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ABSTRACTS

were less accurate than for the corresponding native vowels, with considerable individual differences in imitation success related to training. fMRI results showed significantly greater activation in somato-motor cortex, IFG and superior temporal cortex when participants listened in preparation to produce speech, versus either listening without preparation to repeat, or during production itself. Effects of training varied across individuals, and were associated with activation of lateral somato-motor, inferior frontal and cerebellar regions. rtMRI data revealed measurable changes in lip aperture, and some evidence of increased lip protrusion, due to training in lip rounding. Profiles of distance between articulators across the length of the vocal tract also allowed us to identify the articulatory changes related to rounding. Using representational similarity statistics (Kriegeskorte et al., 2008), we then applied a novel analysis approach, by directly comparing rtMRI of vocal tract articulators to fMRI activity during phoneme production. By generating representational similarity matrices to describe the articulation of different vowel categories, we were able to probe the functional fronto-temporal speech production network to identify regions representing the categorical dimensionality of trained and untrained vowels. These results will help to inform an account of vocal imitation as a skill, with respect to acoustic, articulatory and neural indices.

E39 Imitation and language development in deaf and hearing schoolchildren *Emil Holmer[1], Mikael Heimann[2], Mary Rudner[1]; [1]Linnaeus Centre HEAD, Swedish Institute for Disability Research, Department of Behavioural Sciences and Learning, Linköping University, [2]Swedish Institute for Disability Research and Division of Psychology, Department of Behavioural Sciences and Learning, Linköping University*

Introduction: Deaf signing children and hearing children reveal different developmental trajectories in several aspects of neurocognitive functioning; however, comparative studies of imitation across these groups are lacking. Imitation has been suggested to play a part in language and cognitive development, and the ability to imitate indicates multi-modal integration and analysis (e.g., Meltzoff & Williamson, 2013). Thus, understanding the function of imitation in typical and atypical groups is of theoretical interest, but may also have practical implications. Because sign language is gesture based, it is likely that deaf signing children can tap into existing linguistic representations during gesture imitation whereas only motor representations are available for non-signing individuals. Thus, gesture imitation is likely to be supported by different cognitive skills in the signing and non-signing individuals. Importantly, imitation may expose qualities of generic mechanisms in the representational system. Method: Thirteen school-aged deaf users of Swedish Sign Language and 36 hearing non-signing children, at similar levels of non-verbal cognitive ability and word reading skills, performed an experimental imitation task. The task involved spontaneous imitation of a set of manual gestures. Participants performed the task at two occasions, separated by 35 weeks. Tests of non-verbal intelligence, visual working memory, phonological awareness, word reading and reading comprehension were also administered. We investigated the precision of the imitative acts across groups and time, as well as relationships between imitative precision and cognitive and language skills in both groups. Results: A split-plot repeated measures ANOVA demonstrated that deaf signers imitate manual gestures with greater precision than hearing non-signing children. Further, improvement in imitative precision over time was greater for deaf than for hearing participants. Correlational patterns indicated that imitative precision was positively associated with language skills in both groups. Specifically, for deaf children, word reading skills at both assessment points and performance on a sign similarity judgment task at the second assessment were correlated positively with imitative precision. For the hearing participants, positive connections to word reading skills and performance on a rhyme task were observed at the second assessment point. In both groups, a significant connection between imitative precision and reading comprehension was observed at the second assessment point. Conclusion: Our results demonstrate that sign language experience enhances the ability to imitate manual gestures longitudinally. They also show that imitation ability is linked to language skills in the non-manual, speech-related domain. We propose that the precision of imitative acts reflects the quality of linguistic and motor representations and the ability to employ them in language processing.

E40 Language lateralization in right- and left-handed individuals: an fMRI study *Grigory Ignatyev[1], Rosa Vlasova[1,2], Yulia Akinina[1,3], Maria Ivanova[1], Olga Dragoy[1]; [1]National Research University Higher School of Economics, [2]Federal Center of Medicine and Rehabilitation, [3]University of Groningen*

There are a number of neuroimaging studies focusing on handedness and language lateralization. These studies compare mean lateralization indices (LI) between groups (Ramsey, Sommer, Rutten, & Kahn, 2001), present a correlation between LI and handedness quotients (HQ) (Szaflarski et al., 2002), or assess variability of hemisphere dominance within different groups (Pujol, Deus, Losilla, & Capdevila, 1999). The goal of the present study was to measure functional language lateralization in healthy right- and left-handers and to test the following hypotheses: i) whether mean LIs between these groups are different; ii) whether there is a correlation between LI and HQ; and iii) whether there is a higher variability of hemisphere dominance within the group of left-handers. Language-related lateralization of brain activation within the frontal and the temporal lobes were assessed. A block design fMRI paradigm and a sentence completion task were used. Each block consisted of three five-word incomplete sentences with a direct object omitted, e.g. «Yesterday the detective

