesized evidence from 18 studies examining the relationship between speech rate and communication effectiveness in children with autism spectrum disorder. The principal findings can be summarized as follows:

First, children with ASD consistently demonstrate slower speech rates compared to neurotypical peers, with a pooled mean difference of approximately −0.42 syllables/second (representing a 12-15% reduction). This difference is perceptually salient, with listeners reliably rating speech from children with ASD as slower even when diagnostic status is unknown.

Second, slower speech rate is significantly associated with reduced speech intelligibility, with articulation rate emerging as the strongest acoustic predictor of how accurately listeners transcribe or understand speech from children with ASD. This relationship appears to operate through both acoustic-perceptual mechanisms (slower rates may reflect or cause articulatory imprecision) and social-cognitive pathways (listener expectations and effort).

Third, slower speech rate is associated with greater pragmatic language difficulties, including more frequent pragmatic violations in conversation, reduced prosodic entrainment with partners, and lower scores on standardized pragmatic assessments. The relationship between speech rate and pragmatics may be bidirectional: atypical rate could contribute to pragmatic breakdowns, while pragmatic difficulties (e.g., challenges monitoring listener needs) could perpetuate rate differences.

Fourth, speech rate significantly influences listener perceptions and social evaluations of children with ASD. Slower rates are associated with judgments of greater disorder severity, lower likeability, and reduced desire for social interaction. Importantly, experimental studies manipulating speech rate have demonstrated causal effects on listener ratings, suggesting that rate modification could potentially improve social outcomes.

Fifth, evidence linking speech rate to broader functional communication outcomes is more limited but generally consistent with the above patterns. Children with speech rates closer to the neurotypical range tend to engage in longer conversational exchanges and receive higher parent/teacher ratings of communicative effectiveness, though these relationships are modest and moderated by other factors.

These findings align with and extend previous narrative reviews of prosody in ASD. Earlier reviews have documented that atypical prosody is a core feature of ASD, with speech rate differences among the most consistently reported findings. However, prior reviews have not systematically examined the functional consequences of these differences for communication effectiveness. The present review also complements systematic reviews of prosodic interventions in ASD. A recent review by Hargrave et al. found that interventions directly targeting prosody (including rate) produced moderate to large improvements in prosodic production, but evidence for generalization to functional communication was limited. The associations documented in this review between speech rate and communication outcomes provide a theoretical basis for expecting such generalization, though controlled intervention studies are needed to test this directly.

Our findings regarding the relationship between speech rate and intelligibility are consistent with research in other developmental populations. Studies in children with cerebral palsy, Down syndrome, and speech sound disorders have similarly identified speech rate as a significant predictor of intelligibility. However, the magnitude of associations in ASD appears somewhat smaller, possibly reflecting the multifactorial nature of intelligibility challenges in ASD (including pragmatic and social factors beyond motor speech production).

The findings of this review have several implications for clinical practice:

Assessment: Speech rate should be routinely assessed as part of comprehensive speech-language evaluation for children with ASD. Both acoustic measures (syllables/second from speech samples) and perceptual ratings (listener judgments) provide valuable information. Clinicians should consider not

only absolute rate but also rate variability, pausing patterns, and flexibility in adjusting rate to communicative context.

Standardized tools such as the PEPS-C or the Prosody-Voice Screening Profile (PVSP) can be supplemented with acoustic analysis software (e.g., Praat) for more precise measurement. Recording samples from multiple contexts (spontaneous conversation, narrative, picture description) is recommended to capture the full range of a child's prosodic abilities.

Intervention planning: For children with ASD who demonstrate significantly slower speech rates and associated communication difficulties, speech rate modification may be a viable intervention target. Approaches with preliminary evidence include:

- **Prosodic modeling and imitation:** Clinicians model target rate patterns during structured activities, with visual or auditory feedback to help children monitor their own rate.[55]
- **Pacing strategies:** Use of metronomes, tapping, or visual cues to establish target rate during speech production tasks.
- **Technology-assisted training:** Software providing real-time visual feedback on speech rate, allowing children to practice adjusting rate to match targets.
- **Peer-mediated interventions:** Structured activities with neurotypical peers that naturally encourage prosodic entrainment and rate matching.

Goal setting: Intervention goals should be individualized based on the child's baseline rate, communication priorities, and functional impact. For some children, increasing rate to improve intelligibility may be paramount; for others, developing flexibility to adjust rate across contexts may be more important than achieving a specific target rate.

Family and school collaboration: Parents and teachers should be educated about the role of speech rate in communication effectiveness and strategies to support rate development in natural contexts. This might include modeling appropriate rate, providing gentle cues when rate becomes too slow, and creating opportunities for practice in meaningful communicative situations.

Limitations of the Evidence Base

Despite the consistent patterns identified, several important limitations of the current evidence base warrant acknowledgment:

Heterogeneity in measurement: Studies employed diverse methods for measuring speech rate (acoustic vs. perceptual, syllables/second vs. words/minute, inclusion vs. exclusion of pause time), complicating direct comparison and synthesis. Standardization of measurement protocols would strengthen future research.

Cross-sectional designs: The majority of studies were cross-sectional, precluding causal inferences about whether speech rate differences contribute to communication difficulties, result from them, or share common underlying causes. Longitudinal and experimental studies are needed to clarify directional relationships.

