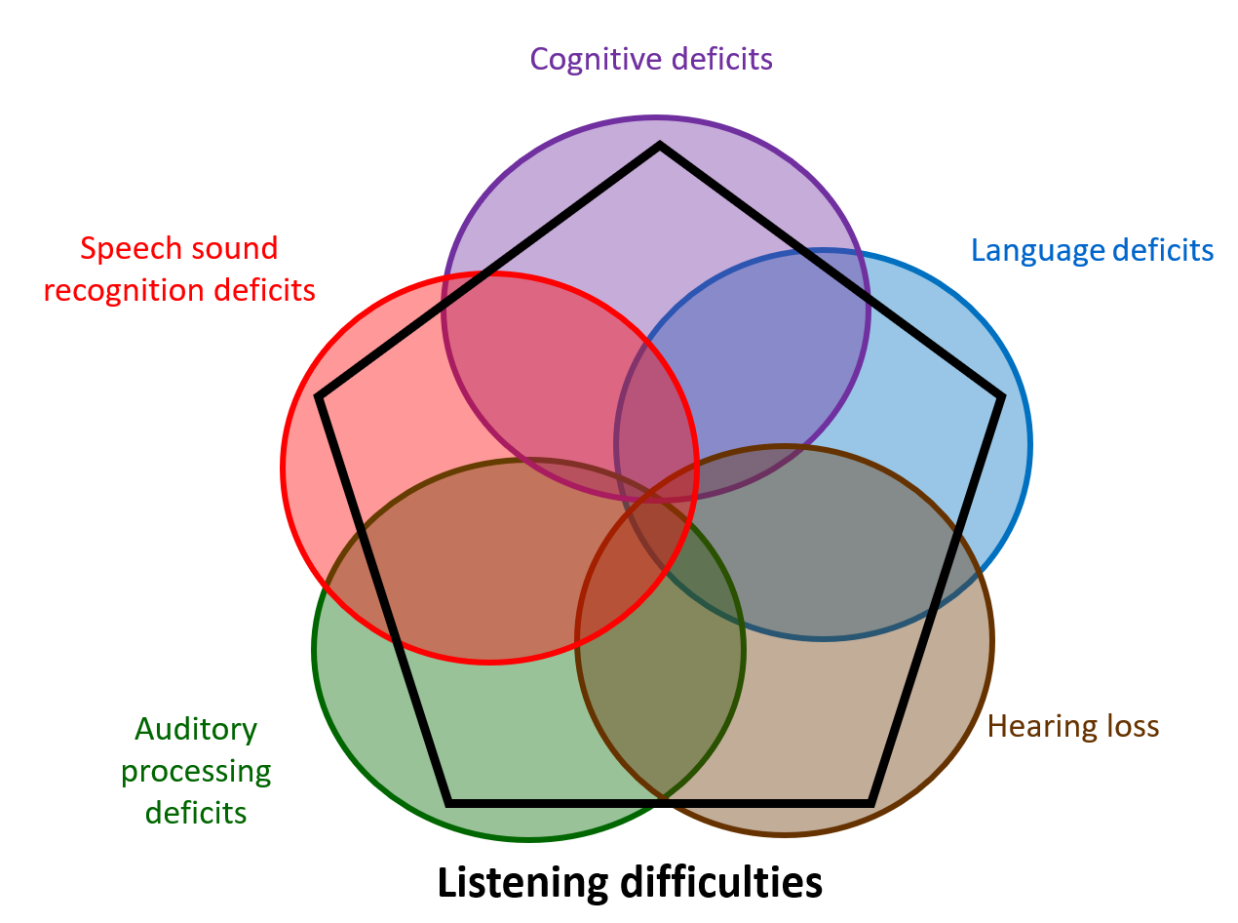


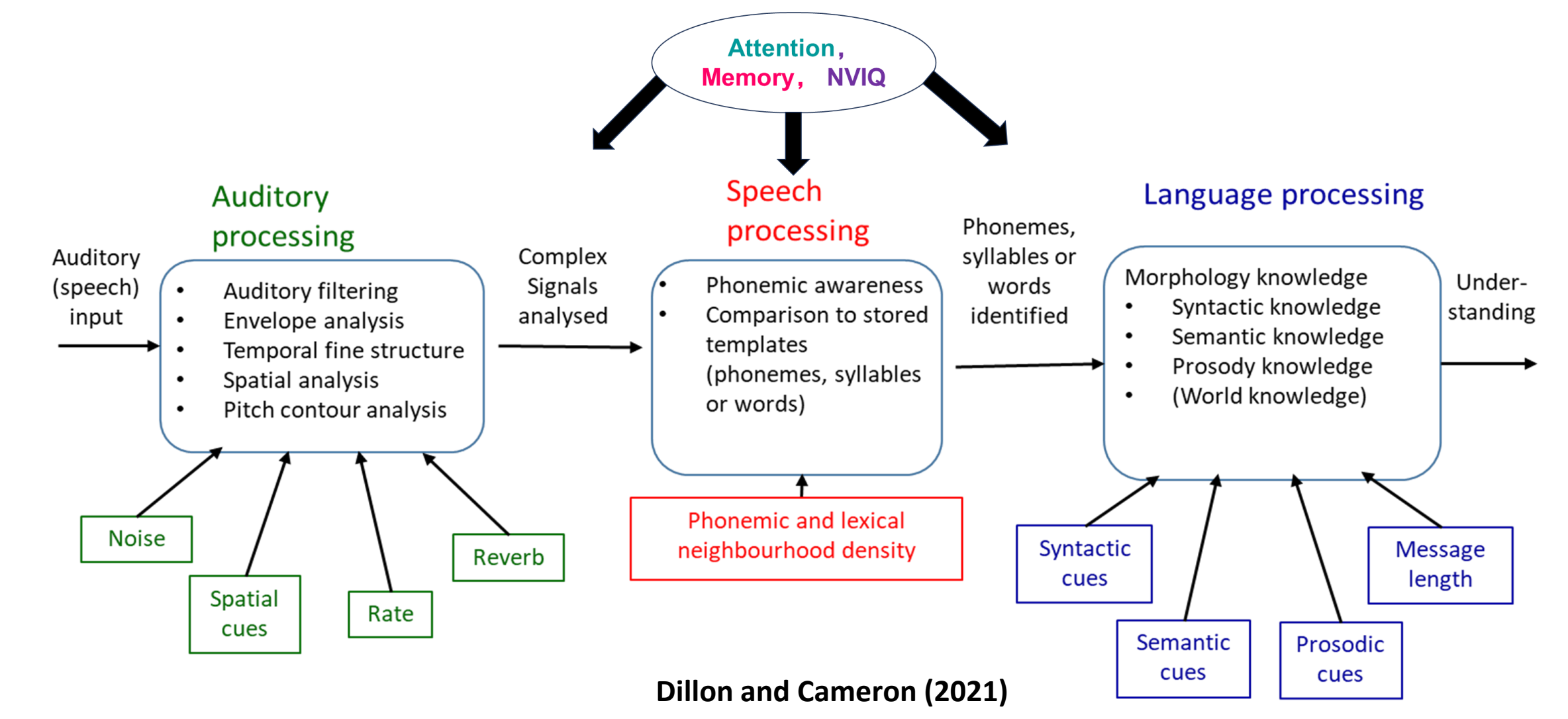
- Children with Listening Difficulties
- Poor listening skills in noisy environment
- Difficulty with phonics and reading
- Frequent asking for repetition
- Keeping up with the rapid speech
- Localization of the source of signals

### Challenges in Diagnosing Listening Difficulties

- Lack of Standardized Diagnostic Criteria**  
According to different diagnostic criteria and test batteries, the estimated prevalence of auditory processing disorders in children varied widely from 0.2% ~ 10% ( Silman et al., 2000; Bamiou et al., 2001; Nagao et al., 2016).
- Overlap with Other Conditions**  
Symptoms of children with listening difficulties may also occur in children with other developmental disorders such as AD(H)D, DLD, dyslexia and learning disorders (de Wit et al., 2017).



