

## INTRODUCTION

In people without Down Syndrome, training in rhythm can improve aspects of speech perception, even in children with hearing impairments (e.g. Cason et al., 2015; Hidalgo, Falk & Schön, 2017). This makes music a potentially valuable means to support speech perception in people with Down Syndrome. However, it is unclear how their developmental, sensory or cognitive factors may affect temporal perception or production in music or speech. This study examined aspects of speech and rhythmic abilities in 2 young adults with Down Syndrome. It hoped to understand if and how their rhythmic abilities are connected in speech and music domains.

## OBJECTIVES

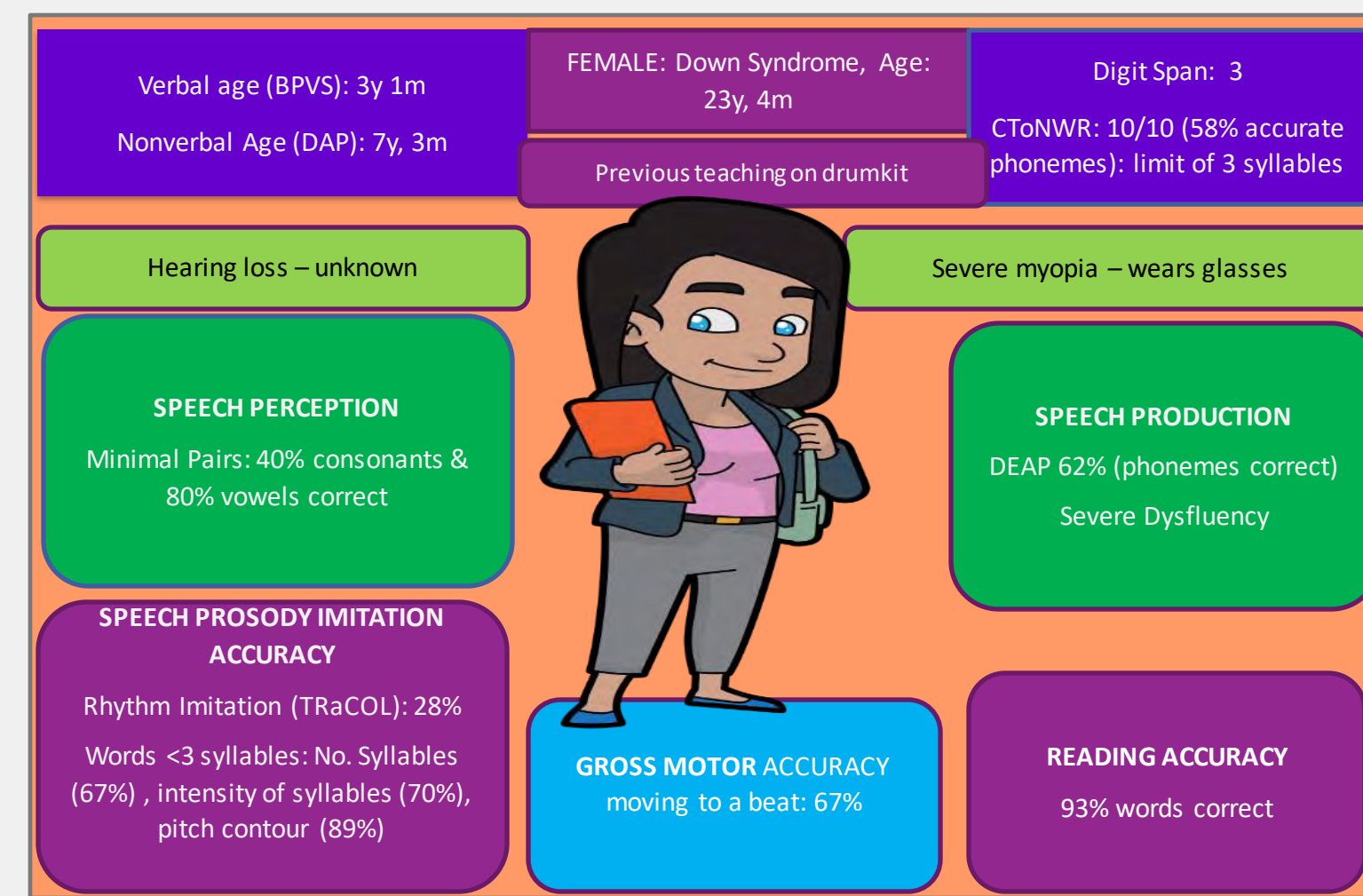
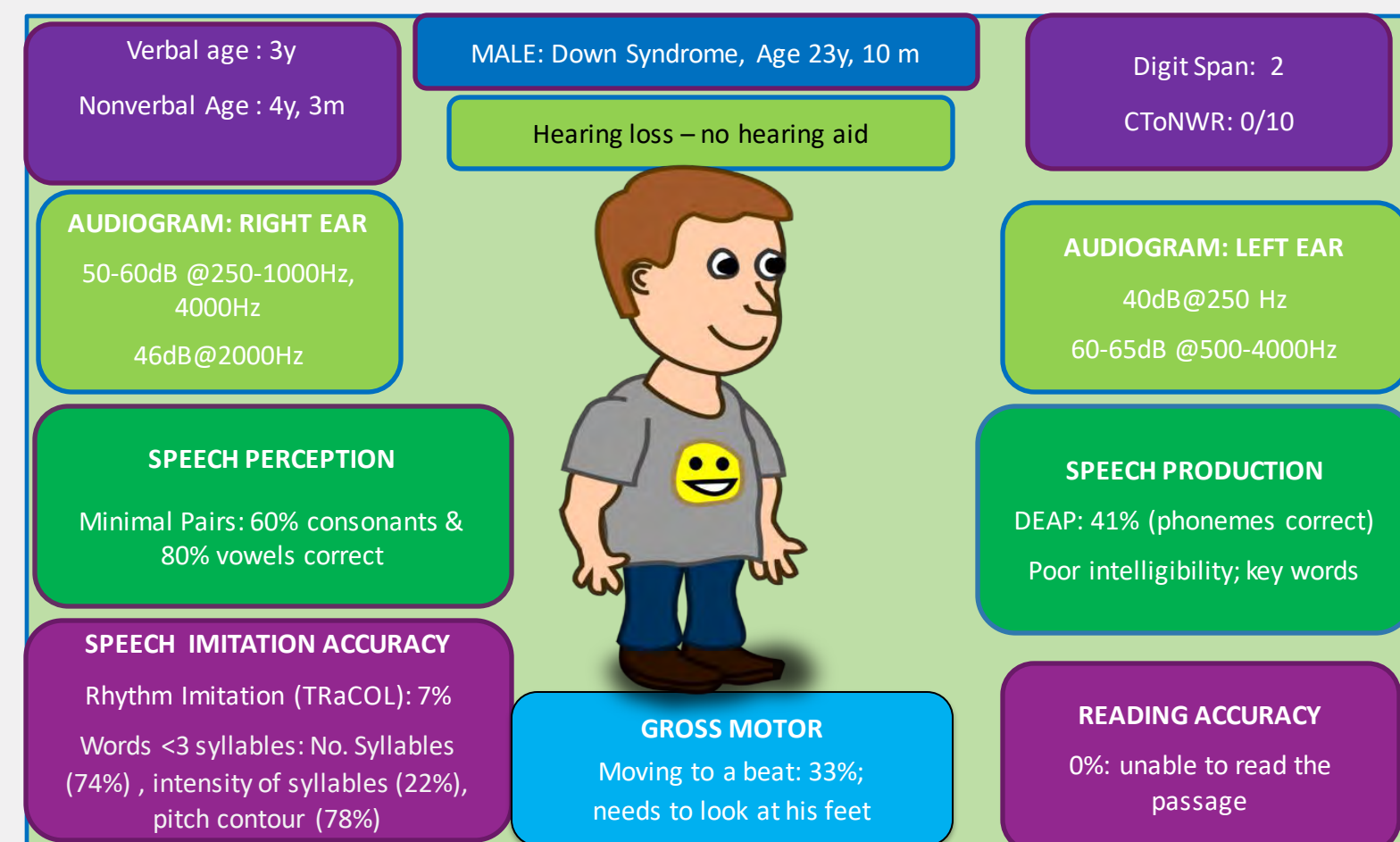
This study aimed to find out:

- How accurately do the participants tap in time to a metronome beat at 3 tempi (104 bpm, 120 bpm, 132 bpm)?
- How accurately do they tap to a non-isochronous rhythm?
- Which factors from their profile might explain their abilities or difficulties?

