

# Validation of browser-based Arabic Digits-In-Noise tests, including comparisons of diotic and antiphase versions

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## Background

- The need for accessible, valid and reliable hearing screening tools in the Arab region is largely unmet.
- Digits-in-noise (DIN) tests are used in many world languages to screen for hearing loss and assess functional hearing ability (Van et al., 2021)
- Standard DIN tests involve diotic digits in diotic noise. Antiphase stimuli, in which the digits are phase-reversed between the ears, are suggested to be more predictive of pure-tone audiometric (PTA) thresholds (Smits et al., 2004; De Sousa et al., 2022)
- This study aims to:**
  - Determine whether Arabic DIN thresholds are linearly related to the worse-ear PTA threshold average, after controlling for age.
  - Determine whether antiphase DIN thresholds are superior to diotic DIN thresholds in predicting worse-ear PTA.
  - Determine the test-retest reliability of both versions of the DIN test.

## Methods

### Participants

- A total of 128 native-Arabic Jordanian participants (57 males) aged 18 – 80 with a wide variety of audiometric profiles completed Session 1 of the study.
- A subset of 30 participants completed Session 2 of the study (assessing reliability).

### Procedures

- In Session 1, participants were tested using PTA, tympanometry, and diotic and antiphase Arabic DIN tests.
- Session-2 of the study involved re-testing participants using tympanometry, and diotic and antiphase Arabic DIN tests.
- Partial correlations and linear regressions were calculated to assess relations between the DIN tests and worse-ear PTA.
- ROC curves were obtained to determine sensitivity and specificity of the DIN tests in predicting a PTA average > 25 dB HL.
- Test-retest reliability was assessed using the one-way, random-effects, single-rater intraclass correlation coefficient (ICC[1,1]).

