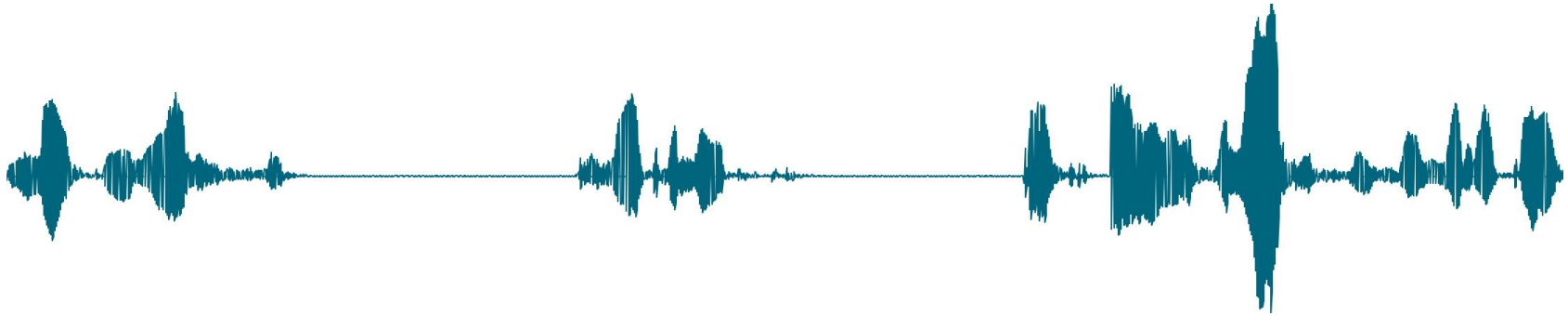


Prosody of Finnish speakers on the autism spectrum: acoustic, multimodal, and interactional perspectives

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A CROSSLINGUISTIC INVESTIGATION OF PROSODIC PATTERNS RELATED TO AUTISM SPECTRUM

Acoustic, Experimental and Multimodal Analysis

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Team: Dr. prof. Martti Vainio, Lari Vainio, Ida-Lotta Myllylä, Viljami Haakana, Alexandra Wikström, Reetta Jokinen, Sara Kurki

And many important collaborators!

Suomen Akatemia
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EMIL AALTOSEN SÄÄTIÖ

PROSO ASD

Contents of this talk

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Motivation and objectives

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Autistic individuals may exhibit non-conventional features of speech prosody – we need to build a broader understanding on spoken communication and autism to support this community better!

More detailed research on speech and interaction is needed to show, that there isn’t any one simple deficit located in autistic speakers

Conceptual grounding

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the Double Empathy Theory (Milton, 2012)

differences-not-deficits perspective, questioning medical deficit-based models

centering neurodiversity and neuro-affirming practice, highlighting heterogeneity

Autism

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- Developmental neurobiological condition with a complex variety of early-appearing features (Lord et al., 2020)

- Approximately **1/100** children diagnosed with autism globally (Zeidan et al., 2022), varying estimates (**1 – 8.4 / 1000**) for prevalence in Finland (Lampi et al., 2011; Mattila et al., 2007, 2011)

- Significant individual variation in how autism is experienced (Lord et al., 2018)

- Common features (Hodges et al., 2020; Lord et al., 2018) include:
  - **differences in social communication and interaction**
  - restricted or repetitive sensory-motor behaviours

Autism and prosody

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- **Inconsistent findings** cross-linguistically; around **50%** of individuals estimated to have divergent prosody (Fusaroli et al., 2017; Asghari et al., 2021)

- Some replicated prosodic tendencies: **greater pitch variation**, **longer silent pauses**, prosodic extremes in general (Fusaroli et al., 2022, (Wiklund & Vainio, 2019)

- Prosodic differences may focus on **pragmatic prosody** (Grice et al., 2023)

- Distinct prosody may lead to **perceptions of 'atypicality',** which may affect interactions and social acceptance of autistic people (Wiklund et al., 2022)

