Phonetics of head nods in German Sign Language (DGS)

Anastasia Bauer[1], Anna Kuder[1], Marc Schulder[2]

[1]University of Cologne

[2]University of Hamburg

{anastasia.bauer, akuder}@uni-koeln.de; marc.schulder@uni-hamburg.de

Head nod is one of the most commonly produced bodily signals in interaction, an up-and-down movement of the head, often repeated. Both signers/speakers as well as addressees produce head nods during the interaction. Head nod is associated with a number of different functions in communicative interaction such as affirmation, emphasis, affiliation, and feedback among other (Darwin 1872; Heath 1992; McClave 2000; Cerrato 2005; Stivers 2008; Pupponen et al. 2015). As for spoken languages, it has been suggested that distinct forms of nods convey particular meanings even in the absence of accompanying verbal tokens. Whitehead (2011:28) suggests that in spoken English dyadic interaction expansive nods appear to be used to register a prior utterance as news and less expansive nods can be used to register receipt of a prior utterance without treating it as news. Linguists working on sign languages have so far described head nods as aspectual or prosodic nonmanual markers to signal clause and constituent boundaries and to mark phonological and intonational phrases in signed narratives (Liddell 1980; Nespor & Sandler 1999; Volk & Herrmann 2021; Wilbur 2021). Not much is known about the phonetic properties of head nods and their interaction with other (non-)manual elements in signed conversation, especially when the head nods are used by the addressee during interaction.

In this study we analyze head nods in German Sign Language (DGS), using the Public DGS Corpus (Konrad et al., 2020). We identify that head nods simultaneously occur with various (non)-lexical manual forms, but more frequently head nods are produced on their own and/or replace the manual signs. The aim of the study is two-fold. First, we describe the basic phonetic properties of head nods in DGS and their interaction with manual signs. Secondly, we investigate whether the phonetic properties of head nods fulfilling various functions in discourse differ significantly. We hypothesize that head nods functioning as affirmative responses are larger in amplitude than head nods which signal feedback in interaction. We define feedback very broadly as interactional moves that display some kind of stance towards the information represented by another signer and focus in our analysis on the most frequent type of feedback (Dingemanse et al. 2022) variously called continuers (Schegloff 1982) or backchannels (Mesch 2016). In our data we consider head nods which function as responsive items indicating a non-uptake of a conversation turn and demonstrating understanding. This provides participants in conversations with a sense that things are proceeding smoothly, including that current signer is being understood (Gardner 2001). Common examples of continuers are verbal forms like *mm, uh huh, yeah* in English (Liesenfeld & Dingemanse 2022). We expect that head nods functioning as continuers have a smaller amplitude but a longer duration of the movement and are typically produced without co-occurring manual signs.

To test this prediction, we use the body pose information provided by the Public DGS Corpus. Based on this information, which was automatically generated using the Computer Vision (CV) tool OpenPose (Cao et al., 2019), we calculate head nods measurements from video recordings (see Figure 1), and investigate the head nods in DGS in terms of the number of peaks, the amplitude of the nod, the frequency and the duration of these head movements. We also inspect the spectral qualities of head nods through the use of Short-time Fourier transforms. For this study we investigate 2 hours of naturalistic dyadic interaction from 10 native DGS signers. Prior to the analysis, we identify all head nods in the data and annotate them manually in ELAN. Consequently, we use the pose information to compute statistics about head nodding to further analyze phonetic properties of these movements quantitatively. The applicability of CV-tools for phonetic analysis of non-manuals has lately been successfully tested for sign languages (Kimmelman et al. 2020). Chizhikova & Kimmelman (2022:34) had shown that a semi-automatic approach, a combination of measurements extracted with pose estimation software and a manual inspection of video recordings, appears to be the most suitable for linguistic analysis of non-manuals for the time-being. Building on their work we analyzed the phonetics of head nods using the same approach.

While the quantitative data analysis as well as the data annotations are still ongoing, our preliminary results indicate that different phonological types of head nods may exist in DGS. Having analyzed 545 head nods in our data, we find some interesting tendencies. Our data appears to be much richer with head nods which are used as continuers to display recipiency and understanding (70%) rather than the head nods used as affirmative responses (3%). While more data is needed to verify the initial findings, we notice that head nods used as continuers appear to be produced noticeably slower, longer and less expansive in their amplitude than the head nods used as affirmation. Such slower and less expansive head movements could be justified by the unwillingness to signal the desire or intention of the addressee to interrupt or take over the floor.

Index Terms: head nods, German Sign Language, sign-gesture interaction, feedback signals, pose estimation

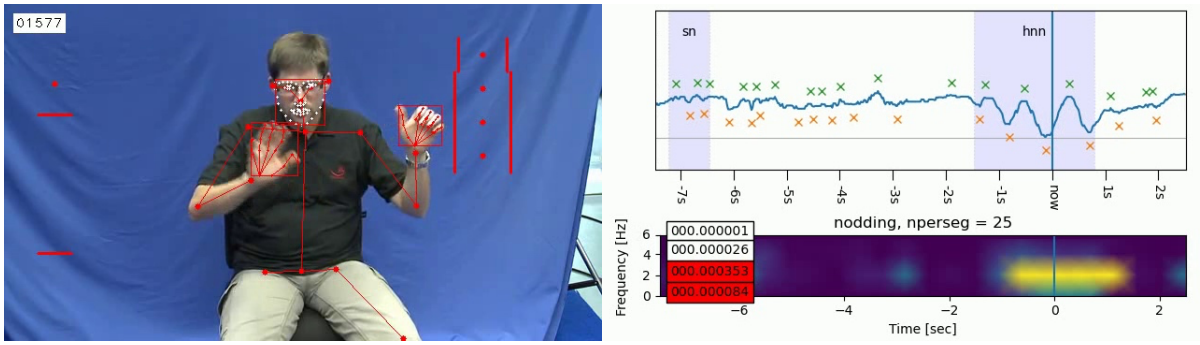

Figure 1: *Visualisation of head nods. The source video (left) is overlaid with the OpenPose body points used for the calculations. On the line graph (upper right) the upper (blue) line represents the vertical motion of the nose relative to body position, while the lower (red) line indicates the nose location prediction confidence of OpenPose (worse during blur or when occluded) Light blue boxes indicate durations manually labeled as head nods. The spectrogram (lower right) visualizes the spectrum of frequencies of vertical nose movement, with brighter areas indicating repeated up and down motion as during nodding.*

