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Hello, who is this? The relationship between linguistic and speaker-dependent information in the acoustics of consonants

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Citation

Smorenburg, B. J. L. (2023, June 28). *Hello, who is this?: The relationship between linguistic and speaker-dependent information in the acoustics of consonants*. LOT dissertation series. LOT, Amsterdam. Retrieved from <https://hdl.handle.net/1887/3627840>

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Appendix

Appendix A. *Fixed effects in best-fitting linear mixed-effects models for English /s/ including an additional factor for measurements taken in the studio recording over the 550 – 3,400 Hz bandwidth ($N = 60$, $n = 6,000$, default factor level = Telephone: 550 – 3,400 Hz).*

<i>Effect</i>	M1 [Hz]				M2 [Hz]			
	<i>Est.</i>	<i>SE</i>	<i>t</i>	<i>p</i>	<i>Est.</i>	<i>SE</i>	<i>t</i>	<i>p</i>
(intercept)	2,078	31	66.9	***	732	6	126.2	***
Channel: Studio (550-8000 Hz)	2,943	95	30.8	***	536	26	20.9	***
Channel: Studio (550-3400 Hz)	225	16	13.9	***	19	8	2.4	0.017
		L3				L4		
(intercept)	1.53	0.07	20.9	***	36.33	1.62	22.5	***
Channel: Studio (550-8000 Hz)	-1.34	0.13	-9.9	***	–	1.30	–	***
Channel: Studio (550-3400 Hz)	-0.43	0.07	-6.6	***	32.48	1.30	25.03	0.263
		dynamic M1 ^{linear} [Hz]			dynamic M1 ^{quadratic} [Hz]			
(intercept)	76	15	5.0	***	-194	10	-19.9	***
Channel: Studio (550-8000 Hz)	-81	25	-3.2	0.001	-545	7	-75.0	***
Channel: Studio (550-3400 Hz)	-38	16	-2.4	0.018	-31	7	-4.2	**
		Peak [Hz]			Tilt [dB/decade]			
(intercept)	2,108	50	42.2	***	3.50	0.85	4.1	**
Channel: Studio (550-8000 Hz)	2,669	130	20.5	***	11.86	1.22	9.7	***
Channel: Studio (550-3400 Hz)	335	31	10.8	***	5.73	0.55	10.5	***

Bibliography

- Aitken, C. G. G., & Lucy, D. (2004). Evaluation of trace evidence in the form of multivariate data. *Journal of the Royal Statistical Society. Series C: Applied Statistics*, 53(1), 109–122. <https://doi.org/10.1046/j.0035-9254.2003.05271.x>
- Amino, K., & Arai, T. (2009). Speaker-dependent characteristics of the nasals. *Forensic Science International*, 185(1–3), 21–28. <https://doi.org/10.1016/J.FORSCIINT.2008.11.018>
- Amino, K., Arai, T., & Sugawara, T. (2007). Effects of the phonological contents on perceptual speaker identification. In C. Müller (Ed.) *Speaker Classification II: Selected papers. Lecture Notes in Computer Science* (Vol. 4441 LNAI, pp. 83–92). Berlin, Heidelberg: Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-74122-0_8
- Audibert, N., Fougeron, C., & Chardenon, E. (2021, February 4-5). Do you remain the same speaker over 21 recordings? [Conference presentation]. *XVII National congress of the Italian Association of Speech Science (AISV)*, Zürich, Switzerland. Retrieved from https://www.cl.uzh.ch/dam/jcr:e6a8ac08-5b5b-4bba-9146-ac6d1256d72c/AISV2021_book%20of%20abstracts_v2.pdf.

- Baayen, R. H., Piepenbrock, R., & Van Rijn, H. (1993). *The CELEX Lexical Database*. Philadelphia Linguistics Data Consortium, University of Pennsylvania. <https://doi.org/10.1016/j.bbrc.2013.10.120>
- Bang, H.-Y., Clayards, M., & Goad, H. (2017). Compensatory Strategies in the Developmental Patterns of English /s/: Gender and Vowel Context Effects. *Journal of Speech Language and Hearing Research*, 60(3), 571–591. https://doi.org/10.1044/2016_JSLHR-L-15-0381
- Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, 68(3). <https://doi.org/10.1016/j.jml.2012.11.001>
- Bates, D., Kliegl, R., Vasishth, S., & Baayen, H. (2015). Parsimonious mixed models. *arXiv preprint arXiv:1506.04967*.
- Bell, A. (1984). Language style as audience design. *Language in society*, 13(2), 145-204. <https://doi.org/10.1017/S004740450001037X>
- Bell, A., Brenier, J. M., Gregory, M., Girand, C., & Jurafsky, D. (2009). Predictability effects on durations of content and function words in conversational English. *Journal of Memory and Language*, 60(1), 92-111. <https://doi.org/10.1016/j.jml.2008.06.003>
- Bell-Berti, F., & Harris, K. S. (1979). Anticipatory coarticulation: Some implications from a study of lip rounding. *Journal of the Acoustical Society of America*, 65(5), 1268–1270. <https://doi.org/10.1121/1.382794>
- Bell-Berti, F., & Harris, K. S. (1982). Temporal patterns of coarticulation: Lip rounding. *Journal of the Acoustical Society of America*, 71(2), 449–454. <https://doi.org/10.1121/1.387466>
- Benzeghiba, M., De Mori, R., Deroo, O., Dupont, S., Erbes, T., Jouvét, D., Fissore, L., Laface, P., Mertins, A., Ris, C., Rose, R., Tyagi, V., & Wellekens, C. (2007). Automatic speech recognition and speech variability: A review. *Speech communication*, 49(10-11), 763-786. <https://doi.org/10.1016/j.specom.2007.02.006>
- Bessette, B., Salami, R., Lefebvre, R., Jelínek, M., Rotola-Pukkila, J., Vainio, J., Mikkola, H., Järvinen, K. (2002). The Adaptive Multirate Wideband speech codec (AMR-WB). *IEEE Transactions on Speech and Audio Processing*, 10(8), 620–636. <https://doi.org/10.1109/TSA.2002.804299>