## PARTICIPANT PROFILES

The participants had previously been assessed against aspects of:

- Speech perception (Minimal pairs) and Speech errors (DEAP)
- Verbal and nonverbal mental age (BPVS I, Draw-A-Person test)
- Auditory verbal memory (Digit Span, Children's Test on Nonword Repetition)
- Reading accuracy
- Accuracy in imitating gross-motor movements to music, and their ability to clap speech rhythm (TRaCOL)
- Accuracy in imitating prosody of words of up to 3 syllables
- Hearing acuity and speech (details from SALT files, where known)



## METHODS

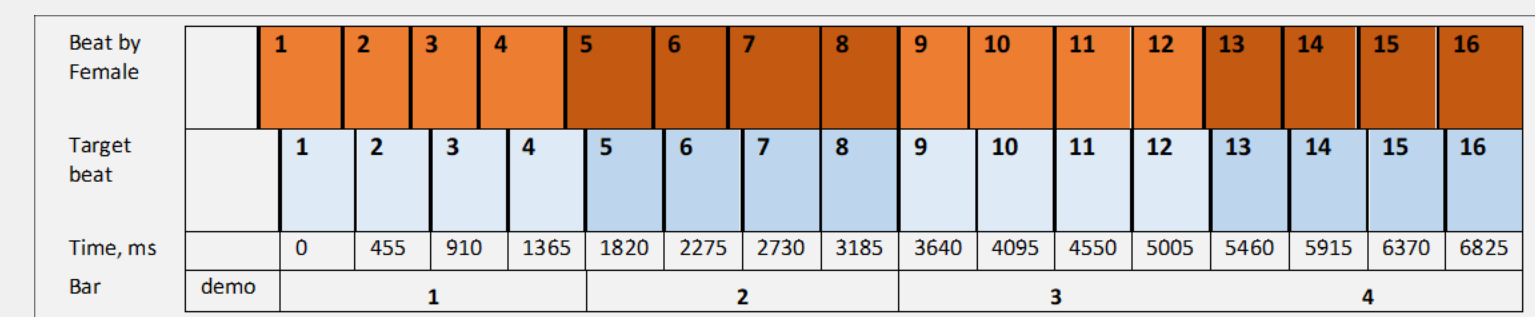
Each participant took part in rhythmic motor-movement tasks:

- **Beat entrainment:** the participants listened for four bars (16 beats), then tapped on a small hand-drum in time to the beat for five bars (30 beats). They tapped at 3 tempi: 104 bpm; 120 bpm; 132 bpm. Accuracy was measured in terms of stability of timing between tap, and synchronisation to the beat.
- **Rhythm entrainment:** two binary rhythms of half and quarter notes were looped to create a 10-bar pattern and were joined together to form a 20-beat sequence. Participants were instructed to listen to the first two bars of Rhythm 1 and to join in on the drum after a verbal cue of *1,2,3, go*.
  - Rhythm 1: *Tee-tee, Tee-tee, Ta, Ta;*
  - Rhythm 2: *Ta Tee-tee Ta Ta;*
  - No advance warning was given about the change to Rhythm 2, but...
  - **Visual cues** were given if the participant struggled to match aurally.