- Reasons for differences in prosody are **unclear**, theories include:
  - differences in social cognition and theory of mind (Tager-Flusberg, 1996)
  - challenges in conversational attunement (Shriberg et al., 2011)
  - executive functioning differences (Udhnani et al., 2020)
  - neural differences (Erwin et al., 1991; Patel et al., 2019)

- Prosodic divergences may simply reflect different communicative prioritisation rather than any one specific, cognitive or neuromotor difference (Fusaroli et al., 2017; Milton, 2012)

Prior findings on Finnish: prosody production

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- **Grammatical prosody:** Autistic speakers performed well on phonological, lexical and syntactic prosodic tasks, ‘stiff’ or ‘pedantic’ labels were found to be mostly impressionistic (Niemi, 2008)
- **Pitch:** Pitch (F0) features in Finnish- and French-speaking autistic preadolescents; some shared across languages, some language-specific, large individual differences (Wiklund & Vainio, 2019)
- **Intonation as a resource:** autistic preadolescents used final rises to invite responses and orient to recipients (Wiklund, Ihaksinen & Vainio 2020)
- In **trouble-source** conversational turns, prosodic features were **rarely** the main cause understanding problems; most frequent feature in these turns was **creaky voice** (Wiklund, 2016)
- Other studies have focused for instance on **stuttering**, **fluency** or **language abilities** more broadly (e.g. Pirinen et al., 2023; Saalasti, 2008)

Prior findings on Finnish: prosody perception

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- **Neural responses:** differences in early auditory discrimination of emotional utterances (Kujala et al., 2005; Korpilahti et al., 2007) and in neural responses to scornful prosody in autistic individuals (Lindström et al., 2018)
- **Non-verbal pragmatics:** young autistic adults may use compensatory strategies, but naturalistic pragmatic processing may take extra effort (Kotila et al., 2021)
- **Audiovisual perception:** lessened McGurk effect in autistic adults, without differences in gaze or unisensory perception (Saalasti et al., 2012)
- **Prosody-gesture perception**: no difference between autistic and non-autistic adults in perceiving prosodic and facial gestures related to uncertainty (Vainio et al., upcoming)

Research is scarce on **gesture production** of Finnish-speaking autistic individuals (Wiklund, 2016 on gaze; Dindar, 2017 on pointing)

Research focus

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How do Finnish-speaking autistic individuals use pitch-related prosody, pausing and voice quality in spontaneous and task-oriented conversation?

How is Finnish-speaking autistic individuals' prosody perceived and how do those perceptions map to acoustic measurements?

How is Finnish-speaking autistic individuals perceive multimodal prosody?

How do Finnish-speaking autistic individuals align prosody and hand gestures in spontaneous conversation?

Materials and methods

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Spontaneous speech data from group interactions:

- Autism group (*n* = 5+2*), comparison group (*n* = 6)
- 11–13-year-old males, monolingual native Finnish speakers
- Autism group data from a **therapeutic group setting,** comparison group data from a constructed **conversational setting**

Spontaneous and task-based multimodal data from dyadic interactions:

- Autism group (*n* = 30), comparison group (*n* = 32)
- 19–52-year-old adults, monolingual native Finnish speakers
- Neurotype-matched and mixed dyads

Acoustic-phonetic analysis

Perception experiments

Multimodal analysis

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Listen

Research Article

Perceived prosodic typicality in Finnish preadolescents: Findings from speakers on the autism spectrum

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Myllylä et al. (2026) Perceived prosodic typicality in Finnish preadolescents: findings from speakers on the autism spectrum

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Wiklund et al., (2022):

- 50 listeners evaluated the (a)typicality of 150 samples (75 A, 75 NA) on a 5-point scale
- Listeners provided written comments on the samples
- **Autism group samples were rated as more atypical**
- Autism group samples were noted to have more:
  - irregular rhythm
  - **melodic intonation**
  - sometimes flat intonation
  - morpho-syntactic errors
  - unclear articulation

Myllylä et al., (2026):

- 53 listeners evaluated the same samples (75 A, 75 NA) and gave comments, but the samples were **low-pass filtered**
- **No significant difference in evaluations between speaker groups**
- Listeners varied a lot more than previously in their ratings
- Autism group samples noted to have more:
  - irregular rhythm
  - **varying intonation**
  - non-conventional voice quality