- Biber, D., & Conrad, S. (2005). Register variation: A corpus approach. In D. Schiffrin, D. Tannen, & H. E. Hamilton (Eds.) *The handbook of discourse analysis* (pp. 175-196). Blackwell Publishers Ltd. <https://doi.org/10.1002/9780470753460.ch10>
- Boersma, P. & Weenink, D. (2020). Praat: doing phonetics by computer [Computer program]. Version 6.0.40, retrieved from <http://www.praat.org/>
- Bosma, W., Dalm, S., van Eijk, E., El Harchaoui, R., Rijgersberg, E., Tops, H. T., Veenstra, A. & Ypma, R. (2020). Establishing phone-pair co-usage by comparing mobility patterns. *Science & Justice*, 60(2), 180-190. <https://doi.org/10.1016/j.scijus.2019.10.005>
- Bradlow, A. R., Nygaard, L. C., & Pisoni, D. B. (1999). Effects of talker, rate, and amplitude variation on recognition memory for spoken words. *Perception & Psychophysics*, 61(2), 206–219. <https://doi.org/10.3758/BF03206883>
- Brümmer, N., & Du Preez, J. (2006). Application-independent evaluation of speaker detection. *Computer Speech and Language*, 20(2-3), 230–275. <https://doi.org/10.1016/j.csl.2005.08.001>
- Bürki, A. (2018). Variation in the speech signal as a window into the cognitive architecture of language production. *Psychonomic Bulletin & Review*, 25(6), 1973–2004. <https://doi.org/10.3758/s13423-017-1423-4>
- Byrd, D., Tobin, S., Bresch, E., & Narayanan, S. (2009). Timing effects of syllable structure and stress on nasals: A real-time MRI examination. *Journal of Phonetics*, 37(1), 97–110. <https://doi.org/10.1016/J.WOCN.2008.10.002>
- Byrd, D., & Saltzman, E. (2003). The elastic phrase: Modeling the dynamics of boundary-adjacent lengthening. *Journal of Phonetics*, 31(2), 149-180. [https://doi.org/10.1016/S0095-4470\(02\)00085-2](https://doi.org/10.1016/S0095-4470(02)00085-2)
- Byrne, C., & Foulkes, P. (2004). The “Mobile Phone Effect” on Vowel Formants. *International Journal of Speech Language and the Law*, 11(1), 83–102. <https://doi.org/10.1558/ijssl.v11i1.83>
- Cho, T., & McQueen, J. M. (2005). Prosodic influences on consonant production in Dutch: Effects of prosodic boundaries, phrasal accent and lexical stress. *Journal of Phonetics*, 33(2), 121–157. <https://doi.org/10.1016/j.wocn.2005.01.001>

- Cho, T., Lee, Y., & Kim, S. (2014). Prosodic strengthening on the /s/-stop cluster and the phonetic implementation of an allophonic rule in English. *Journal of Phonetics*, 46, 128-146. <https://doi.org/10.1016/j.wocn.2014.06.003>
- Cholin, J., Levelt, W. J., & Schiller, N. O. (2006). Effects of syllable frequency in speech production. *Cognition*, 99(2), 205-235. <https://doi.org/10.1016/j.cognition.2005.01.009>
- Collins, B., & Mees, I. M. (1984). *The sounds of English and Dutch* (5th ed.). Leiden, Netherlands: Brill Archive.
- Cunha, C., & Reubold, U. (2015). The contribution of vowel coarticulation and prosodic weakening in initial and final fricatives to sound change. In The Scottish Consortium for ICPhS 2015 (Ed.), *Proceedings of the 18th International Congress of Phonetic Sciences*. Glasgow, UK: the University of Glasgow. ISBN 978-0-85261-941-4. Paper number 0979 retrieved from <http://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS2015/Papers/ICPHS0979.pdf>
- De Boer, M. M., & Heeren, W. F. L. (2021, February 4-5). Language-dependency of /m/ in L1 Dutch and L2 English [Conference presentation]. *XVII National congress of the Italian Association of Speech Science (AISV)*, Zürich, Switzerland. Retrieved from https://www.cl.uzh.ch/dam/jcr:e6a8ac08-5b5b-4bba-9146-ac6d1256d72c/AISV2021_book%20of%20abstracts_v2.pdf.
- De Boer M. M., Quené H. & Heeren W. F. L. (2022), Long-term within-speaker consistency of filled pauses in native and non-native speech, *JASA Express Letters* 2(3): 035201.
- Ditewig, S., Pinget, A. C. H., & Heeren, W. F. L. (2019). Regional variation in the pronunciation of /s/ in the Dutch language area. *Nederlandse Taalkunde*, 24(2), 195–212.
- Ditewig, S., Smorenburg, L., Quené, H., & Heeren, W. (2021). An acoustic-phonetic study of retraction of /s/ in Moroccan Dutch and endogenous Dutch. *Nederlandse Taalkunde*, 26(3), 315–338. <https://doi.org/10.5117/NEDTAA2021.3.001.DITE>
- Dumay, N., Content, A., & Frauenfelder, U. (1999). Acoustic-phonetic cues to word boundary location: Evidence from word spotting. In J. O. Ohala, Y. Hasegawa, M. Ohala, D. Granville, & A. C. Bailey (Eds.) *Proceedings of the 14th international congress of phonetic sciences* (pp. 281-284). San Fransisco, USA: University of California. Retrieved

from https://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS1999/p14_0281.html