### How to Separate the Causes? Tri-structured Test battery



### Our Questions

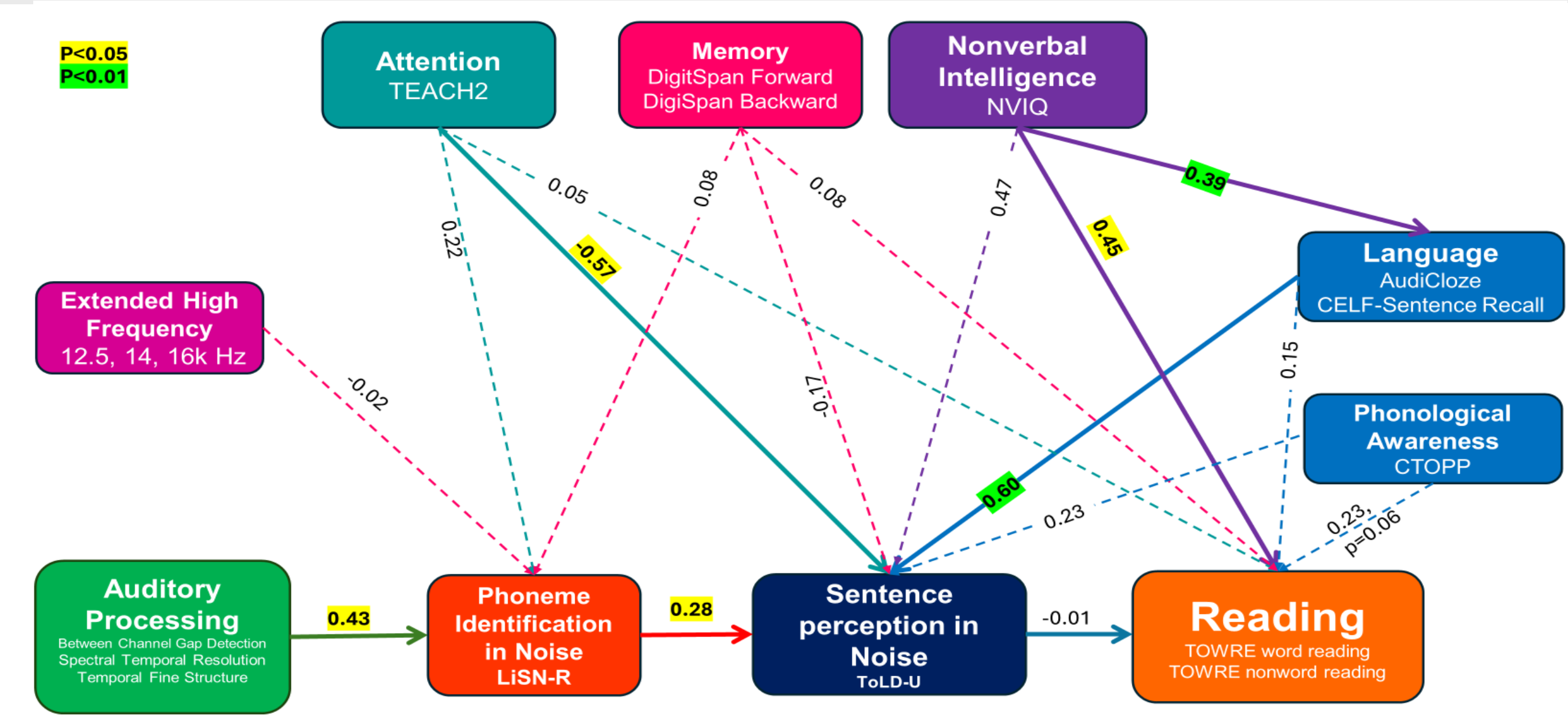
- What are the correlations between each of the measures of non-speech auditory processing, phoneme identification in noise, sentence perception in noise, language and cognition in typically developing population?
- What affects children's phoneme identification in noise, sentence perception in noise, language and reading abilities?

### Method

- Participants:** A total of 227 children, aged 5-12 years, from mainstream primary schools in Greater Manchester.
- Hearing Status:** Normal peripheral hearing.
- Testing Procedure:** Each child completed 7 of 12 randomly assigned tests in a comprehensive battery assessing auditory processing of nonspeech signals, phoneme identification in noise, sentence perception in noise abilities, teacher-rated listening ability in the classroom, cognitive abilities (memory, attention, and non-verbal intelligence), language and reading ability over 2-3 sessions.

