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Speech rate perception in audios in Easy Language amongst individuals with intellectual disabilities

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Abstract: Easy Language is a simplified language variety designed to enhance accessibility for individuals with comprehension difficulties. While its application in audiovisual contexts—such as podcasts and radio news produced in various languages—has garnered interest, guidelines for its oral and audio use remain limited. One common recommendation is to adopt a slower speech rate, yet specific guidance is rarely provided. Furthermore, it must be considered that speech rate perception is influenced by various factors, including language-specific norms and cognitive load, complicating the development of universal recommendations. This intralingual study investigates speech rate perception among 35 native Catalan-speaking individuals with intellectual disabilities, evaluating responses to Easy Language recordings in Catalan at four speech rates: 130 wpm, 150 wpm, 170 wpm, and 190 wpm. Participants rated the perceived speed of each recording on a five-point Likert scale, ranging from "too slow" to "too fast". Results revealed two distinct patterns: one subgroup found all speech rates acceptable, while the other exhibited greater variability in ratings, reflecting a more refined perception or reduced acceptability of certain speeds. A significant age difference was observed between these subgroups, though no differences were identified in cognitive performance, as measured by Raven scores.
Keywords: intellectual disability; easy language; speech rate; perception.

1. Introduction

Easy Language is a simplified language variety that falls under the broader category of Easy-to-Understand languages. It applies a set of recommendations related to wording, syntactic structure, visual design, and comprehension evaluation to make information more accessible to individuals with comprehension difficulties (ISO, 2023). From a translation studies perspective, Easy Language can also be understood as a form of intralingual and intersemiotic translation aimed at functional adaptation to different communicative needs (Castro Robaina & Amigo Extremera, 2024).

Seibel and Carlucci (2021) further argue that it can also involve an interlingual translation process. Recently, research has begun to explore the use of Easy Language in intralingual audiovisual content, such as podcasts (Perego, 2024), interpreting (Rubanovsky-Paz et al., 2024), or radio news (Miyazaki, 2007). However, guidelines for incorporating Easy Language in oral and audio contexts remain limited and often lack clarity (Pujadas-Farreras & Matamala, forthcoming). One of the most frequently suggested practices is to use a slower speech rate when delivering or recording Easy Language audio, though specific speed recommendations are typically not provided (Inclusion Europe, 2009; North Yorkshire County Council, 2014; Pujadas-Farreras & Matamala, forthcoming).

Additionally, as Coupé et al. (2019) observed in their study, speech rates can vary significantly across languages, suggesting that a universal speech rate recommendation may not be applicable to all languages. For instance, native speakers of Japanese and Spanish—the fastest languages in Coupé's study—would likely perceive "slower speech" differently from native Thai speakers, whose language exhibited the slowest speech rate in that study.

In Catalan, the average speaking rate ranges from 120 to 150 words per minute (wpm) (Canals et al., 2006), with the recommended rate for oral discourses being around 150 wpm (Albaladejo Mur, 2020). However, the perceived speech rate does not always align with the objective speaking rate. Research has shown that various factors can influence how speech rate is perceived. For example, listening to faster speech may make subsequent speech seem relatively slower (Ainsworth, 1974), while increased cognitive load can cause listeners to perceive speech as faster than it actually is (Bosker et al., 2017).

Given these complexities, when considering recommendations for slower speech in Easy Language, it is essential not only to measure the objective speech rate but also to assess how users perceive the speech rate in Easy Language recordings. This study aims to investigate speech rate perception among individuals with intellectual disabilities when listening to Catalan Easy Language audio recordings. Specifically, it seeks to evaluate how participants rate and respond to varying speech rates (130 wpm, 150 wpm, 170 wpm, 190 wpm), offering insights into individual differences in speech rate perception and acceptability.

The structure of this article is as follows: Section 2 offers a review of speech rate and the factors that influence its perception, while Section 3 focuses on speech rate perception in individuals with cognitive difficulties. Section 4 details the methods used in the study, followed by Section 5, which presents and discusses the results. Finally, Section 6 concludes the study.

2. Speech rate perception

Speech rate can be objectively quantified using various metrics, such as words per minute or syllables per second. Beyond these objective measures, research has shown that listeners are adept at accurately judging speech rates. For instance, it has been shown that listeners are capable of assessing speech rates even when the speech signal is degraded, as they can distinguish the rates of tone-silence sequences, indicating that minimal non-linguistic cues may suffice for making broadly accurate estimates of speech rates (Crown & Feldstein, 1991). Moreover, listeners are also able to accurately estimate speech rates in unfamiliar languages by relying on temporal features within the speech signal rather than lexical content or meaning (Vaane, 1982).

However, the ability to accurately perceive speech rate is not constant over time. Lamotte and Droit-Volet's (2017) findings revealed that it is influenced by developmental changes, with accuracy showing a slight improvement around the age of 26, followed by a noticeable decline after the age of 45. Furthermore, the perception of speech rate can be affected by many cognitive and external factors as well.

Studies have also indicated that the surrounding speech context significantly influences how listeners perceive subsequent speech. For instance, a slow contextual rate—whether consisting of speech or non-speech sounds—causes listeners to perceive an ambiguous stretch of speech as relatively shorter. In contrast, a fast contextual rate leads to the same segment being perceived as longer (Ainsworth, 1974; Fujisaki et al., 1975; Summerfield, 1981). Interestingly, these contextual effects are not limited to single speakers. Even when the context is provided by one talker and the target by another, the perception of speech rate remains influenced by the initial context (Newman & Sawusch, 2009).