- Eaton, J. W., Bateman, D., Hauberg, S., & Wehbring, R. (2019). GNU Octave version 5.2.0 manual: a high-level interactive language for numerical computations [Computer program]. Retrieved from <https://www.gnu.org/software/octave/doc/v5.2.0/>
- Fant, G. (1970). *Acoustic theory of speech production (2nd ed.)*. The Hague: Mouton.
- Forrest, K., Weismer, G., Milenkovic, P., & Dougall, R. N. (1988). Statistical analysis of word-initial voiceless obstruents: Preliminary data. *Journal of the Acoustical Society of America*, 84(1), 115–123. <https://doi.org/10.1121/1.396977>
- Fougeron, C. (2001). Articulatory properties of initial segments in several prosodic constituents in French. *Journal of Phonetics*, 29(2), 109–135. <https://doi.org/10.1006/JPHO.2000.0114>
- Fougeron, C., & Keating, P. A. (1998). Articulatory strengthening at edges of prosodic domains. *Journal of the Acoustical Society of America*, 101(6), 3728. <https://doi.org/10.1121/1.418332>
- Friedman, J., Hastie, T., & Tibshirani, R. (2010). Regularization paths for generalized linear models via coordinate descent. *Journal of Statistical Software*, 33(1), 1–22. <https://doi.org/10.18637/jss.v033.i01>
- Fuchs, S., & Toda, M. (2010). Do differences in male versus female /s/ reflect biological or sociophonetic factors? In S. Fuchs, M. Toda, & M. Żygis (Eds.), *Turbulent sounds: an interdisciplinary guide* (pp. 281–302). Berlin: De Gruyter Mouton. <https://doi.org/10.1515/9783110226584.281>
- Fuchs, S. (2022, July 10-13). Flexibility and stability of respiration in human actions [Conference presentation]. *The 30th annual IAFPA conference*, Prague, Czech republic.
- Fujimura, O. (1962). Analysis of Nasal Consonants. *Journal of the Acoustical Society of America*, 34(12), 1865–1875. <https://doi.org/10.1121/1.1909142>
- Glenn, J. W., & Kleiner, N. (1968). Speaker Identification Based on Nasal Phonation. *Journal of the Acoustical Society of America*, 43(2), 368–372. <https://doi.org/10.1121/1.1910788>

- Gold, E., & French, P. (2011). International practices in forensic speaker comparison. *International Journal of Speech, Language and the Law*, 18(2), 293–307. <https://doi.org/10.1558/ijssl.v18i2.293>
- Gold, E., & French, P. (2019). International practices in forensic speaker comparisons: Second survey. *International Journal of Speech, Language and the Law*, 26(1), 1–20. <https://doi.org/10.1558/ijssl.38028>
- Gold, E., Ross, S., & Earnshaw, K. (2018). The “West Yorkshire Regional English Database”: Investigations into the generalizability of reference populations for forensic speaker comparison casework. In *Proceedings of the Annual Conference of the International Speech Communication Association, INTERSPEECH* (Vol. 2018, pp. 2748–2752). International Speech Communication Association. <https://doi.org/10.21437/Interspeech.2018-65>
- Goldinger, S. D. (1998). Echoes of echoes? an episodic theory of lexical access. *Psychological Review*, 105, 251–279. <https://doi.org/10.1037/0033-295X.105.2.251>
- Gow, D. W., Melvold, J., & Manuel, S. (1996). How word onsets drive lexical access and segmentation: Evidence from acoustics, phonology and processing. In *Proceedings of International Conference on Spoken Language Processing ICSLP'96* (Vol. 1, pp. 66–69), Philadelphia, PA, USA: IEEE. <https://doi.org/10.1109/icslp.1996.607031>
- Guillemin, B. J., & Watson, C. I. (2006). Impact of the GSM AMR Speech Codec on Formant Information Important to Forensic Speaker Identification. In P. Warren & C. I. Watson (Eds.) *Proceedings of the 11th Australian International Conference on Speech Science & Technology* (pp. 483–488). Australian Speech Science & Technology Association Inc.
- Gussenhoven, C. (1999). Dutch. In *Handbook of the international phonetic association* (pp. 74–77). Cambridge: Cambridge University Press.
- Hardcastle, W. J. (1985). Some phonetic and syntactic constraints on lingual coarticulation during /kl/ sequences. *Speech Communication*, 4(1–3), 247–263. [https://doi.org/10.1016/0167-6393\(85\)90051-2](https://doi.org/10.1016/0167-6393(85)90051-2)
- Harst, S. Van der, Velde, H. Van de, & Schouten, B. (2007). Acoustic characteristics of Standard Dutch /x/. In J. Trouvain & Barry, W. J. (Eds.) *Proceedings of the 16th International Congress of Phonetic Sciences* (pp. 1469–1472). Saarbrücken, Germany. Retrieved from <http://www.icphs2007.de/conference/Papers/1479/1479.pdf>

- Hawthorne, K., Mazuka, R., & Gerken, L. (2015). The acoustic salience of prosody trumps infants' acquired knowledge of language-specific prosodic patterns. *Journal of Memory and Language*, 82, 105-117.
- He, L., & Dellwo, V. (2017). Between-speaker variability in temporal organizations of intensity contours. *Journal of the Acoustical Society of America*, 141(5), EL488-EL494. <https://doi.org/10.1121/1.4983398>
- He, L., Zhang, Y., & Dellwo, V. (2019). Between-speaker variability and temporal organization of the first formant. *Journal of the Acoustical Society of America*, 145(3), EL209-EL214. <https://doi.org/10.1121/1.5093450>
- Heeren, W. F. L. (2018). Does a token's linguistic context affect its speaker-dependent information? [Conference presentation]. *Proceedings of the 26th IAFPA*, (pp 31–32), Huddersfield, UK. Retrieved from <https://www.iafpa.net/tag/2018/>
- Heeren, W. F. L. (2020a). The effect of word class on speaker-dependent information in the Standard Dutch vowel /a:/. *Journal of the Acoustical Society of America*, 148(4), 2028–2039. <https://doi.org/10.1121/10.0002173>
- Heeren, W. F. L. (2020b). The contribution of dynamic versus static formant information in conversational speech. *International Journal of Speech, Language & the Law*, 27(1), 75–98. <https://doi.org/10.1558/ijssl.41058>
- Herrmann, F., Whiteside, S. P., & Cunningham, S. (2008, June). An acoustic investigation into coarticulation and speech motor control: high vs. low frequency syllables. *Proc. Mtgs. Acoust.*, 4(1), 060007. <https://doi.org/10.1121/1.3085742>
- Hirson, A., & Duckworth, M. (1993). Glottal fry and voice disguise: a case study in forensic phonetics. *Journal of Biomedical Engineering*, 15(3), 193–200. [https://doi.org/10.1016/0141-5425\(93\)90115-F](https://doi.org/10.1016/0141-5425(93)90115-F)
- Holliday, J. J., Reidy, P. F., Beckman, M. E., & Edwards, J. (2015). Quantifying the Robustness of the English Sibilant Fricative Contrast in Children. *Journal of Speech, Language, and Hearing Research*, 58(3), 622–637. https://doi.org/10.1044/2015_JSLHR-S-14-0090
- Hoole, P., Nguyen-Trong, N., & Hardcastle, W. (1993). A comparative investigation of coarticulation in fricatives: Electropalatographic,