## RESULTS

### Beat entrainment:

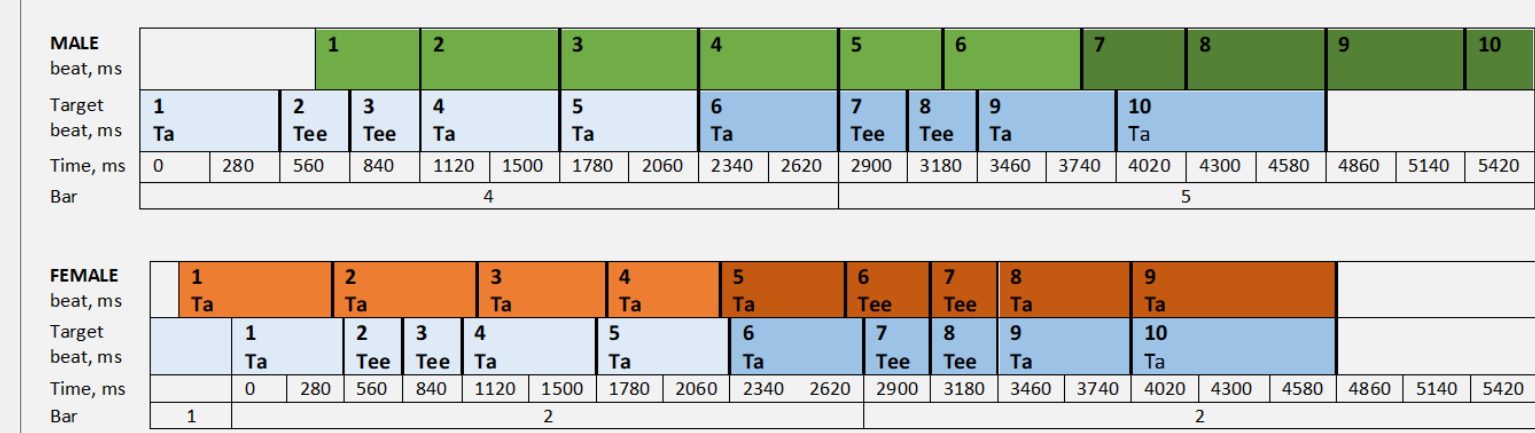
- The **male participant** did not match beats at any tempo, even with visual cues. He played slowly: at 72-78% of the tempo at 104 bpm and 132 bpm; at 90% at 160 bpm. He played after the beat by 32%, 24% and 53%.
- The **female participant** was least accurate at 160 bpm: 6% too fast; up to 20% too ahead of the beat. She was most accurate at 132 bpm, less than 7% ahead of the beat (Figure 1).



**FIGURE 1. Beat entrainment @ 132 bpm by the Female participant.** The timeline shows the approximate alignment of the female participant's beats in relation to the onset of 16 Target beats (shaded blue) from the end of the demonstration and to the end of the 4<sup>th</sup> bar. The approximate duration (ms) is also shown.

