JCHR

Journal of Community Health Research 2025; 14(1): 79-86.

Study of Prosodic Skills of Persian-Speaking Adults with Autism Spectrum Disorder Based on the *Persian Version of Montreal Protocol for the Evaluation of Communication (P.M.E.C.)*

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ARTICLE INFO

Original Article

Received: 10 Mar 2025
Accepted: 15 Apr 2025

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ABSTRACT

Background: Research indicates that individuals with autism spectrum disorder (ASD) often struggle with prosodic skills, which include the rhythm, stress, and intonation of speech. While most studies focus on children, some findings suggest these challenges persist into adulthood.

Methods: This comparative cross-sectional study used a quantitative approach to assess prosodic impairments in Persian-speaking adults with ASD. Thirteen Persian-speaking men with autism, aged 25 to 44 (mean = 32.84, SD = 4.17), participated. Their educational backgrounds ranged from third grade to 20 years of formal education. A control group of 26 healthy Persian-speaking men matched in age and education was also included. Prosodic skills were evaluated using five subtests from the Persian version of the Montreal Protocol for the Evaluation of Communication (P.M.E.C.): linguistic prosody comprehension, linguistic prosody repetition, emotional prosody comprehension, emotional prosody repetition, and emotional prosody production. Data were analyzed using descriptive statistics, independent samples t-tests, and the Kolmogorov-Smirnov test.

Results: Participants with ASD performed significantly worse than the control group across all five subtests. Significant differences were found in linguistic prosody comprehension ($p = 0.002$), linguistic prosody repetition ($p = 0.0001$), emotional prosody comprehension ($p = 0.004$), emotional prosody repetition ($p = 0.015$), and emotional prosody production ($p = 0.0001$). These results highlight substantial deficits in both linguistic and emotional prosody among adults with ASD.

Conclusion: This study emphasizes the need for targeted assessment and intervention strategies for prosodic impairments in adults with autism. The findings have practical implications for clinical, educational, and research settings.

Keywords: Autism Spectrum Disorder, P.M.E.C. Protocol, Prosodic Skills, Prosodic Impairments

How to cite this paper:
Zandiehrad Sh, Raghibdoust Sh, Joghataei MT, Golfam A. Study of Prosodic Skills of Persian-Speaking Adults with Autism Spectrum Disorder Based on the *Persian Version of Montreal Protocol for the Evaluation of Communication (P.M.E.C.)*. J Community Health Research 2025; 14(1): 79-86.

[DOI: 10.18502/jchr.v14i10.18568]

Introduction

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition characterized by challenges in social interaction, communication, and repetitive behaviors, first described by Kanner (1943) and Asperger (1944) (1–3). The manifestation and severity of symptoms vary greatly, ranging from severe cognitive impairments to high-functioning individuals known as "autistic savants" (4). Language development in individuals with autism often shows delays or atypical patterns, affecting both comprehension and expression (5). Epidemiological data show that autism is significantly more prevalent in boys, with increasing global incidence over recent decades (6, 7). Studies show that nearly two-thirds of autistic adult's experience profound disabilities, underscoring the urgent need for enhanced diagnostic tools and therapies focused on language and communication (8). Various assessments like PPVT, CELF, and the Montreal Protocol for the Evaluation of Communication (M.E.C.) are utilized to evaluate linguistic skills, with the M.E.C. particularly focusing on discourse, pragmatics, lexical-semantic ability, and prosody (9–13). This study specifically explores prosodic aspects in Persian-speaking adults with autism using the Persian version of M.E.C., aiming to contribute to better treatment strategies.

Domestic and international research supports the notion that individuals with ASD exhibit significant linguistic impairments across various domains. Iranian studies by Karami (2011), Rohparvar, and Karami (2012) found that children with autism underperformed in phonology, semantics, pragmatics, and idiomatic understanding compared to typically developing peers (14, 15). Mahdizadeh et al. (2015) confirmed these deficits, showing significant delays in all language dimensions (16). Other studies using the M.E.C. protocol, such as the one by Torabi (2019) and Arianpour (2021), revealed that damage to either hemisphere—especially the right temporal lobe—affects pragmatic and prosodic communication abilities (17, 18). Asghari et al. (2021) and Zandieh Rad et al. (2024) highlighted significant differences in prosodic and lexical-semantic subtests between autistic individuals and controls (19–21). These findings collectively emphasize the necessity for linguistically sensitive tools to assess and support communication in individuals with ASD.

