

Abstract

Autism spectrum disorder (ASD) is characterized by communication difficulties and is known to have difficulties with listening in noisy environments, although pure tone listening ability is not a problem. However, **it is unknown what the detail mechanisms and characteristics of the auditory perception of ASD individuals are.** In this study, we approached the "auditory perception" of ASD individuals from three aspects. Instead of taking a "hear/don't hear" approach such as audiometric test, we **examined the characteristics and perceptual content of auditory perception in detail, from the peripheral auditory system to the central auditory system.** The results revealed some surprising, previously unknown characteristics, such as a strong tendency for ASD individuals to produce a variety of deviant perceptions when they listen to words repeatedly. **Understanding the perceptual diversity of people with ASD by examining their perceptions may lead to the proposal of supporting methods** for ensuring smooth communication of information.

Auditory Perception in ASD

【Diagnosis Criteria】 (APA, 2013)

- Deficits in social communication
- Restricted/repetitive patterns of behavior

【Auditory Characteristics】

- Difficulty in hearing sounds when there are interfering sounds
- Difficulty in listening to a human voice

An attempt to understand communication barriers based on **differences in "auditory perceptual contents."**

Exploring the auditory perceptual contents

- Hearing involves various neural information processing.
- To understand the auditory processing mechanisms, it is important to examine "how it sounds."

The diagram illustrates the auditory pathway and brain regions involved in speech processing. It shows the flow of information from the Cochlea through the Auditory nerve, Brainstem, Thalamus, and Auditory cortex. Key brain regions highlighted include the Premotor area, Inferior frontal gyrus, and Superior temporal gyrus. The diagram is divided into three numbered sections: 1. Subcortical processing (Auditory cortex, Thalamus, Brainstem, Auditory nerve, Cochlea), 2. Speech processing in the cerebral cortex (Premotor area, Inferior frontal gyrus, Superior temporal gyrus), and 3. The mechanisms for speaking and linguistic knowledge also contribute toward listening to speech sounds. (prediction/hypothesis generation).

① Binaural processing^[1]

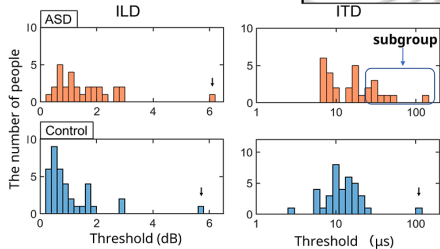
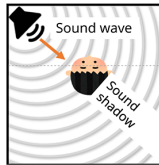
Interaural Level Difference: ILD

Difference in the loudness and frequency distribution between the two ears

Interaural Time Difference: ITD

Difference in the time of arrival of the sound

- Important cues for orientation localization, sound separation, and signal detection in noise.
- ILD and ITD are first processed in the superior olive nucleus of the brainstem.

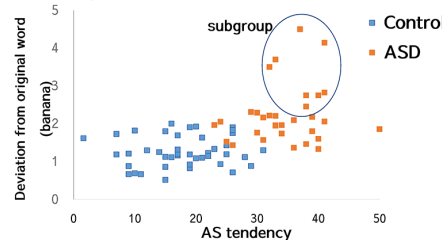


- The ASD group had higher thresholds for ILD and ITD.
- ✓ There was a subgroup with low sensitivity, especially in ITD.
- ✓ Some individuals with ASD had difficulties with sound localization, sound separation, and signal detection in noise.

② Perceptual variability^[2]

Verbal transformations

- An auditory illusion in which different words were perceived when the same word was listened repeatedly, even though it had not changed acoustically.
- Perceptual changes involved brain network activity.

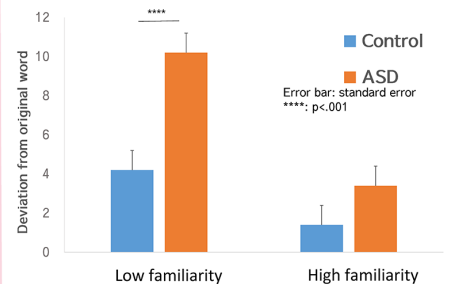


- The ASD group reported a greater variety of deviant words than the typically developing group. e.g., ASD : pendant, highland, etc. Typically developed: banaN, Namba, etc.
- ✓ Individuals with ASD did not "dislike change;" however, rather "made change."
- ✓ Reflected the differences of variability in neural activity and activity of the brain network to sound?

③ Linguistic knowledge

Listening target words under noise

- Fourty 4-mora words (twenty each of low and high familiarity) were presented under noise and participants wrote what they heard.
- Low familiarity : Takadono, Somayama, etc.
- High familiarity : Dorayaki, Rusuban, etc.



- The ASD group reported more distant words for low familiarity words.
- ✓ Individuals with ASD did not "hear nothing" in the noise, rather perceived words with greater variation.
- ✓ There was a difference in perceived content between the ASD and typical development groups.

Exploring the perceived content may lead to a better understanding of each other's communication difficulties.

References

[1] H. Fujihira, C. Itoi, S. Furukawa, N. Kato, M. Kashino, "Sensitivity to interaural level and time differences in individuals with autism spectrum disorder," *Scientific Reports*, Vol. 12(1), pp. 19142, 2022.
 [2] C. Itoi, N. Kato, M. Kashino, "People with autism perceive drastic illusory changes for repeated verbal stimuli," *Scientific Reports*, Vol. 9(1), pp.15866, 2019.

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