electromagnetic, and acoustic data. *Language and Speech*, 36(2–3), 235–260. <https://doi.org/10.1177/002383099303600307>

- Hughes, V., & Foulkes, P. (2015). The relevant population in forensic voice comparison: Effects of varying delimitations of social class and age. *Speech Communication*, 66, 218–230.
- Ingemann, F. (1968). Identification of the Speaker's Sex from Voiceless Fricatives. *Journal of the Acoustical Society of America*, 44(4), 1142–1144. <https://doi.org/10.1121/1.1911208>
- Jang, J., Kim, S., & Cho, T. (2018). Focus and boundary effects on coarticulatory vowel nasalization in Korean with implications for cross-linguistic similarities and differences. *Journal of the Acoustical Society of America*, 144(1), EL33–EL39. <https://doi.org/10.1121/1.5044641>
- Jannedy, S., & Weirich, M. (2017). Spectral moments vs discrete cosine transformation coefficients: Evaluation of acoustic measures distinguishing two merging German fricatives. *Journal of the Acoustical Society of America*, 142(1), 395–405. <https://doi.org/10.1121/1.4991347>
- Johnson, K. (2003). *Acoustic and Auditory Phonetics (2nd ed.)*. Oxford: Blackwell. <https://doi.org/10.2307/417784>
- Johnson, K. (2005). Speaker normalization in speech perception. In D. B. Pisoni & R. E. Remez (Eds.), *The handbook of speech perception* (p. 363–389). Oxford: Blackwell.
- Jongman, A., Wayland, R., & Wong, S. (2000). Acoustic characteristics of English fricatives. *Journal of the Acoustical Society of America*, 108(3), 1252. <https://doi.org/10.1121/1.1288413>
- Jovičić, S. T., Jovanović, N., Subotić, M., & Grozdić, Đ. (2015). Impact of mobile phone usage on speech spectral features: Some preliminary findings. *International Journal of Speech, Language and the Law*, 22(1). <https://doi.org/10.1558/ijssl.v22i1.17880>
- Junqua, J. (1993). The Lombard reflex and its role on human listeners and automatic speech recognizers. *Journal of the Acoustical Society of America*, 93(1), 510–524. <https://doi.org/10.1121/1.405631>
- Junqua, J.-C., Fincke, S., & Field, K. (1999). The Lombard effect: a reflex to better communicate with others in noise. In *1999 IEEE International Conference on Acoustics, Speech, and Signal Processing* (pp. 2083–2086). IEEE. <https://doi.org/10.1109/icassp.1999.758343>

- Kachkovskaia, T., Menshikova, A., Kocharov, D., Kholiavin, P., Mamushina, A. (2022, May 23-26). Social and situational factors of speaker variability in collaborative dialogues [Conference presentation]. *Proceedings of Speech Prosody 2022* (pp. 455-459). <https://doi.org/10.21437/SpeechProsody.2022-93>
- Kavanagh, C. M. (2012). New consonantal acoustic parameters for forensic speaker comparison [Doctoral dissertation]. York, UK: University of York.
- Klecka, W. R. (1980). Discriminant Analysis. In *Quantitative Applications in the Social Sciences* (Vol. 19). London: Sage Publications.
- Kleinschmidt, D. F. (2019). Structure in talker variability: How much is there and how much can it help? *Language, cognition and neuroscience*, 34(1), 43-68. <https://doi.org/10.1080/23273798.2018.1500698>
- Koenig, L. L., Shadle, C. H., Preston, J. L., & Mooshammer, C. R. (2013). Toward improved spectral measures of /s/: Results from adolescents. *Journal of Speech Language and Hearing Research*, 56(4), 1175. [https://doi.org/10.1044/1092-4388\(2012/12-0038\)](https://doi.org/10.1044/1092-4388(2012/12-0038))
- Krakov, R. A. (1993). Nonsegmental influences on velum movement patterns: Syllables, sentences, stress, and speaking rate. In M. K. Huffman & R. A. Krakow (Eds.) *Phonetics and Phonology: Nasals, Nasalization, and the Velum*, Vol. 5 (pp. 87–116). Academic Press. <https://doi.org/10.1016/b978-0-12-360380-7.50008-9>
- Künzel, H. J. (2001). Beware of the “telephone effect”: the influence of telephone transmission on the measurement of formant frequencies. *Forensic Linguistics* 8(1), 80–99.
- Kurowski, K., & Blumstein, S. E. (1984). Perceptual integration of the murmur and formant transitions for place of articulation in nasal consonants. *Journal of the Acoustical Society of America* 76(2), 383–390. <https://doi.org/10.1121/1.391139>
- Kurowski, K., & Blumstein, S. E. (1987). Acoustic properties for place of articulation in nasal consonants. *Journal of the Acoustical Society of America*, 81(6), 1917–1927. <https://doi.org/10.1121/1.394756>
- Levelt, W. J., & Wheeldon, L. (1994). Do speakers have access to a mental syllabary? *Cognition*, 50(1-3), 239-269.