### Results

	WCGD	BCGD	STR_Sweep	STR_Dur	TFS	Phoneme identification in noise	Sentence perception in noise	AudiCloze	CELF sentence recall	CTOPP_NWR	TONI	DigiForward	DigiReverse	TOWRE_word	TOWRE_nonword	Atten
WCGD	1	0.32	0.12	0.17	0.34	0.07	-0.05	0.21	0.09	0.11	-0.03	0.15	0.07	0.07	0.29	0.03
BCGD	0.32	1	0.42	0.42	0.37	0.3	0.1	0.25	0.25	0.25	-0.06	0.06	0.16	0.2	0.29	0.01
STR_Sweep	0.12	0.42	1	0.53	0.2	0.34	0.17	0.2	-0.01	0.11	0.21	0.1	0.15	0.21	0.25	0.14
STR_Dur	0.17	0.42	0.53	1	0.19	0.17	0.02	0.01	-0.11	0.02	0.45	0.06	0.26	0.16	0.27	0.03
TFS	0.34	0.37	0.2	0.19	1	0.2	0.1	0.4	0.22	0.16	0.18	0.1	0	0.29	0.19	0.02
Phoneme identification in noise	0.07	0.3	0.34	0.17	0.2	1	0.48	0.07	0.24	0.07	0.28	0.06	0.03	0.15	0.13	0.07
Sentence perception in noise	-0.05	0.1	0.17	0.02	0.1	0.48	1	0.42	0.46	0.2	0.33	0.19	0.01	0.2	0.13	-0.12
AudiCloze	0.21	0.25	0.2	0.01	0.4	0.07	0.42	1	0.63	0.24	0.26	0.38	0.22	0.29	0.13	0
CELF sentence recall	0.09	0.25	0.01	0.11	0.22	0.24	0.46	0.63	1	0.25	0.16	0.55	0.26	0.24	0.37	-0.01
CTOPP_NWR	0.11	0.25	0.11	0.02	0.16	0.07	0.2	0.24	0.25	1	0.26	0.25	0.2	0.44	0.34	0.23
TONI	-0.03	0.06	0.21	0.45	0.18	0.28	0.33	0.26	0.16	0.26	1	0.16	0.17	0.51	0.38	0.17
DigiForward	-0.15	0.06	0.1	0.06	0.1	0.06	0.19	0.38	0.55	0.25	0.16	1	0.5	0.14	0.27	-0.13
DigiReverse	-0.07	0.16	0.15	0.26	0	0.03	0.01	0.22	0.26	0.2	0.17	0.5	1	0.14	0.28	0.04
TOWRE_word	0.07	0.2	0.21	0.16	0.29	0.15	0.2	0.29	0.24	0.44	0.51	0.14	0.14	1	0.69	0.19
TOWRE_nonword	0.29	0.29	0.25	0.27	0.19	0.13	0.13	0.13	0.37	0.34	0.38	0.27	0.28	0.69	1	0.1
Atten	0.03	0.01	0.14	0.03	0.02	0.07	-0.12	0	-0.01	0.23	0.17	-0.13	0.04	0.19	0.1	1



### Conclusions

- Phoneme Identification in Noise (LiSN-R):** Positively influenced by Auditory Processing abilities (0.43, p < 0.05).
- Sentence Perception in Noise (ToLD-U):** Negatively impacted by Attention (-0.57, p < 0.05) and positively influenced by Phoneme Identification in Noise (0.28, p < 0.05) and Language (0.60, p < 0.01).
- Language:** Positively influenced by Nonverbal Intelligence (0.39, p < 0.01)
- Reading:** Positively influenced by Nonverbal Intelligence (0.45, p < 0.05) and Phonological Awareness trending toward significance (0.23, p = 0.06).

### References

Bamiou, D. E., Musiek, F. E., & Luxon, L. M. (2001). Aetiology and clinical presentations of auditory processing disorders—a review. *Archives of Disease in Childhood*, 85(5), 361–365.

Dillon, H., & Cameron, S. (2021). Separating the causes of listening difficulties in children. *Ear and Hearing*, 1097–1108. <https://doi.org/10.1097/AUD.0000000000001098>

Nagao, K., Rieger, T., Padilla, J., Greenwood, L. A., Loson, J., Zavala, S., & Morlet, T. (2016). Prevalence of auditory processing disorder in school-aged children in the Mid-Atlantic region. *Journal of the American Academy of Audiology*, 27(9), 691–700.

Silman, S., Silveira, C. A., & Enmer, M. B. (2000). Central auditory processing disorders and reduced motivation: Three case studies. *Journal of the American Academy of Audiology*, 11(2), 57–63.

Wit, E. de, Neijhuis, K., & Luings, M. (2017, October). Dutch position statement: Children with listening difficulties. *Hanze; Bureau AudCom voor FENAC en Siméa*. <https://research.vu.nl/en/publications/dutch-position-statement-children-with-listening-difficulties>