In addition to contextual factors, cognitive load plays a significant role in shaping speech rate perception. When speech rate increases, the cognitive effort required for processing also increases, which can lead to a phenomenon known as the 'shrinking of time', where time seems to pass more quickly (Bosker et al., 2017; Yang, 2019). However, this relationship is complex and can be influenced by other factors. Variability in the speaker's identity or the content of the speech can diminish the impact of speaking rate on how listeners perceive speech sounds (King et al., 2024). This shows that speech perception also depends on a delicate balance between timing, speaker identity, and sentence content.

Listeners also engage in a process called rate normalization, where the perception of speech sounds is adjusted based on the context and the speaker's rate of speech (Jaekel et al., 2017). This process happens automatically, as listeners continuously adapt their perception of speech rate to align with the surrounding context (Maslowski et al., 2019b). Interestingly, listeners encode a talker's habitual speech rate relative to the rates of other speakers, interpreting a person's usual speaking speed in relation to that of others (Maslowski et al., 2019a).

In addition to contextual and cognitive factors, speech rate perception is also influenced by a range of acoustic and visual cues. Variations in vocal frequency and intensity, for instance, can alter how listeners perceive speech rate (Bond et al., 1988; Feldstein & Bond, 1981). Furthermore, visual information, such as lip movements, can also integrate with auditory signals to modulate speech rate perception (Bosker et al., 2020).

Lastly, the perception of speech rate can also differ between natural and artificially manipulated speech. For instance, a study by Reinisch (2016) found that natural fast speech is perceived as faster than speech that has been linearly time-compressed.

Building on the factors that influence speech rate perception, it is important to recognise that speech rate can vary significantly across individuals and contexts. Previous research has shown that speech rate can differ based on gender, age, and dialect (Jacewicz et al., 2010; Quené, 2008), as well as within individual talkers (Miller et al., 1984). For example, speech rate can fluctuate depending on the interlocutor or the level of ambient noise in the environment (Miller et al., 1984). These variations in speech rate across speakers—both within and between individuals—can affect how speech is perceived. Notably, between-talker variation in speech rate production may lead to

between-talker variation in speech rate perception, helping to explain why speakers in conversation tend to adjust their speaking rates to align with one another (Bosker, 2016).

In addition to individual and contextual differences in speech rate, increased cognitive load during speech processing can significantly impair listeners' ability to comprehend speech, particularly when speech rate increases (Jeong et al., 2024). This impact on speech processing can affect multiple levels, such as the retention of words in working memory or semantic processing (Jeong et al., 2024). These effects are compounded by contextual influences on speech perception, such as how speech rate affects the processing of phonemes, morphemes, and words. Studies have demonstrated that contextual speech rate can influence the perception preceding and subsequent function words (e.g. Dilley & Pitt, 2010; Kim, 2014; Morrill et al., 2014; Wei & Dilley, 2016) and content words (Baese-Berk et al., 2019; Brown, 2023; Dilley et al., 2013).

3. Speech rate and cognitive difficulties

Perception and processing of speech rate can present unique challenges for individuals with cognitive difficulties, including those with autism spectrum disorder, dyslexia, and intellectual disabilities, as well as older adults. These challenges often stem from difficulties in processing temporal information, adapting to contextual speech cues, or entraining to conversational speech rates.

Individuals with dyslexia exhibit impairments in time estimation tasks, demonstrating difficulty in accurately judging whether a given stimulus is longer or shorter when compared to a standard reference stimulus (Khan et al., 2014; Nicolson et al., 1995). These challenges in processing temporal information are not confined to isolated tasks but have broader implications for speech perception. In particular, individuals with dyslexia often struggle to interpret the speech rate of a sentence, which can hinder their ability to accurately recognise the sounds of the words that follow (Gabay et al., 2019).

For individuals with mild intellectual disabilities, challenges with estimating durations can significantly impact their ability to perceive and process speech rate effectively. Studies have indicated that these individuals exhibit systematic impairments in tasks requiring duration estimation, and these difficulties tend to worsen with age. This is especially evident in tasks that involve distinguishing between varying durations of auditory stimuli, highlighting the connection between temporal processing deficits and challenges in speech perception (Rattat & Collié, 2020).

Additionally, while individuals with autism spectrum disorder are generally adept at using contextual cues to interpret speech sounds, they often encounter specific difficulties in processing temporal information during speech (Gabay et al., 2024). Furthermore, a literature review by Kruyt and Beňuš (2021) suggested that existing studies indicate individuals with autism spectrum disorder may exhibit patterns of reduced acoustic-prosodic entrainment or even show disentrainment. Acoustic-prosodic entrainment refers to the process in which speakers adjust their speech patterns to align more closely with those of their conversation partner, including rhythm, intonation, and rate (Gálvez et al., 2020). This pattern is evident in the studies reviewed by Kruyt and Beňuš (2021), including those conducted by Hogstrom et al. (2018), Lehnert-LeHouillier et al. (2020), Ochi et al. (2019) and Wynn et al. (2018). However, Kruyt and Beňuš (2021) cautioned that due to the variation

in tasks analysed across these studies, it is difficult to draw definitive conclusions. In general, they noted that while individuals with autism spectrum disorder tend to exhibit similar entrainment behaviours at the syntactic and lexical levels, they show reduced acoustic-prosodic entrainment compared to typically developing individuals.

Specifically, when it comes to speech rate, Wynn et al. (2018) found that typically developing adults demonstrate the ability to adjust their speech rate naturally during quasi-conversational interactions. In fast speech rate conditions, they tend to speed up their own speech, while in slower conditions, they speak more slowly. However, this same pattern of speech rate adjustment was not observed in individuals with autism spectrum disorder or in child populations. The absence of speech rate entrainment in these groups suggests that this ability may be a skill that develops with age and experience, with evidence pointing to potential deficits in adults with autism spectrum disorder.