Myllylä et al. (2026) Perceived prosodic typicality in Finnish preadolescents: findings from speakers on the autism spectrum

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- Acoustic features associated with **atypicality** regardless of group:
  - Higher mean F0
  - Increased F0 variability*
  - Increased pause count
  - Increased pause-to-speech ratio
- Acoustic features associated with **typicality** regardless of group:
  - Increased intensity variability*
  - Rapid speech rate and articulation rate

In conclusion:

- Perceived (a)typicality did not directly map on to a perceived underlying group distinction; **listener interpretations and expectations dominated**
- Acoustic differences between speaker groups exist, they don't directly map to perceived atypicality
- Perceived atypicality reflects **norm-based social evaluation**, not an objective measure of communicative effectiveness (+ methodological caveats)

Myllylä et al. (under review) Exploring silent pauses and turn-holding in spontaneous interaction among autistic preadolescents

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Findings from the acoustic analysis of the autistic participants' speech:

- **Longer** and durationally varying within-turn silent pauses (A: 643.3 ms vs. NA: 463.6 ms)
- No difference in the proportion of (non-)grammatical pauses
- Trend for rapid articulation rate (A: 5.89 syll./s vs. NA: 5.01 syll./s)
- A trend for a pitch decline pre-pause **(a possible turn-transition point)**

"Despite" the long pauses, speakers maintain conversational turns effectively without overlap from other interlocutors – how?

- **Increased** use of **glottal stops, in-breaths** and **click-like articulatory events** in the autism group were identified, which may contribute to signalling turn-holding

Potential turn-holding cues

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- Two types of **cues** were identified surrounding or characterizing the within-turn silent pauses:

Pause **accompanied** by:

- **click-like event** (A: 8.7%) (click, glottal opening, mouth opening, momentary creak, other transient sound)
- swallowing (A: 1.45%)

Pause **produced** as:

- **glottal stop** (A: 53.8%; NA: 29.5%)
- **in-breath** (A: 24.5%; NA: 36.8%)
- out-breath (A: 8.8%; NA: 2.6%)
- in-breath - out-breath (A 1%)
- out-breath - in-breath (A: 0.6%)

Silent or not? (e.g. Belz & Trouvain 2019)

- **pause without cues** (A: 1.2%; NA: 29.5%)

Cautious interpretations

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- Cues as an “alternative”, less cognitively taxing **turn-holding method** (if other cues were to be misinterpreted?)

- **Is it all just situational and context-dependent?**
  - Degree of familiarity in the autism group
  - Listener attunement
  - Social and situational expectations and norms
  - Implicit and explicit ways to achieve therapeutic goals

- **Finnish** as an allowing conversational environment regarding pausing and temporality?
- **More data from different conversational contexts needed** – follow-up study planned with the new adult speech corpus

Myllylä et al. (upcoming) Prosodic prominence and beat gesture perception in Finnish autistic and non-autistic adults

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- **Does seeing simultaneous beat gestures change what speech units Finnish listeners hear as prominent?**

- **Question:** Does the "manual McGurk effect" (Bosker & Peeters, 2021), where a beat gesture's timing shifts perceived stress, also work in Finnish? Finnish has fixed initial stress, and we test it at the sentence and word level
- **Design:** a 7-step F0 continuum × a beat gesture landing on the first or second target, in *"Menemme **lai**valla **Le**mille"* and *"noni"*
- The audio is identical in both gesture conditions, so only the visual timing differs

- **First results (22 non-autistic and 22 autistic adults):**
  - The gesture shifted perceived prominence in both tasks and both groups
  - The effect was smaller within the word, where the initial-stress prior is strongest
  - There was no reliable group difference, but large individual variation
- Follow-up experiment with an abstract moving shape instead of a hand – does the effect need a *hand*, or just synchronised movement?