- Li, F., Rendall, D., Vasey, P. L., Kinsman, M., Ward-Sutherland, A., & Diano, G. (2016). The development of sex/gender-specific /s/ and its relationship to gender identity in children and adolescents. *Journal of Phonetics*, *57*, 59–70. <https://doi.org/10.1016/J.WOCN.2016.05.004>
- Lo, J. J. H. (2021). Seeing the trees in the forest: Diagnosing individual performance in likelihood ratio based forensic voice comparison. In C. Bernardasci, D. Dipino, D. Garassino, S. Negrinelli, E. Pellegrino, & S. Schmid (Eds.) *L'individualità del parlante nelle scienze fonetiche: applicazioni tecnologiche e forensi [Speaker individuality in phonetics and speech sciences: speech technology and forensic applications]* (*Studi AISV8*, pp. 77–96. Italy, Officinaventuno. <https://doi.org/10.17469/O2108AISV000004>
- Luyckx, K., Kloots, H., Coussé, E., & Gillis, S. (2007). Klankfrequenties in het Nederlands. In *Tussen taal, spelling en onderwijs. Essays bij het emeritaat van Frans Daems* (pp. 141–154). Academia Press.
- Magen, H. S. (1997). The extent of vowel-to-vowel coarticulation in English. *Journal of Phonetics*, *25*(2), 187–205. <https://doi.org/10.1006/jpho.1996.0041>
- Maniwa, K., Jongman, A., & Wade, T. (2009). Acoustic characteristics of clearly spoken English fricatives. *Journal of the Acoustical Society of America*, *125*(6), 3962–3973. <https://doi.org/10.1121/1.2990715>
- Marslen-Wilson, W., & Zwitserlood, P. (1989). Accessing Spoken Words: The Importance of Word Onsets. *Journal of Experimental Psychology: Human Perception and Performance*, *15*(3), 576. <https://doi.org/10.1037/0096-1523.15.3.576>
- McDougall, K. (2004). Speaker-specific formant dynamics: an experiment on Australian English /ai/. *International Journal of Speech, Language and the Law*, *11*(1), 103-130.
- McDougall, K. (2006). Dynamic features of speech and the characterization of speakers: Towards a new approach using formant frequencies. *International Journal of Speech, Language and the Law*, *13*(1), 89–125. <https://doi.org/10.1558/sll.2006.13.1.89>
- Mermelstein, P. (1977). On detecting nasals in continuous speech. *Journal of the Acoustical Society of America*, *61*(2), 581–587. <https://doi.org/10.1121/1.381301>

- Monson, B. B., Lotto, A. J., & Story, B. H. (2012). Analysis of high-frequency energy in long-term average spectra of singing, speech, and voiceless fricatives. *Journal of the Acoustical Society of America*, 132(3), 1754–1764. <https://doi.org/10.1121/1.4742724>
- Morrison, G. S. (2007). Matlab implementation of Aitken & Lucy's (2004) forensic likelihood ratio software using multivariate-kernel-density estimation. [Computer program].
- Morrison, G. S., Sahito, F. H., Jardine, G., Djokic, D., Clavet, S., Berghs, S., & Dorny, C. G. (2016). INTERPOL survey of the use of speaker identification by law enforcement agencies. *Forensic science international*, 263, 92-100.
- Mourigh, K. (2017). Stance-taking through sibilant palatalisation in Gouda Moroccan Dutch. *Nederlandse Taalkunde*, 22(3), 421–446. <https://doi.org/10.5117/nedtaa2017.3.mour>
- Munson, B. (2001). A method for studying variability in fricatives using dynamic measures of spectral mean. *Journal of the Acoustical Society of America*, 110(2), 1203–1206. <https://doi.org/10.1121/1.1387093>
- Munson, B. (2004). Variability in /s/ Production in Children and Adults. *Journal of Speech Language and Hearing Research*, 47(1), 58–69. [https://doi.org/10.1044/1092-4388\(2004/006\)](https://doi.org/10.1044/1092-4388(2004/006))
- Munson, B., McDonald, E. C., DeBoe, N. L., & White, A. R. (2006). The acoustic and perceptual bases of judgments of women and men's sexual orientation from read speech. *Journal of Phonetics*, 34(2), 202–240. <https://doi.org/10.1016/J.WOCN.2005.05.003>
- Nederlands Forensisch Instituut (2020, February). Vakbijlage – Vergelijkend spraakonderzoek (version October 2016). Ministerie van Veiligheid en Justitie. Retrieved from <https://www.forensischinstituut.nl/publicaties/publicaties/2020/02/03/vakbijlage-vergelijkend-spraakonderzoek>
- Nederlands Forensisch Instituut (2017, May). Vakbijlage – De reeks waarschijnlijkheidstermen van het NFI en het Bayesiaanse model voor interpretatie van bewijs (version 2.2). Ministerie van Veiligheid en Justitie. Retrieved from <https://www.forensischinstituut.nl/publicaties/publicaties/2017/10/18/vakbijlage-waarschijnlijkheidstermen>