In conclusion, in addition to the cognitive and external factors previously discussed that can influence speech rate perception, individuals with cognitive difficulties face other unique challenges that can further impact how they perceive speech. These challenges highlight the importance of testing recommendations, such as using a "slower speed" in audio materials in Easy Language, directly with target groups for this language variety. This ensures that the end results are in line with their perceptions and that they find them acceptable.

4. Methods

This study aimed to investigate the subjectivity of speech rate perception among individuals with intellectual disabilities when listening to Catalan Easy Language audio recordings. Specifically, it sought to evaluate how participants rated and responded to varying speech rates, providing insight into individual preferences and the variability in speech rate acceptability. The following sections describe the participant demographics, materials, experimental procedure, and the validation process for the materials used in the study.

4.1 Participants

The study initially included 37 adult participants, all native Catalan speakers with intellectual disabilities, recruited through local associations. However, only 35 were considered valid for analysis (mean age = 45.66 years, SD = 14.58), after applying exclusion criteria to ensure a homogeneous sample. All participants signed a consent form, written in Easy Language to ensure accessibility, which was approved by the Ethics Committee of the Autonomous University of Barcelona.

To assess cognitive ability, all participants completed the Raven Coloured Progressive Matrices test (Raven, 1998), a widely used non-verbal assessment designed to measure fluid intelligence and abstract reasoning (Bilker et al., 2012). This specific version of the test is also tailored for populations such as young children, individuals with intellectual disabilities, and older adults (Domino & Domino, 2006).

The exclusion criteria were: (1) Raven test scores or ages significantly outside the typical range for the sample, to ensure group homogeneity in cognitive and developmental profiles; and (2) the presence of visual or auditory impairments, as the intelligence test was visually based and the

experimental tasks were auditory. Two of the initial participants were excluded due to hearing impairments, but there were no exclusions based on age or Raven scores.

4.2 Materials and procedure

The study utilised four prerecorded audio samples in Catalan, each specifically created for the experiment in Easy Language. Each sample contained 130 words and was narrated by a professional female voice actor who was a native Catalan speaker. To ensure consistency across recordings, the voice actor maintained a clear, natural, and uniform tone throughout all the samples, minimising any potential variability in delivery style. The audio samples were modified to test four different speech rates: 130 wpm, 150 wpm, 170 wpm, and 190 wpm. After these modifications, all the samples were digitally normalised to a uniform sound level and inspected to rule out technical issues such as clipping or background noise.

While the content of the four audio recordings differed, each sample was validated for consistency in difficulty level by the Associació Lectura Fàcil (Easy-to-Read Association) (see Section 4.3), ensuring that the material aligned with Easy Language recommendations, such as using common vocabulary and simple sentence structures. Additionally, pauses in speech within the recordings were adjusted to maintain the same length across all speech rates. The pause lengths were modified based on the average pause durations suggested by Cantin and Ríos (1991), ensuring that pauses did not interfere with the perception of speech rate (Liu, 2022).

The testing procedure was conducted in person. Participants listened to the audio samples through the same set of headphones (Skullcandy Riff Wireless) to maintain consistency in sound delivery, and a pre-experiment sound check allowed each participant to adjust volume and confirm audio clarity. The experiment followed a within-subject design (Kim, 2010), meaning each participant was exposed to all four speech rates, allowing for direct comparisons between the different conditions. All sessions took place individually in a silent room to minimize background noise and external interruptions.

Before the main experiment, a volume test was conducted to ensure each participant could adjust the volume to their preferred level for optimal listening comfort. Participants heard the four speech rates in a randomised order to control for any order effects. After listening to each recording, participants rated their perception of the speech rate on a five-point Likert scale: (1 = too slow, 2 = slow, 3 = acceptable, 4 = fast, 5 = too fast). They were informed that they could assign the same rating to more than one speech rate if needed.

4.3 Validation process

The validation of the audio texts followed a multi-step process to ensure consistency in content difficulty and adherence to Easy Language principles. Validation was conducted through expert judgment, a common method in research practices consisting of gathering in-depth insights from specialists in the relevant field (Cabero Almenara & Llorente Cejudo, 2013; Escobar-Pérez & Cuervo-Martínez, 2008). In terms of the number of experts consulted, there is no strict consensus in the literature. Different studies and authors suggest varying numbers based on different factors

such as the experts' level of expertise, the scope of their knowledge, and the specificity of the field under consideration (Powell, 2003; Robles Garrote & Rojas, 2015; Williams & Webb, 1994).

In this study, the external validation phase included four experts, reflecting the limited availability of specialists in Catalan Easy Language. This aligns with Cabero Almenara and Llorente Cejudo's (2013) suggestion to consider practical constraints such as the availability of qualified professionals in the field.

The process was divided into two phases: an internal validation and an external validation. In the first internal validation phase, an expert in Easy Language within the research group evaluated the texts and provided recommendations for improvement. Based on this feedback, adjustments were made to refine the grammar, vocabulary, and overall structure of the texts. In the second phase, the external validation, specialists from the Easy-to-Read Association reviewed the materials independently, without direct communication, following the individual assessment method outlined by Cabero Almenara and Llorente Cejudo (2013).