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Finnish Autistic and Non-autistic Dyadic Interactions – Multimodal Corpus

Corpus building

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Participants

- Autistic adult Finnish speakers, gender-diversity and broad age range (19–52)
- Recruitment through the University of Helsinki and social media
- n = 62
- Three kinds of dyadic interaction, dyads matched on age and (when possible) gender
  - A-A (10 dyads, 20 speakers)
  - NA-NA (11 dyads, 22 speakers)
  - A-C (10 dyads, 20 speakers)
- Session includes both spontaneous conversation and structured tasks

Session

- Introductory conversation (5-7min)
- Reading simultaneously (2min)
- Game 1: Spot the differences (8min)
- Break
- Reading alone, sustained vowel phonation (10min)
- Game 2: Map Task (8min)
- Closing conversation (7-10min)

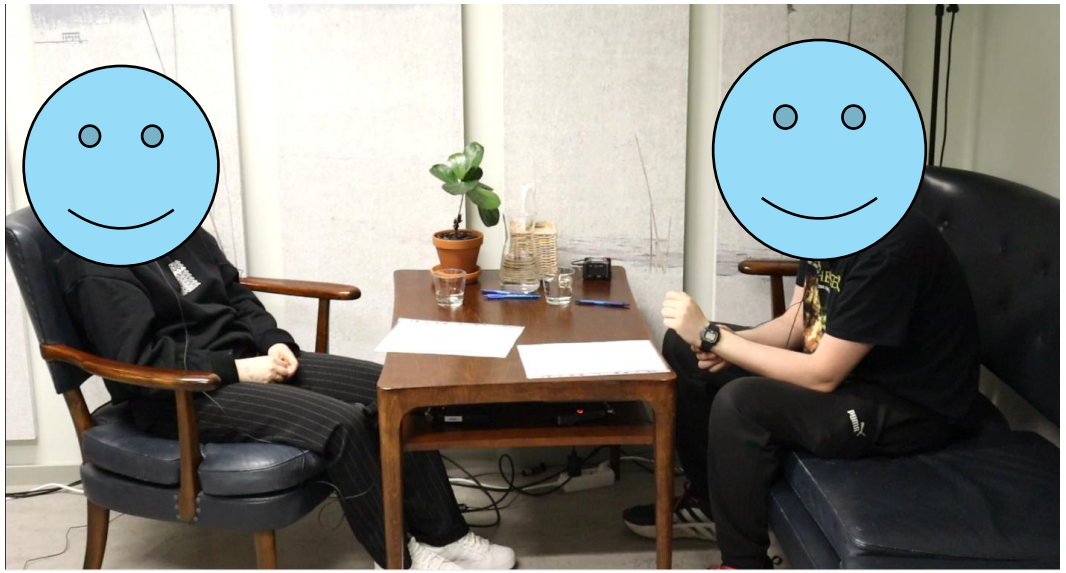
Corpus building and plans



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Location and equipment

- InterLab, University of Helsinki
- Three cameras: one per participant (front view) and a room camera (side view)
- Headset microphones for primary audio source
- Lavalier microphones for backup audio and video synchronization



What to do? Anything!

- Acoustic analysis of prosody between groups, tasks and speakers
- Similarly, multimodal analysis of gesture
- Useful for other kinds of investigations too!

Upcoming studies with the new data

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- Seebauer, F. & Myllylä, IL. (upcoming) Investigating laughter amount and voicing in both autistic and non-autistic Finnish adult speakers
- Myllylä, IL., Wiklund M. & Vainio M. (in prep.) Pitch and phonation characteristic of backchanneling units produced by autistic and non-autistic Finnish adult speakers in dyadic interaction
- Others:
  - Pitch variability between spontaneous conversation and structured tasks
  - Turn-timing in spontaneous conversation between dyad types
  - Beat gesture and prominence alignment in spontaneous conversation

Got an idea? Let's collaborate!

Take-home message

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- Prosody in autism may have distinctive acoustic and multimodal features that we need to understand better
- The features are not simply communicative failures although they sometimes may be interpreted so
- The interactional breakdowns may stem from the mismatch between neurotypical and neurodivergent interactional conventions
- Taking into account conversational setting, cultural norms, sensory processing and individual differences is key!



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Thank you! Kiitos!

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