- Niebuhr, O., Clayards, M., Meunier, C., & Lancia, L. (2011). On place assimilation in sibilant sequences—Comparing French and English. *Journal of Phonetics*, 39(3), 429–451. <https://doi.org/10.1016/J.WOCN.2011.04.003>
- Nittrouer, S., & Whalen, D. H. (1989). The perceptual effects of child–adult differences in fricative-vowel coarticulation. *Journal of the Acoustical Society of America*, 86(4), 1266–1276. <https://doi.org/10.1121/1.398741>
- Noiray, A., Cathiard, M. A., Abry, C., & Ménard, L. (2010). Lip rounding anticipatory control: Crosslinguistically lawful and ontogenetically attuned. In B. Maassen & P. van Lieshout (eds.) *Speech motor control: New developments in basic and applied research* (pp. 153–171). Oxford: Oxford University Press.
- Nolan, F. (1983). *The Phonetic Bases of Speaker Recognition*. Cambridge Studies in Speech Science and Communication. Cambridge, UK: Cambridge University Press. <https://doi.org/10.1121/1.392415>
- Nolan, F. (2001). Speaker identification evidence: its forms, limitations, and roles. In *Law and Language: Prospect and Retrospect* (pp. 1–19). Levi, Lappland. Retrieved from <http://www.ling.cam.ac.uk/francis/lawlang.doc>
- Nortier, J., & Dorleijn, M. (2008). A Moroccan accent in Dutch: A sociocultural style restricted to the Moroccan community?. *International Journal of Bilingualism*, 12(1-2), 125-142.
- Odinot, G., Jong, D. de, Leij, J. B. J. van der, Poot, C. J. de, & Straalen, E. K. van. (2010). *Het gebruik van de telefoon- en internettap in de opsporing (Onderzoek)*. Meppel: Boom Lemma uitgevers. Retrieved from <https://repository.tudelft.nl/view/wodc/uuid:a4b1041c-0af4-4b30-bca2-ecc28dd79c8d>
- Ohala, J. J., & Kawasaki, H. (1984). *Prosodic phonology and phonetics*. *Phonology*, 1, 113–127. <https://doi.org/10.1017/S0952675700000312>
- Oliveira, M., & Freitas, T. (2008). Intonation as a cue to turn management in telephone and face-to-face interactions. In *Proceedings of Speech Prosody* (pp. 485–488). Campinas, Brazil: ISCA. Retrieved from https://www.isca-speech.org/archive/speechprosody_2008/oliveirajr08_speechprosody.html

- Oostdijk, N. H. J. (2000). Corpus Gesproken Nederlands. *Nederlandse Taalkunde*, 5(3), 280–284. Retrieved from <http://repository.ubn.ru.nl/handle/2066/76339>
- Penhallurick, R. (2008). Welsh English: Phonology. In B. Kortmann & C. Upton (eds.) *Varieties of English: The British Isles* (pp. 105-121). Berlin: Mouton de Gruyter.
- Perkell, J. S., & Matthies, M. L. (1992). Temporal measures of anticipatory labial coarticulation for the vowel /u/: Within- and cross-subject variability. *Journal of the Acoustical Society of America*, 91(5), 2911–2925. <https://doi.org/10.1121/1.403778>
- Pinget, A.-F., Van de Velde, H., & Kager, R. (2014). Cross-regional differences in the perception of fricative devoicing. In J. Caspers, J. Pacilly, W. Heeren & Y. Chen (Eds.) *Above and Beyond the Segments* (pp. 230–245). Amsterdam: John Benjamins Publishing Company. <https://doi.org/10.1075/z.189.19pin>
- Pisanski, K., Nowak, J., & Sorokowski, P. (2016). Individual differences in cortisol stress response predict increases in voice pitch during exam stress. *Physiology & behavior*, 163, 234-238.
- Quené, H., Orr, R., & Van Leeuwen, D. (2017). Phonetic similarity of /s/ in native and second language: Individual differences in learning curves. *Journal of the Acoustical Society of America*, 142, 525. <https://doi.org/10.1121/1.5013149>
- R Core Team. (2019). R: A Language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing.
- Recasens, D., & Dolorsallarè, M. (2001). Coarticulation, assimilation and blending in Catalan consonant clusters. *Journal of Phonetics*, 29, 273–301. <https://doi.org/10.006/jpho.2001.0139>
- Recasens, D. (2004). The effect of syllable position on consonant reduction (evidence from Catalan consonant clusters). *Journal of Phonetics*, 32(3), 435–453. <https://doi.org/10.1016/J.WOCN.2004.02.001>
- Redford, M. A., & Diehl, R. L. (1999). The relative perceptual distinctiveness of initial and final consonants in CVC syllables. *Journal of the Acoustical Society of America*, 106(3), 1555. <https://doi.org/10.1121/1.427152>

- Reynolds, D. A. (1995). Large Population Speaker Identification Using Clean and Telephone Speech. *IEEE Signal Processing Letters*, 2(3), 46–48. <https://doi.org/10.1109/97.372913>
- Rose, P. (2002). *Forensic Speaker Identification*. London, UK: CRC Press. <https://doi.org/10.1201/9780203166369>
- Rowe, B. M., & Levine, D. P. (2018). *A concise introduction to linguistics* (5th ed.). London: Routledge. <https://doi.org/10.4324/9781315227283>.
- Rudzicz, F. (2007). Comparing speaker-dependent and speaker-adaptive acoustic models for recognizing dysarthric speech. In *Proceedings of the 9th international ACM SIGACCESS conference on Computers and accessibility* (pp. 255-256). <https://doi.org/10.1145/1296843.1296899>
- Schilling, N. (2004). Investigating stylistic variation. In J. K. Chambers, P. Trudgill, & N. Schilling (Eds.), *The handbook of language variation and change* (pp. 375-401). John Wiley & Sons, Inc. <https://doi.org/10.1002/9781118335598.ch15>
- Scobbie, J.M. (2012). Interface and Overlap in Phonetics and Phonology. In G. Ramchand & C. Reiss (eds.) *The Oxford Handbook of Linguistic Interfaces* (pp. 17-52). Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199247455.013.0002>
- Saon, G., Soltau, H., Nahamoo, D., & Picheny, M. (2013, December). Speaker adaptation of neural network acoustic models using i-vectors. In *2013 IEEE Workshop on Automatic Speech Recognition and Understanding* (pp. 55-59). IEEE.
- Schindler, C., & Draxler, C. (2013). Using spectral moments as a speaker specific feature in nasals and fricatives. In *Proceedings of INTERSPEECH* (pp. 2793–2796). Lyon, France: ISCA. <https://doi.org/10.21437/interspeech.2013-639>
- Schwartz, M. F. (1968). Identification of Speaker Sex from Isolated, Voiceless Fricatives. *Journal of the Acoustical Society of America*, 43(5), 1178–1179. <https://doi.org/10.1121/1.1910954>
- Seitz, P. F., McCormick, M. M., Watson, I. M. C., & Bladon, R. A. (1990). Relational spectral features for place of articulation in nasal consonants. *Journal of the Acoustical Society of America*, 87(1), 351–358. <https://doi.org/10.1121/1.399256>