The experts were provided with a validation questionnaire, designed in accordance with the methodology used by Robles Garrote and Rojas (2015). Using a Likert scale ranging from 1 to 4, they assessed the ease of the grammar, vocabulary, and structure of the texts and the adherence to Easy Language recommendations. Based on the experts' recommendations, further modifications were made to the materials. Finally, following ISO recommendations (ISO, 2023) for Easy Language validation, the texts underwent a readability check using the Flesch-Szigriszt index, a tool frequently employed for evaluating Catalan texts (Pérez Colomé, 2011). This final step ensured the materials had similar readability indices, further ensuring that the difficulty levels were similar in each audio.

5. Results and discussion

This section presents the findings derived from the Likert scale regarding the groups' perceptions of different speech rates, along with a discussion of their implications. Initial analysis revealed a clear trend, leading to the classification of participants into two distinct subgroups:

- Group 1: Participants who rated all speech rates as "acceptable". This group comprised 15 participants.
- Group 2: Participants who rated one or more speech rates differently, indicating variability in their perception or acceptability of the speeds. This group included 20 participants.

5.1 Demographics of the groups

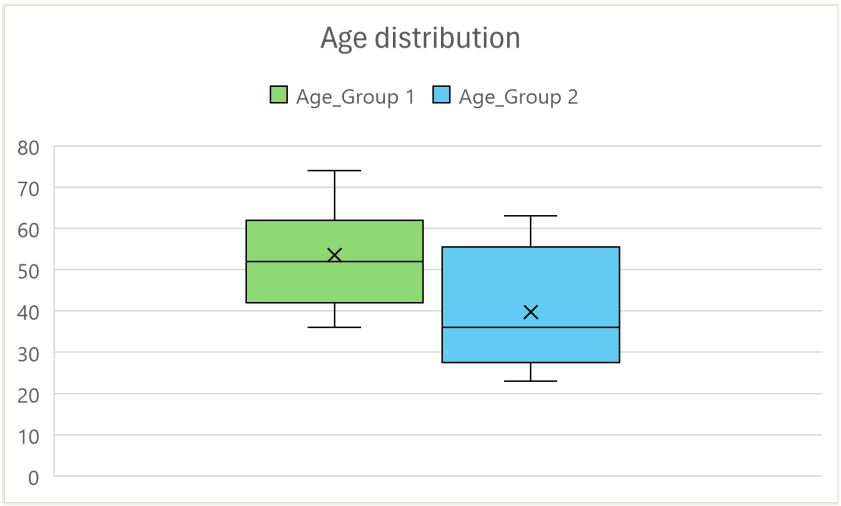
A demographic analysis provided insights into the observed trend, highlighting significant differences between the two groups. Group 1 had a mean age of 53.5 years (SD = 11.77), while Group 2 had a lower mean age of 39.8 years (SD = 13.87). This age difference was statistically significant ($p = 0.004$), suggesting that age may be an important factor influencing the perception and acceptability of speech rates.

The significant age difference between the two groups in this study may be explained by established research on age-related changes in temporal perception. Older adults tend to prefer

slower internal timing when assessing durations (Block et al., 1998), which may influence their broader acceptance of varying speech rates, as observed in Group 1. By contrast, younger participants in Group 2 displayed greater sensitivity to variations in speed, possibly reflecting more precise temporal processing. This aligns with Lamotte and Droit-Volet's (2017) findings, which indicated a slight improvement in the accuracy of time perception estimations at age 26, followed by a marked decline by age 45, corresponding to the mean ages of the two groups. Additionally, age-related declines in attentional capacities (Lustig, 2003; Vanneste & Pouthas, 1999) may make older adults less reactive to differences in speech rates, as they might rely more on syntactic and semantic cues for comprehension rather than auditory precision (Pichora-Fuller, 2003).

However, this relationship can depend on modality and user experience: for instance, a study on speech rate adjustment in audio description (Nakajima et al., 2024) found that participants with sight loss preferred faster delivery speeds, even though one of the groups had a mean age of 49.9 years (SD = 9.2), similar to Group 1 in the present study. This discrepancy is not unexpected, as accessibility studies with blind and low-vision users have shown that frequent exposure to audio materials—such as screen readers—can significantly increase tolerance for faster speech through compensatory listening strategies and auditory training (Dietrich et al., 2013; Gordon-Salant & Friedman, 2011; McCarthy et al., 2013). This effect has also been observed in users without sight loss who engage extensively with audio content, such as audiobooks or podcasts (Chen et al., 2024; Krokar et al., 2023). In comparison, audio materials in Easy Language are still emerging and remain relatively scarce, meaning that the participants in this study have had little chance to develop similar familiarity or training effects.

Figure 1: Age distribution between the two groups



Source: Author (2025)

In contrast, no significant differences were observed in Raven's Progressive Matrices scores between the two groups, with Group 1 achieving a mean score of 19.1 (SD = 5.96) and Group 2 a mean score of 23.0 (SD = 7.23). This indicates that cognitive ability, as measured by Raven's test, does not explain the differences in speech rate perception observed between the groups.

5.2 Ratings of speeds

Following the categorization of participants into two distinct groups based on their overall perception of speech rate acceptability, further analysis of Group 2 revealed an interesting trend in how they perceive the different speech rates. As previously mentioned, this perception was assessed using a five-point Likert scale, where a rating of 1 indicated "too slow" and 5 indicated "too fast".

When examining the mean ratings, the results appeared to be somewhat aligned with the expected perceptions of the speech rates employed. The slowest rate, 130 wpm, received a mean score of 2.55, indicating that it was generally considered slow. The next speed, 150 wpm earned a rating of exactly 3, reflecting that it was viewed as "acceptable" or "normal", as some participants described it. The 170 wpm rate received a slightly higher mean score of 3.40, still within the "acceptable" range. Finally, the 190 wpm rate was generally perceived as fast, with a mean score of 4.