cautiously unlocked the …». Sequences of meaningless syllables of equal length were used in the control condition. Participants had to read the sentences and syllables aloud and either to complete a sentence with a single word or to repeat the last syllable of the presented sequence. Thirteen healthy subjects (6 right- and 7 left-handed; 7 female; mean age 24 years) were tested. Handedness quotient for each participant was calculated using the Edinburgh Handedness Inventory (Oldfield, 1971). FMRI images were acquired in a 1.5T Siemens Avanto scanner using a sparse-sampling paradigm to minimize scanner noise and to register participants' responses. The data were analyzed in the SPM12 software. Lateralization indices were calculated in the LI toolbox (Wilke & Lidzba, 2007) using t-weighting of voxels and frontal and temporal lobes masks. Two-way ANOVA was performed to compare LIs between the groups and the lobes. No significant difference between the groups was found ($F = 1.8$, $p = .21$), but the main effect of the lobe (frontal vs. temporal) was revealed ($F = 7.2$, $p = .02$), with higher LI within the frontal lobe ($M = .69$, $SD = .31$) compared to the temporal lobe ($M = .34$, $SD = .36$). No significant correlation was found between LI and HQ ($r = .24$, $p = .45$). There was low variability of hemisphere dominance within the group of right-handers (all of them showing left hemisphere dominance, threshold = .25), but the variability increased in the group of left-handers, two of them showing bilateral activation. Thus, the present study failed to find difference between mean LIs in the groups of left- and right-handers, and no correlation between HQ and LI was revealed (likely due to the small sample). However, a significant difference in the variability of hemisphere dominance was found, the group of right-handers having more uniformly left-lateralized activation. Overall higher LIs in the frontal lobe suggest that language lateralization within anterior language regions is universally stronger than in the temporal lobe. Acknowledgement: The study was supported by the Russian Foundation for Basic Research (grant 15-06-08516a).

E41 Direct Cortical Recording of Regions Implicated in Speech Production During Pseudoword Articulation

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To date, many studies have investigated the neural correlates of speech production. Results have implicated multiple cortical regions in articulation, including the superior precentral gyrus of the insula (SPGI; Dronkers, 1996), inferior frontal gyrus pars opercularis (IFGpo; Hillis et al., 2004; Richardson et al., 2012), precentral gyrus (PrCG; Graff-Radford et al., 2014; Basilakos et al., 2015), and post-central gyrus (PoCG; Hickok et al., 2014). Thus, a network of regions is involved in articulation, but questions have arisen regarding regions that are crucial for articulation, and which are involved in a more secondary role. The insula has traditionally been discussed as the primary region for coordinating articulatory movements, with support from lesion data (Dronkers, 1996) and studies that show its response is modulated with increasing articulatory difficulty (Ogar et al., 2006; Baldo et al., 2011). However, more recent studies with post-stroke individuals have provided greater support for the primary role of other regions in speech production. Here, we report findings from direct cortical recordings of two patients who completed an articulation task while undergoing intracranial EEG monitoring for surgical management of epilepsy. Both patients had electrode contacts in areas implicated in speech production. One patient (Patient 2) had depth electrode placement in the left and right anterior insula (AIns), allowing for direct observation of insula activity during articulation. The two patients (both female, ages 25, 36) were implanted with 10-channel stereo-electroencephalographic (sEEG) depth electrodes. Patients completed a pseudoword articulation task, consisting of twelve different bisyllabic pseudowords presented over eight blocks. Stimuli belonged to one of two groups – easy (CVCV) and hard (CCVCCV). A post-implant structural T1-MRI was used to localize electrodes. Normalization of T1 images was completed with the Clinical Toolbox for SPM8. Normalization utilized cost-function masking, where electrode locations were manually drawn on each T1. Contact coordinates were localized with the AAL atlas (Tzourio-Mazoyer et al., 2002). High gamma activity in the following regions of interest were analyzed with an in-house code for Matlab: premotor cortex, PrCG, PoCG, L and R AIns, and IFGpo. The following analyses were completed in 100msec time bins prior to and after the onset of articulation: 1) pseudoword articulation>pseudoword perception; and 2) hard>easy articulation (level of significance set to $p<0.05$). T-tests of high-gamma activation for contacts in the LAIns, RPoCG, and left premotor cortex reveal significant effects for articulation relative to perception. Inspection of the time course of articulation shows that significant differences emerged in the RPoCG and left premotor cortex first, followed by the LAIns. For the hard>easy articulation conditions, the following patterns emerged: the LPoCG, left and right premotor cortex, and RPrCG showed a significant effect of condition, whereas the IFGpo, left and right AIns did not show this effect. This study did not find that the AIns is modulated by articulatory task difficulty; rather, this modulation was found for the premotor, motor and post-central sensory regions. Although our sample size is limited, these results add to the growing body of literature suggesting that articulation is crucially supported by sensorimotor cortical regions.

E42 Syllable is proximate unit of word-form encoding in speech production for Mandarin speakers

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