References

Cao, Z., Hidalgo, G., Simon, T., Wei, S.-E. & Sheikh, Y. A. 2019. OpenPose: Realtime Multi-Person 2D Pose Estimation using Part Affinity Fields. *IEEE Transactions on Pattern Analysis and Machine Intelligence* 43(1), 172–186. https://doi.org/10.1109/TPAMI.2019.2929257

Cerrato, L. 2005. Linguistic functions of head nods. In Allwood, J., Dorriots, B. (Eds.), *Proceedings from The Second Nordic Conference on Multimodal Communication*. Göteborg: Göteborg University, 137–152.

Chizhikova, A., & Kimmelman, V. 2022. Phonetics of Negative Headshake in Russian Sign Language: A Small-Scale Corpus Study. In Efthimiou, E., Fotinea, S-E., Hanke, T., Hochgesang, J.A., Kristoffersen, J., Mesch, J., & Schulder, M. (Eds.), *Proceedings of the 10th Workshop on the Representation and Processing of Sign Languages: Multilingual Sign Language Resources. International Conference on Language Resources and Evaluation (LREC 2022).* Marseille, France: European Language Resource Association (ELRA), 29–36.

Darwin, C. 1872. *The expression of the emotions in man and animals*. London: John Murray.

Dingemanse, M., Liesenfeld, A., & Woensdregt, M. 2022. Convergent Cultural Evolution of Continuers (mmhm). *PsyArXiv.* https://doi.org/10.31234/osf.io/65c79

Gardner, R. 2001. *When Listeners Talk: Response tokens and listener stance*. John Benjamins Publishing Company. https://doi.org/10.1075/pbns.92

Heath, C.1992. Gesture's discreet tasks: Multiple relevancies in visual conduct and in the contextualization of language. In Auer, P., & Di Luzio, A. (Eds.), *The contextualization of language*. Amsterdam: John Benjamins, 101–127.

Kimmelman, V., Imashev, A., Mukushev, M., & Sandygulova, A. 2020. Eyebrow Position in Grammatical and Emotional Expressions in Kazakh-Russian Sign Language: A Quantitative Study. *PLoS ONE* 15(6).

Konrad, R., Hanke, T., Langer, G., Blanck, D., Bleicken, J., Hofmann, I., Jeziorski, O., König, L., König, S., Nishio, R., Regen, A., Salden, U., Wagner, S., Worseck, S., Böse, O., Jahn, E., & Schulder, M. 2020. MY DGS – annotated. Public Corpus of German Sign Language, 3rd release [Dataset]. Universität Hamburg. https://doi.org/10.25592/dgs.corpus-3.0

Liesenfeld, A., Dingemanse, M. (2022) Bottom-up discovery of structure and variation in response tokens ('backchannels') across diverse languages. *Proc. Interspeech 2022*, 1126-1130, doi: 10.21437/Interspeech.2022-11288

Liddell, S. 1980. *American Sign Language Syntax.* Berlin, Boston: De Gruyter Mouton.

McClave, E. Z. 2000. Linguistic functions of head movements in the context of speech. *Journal of Pragmatics*, 32(7), 855–878. https://doi.org/10.1016/S0378-2166(99)00079-X

Mesch, J. (2016). Manual backchannel responses in signers' conversations in Swedish Sign Language. *Language & Communication*, 50, 22–41. https://doi.org/10.1016/j.langcom.2016.08.011

Nespor, M., & Sandler, W. 1999. Prosody in Israeli Sign Language. *Language and Speech*, 42(2-3), 143–176. https://doi.org/10.1177/00238309990420020201

Puupponen, A., Wainio, T., Burger, B., & Jantunen, T. 2015. Head Movements in Finnish Sign Language on the Basis of Motion Capture Data: A Study of the Form and Function of Nods, Nodding, Head Thrusts, and Head Pulls. *Sign Language & Linguistics* 18(1), 41–89. https://doi.org/10.1075/sll.18.1.02puu.

Schegloff, E. A. 1982. Discourse as an interactional achievement. some uses of 'uh huh' and other things that come between sentences, *Analyzing Discourse. Text and Talk* (Deborah Tannen, ed.), Washington, D.C., Georgetown University Press, 71–93.

Stivers, T. 2008. Stance, Alignment, and Affiliation During Storytelling: When Nodding Is a Token of Affiliation. *Research on Language and Social Interaction* 41(1), 31–57. https://doi.org/10.1080/08351810701691123.

Volk, E., & Herrmann, A. 2021. Discourse Particles - Theoretical Perspectives. In: Quer, J., Pfau, R., & Herrmann, A. (Eds.), *Theoretical and Experimental Sign Language Research*. London: Routledge, 480–499.

Whitehead, K. (2011). Some uses of head nods in "third position" in talk-in-interaction. *Gesture,* 11/2, 103–122.

Wilbur, R. 2021. Non-manual markers. Theoretical and experimental perspectives. In: Quer, J., Pfau, R., & Herrmann, A. (Eds.), *Theoretical and Experimental Sign Language Research*. London: Routledge, 530–565.