The ratings for the 150 wpm speed, which were considered "acceptable", align with the average Catalan speaking rate, which ranges between 120-150 wpm (Canals et al., 2006). However, the 130 wpm speed, rated as somewhat slow, suggests that the participants may have a higher baseline for what they consider an "acceptable" speed. This could be explained by the tendency for younger individuals to speak at faster rates on average (Wasowicz et al., 1986), thus influencing their perception of 130 wpm as slower than expected. Additionally, the 170 wpm rate, rated as "acceptable" by participants, may also reflect this inclination towards faster speech rates in young adults, making them more accustomed to this speed and more comfortable with it.

Another possible explanation is the influence of participants' Spanish language proficiency. While they were native Catalan speakers, all were fluent in Spanish due to its official status in Catalonia. Given that Spanish is typically spoken at a faster rate than Catalan (Coupé et al., 2019), their familiarity with Spanish could have contributed to their greater comfort with higher speech speeds. This might also help explain why the 190 wpm rate was rated as fast but not excessively fast on average. This preference aligns with findings from a Spanish-language study on audio description, in which sighted participants favoured slightly higher-than-average speech rates when the voice was female—as is the case with this study. Interestingly, slower speech rates were preferred with male voices (Machuca et al., 2020).

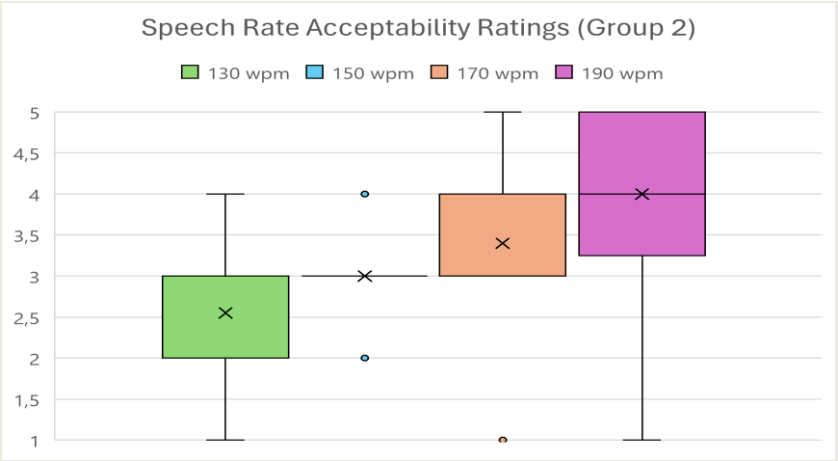
Media exposure to content in standard language, particularly news broadcasts, may also help account for participants' acceptance of the 170 wpm speed and their perception of 190 wpm as fast, but not excessively so. A study by the Institut d'Estudis Catalans (2023) found that the average speaking rate in Catalan weather forecasts on television is around 189 wpm. Frequent exposure to this type of media may have familiarized participants with these speech rates, making them more comfortable with similar speeds in the study.

An examination of the standard deviations of these scores revealed another important aspect of the data. While the mean ratings showed a logical progression from slow to fast speech rates, the variation in responses suggests that the perception of speech rate within this group is more individualized. The most consistently rated speed was 150 wpm, with a standard deviation of 0.459, indicating a high level of agreement among participants that this speed is considered "acceptable". In contrast, the other speeds exhibited greater variability in perception. For example, 130 wpm, with

a standard deviation of 0.759, showed a wider range of opinions, with some participants rating it as "too slow" and others closer to "acceptable". At 170 wpm, the variability increased further (SD = 0.883), with ratings moving toward "too fast". Finally, 190 wpm, which received the highest standard deviation of 1.124, demonstrated the greatest diversity in perception, as participants' ratings ranged from "too slow" to "too fast", highlighting the subjectivity involved in assessing faster speech rates.

The variability in the ratings for 190, 170, and 130 wpm further seems to suggest that individual factors such as those previously mentioned, for example familiarity with certain speech rates or personal speaking habits, play a role in shaping participants' perceptions of speech rate. Conversely, the low variability in ratings for 150 wpm suggests a strong consensus among participants, highlighting its alignment with the speech rate typically perceived in Catalan. This uniformity likely reflects a shared familiarity with this pace, consistent with the average speech rate for the language.

Figure 2: Speech rate acceptability ratings (Group 2)



Source: Author (2025)