Research beyond Iran further explores the unique linguistic profile of individuals with ASD. Early work by Hermelin and O'Connor (1967) et al. (22–24) revealed distinct semantic processing and memory patterns. Holin (2003) identified a substantial vocabulary delay even in high-functioning individuals (25). Studies by Presler and Carey (2005) and Tek et al. (2008) suggested that while ASD individuals may retain some capacity for word learning, they often struggle with context-based word inference and object-label matching (26, 27). Ahtam et al. (2020) observed reduced semantic networks in adults with ASD (28). Recent studies by Ahmadi et al. (2022) and Knudsen et al. (2024) demonstrated distinct prosodic features in ASD speech, including pitch variability and duration, and also identified gender-based differences in prosody, further highlighting the complexity and individuality of speech patterns in ASD populations (29, 30). These findings collectively support the development of nuanced, linguistically and culturally appropriate diagnostic tools.

As observed, the review of previous research on autism indicates that pragmatic skills in these patients at older age levels have not yet been assessed using the P.M.E.C. protocol. Therefore, the present study aims to examine these skills based on this protocol.

Methods

Participants

The statistical population of this study comprised Persian-speaking adults diagnosed with autism. Participants were purposefully selected from accessible cases in speech therapy clinics, Tehran Autism Association, exceptional education institutions, and Tehran Welfare Organization. As these centers primarily serve children and

[DOI: 10.18502/jchr.v14i10.18568]

adolescents, and this study focused on adults with autism, the centers were requested to identify individuals who had been diagnosed in earlier years and now fall within the target age range of 25 to 44. Many of these individuals were contacted by phone; however, due to outdated contact information or a lack of interest in participating, many could not be recruited. After applying the inclusion and exclusion criteria, 13 individuals with autism were selected.

Eligible participants were adults aged 25–44, native Persian speakers, with an official diagnosis of autism documented in their clinical records. Exclusion criteria included a history of psychiatric or neurological disorders, substance abuse, uncorrected hearing or visual impairments, left hemisphere brain damage, or prior speech therapy treatment.

The study used purposive sampling to recruit participants. Ultimately, 13 male participants with autism remained in the study, with ages ranging from 25 to 44 (mean age = 32.84, SD = 4.17), and educational backgrounds ranging from the third grade to having 20 years of formal education.

A control group consisting of 26 individuals—twice the number of autistic participants—was also included. These individuals had no history of brain injury and were matched to the autistic group based on age, gender, city of residence, native language, and education level. Table 1 provides the demographic and clinical details of the autistic participants in this study.

Table 1. Demographic information of adults with autism

Row	Age	Education	Occupation	Age at diagnosis
1	31	9th grade	Café worker	5 years old
2	41	9th grade	Restaurant delivery	3 years old
3	32	Technical diploma	Copy machine technician	4 years old
4	26	4th grade	Carpenter's apprentice	5 years old
5	32	9th grade	janitor	3 years old
6	36	9th grade	Pet trainer	6 years old
7	30	Master's degree	Private company engineer	7 years old
8	29	7th grade	Building painter	6 years old
9	26	10th grade	Café worker	3 years old
10	41	Bachelor's degree	Art teacher	5.2 years old
11	39	7th Grade	Restaurant kitchen work	4 years old
12	27	Master's degree	Librarian	3 years old
13	37	5th grade	Construction worker	5 years old

Tools

Montreal Evaluation of Communication (MEC) protocol, developed by Joanette and colleagues in 2004, was designed to assess communication skills in individuals with right hemisphere brain damage, originally in French language. It evaluates four key linguistic domains: discourse, pragmatic inferencing, lexical-semantic abilities, and prosody. The protocol has been standardized in multiple countries, including Iran, where Raghibdoust et al. (2023) adapted the Persian version—referred to as the Persian P.M.E.C. This version includes five subtests: comprehension and repetition of linguistic prosody, comprehension and repetition of emotional prosody, and emotional prosody production. These subtests assess participants' abilities to perceive, identify, reproduce, and generate both grammatical and emotional intonation in spoken language.

Each subtest consists of simple subject–verb–object sentences with neutral content, presented with varying prosodic tones. The linguistic prosody tasks focus on identifying and reproducing affirmative, interrogative, and imperative intonations. Emotional prosody tasks evaluate recognition and reproduction of joyful, sad, and angry tones. The production subtest adds a contextual element, requiring participants to express emotions based on short, scripted scenarios. All stimuli are pre-recorded and

[DOI: 10.18502/jchr.v14i10.18568]

presented in a pseudo-random order to avoid predictability, ensuring the evaluation of genuine prosodic processing abilities.

Procedure

Consent forms were signed by individuals with autism or their companions to confirm participation in the study. Participants with autism were encouraged to respond to the questions independently; however, if they encountered difficulties, a family member or acquaintance present assisted by clarifying the questions. Two subtests from the P.M.E.C. protocol were then administered, each session lasting approximately 20 minutes.