## Results

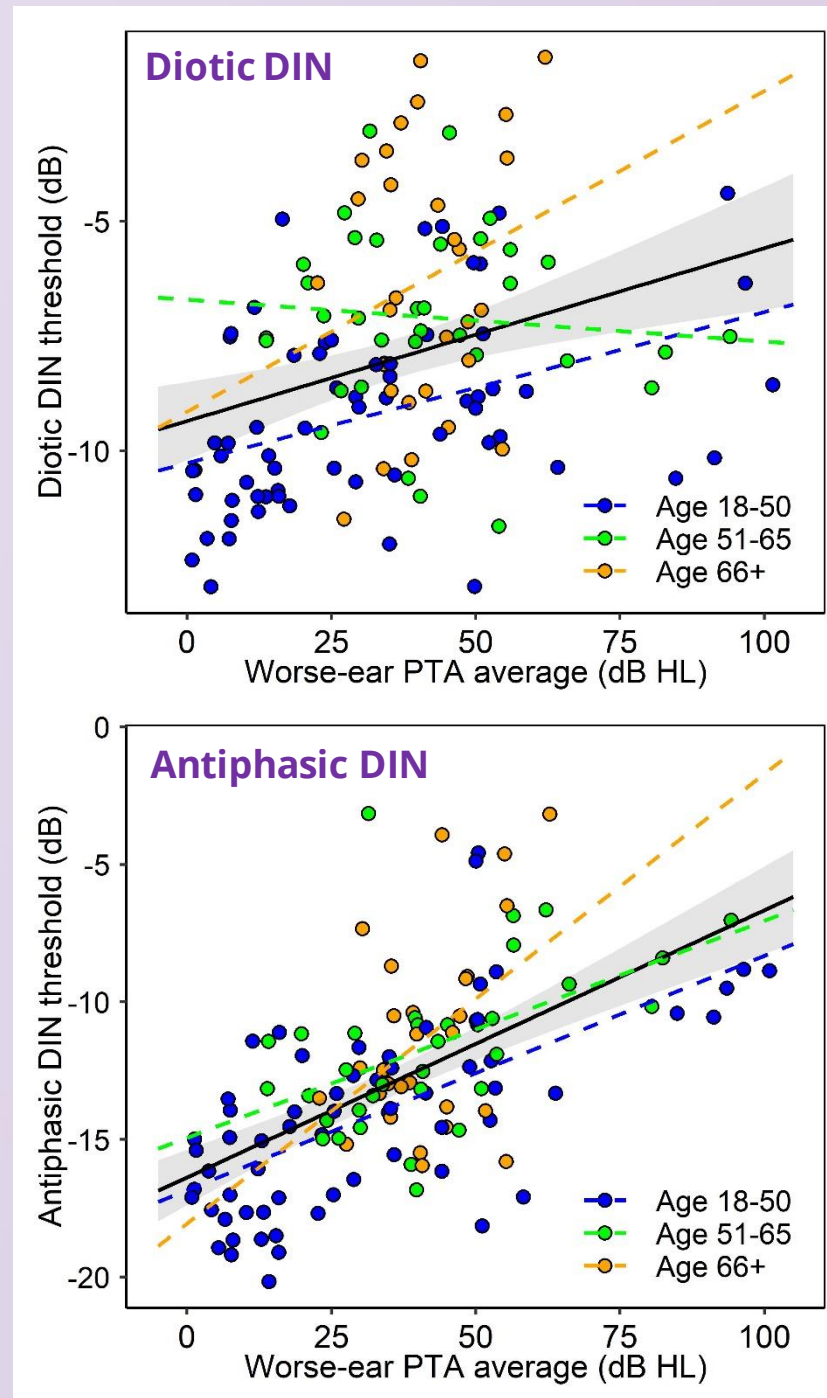


Fig. 1 Relations between DIN thresholds and PTA

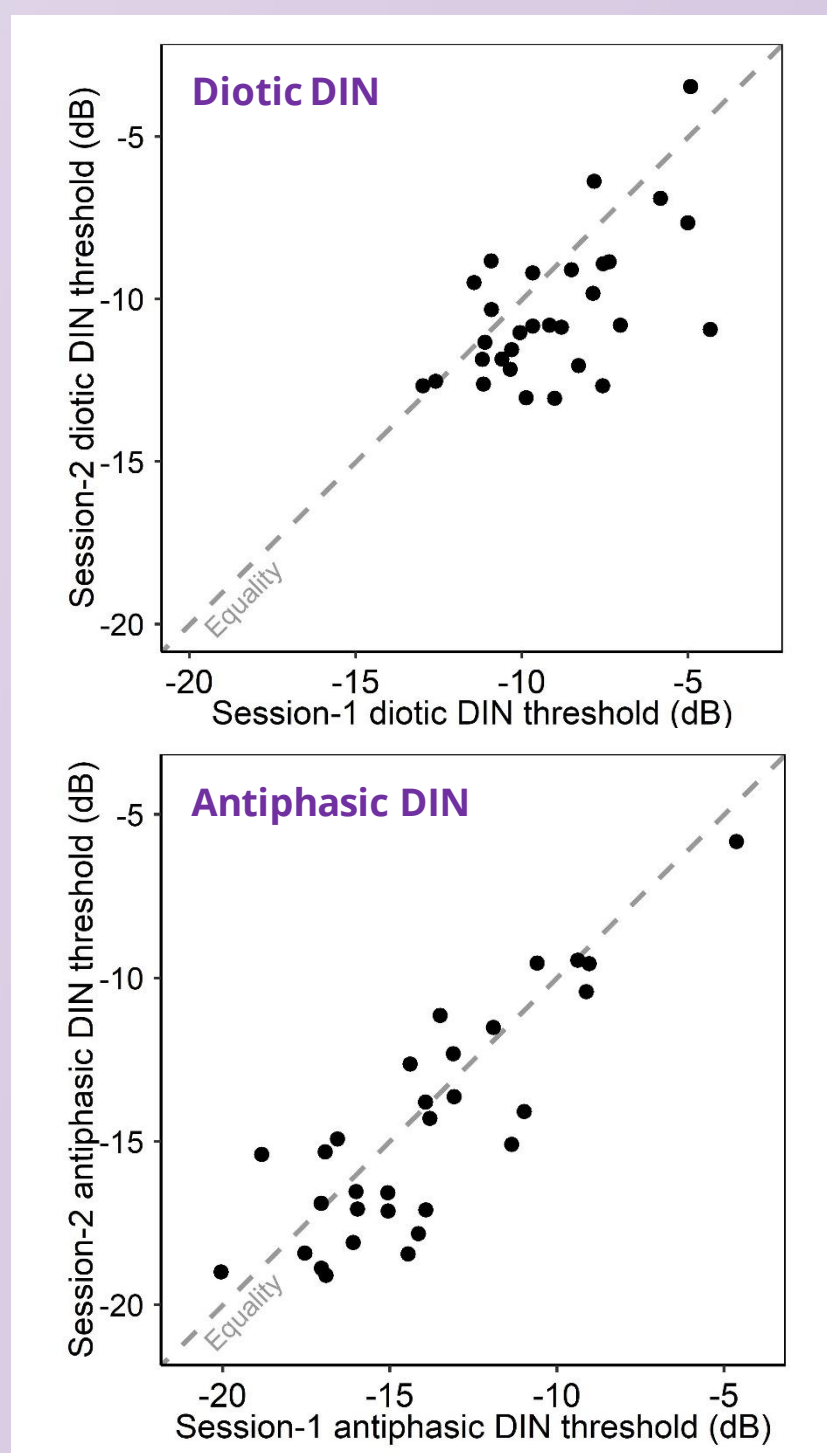


Fig. 2 Relations between diotic and antiphase DIN thresholds obtained in Session 1 and Session 2