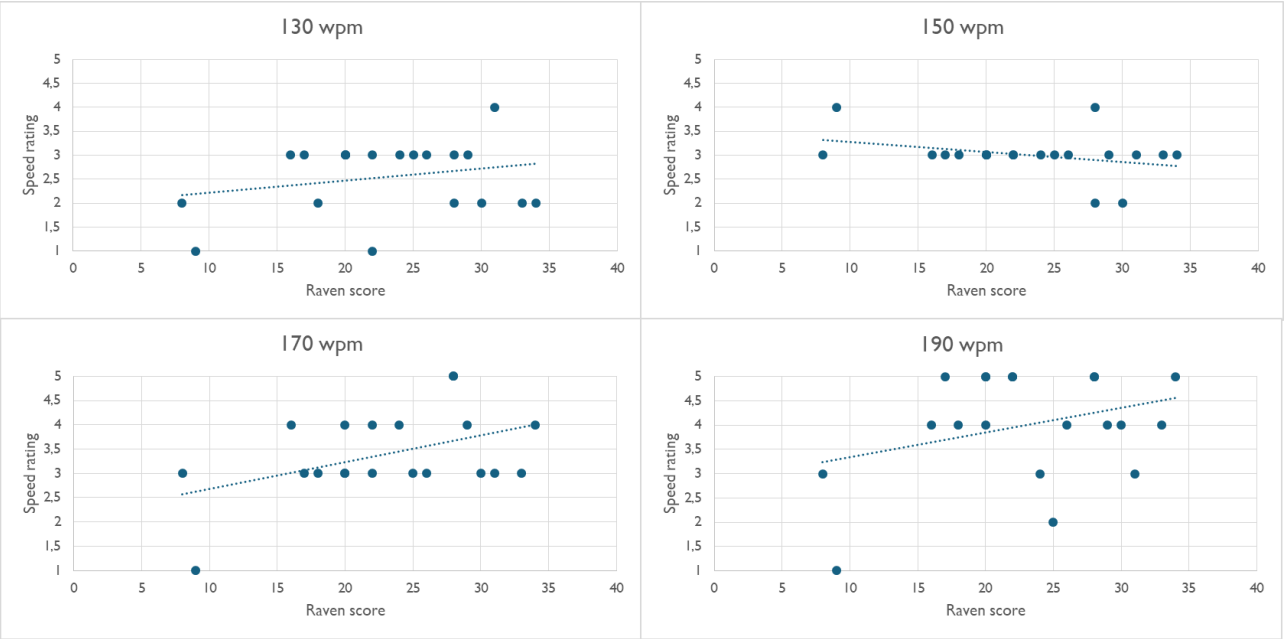
5.3 Correlation analysis

To further explore the relationship between cognitive ability and speech rate perceptions, Spearman's rank correlation coefficients were calculated for Group 2 to examine potential associations between Raven scores, age, and the ratings given to each speech rate. The aim was to assess whether cognitive ability (as measured by Raven's Progressive Matrices) or age influenced how participants in Group 2 rated different speech speeds, providing deeper insight into the factors that may shape individual perceptions of speech rate. Since Group 1 demonstrated no variability in their ratings, this analysis was not conducted for that group.

Starting with the correlation between Raven's Progressive Matrices scores and speech rate ratings, the analysis revealed no significant relationships. At 130 wpm, the correlation coefficient was 0.082 ($p = 0.731$), indicating no significant association between Raven scores and ratings. Similarly, at 150 wpm, the correlation coefficient was -0.291 ($p = 0.212$), suggesting a weak negative trend, though it was not statistically significant. At 170 wpm, the correlation coefficient was 0.303 ($p = 0.194$), showing a weak positive correlation, yet again lacking statistical significance. Finally, at 190

wpm, the correlation coefficient was 0.128 (p = 0.592), demonstrating no meaningful relationship between Raven scores and ratings at this speed either.

Figure 3: Correlation between Raven and speed ratings

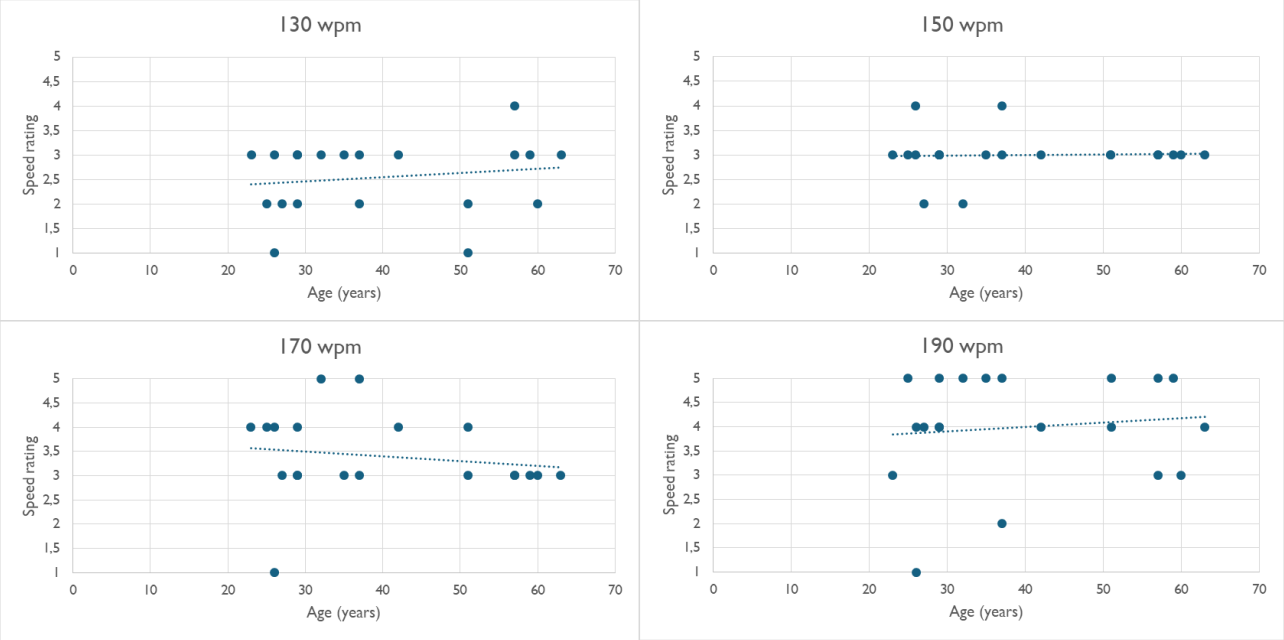


Source: Author (2025)

These findings indicate that cognitive ability, as measured by Raven's test, does not significantly influence participants' ratings of speech rate, suggesting that other factors may shape how speech rate is perceived across different speeds in this sample. This outcome is not surprising, as the initial participant sample was selected and assessed using the Raven test to ensure cognitive homogeneity, reducing the likelihood of detecting a meaningful correlation even after dividing the sample into two groups. Additionally, other factors may have contributed to the lack of correlation. The language of the audios was carefully validated to maintain consistent difficulty across recordings, and the use of Easy Language reduced the cognitive load required for comprehension compared to standard language. While prior studies, such as Bosker et al. (2017), have demonstrated that increased cognitive load can lead to a perceptual increase in speech rate through a "shrinking of time" mechanism, the cognitive load in these audios may have been too low for this effect to manifest.

