

### **Supplemental Material S5. Data visualization using tSNE embeddings.**

Hidden layer features were extracted for all recordings and visualized in 2 dimensions using t-distributed stochastic neighbor embedding (tSNE) plots (Van der Maaten & Hinton 2008). Dimensionality reduction via tSNE preserves both inter-cluster and intra-cluster distances between feature vectors. Each point in the tSNE plots corresponded to a recording and was labeled by diagnosis, DDK rate, ALSFRS-R speech subscore, ALSFRS-R salivation subscore, and ALSFRS-R dressing subscore.

The intermediate feature representations are high-dimensional; however, we can project them on two dimensions for visualization using t-distributed Stochastic Neighbor Modeling (tSNE) described by Van der Maaten et al., 2008. Acoustic model features were extracted from all recordings in the ALS-at-Home data, and the resulting tSNE visualization is shown in (Figure S5). Clustering via tSNE aligns with the observed classification performance: there is minimal overlap between the bulbar and healthy recordings, and moderate overlap between healthy and non-bulbar recordings (Figure S5a). The first TSNE axis correlates highly with the DDK rate and bulbar function: in Figure S5b-S5d, each point represents one DDK recording and color gradient was applied based on the estimated DDK rate (Figure S5b), the ALSFRS-R speech subscore (Figure S5c), and the ALSFRS-R salivation subscore (Figure S5d). Figure S5e colors each recording by ALSFRS-R dressing subscore, a measure of gross motor function. This figure demonstrates that the speech features cluster by relevant clinical variables (e.g., ALSFRS speech/salivation subscore), but they do not cluster by clinical variables that are not captured by speech (e.g., ALSFRS dressing subscore). A more detailed discussion of this follows in the ensuing section.

TSNE visualizations (Figure S5) of the average feature vector extracted from each recording demonstrated that the hidden layer features stratify assessments by bulbar function. A clear right to left gradient of the bulbar function is observable in the plots. Recordings toward the right of the plots, along the first tSNE axis, corresponded to high DDK rate (Figure S5b), high ALSFRS-R speech subscore (Figure S5c), and high salivation subscore (Figure S5c). Points progressively towards the left of the first tSNE axis corresponded with gradually lower DDK, and lower ALSFRS-R bulbar subscores. However, no such gradient is present when plotting ALSFRS-R subscores associated with limb onset and gross motor function, such as dressing subscore (Figure S5e). The use of tSNE as a visualization tool to visualize high dimensional data is common not only for clinical data but a wide range of other applications. This provides strong evidence that the acoustic model features extracted from the DDK task are clinically useful in observing the impact of bulbar onset ALS on speech function.