Participant responses, including those from the control group, were recorded using a SONY Stereo IC Recorder ICD-UX560F (2017, China), and the recordings were reviewed by the researcher to ensure accurate scoring. Data from the five subtests across both groups were first organized in Microsoft Excel (2019) and later imported into SPSS for analysis. Statistical procedures were performed using a Lenovo G510i Core i7 laptop (China), and based on the Kolmogorov-Smirnov test confirming normal data distribution, a paired t-test was employed to compare the groups.

Results

Table 2 displays the statistical results related to the comparison between the control group and the adults with autism. Based on the data in Table 2, it can be concluded that considering the p-value ($P < 0.002$) in the linguistic prosody comprehension subtest, the p-value ($P= 0.0001$) in the linguistic prosody repetition subtest, the p-value ($P= 0.004$) in the emotional prosody comprehension subtest, the p-value ($P= 0.015$) in the emotional prosody repetition subtest and the p-value ($P= 0.0001$) in the emotional prosody production subtest, there is a significant difference in performance between individuals with autism and the control group ($P < 0.05$). Therefore, it can be inferred that the performance of the test group in the five subtests is significantly weaker compared to the control group.

Table 2. Results of paired t-test comparing two groups for prosody skills subtests

Prosody skills subtests	P-value
linguistic prosody comprehension	<0.002
Linguistic prosody repetition	<0.0001
Emotional prosody comprehension	<0.004
Emotional prosody repetition	<0.015
Emotional prosody production	<0.0001

Conclusion

The present study aimed to assess the prosodic skills of P.M.E.C. (Raghibdoust et al., 2023): linguistic prosody comprehension, linguistic prosody repetition, emotional prosody comprehension, emotional prosody repetition, and emotional prosody production. The findings revealed that participants with autism performed significantly worse than the control group in all five prosodic subtests. Comparing these findings with previous research highlights the following key points:

1- The results of the present study revealed that the performance of the autistic group in all five subtests—linguistic prosody comprehension, linguistic prosody repetition, emotional prosody comprehension, emotional prosody repetition, and emotional prosody production—was significantly weaker compared to the control group. These findings are consistent with those reported by Holbrook and Eiseleirsen (2020), who demonstrated that individuals with autism exhibit substantial differences in all areas of language, with the most pronounced deficits occurring in the domain of speech prosody. Their study emphasized the impact of atypical prosodic patterns, such as monotonic intonation, misplaced stress, and difficulties in expressing emotional cues through speech, which impair both expressive and receptive communication. The present study confirms and extends these findings within a Persian-speaking adult population, further underscoring that prosodic impairments are a persistent and cross-linguistic feature of ASD (31). At the group level, the present study found that individuals with autism exhibited severe to mild impairments in prosodic skills. The most significant difficulties were observed in the subtests of linguistic prosody comprehension

[DOI: 10.18502/jchr.v14i10.18568]

(84.61%) and linguistic prosody repetition (84.61%), followed by moderate impairments in emotional prosody – comprehension (61.53%). Milder deficits were noted in emotional prosody – repetition (15.38%) and emotional prosody – production (38.46%). In contrast, the control group showed the highest impairment rates in linguistic prosody – comprehension (23.07%) and emotional prosody – comprehension (15.38%). The lowest impairment rates were observed in the linguistic prosody–repetition subtest (7.69%), indicating a significantly better performance compared to individuals with autism.

2- As mentioned earlier, individuals with autism demonstrated weak performance in the prosodic subtests. Liakso et al. (2016) examined the acoustic characteristics of three types of speech—emotional, spontaneous, and word repetition—in 25 children with autism aged 5 to 14. Their study revealed that stressed vowels used by individuals with autism exhibit a higher pitch in spontaneous speech, while pitch remains monotonous in repeated words. Additionally, their speech and voice display an atypical pitch range, with acoustic features showing an exceptionally high frequency. These findings align with the present study, further highlighting the prosodic irregularities observed in individuals with autism (32).

3- Regarding adults with autism, Krüger et al. (2018) found that these individuals struggle to recognize prosodic cues when acting as listeners and face difficulties in selecting appropriate pitch variations (33). Similarly, Volk et al. (2019) discovered that some individuals with autism who experience severe language impairments also exhibit more pronounced phonological difficulties, including issues with phonetic processes, prosody, and consonant inventories. These findings further support the notion that prosodic and phonological deficits are core challenges for individuals with autism (34).