The correlation analysis between the age of participants in Group 2 and their ratings of the different speech rates also revealed a consistent lack of significant relationship. At 130 wpm, the Spearman's correlation was 0.180 (p = 0.447), indicating a weak positive correlation, which was not statistically significant. A similar pattern was observed at 150 wpm, where the correlation was 0.019 (p = 0.935), suggesting no meaningful relationship between age and ratings. At 170 wpm, the correlation was -0.254 (p = 0.280), indicating a slight non-significant negative relationship. Finally, at 190 wpm, the correlation was 0.092 (p = 0.669), showing also no relationship between age and the ratings.

Figure 4: Correlation between age and speed ratings



Source: Author (2025)

Similarly to the Raven test measure, age was also an exclusion criterion to ensure the homogeneity of the initial sample. As a result, it is not unexpected that, even after dividing the sample into groups, age does not significantly correlate with the speed ratings in Group 2. Although Group 1 exhibited a significant age difference compared to Group 2 and rated most speech rates as acceptable, the overall sample was designed to minimise extreme age variability. This homogeneity in the broader sample likely reduced the potential impact of age on Group 2's speech rate perceptions, explaining why no significant correlation between age and speech rate ratings was found in that group.

5.4 Individual case examples

To further illustrate the variability observed in Group 2's ratings of speech rates, individual responses that deviated from expected patterns were analysed. These case examples demonstrate the subjective nature of speech rate perception and highlight instances where participants rated speeds atypically compared to the broader trends. In general, two distinct trends emerged among participants who provided unusual ratings. The first trend involved participants who appear to have been influenced by the order in which the speeds were presented. However, while individual cases suggest such an influence, the group as a whole did not show a statistically significant effect of presentation order on ratings. The second trend encompassed participants who exhibited no clear or consistent pattern in how they rated the different speech speeds.

Participant P35 provided an unusual rating by marking 170 wpm as "fast" while considering the faster rate of 190 wpm "acceptable". This inconsistency may have been influenced by the order in which the speeds were presented, as P35 encountered the 170 wpm audio immediately after the 130 wpm one. This contrast could have amplified the perceived rapidity of 170 wpm, while 190 wpm, presented later, might have been perceived as less pronounced in its speed.

Participant P34 also exhibited an unusual trend by rating 150 wpm as "slow", while the slower rate of 130 wpm was deemed "acceptable". As with P35, this rating pattern may have been influenced by the order in which the audio clips were presented. Specifically, the 150 wpm speed was heard immediately after the 190 wpm audio. The contrast between these two speeds may have affected the participant's perception, making the 150 wpm speed seem slower in comparison to the faster rate they had just encountered.

In both cases, the participants' responses are consistent with findings from previous research, which suggest that exposure to slower speech rates can cause later speech to be perceived as faster, while exposure to faster speech rates can lead to the same speech being perceived as slower (Ainsworth, 1974; Fujisaki et al., 1975; Summerfield, 1981). However, since the order of speech rates was randomised to avoid this, the group as a whole was not influenced by this effect.

In contrast, participant P8 rated the slowest speed, 130 wpm, as "fast" while marking all other speeds as "acceptable". For this specific participant, the 130 wpm audio was the first presented in the test. However, it is challenging to ascertain why this participant perceived the slowest speed as "fast", especially since the subsequent 190 wpm audio, representing a significant speed increase, was rated as "acceptable". This suggests that, unlike the cases mentioned before, P8's perception of the speeds was not influenced by the abrupt change in tempo.

Participant P20 also demonstrated a markedly distinct pattern by rating the 130 wpm, 170 wpm, and 190 wpm speeds as "too slow", while perceiving 150 wpm as "fast". This atypical rating cannot be attributed to the order in which the speeds were presented, as the 150 wpm speed was heard after the 190 wpm audio. Given that 190 wpm was rated as "too slow", it is unlikely that the presentation order influenced the participant into perceiving 150 wpm as faster.

Finally, participant P30 also stands out for their rating pattern by considering 190 wpm "slow", while perceiving all other speeds as "acceptable", indicating that the participant found the other speeds faster. In this case, the presentation order does not appear to have a relation again, as the slowest speed, 130 wpm, was heard after 190 wpm, and was still considered faster.

These atypical cases that do not appear to have been influenced by the order in which the speech rates were presented may have been shaped by various individual factors. One possibility is that these participants experienced lapses in attention during certain sections of the test, which could have resulted in inconsistent or arbitrary ratings for some of the speech rates, despite the measures outlined in Section 4.2 to minimise distractions. It is also plausible that some participants perceived certain rates as uncomfortable or unsuitable but were unable to clearly identify the specific reason behind their discomfort. Consequently, they may have struggled to classify these speeds as definitively "slow" or "fast", and instead provided these labels without a clear rationale, simply selecting one or the other to express their dissatisfaction with the rate. Additionally, personal factors such as individual preferences and familiarity with different speeds may have contributed to these atypical responses. However, these possibilities remain speculative as the methodology employed does not offer insight into participants' underlying reasoning.