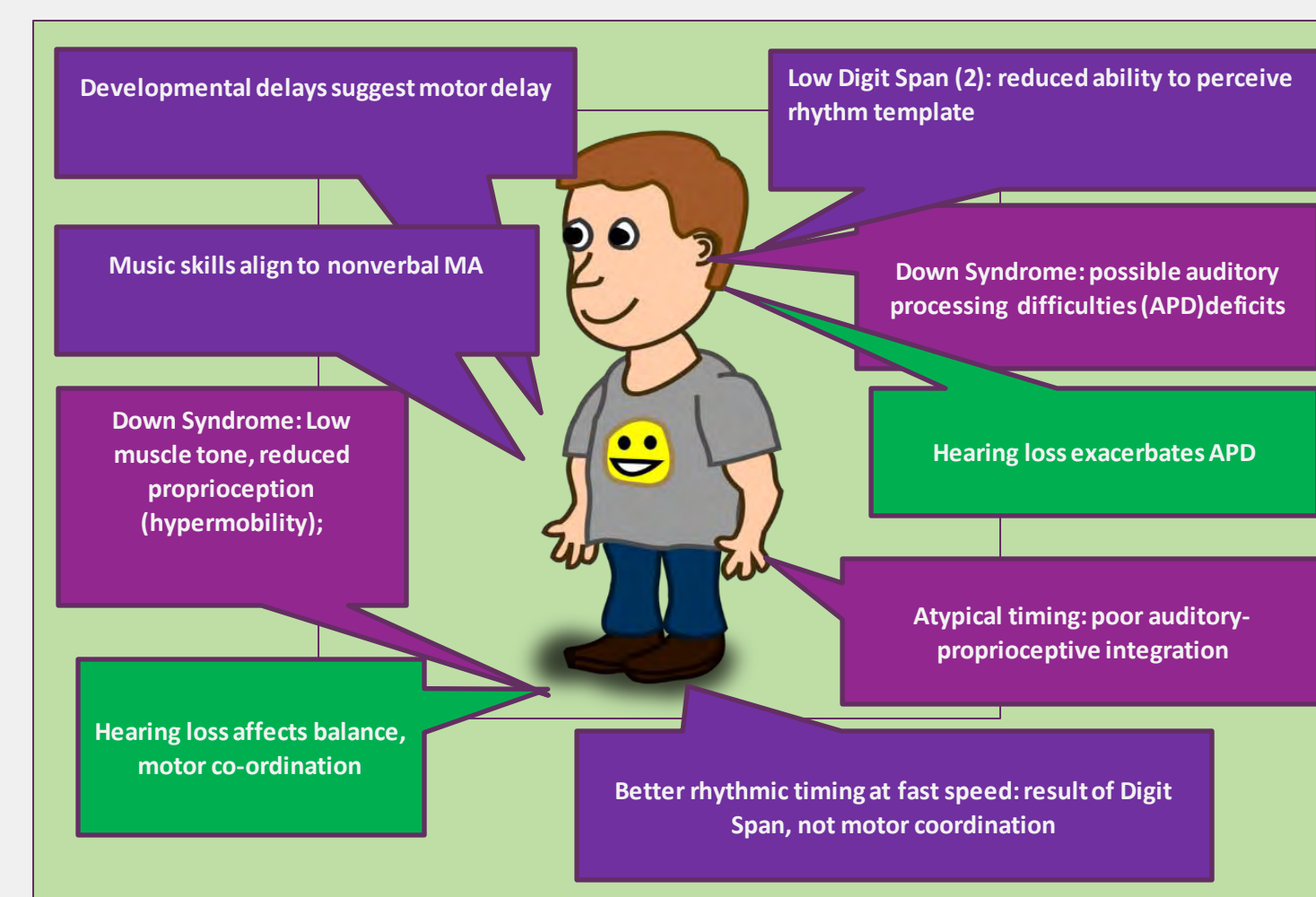
### Rhythm Entrainment.

- The **male participant** did not spontaneously reproduce changes in duration in Rhythm 1 or 2. With visual cues, he began to vary duration between beats in Rhythm 2 (Figure 2).
- The **female participant** played Rhythm 1 accurately. In **Rhythm 2**, she began to play the beat then corrected herself and played the rhythm (Figure 2, from her beat 5).