4- The present study found that the performance of the autistic group was significantly weaker than that of the control group across all the five prosodic subtests. These results highlight a broad pattern of prosodic impairments among Persian-speaking adults with autism. However, in contrast to the uniform deficits observed in this sample, the study by De Pape et al. (2012) demonstrated that atypical prosody is not consistent across all individuals with autism. Their findings showed that language proficiency significantly influences prosodic performance: individuals with higher language abilities may exhibit minimal or no significant differences in prosody compared to neurotypical peers. This discrepancy suggests that the severity of prosodic impairment may vary depending on the individual's overall communicative and linguistic competence. Therefore, the pronounced deficits found in the current study may be influenced by varying language proficiency levels within the autistic group, a factor that should be explored in future research (35).

5- In the present study, it was found that the performance of the autistic group was significantly weaker than that of the control group across all five prosodic subtests. These results point to broad deficits in both linguistic and emotional aspects of prosody among Persian-speaking adults with autism. However, this outcome contrasts with the findings by Grace et al. (2023), who conducted a comprehensive review and identified cases where no significant prosodic differences were observed between autistic and neurotypical individuals. In particular, they noted that in tasks requiring the imitation of melodic patterns, such as questions and declarative sentences, both groups often performed similarly. This suggests that while prosodic impairments are common in individuals with autism, they may not be universal and can depend on the type of task, context, and individual variability. The discrepancy may also reflect differences in study design, language background, or the specific prosodic features assessed, underlining the importance of tailoring assessment tools to cultural and linguistic contexts. The studies by Bellinghausen et al. (2024) and Putnam (2024) were consistent with the present study, demonstrating that prosodic differences in individuals with autism can impact their ability to

[DOI: 10.18502/jchr.v14i10.18568]

comprehend written texts and their reading comprehension. These findings highlight the crucial role of prosodic skills in social interactions and learning, emphasizing that difficulties in prosody may extend beyond verbal communication to affect broader cognitive and educational outcomes (36, 37,38).

Overall, the findings of the present study on Persian-speaking adults with autism spectrum disorder indicate significant impairments in prosodic subtests. The statistically significant differences between the autism group and the control group further confirm this issue. These results demonstrate the direct impact of autism on prosodic skills. Prosodic impairments can hinder effective communication between individuals with autism and others, potentially leading to communication breakdowns, social disengagement, and a reduced quality of life.

The findings of the present study reveal significant impairments in prosodic skills among Persian-speaking adults with ASD. The collective findings underscore the importance of prosodic skills in the communicative profile of individuals with ASD. Deficits in prosody can interfere with social interaction, emotional recognition, and pragmatic language use, making them a key focus for both assessment and intervention. The significant weaknesses observed across all subtests further validate the need for culturally and linguistically adapted diagnostic tools such as the Persian P.M.E.C., which proved sensitive in capturing the subtle yet impactful differences in prosodic functioning. This study highlights the importance of addressing prosodic skills in the treatment and intervention processes for individuals with autism. The findings can be valuable for both assessment and therapeutic approaches in rehabilitation centers, as well as for academic and research institutions aiming to develop more effective strategies for supporting individuals with autism. This study was conducted in full compliance with ethical guidelines for research involving human participants. Ethical approval was obtained from the Ethics Committee of Iran University of Medical Sciences under protocol number IR.IUMS.REC.1398.416. Written informed consent was obtained from all participants or their legal guardians prior to participation. All participants were informed of the study's objectives, procedures, and their right to withdraw at any time without any consequences. Confidentiality and anonymity were maintained throughout the research process. Moreover, data were securely stored and used solely for research purposes. Special attention was paid to the vulnerable status of participants with autism, ensuring that all procedures were explained in accessible terms, and that a familiar person was present if necessary, to assist in communication and comfort during the assessments.

Acknowledgments

This study was part of a PhD thesis. The authors would like to thank the anonymous reviewers for their valuable comments on the earlier draft of the paper.

Conflicts of interest

The authors declared no competing interests.

Ethical considerations

This essay adheres to ethical guidelines by ensuring all sources are properly cited and ideas are presented with academic honesty.

Code of ethics

The tests were conducted in the workplace or the place of residence of the individuals, depending on their preference. The present research was conducted under the supervision of the Ethics Committee of Iran University of Medical Sciences with the ethics code IR.IUMS.REC.1398.416.

Funding

No financial support was received from any institution or organization for conducting this study.

Authors' contributions

S. Z, S. R, did the conceptualization, proposal drafting, project administration, and validation; S. Z, conducted data collection and curation; S .Z, and SR carried out formal analysis and, first drafting; MJ

[DOI: 10.18502/jchr.v14i10.18568]

and AG conducted substantial commenting; S. Z, S. R, M. J and A. G, did the final drafting and had the responsibility of the whole manuscript.

List of abbreviations

P.M.E.C.: Persian Version of Montreal Protocol for the Evaluation of Communication

ASD: Autism Spectrum Disorder

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