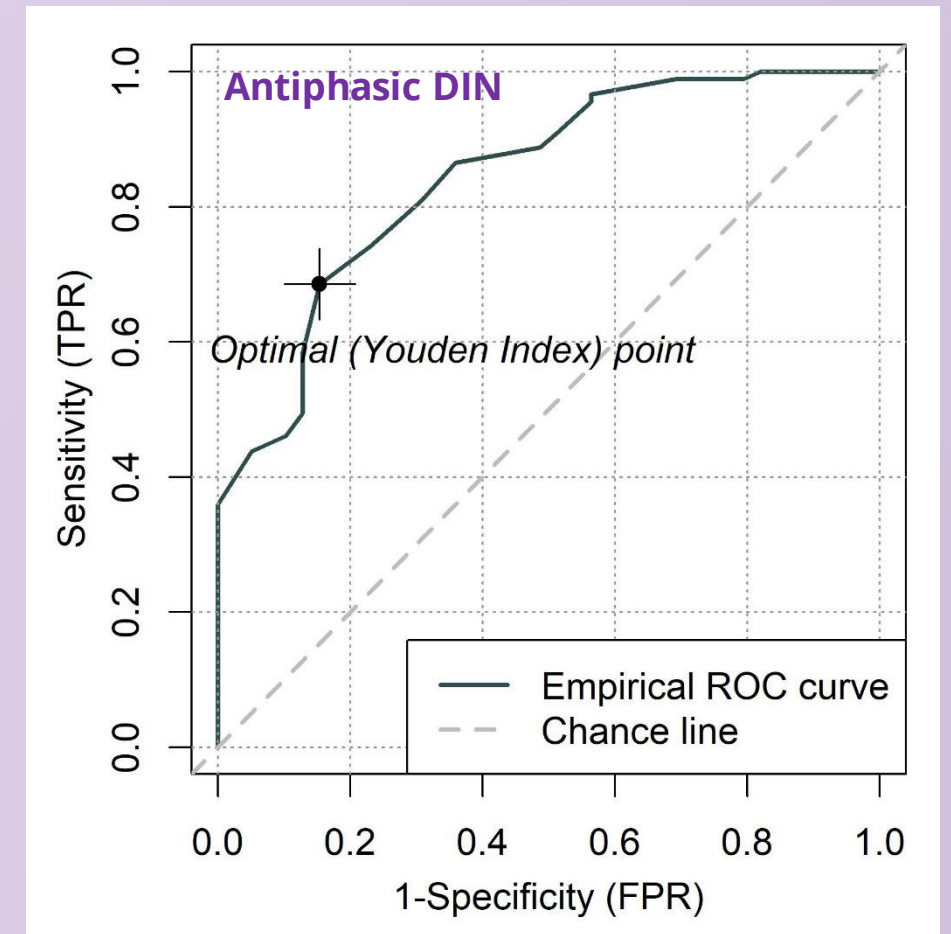


Fig. 3 ROC curve for the antiphase DIN in predicting HL > 25 dB HL

- Partial correlation between worse-ear PTA and diotic DIN, controlling for age:  $r = 0.20$  ( $p = 0.03$ )
- Partial correlation between worse-ear PTA and antiphase DIN, controlling for age:  $r = 0.54$  ( $p < 0.001$ )
- Diotic DIN as a predictor of PTA > 25 dB HL has a sensitivity of 80% and a specificity of 64% at a cut-off of -9 dB (AUC = 0.74)
- Antiphase DIN as a predictor of PTA > 25 dB HL has a sensitivity of 74% and a specificity of 77% at a cut-off of -13.5 dB (AUC = 0.84)
- Antiphase DIN thresholds (ICC = 0.83, 95% CI = 0.68–0.92) are more reliable than diotic DIN thresholds (ICC = 0.46, 95% CI = 0.12–0.70)

## Summary

- Findings support the browser-based Arabic DIN as a valid and reliable screening tool.
- The antiphase DIN appears more strongly related to worse-ear PTA and more reliable than the diotic DIN.
- Given limited access to in-person hearing healthcare in many parts of the Arabic-speaking world, findings could support beneficial hearing-related public-health measures.

## References

- De Sousa, K. C., Smits, C., Moore, D. R., Myburgh, H. C., & Swanepoel, D. W. (2022). **Diotic and antiphase digits-in-noise testing as a hearing screening and triage tool to classify type of hearing loss.** *Ear and Hearing*, 43(3), 1037-1048.
- Smits, C., Kapteyn, T. S., & Houtgast, T. (2004). **Development and validation of an automatic speech-in-noise screening test by telephone.** *International Journal of Audiology*, 43, 15–28
- Van den Borre, E., Denys, S., van Wieringen, A., & Wouters, J. (2021). **The digit triplet test: a scoping review.** *International Journal of Audiology*, 60(12), 946–963. <https://doi.org/10.1080/14992027.2021.1902579>