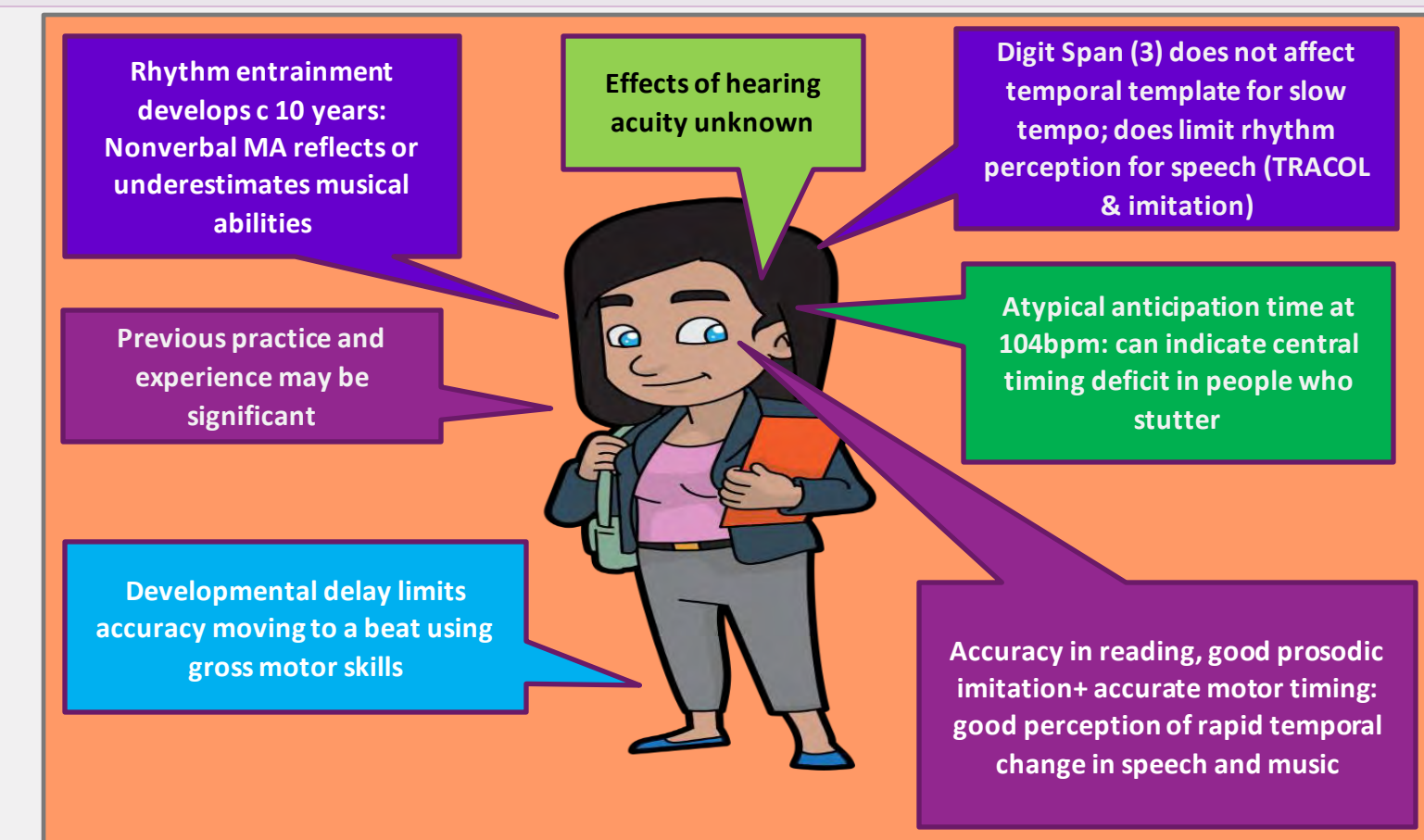


**FIGURE 2: Entrainment to Rhythm 1: Ta Tee-tee Ta Ta by the Male (upper: shaded green) and Female (lower: shaded orange) participants.** Grey-shaded areas exclude previous beats played by the participant. The timelines show the approximate alignment of each participant's beats in relation to the onset of ten Target beats (shaded blue), and the approximate duration (ms) of target beats 1-10.

### Comparison to Profile



- A low digit span and hearing loss limit accuracy in beat and rhythm tasks – adding to motor delays/difficulties (Grahm & Schuit, 2012).
- Atypical (early) synchronisation suggests poor Auditory-Motor integration and/or Auditory Processing difficulties (Thaut, 2008).



- Self-correction and some accurate synchronisation indicates good perception of rapid auditory changes: reflected in reading accuracy (e.g. Flaughnacco et al., 2014).
- Imitation of prosody in words of <3 syllables not matched in entrainment: motor control?
- Dysfluency may manifest as early synchronisation: possible central timing deficit in speech and music (Sares et al., 2019).

## CONCLUSIONS

- Perceptual and Productive difficulties are evident in speech and music domains
- Digit Span and Hearing Acuity may explain difficulties and differences between individuals as well as motor abilities
- Musical ability closer to nonverbal Mental Age than verbal Mental Age

### What can we learn from them about using rhythmic music activities to support speech perception?

- Hearing impairment and low digit span may limit perception of temporal changes through rhythmic activities: non-verbal support needed to support development.
- Further research is needed to learn about the links, and to assess the extent to which rhythmic music-making may influence speech perception

## REFERENCES

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