- Selkirk, E. (1996). The Prosodic Structure of Function Words. In J. L. Morgan & K. Demuth (Eds.), *Signal to Syntax: Bootstrapping From Speech To Grammar in Early Acquisition* (pp. 187–214). Mahwah, NJ: Erlbaum.
- Shadle, C. H. (1986). The acoustics of fricative consonants. *Journal of the Acoustical Society of America*, 79(2), 574. <https://doi.org/10.1121/1.393552>
- Shadle, C. H., & Mair, S. J. (1996). Quantifying spectral characteristics of fricatives. In *Proceeding of Fourth International Conference on Spoken Language Processing* (Vol. 3, pp. 1521–1524). Philadelphia, USA: IEEE. <https://doi.org/10.1109/ICSLP.1996.607906>
- Shadle, C. H., & Scully, C. (1995). An articulatory-acoustic-aerodynamic analysis of [s] in VCV sequences. *Journal of Phonetics*, 23(1–2), 53–66. [https://doi.org/10.1016/S0095-4470\(95\)80032-8](https://doi.org/10.1016/S0095-4470(95)80032-8)
- Shahamiri, S. R. (2021). Speech vision: An end-to-end deep learning-based dysarthric automatic speech recognition system. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 29, 852–861. <https://doi.org/10.1109/TNSRE.2021.3076778>
- Shi, R., Gick, B., Kanwischer, D., & Wilson, I. (2005). Frequency and Category Factors in the Reduction and Assimilation of Function Words: EPG and Acoustic Measures. *Journal of Psycholinguistic Research*, 34(4), 341–364. <https://doi.org/10.1007/s10936-005-6138-4>
- Silva, V. De, Iivonen, A., Bondarko, L. V., & Pols, L. C. W. (2003). Common and Language Dependent Phonetic Differences between Read and Spontaneous Speech in Russian, Finnish and Dutch. In M. J. Solé, D. Recasens, and J. Romero (Eds.), *Proceedings of the 15th International Congress of Phonetic Sciences* (pp. 2761–2764). Barcelona, Spain. ISBN 1-876346-48-5.
- Simpson, A. P. (2009). Phonetic differences between male and female speech. *Language and linguistics compass*, 3(2), 621–640.
- Singmann, H. (2019). afex: Analysis of factorial experiments [Computer program]. Retrieved from <https://github.com/singmann/afex/>
- Smorenburg, L., & Heeren, W. (2020). The distribution of speaker information in Dutch fricatives /s/ and /x/ from telephone dialogues. *Journal of the Acoustical Society of America*, 147(2), 949–960. <https://doi.org/10.1121/10.0000674>

- Smorenburg, L., & Heeren, W. (2021a). Acoustic and speaker variation in Dutch /n/ and /m/ as a function of phonetic context and syllabic position. *Journal of the Acoustical Society of America*, 150(2), 979–989. <https://doi.org/10.1121/10.0005845>
- Smorenburg, L., & Heeren, W. (2021b, August 22-25). Effects of speech channel on acoustic measurements and speaker discrimination from /s/ [Conference presentation]. *The 29th conference of IAFPA*, Marburg, Germany. Retrieved from <https://scholarlypublications.universiteitleiden.nl/handle/1887/3210581>
- Smorenburg, L., & Heeren, W. (2021c, February 4-5). Forensic value of acoustic-phonetic features from Standard Dutch nasals and fricatives [Conference presentation]. *XVII National congress of the Italian Association of Speech Science (AISV)*, Zürich, Switzerland. Retrieved from https://www.cl.uzh.ch/dam/jcr:e6a8ac08-5b5b-4bba-9146-ac6d1256d72c/AISV2021_book%20of%20abstracts_v2.pdf.
- Solé, M.-J. (2003). Aerodynamic characteristics of onset and coda fricatives. In M. J. Solé, D. Recasens, and J. Romero (Eds.), *Proceedings of the 15th International Congress of Phonetic Sciences* (pp. 2761-2764). Barcelona, Spain. ISBN 1-876346-48-5 retrieved from https://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS2003/p15_2761.html
- Soli, S. D. (1981). Second formants in fricatives: Acoustic consequences of fricative-vowel coarticulation. *Journal of the Acoustical Society of America*, 70(4), 976–984. <https://doi.org/10.1121/1.387032>
- Stevens, K. N. (2000). *Acoustic phonetics* (Vol. 30). London, UK: MIT press.
- Stuart-Smith, J. (2007). Empirical evidence for gendered speech production: /s/ in Glaswegian. In J. Cole & J. I. Hualde (eds.) *Laboratory Phonology 9* (pp. 65–86). New York, USA: Mouton de Gruyter.
- Su, L., Li, K. -P., & Fu, K. S. (1974). Identification of speakers by use of nasal coarticulation. *Journal of the Acoustical Society of America*, 56(6), 1876–1883. <https://doi.org/10.1121/1.1903526>
- Sumner, M., Kim, S. K., King, E., & McGowan, K. B. (2014). The socially weighted encoding of spoken words: A dual-route approach to speech perception. *Frontiers in Psychology*, 4, 1015. <https://doi.org/10.3389/fpsyg.2013.01015>