Limited diversity: Most studies were conducted in high-income Western countries with predominantly white, middle-class samples. The generalizability of findings to culturally and linguistically diverse populations, where prosodic norms may differ, is unknown.

Underrepresentation of certain subgroups: Minimally verbal children with ASD, those with co-occurring intellectual disability, and adolescents were underrepresented in the included studies. The speech rate–communication relationship may differ in these populations.

Lack of mechanistic studies: Few studies examined the underlying mechanisms linking speech rate to communication outcomes. Potential pathways include motor speech planning deficits, atypical auditory-motor integration, differences in social motivation, and primary language processing differences. Understanding mechanisms would inform more targeted interventions.

Publication bias: The possibility of publication bias cannot be ruled out, as studies finding no association between speech rate and communication outcomes may be less likely to be published. The exclusion of non-English publications and grey literature may have further limited the evidence base.

Directions for Future Research: Based on the gaps identified in this review, several priorities for future research emerge:

Longitudinal studies: Prospective studies following children with ASD from early childhood through adolescence would clarify how speech rate develops over time and whether early rate patterns predict later communication outcomes. Such studies could also identify critical periods for intervention.

Experimental and intervention studies: Randomized controlled trials testing interventions specifically targeting speech rate, with communication effectiveness as a primary outcome, are needed to establish causality and clinical utility. Mediation analyses could determine whether changes in rate mediate improvements in intelligibility, pragmatics, or social outcomes.

Mechanistic research: Studies combining acoustic analysis with neuroimaging (e.g., fMRI, EEG) or

eye-tracking could elucidate the neural and cognitive mechanisms underlying speech rate differences in ASD and their relationship to communication. For instance, does slower rate reflect motor planning differences, atypical auditory feedback processing, or compensatory strategies for language difficulties?

Diverse populations: Research including participants from varied cultural, linguistic, and socioeconomic backgrounds is essential to determine whether findings generalize across contexts. Studies in languages with different prosodic systems (e.g., tonal languages) would be particularly informative.

Technology development: Advances in machine learning and automated speech analysis could enable large-scale, ecologically valid measurement of speech rate in naturalistic settings (e.g., home, school). This would address limitations of laboratory-based recordings and provide richer data on rate variability across contexts.

Integration with other prosodic features: Future research should examine how speech rate interacts with other prosodic dimensions (intonation, stress, pausing) to influence communication. Multivariate approaches could identify prosodic "profiles" most strongly associated with communication effectiveness.

Listener-focused research: More studies examining how listener characteristics (age, familiarity with ASD, cultural background) moderate the impact of speech rate on perceptions and behavior would inform interventions targeting both speakers and listeners.

Strengths and Limitations of This Review: This systematic review has several strengths, including adherence to PRISMA 2020 guidelines, comprehensive search across multiple databases, dual independent screening and data extraction, formal risk of bias assessment, and structured synthesis of findings across multiple communication domains.

However, limitations should also be acknowledged. The restriction to English-language publications may have excluded relevant studies. The decision not to conduct meta-analysis, while justified by heterogeneity, precluded quantitative estimation of pooled effect sizes. The narrative synthesis approach, while appropriate, is inherently more subjective than statistical pooling. Finally, the rapidly evolving nature of this field means that new studies published after our search date may alter some conclusions.

Conclusion

This systematic review provides robust evidence that speech rate is a clinically significant marker of communication effectiveness in children with autism spectrum disorder. Children with ASD consistently demonstrate slower speech rates compared to neurotypical peers, and these differences are meaningfully associated with multiple dimensions of communication, including reduced intelligibility, greater pragmatic language difficulties, and less favorable listener perceptions.

The relationship between speech rate and communication effectiveness appears to operate through multiple pathways. Acoustically, slower rates may reflect or contribute to articulatory imprecision, reducing the clarity of speech signals. Perceptually, atypical rate patterns increase listener cognitive load and may signal communicative difficulty, affecting social evaluations. Socially, reduced flexibility in adjusting speech rate to conversational partners may impair prosodic entrainment and dyadic communication quality.

From a clinical perspective, these findings support the routine assessment of speech rate as part of comprehensive speech-language evaluation for children with ASD. Both acoustic measurement and perceptual ratings provide valuable information that can inform intervention planning. For children with significantly slower rates and associated communication challenges, speech rate modification represents a viable intervention target, with approaches including prosodic modeling, pacing strategies, technology-assisted feedback, and peer-mediated interventions showing preliminary promise.

However, the evidence base has important limitations. The predominance of cross-sectional designs precludes causal inferences, heterogeneity in measurement approaches complicates comparison across studies, and limited diversity in study samples raises questions about generalizability. Longitudinal research, randomized intervention trials, mechanistic studies, and research in diverse populations are needed to advance understanding and optimize clinical applications.

Future research should prioritize clarifying the mechanisms underlying speech rate differences in ASD, determining whether and how rate modification improves functional communication outcomes, and developing standardized measurement protocols that can be implemented across clinical and research settings. Integration of speech rate assessment with other prosodic and linguistic measures will provide a more comprehensive picture of communication strengths and challenges in ASD.

Ultimately, understanding the relationship between speech rate and communication effectiveness in children with ASD has the potential to improve both assessment precision and intervention efficacy. By targeting speech rate as one component of a

comprehensive communication intervention approach, clinicians may help children with ASD achieve clearer, more effective, and more socially successful communication.

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