6. Conclusion

The objective of this study was to assess the perception of speech rate in audio recordings using Easy Language, a simplified form of communication addressed to individuals with comprehension difficulties. To achieve this, four different speech rates (130 wpm, 150 wpm, 170 wpm, and 190 wpm) were tested with a sample of 35 adult participants with intellectual disabilities, one of the main target groups of Easy Language. Participants' perceptions of these speech rates were measured using a five-point Likert scale, where they were asked to rate each speech speed based on their perception, categorising it as "too slow", "slow", "acceptable", "fast", or "too fast".

The results revealed two distinct trends among the participants. One subgroup rated all speech speeds as "acceptable", while the other group demonstrated more variation in their ratings, reflecting a more nuanced perception of speech rates or, at the very least, a lower overall acceptability of certain speeds. Notably, these two subgroups exhibited a significant age difference, although no significant differences were found in Raven scores between the groups.

Among the subgroup of participants who rated the speech rates differently, the ratings generally aligned with typical Catalan speech rate practices. Specifically, the speech rate of 150 wpm, which is the average rate in Catalan, was consistently rated as "acceptable" by this group. In contrast, the rate of 130 wpm, which also falls within the Catalan average, was considered slow on average. This suggests that this group had a preference for faster speech, with 170 wpm also rated as "acceptable". These results suggest a general preference for slightly faster speech rates within the subgroup, which may reflect the tendency for younger adults, as observed in existing literature, to naturally produce faster speech. It is also important to highlight that, with the exception of 150 wpm, there was an observable trend where the faster the speech rate, the greater the variability in participants' responses. This suggests that as the speech rate increased, participants' perceptions became more diverse.

One limitation of this study is the relatively short duration of the audio clips used. This brevity may have restricted participants' ability to fully engage with the material or evaluate the speech rates in a more nuanced, contextualised manner. Longer audio samples could offer a more accurate representation of how participants perceive speech rate over an extended period and may reveal differences in their perception depending on the speech context. Future research could consider using longer audio clips to determine if the results vary when participants are exposed to speech rates over a more sustained timeframe. Additionally, the speech rates in the study were modified through a program rather than being naturally spoken at the intended speeds. A future study using recordings of speech naturally produced at the desired speech rates would provide insight into whether the findings differ when the speech rate is delivered in a more natural, human-produced context.

Building on the findings of this study, future research could also explore speech rate perception across a broader range of age groups. This study intentionally sought a homogeneous sample in terms of age, which limits the ability to fully assess how age might influence the perception of speech rates. However, the trend observed in this study, particularly the significant age difference between the group that perceived all speeds as acceptable and the other group that did not, suggests that age could be an important factor to consider in future research. Expanding the participant pool

to include a more diverse range of ages, such as children, young adults, middle-aged adults, and older adults, would provide a more comprehensive understanding of how speech rate perception varies across different stages of life. Additionally, it would be valuable to explore how these perceptions evolve over the lifespan, considering potential age-related cognitive and perceptual changes that could influence how speech rates are processed.

Another possible direction for future research would be to explore whether similar results are obtained when testing different Catalan dialects and varieties. It would be important to assess whether familiarity with these dialects or varieties influences the perception of speech rate, as linguistic familiarity may impact how individuals process and evaluate speech. Additionally, investigating whether age affects the perception of speech rates within these dialects or varieties could provide further insights into the role of language exposure and age-related perceptual changes in speech rate preferences.

In terms of practical applications, the results of this study can be valuable for anyone looking to create content in Easy Language with an audio format. To name just a few examples, organisations like the Easy-to-Read Association in Catalonia, which already publishes simplified versions of classic and contemporary literature, could apply these findings when producing audiobooks. This would support users who struggle with reading or prefer auditory learning. Similarly, under the regional Catalan Accessibility Code (Departament de Drets Socials i Inclusió, 2023), public libraries are required to provide materials in multiple accessible formats. Adding Easy Language audiobooks would not only help libraries fulfil this obligation but also expand options for their users, while promoting culture and language. Furthermore, cultural heritage institutions, such as museums, galleries, and historic sites, must also provide Easy Language explanations. While these are typically offered in written formats, the study's findings provide a foundation for creating Easy Language audio versions that could be offered as an alternative audio guide. Lastly, the principles of Easy Language can also be applied in live interactions, such as at information counters, where staff must assist users with different needs. Understanding how to communicate using oral Easy Language will ensure effective communication with all users.

In conclusion, this study contributes to our understanding of how speech rate is perceived by individuals with intellectual disabilities, providing important implications for the design of communication tools, accessibility measures, and content creation that align with their needs. Furthermore, this study examines this speech rate perception using audios in Easy Language, a topic that has only started being explored in research settings. Further research in this area can enhance the development of more inclusive and effective strategies for engaging individuals with intellectual disabilities in various communicative contexts.

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Notes

Authorship contribution

Conceptualization and preparation of the manuscript: M. Pujadas-Farreras
Data collection: M. Pujadas-Farreras
Data analysis: M. Pujadas-Farreras
Results and discussion: M. Pujadas-Farreras
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Research dataset

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Image copyright

Not applicable.

Approval by ethics committee

The study protocol (CEEAH 6026) was approved by the Ethics Committee of the Autonomous University of Barcelona in June 2022.

Conflicts of interest

The author declares no conflicts of interest.

Data availability statement
The research data will become available at the conclusion of the WEL project at the CORA-RDR repository.

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