- Tabain, M., Butcher, A., Breen, G., & Beare, R. (2016). An acoustic study of nasal consonants in three Central Australian languages. *Journal of the Acoustical Society of America*, 139(2), 890–903. <https://doi.org/10.1121/1.4941659>
- Toda, M., Maeda, S., & Honda, K. (2010). Formant-cavity affiliation in sibilant fricatives. In S. Fuchs, M. Toda, & M. Zygis (Eds.) *Turbulent Sounds - an Interdisciplinary Guide* (pp. 343–374). Mouton de Gruyter. <https://doi.org/10.1515/9783110226584>
- Tracy, E. C., Bainter, S. A., & Satariano, N. P. (2015). Judgments of self-identified gay and heterosexual male speakers: Which phonemes are most salient in determining sexual orientation? *Journal of Phonetics*, 52, 13–25. <https://doi.org/10.1016/J.WOCN.2015.04.001>
- Van Bael, C., Van den Heuvel, H., & Strik, H. (2004). Investigating Speech Style Specific Pronunciation Variation in Large Spoken Language Corpora Large Spoken Language Corpora. In Proceedings of Interspeech (ICSLP), Jeju, Korea. Retrieved from http://www.isca-speech.org/archive/interspeech_2004/i04_2793.html
- Van Bergem, D. R. (1993). Acoustic vowel reduction as a function of sentence accent, word stress, and word class. *Speech Communication*, 12(1), 1–23. [https://doi.org/10.1016/0167-6393\(93\)90015-D](https://doi.org/10.1016/0167-6393(93)90015-D)
- Van Bergem, D. (1995). Acoustic and lexical vowel reduction [Doctoral dissertation]. Universiteit van Amsterdam.
- Van Berkum, J. J. A., Van Den Brink, D., Tesink, C. M. J. Y., Kos, M., & Hagoort, P. (2008). The neural integration of speaker and message. *Journal of Cognitive Neuroscience*, 20(4), 580–591. <https://doi.org/10.1162/jocn.2008.20054>
- Van der Harst, S., & Van de Velde, H. (2006). 17 G's in het Standaardnederlands? *Taal en Tongval*, 59, 172–195.
- Van den Heuvel, H. (1996). *Speaker variability in acoustic properties of Dutch phoneme realisations* [Doctoral dissertation]. Nijmegen, Netherlands: Radboud Universiteit.
- Van Leeuwen, D. (2011). SREtools: Compute performance measures for speaker recognition [Software program]. Retrieved from <https://github.com/davidavdav/sretools.R/>

- Van Oostendorp, M. (2001). Nasal consonants in variants of Dutch and some related systems. *Neerlandistiek*. Retrieved from <https://dSPACE.library.uu.nl/handle/1874/28504>
- Van de Pol, W. (2006). *Onder de tap, Afluisteren in Nederland*. Amsterdam: Balans.
- Van Son, R. J. J. H., & Van Santen, J. P. H. (2005). Duration and spectral balance of intervocalic consonants: A case for efficient communication. *Speech Communication*, 47(1–2), 100–123. <https://doi.org/10.1016/j.specom.2005.06.005>
- Van de Velde, H., & Van Hout, R. (2000). N-deletion in reading style. *Linguistics in the Netherlands*, 17(1), 209–219.
- Van de Velde, H., & van Hout, R. (2001). Spreekertypologie met betrekking tot de realisering van de slot-n in het Standaard-Nederlands. *Taal en tongval*, 14, 89–112.
- Van der Vloed, D., Kelly, F., & Alexander, A. (2020). Exploring the Effects of Device Variability on Forensic Speaker Comparison Using VOCALISE and NFI-FRIDA, A Forensically Realistic Database. In *Proceedings of the Odyssey Speaker and Language Recognition Workshop* (pp. 402–407). Tokyo, Japan: ISCA. <https://doi.org/10.21437/odyssey.2020-57>
- Venables, W. N. & Ripley, B. D. (2002). *Modern Applied Statistics with S* (4th ed.). New York, USA: Springer
- Viszlay, P., Juhár, J., & Pleva, M. (2012). Alternative phonetic class definition in linear discriminant analysis of speech. In *19th International Conference on Systems, Signals and Image Processing* (pp. 637–640). Vienna, Austria: IEEE.
- Voeten, C. (2020). buildmer: Stepwise Elimination and Term Reordering for Mixed-Effects Regression. R package version 1.5 [Computer program]. <https://CRAN.R-project.org/package=buildmer>
- Voeten, C. C., Heeringa, W., & Van de Velde, H. (2022). Normalization of nonlinearly time-dynamic vowels. *Journal of the Acoustical Society of America*, 152(5), 2692–2710. <https://doi.org/10.1121/10.0015025>
- Wang, B. X., Hughes, V., & Foulkes, P. (2021, February 4–5). System performance and speaker individuality in LR-based forensic voice comparison [Conference presentation]. *XVII National congress of the Italian Association of Speech Science (AISV)*, Zürich, Switzerland.

Retrieved from https://www.cl.uzh.ch/dam/jcr:e1037cb2-8839-4b8a-89f3-a2cc428cf2ff/AISV_2021_Wang%20Hughes%20Foulkes.pdf

- Weatherholtz, K., & Jaeger, T. F. (2016). Speech Perception and Generalization Across Talkers and Accents. *Oxford Research Encyclopedia of Linguistics*. <https://doi.org/10.1093/acrefore/9780199384655.013.95>.
- Weirich, M. (2015). Organic sources of inter-speaker variability in articulation: Insights from twin studies and male and female speech. In S. Fuchs, D. Pape, C. Petrone, & P. Perrier (Eds.) *Individual differences in speech production and perception* (Vol. 3, pp. 189–222). Peter Lang International Academic Publishers.
- Yun, G. (2006). The effects of lexical frequency and stress on coarticulation. In *Annual Meeting of the Berkeley Linguistics Society* (Vol. 32, No. 1, pp. 441–452).

