Speakers and listeners switch their roles with small or even no time lag during conversations. Such accurate timing requires the next speaker of a conversation to anticipate the moment when the current turn is going to end, because the production system is quite slow and the response must be underway before the other speaker has stopped speaking. How people are able to anticipate the end of a turn is topic of current research. In earlier work it was shown that anticipation of a turn-end relies more on the semantic and syntactic information of a turn than on the prosody (De Ruiter et al., 2006). However, it is yet unclear how lexico-syntactic information helps in predicting the moment when a turn ends. We hypothesize that people can predict the time of turn-ends by predicting the upcoming word forms that finish the turn. We have shown that turns which end-point can be more accurately predicted have also more predictable last words (Magyari, De Ruiter, 2008). Evidence for anticipatory processes that pre-activate words during sentence processing has been around for some time (DeLong et al., 2005), but turn-taking provides evidence that language comprehension should help also in estimating the duration of the upcoming linguistic information. Such forward-looking processing is crucial for response preparation.

In order to gain a better understanding of the anticipatory processes involved in turn-taking, we need to have a better view on the temporal evolution of turn-end anticipation. Word production experiments have shown that it takes 600-1200 ms for the production system to get from the thought to the articulation of a word (Indefrey, Levelt, 2004). Therefore, preparation for a turn-end must be active at least 600 ms before a (predictable) turn-end. Similarly, turn-end anticipation must occur also around this time as latest.

To test this hypothesis empirically, we recorded EEG in order to identify the neuronal processes accompanying the anticipation of turn ends. We focused on the dynamics of EEG oscillations, as oscillatory dynamics have been clearly associated with both motor and non-motor anticipation in the past (Bastiaansen, Brunia, 2001).

In our experiment, participants were listening to turns taken out of real conversations and they were instructed to try press a button exactly when a turn ended. The experimental task and stimuli were the same as in De Ruiter et al.'s study (2006). In a behavioral pretest, we used a gating paradigm to quantify the predictability of the last few words of each turn. Turns in which the last few words were predictable were assigned to the predictable (PRED) condition, turns with less predictable last few words formed the unpredictable (UNPRED) condition. Next to a 64-channel EEG recording, we also recorded the (timing accuracy of the) button-presses.

The behavioral results showed that participants were more accurate in predicting turn-ends in the PRED condition than in the UNPRED condition. Time-frequency analysis performed on the EEG data from 2 s before until the button-press showed that oscillatory dynamics were significantly different between the two conditions in the 11-18 Hz (lower beta) frequency range. Over frontal electrodes, we observed a significant beta band power decrease starting as early as 1.7 s before the button-press in the PRED condition. In the UNPRED condition, a beta power increase was observed during this time interval. Over motor areas, beta power decreases were observed for both conditions. In order to estimate the source of the frontal beta power decrease we used a source-localization method based on beamformers (Dynamic Imaging of Coherent Sources, Gross et al., 2001). This analysis revealed sources in
midfrontal and left frontal areas, with a maximum in the left inferior frontal gyrus (LIFG, BA 47).

Figure 1. A) Time-frequency representation (TFR) of the oscillatory activity at electrode 59. The x-axis represents the time from 2s before the button-press until the button-press. The y-axis represents the frequency bins. The relative power changes are color-coded (see the color bars). The first column shows the TFRs for each condition. The second column shows the differences of the TFRs between the two conditions. The third column shows only the significant differences. B.) Schematic head with the electrode positions. Electrode 59 is shown in black. C.) The source reconstruction of the significant beta power changes.

The button-press results further support the claim that people rely on their predictions about the upcoming word forms for anticipating turn ends. The EEG results showed that people anticipated the turn-end already 1.7 s before the button-press when the words were predictable in the turn. Further, the EEG data suggest that turn-end anticipation is mediated by midfrontal and left frontal cortical areas, including LIFG. The LIFG has been proposed to play a role in the unification of sentence- and discourse-level linguistic information. The midfrontal areas have been suggested to be part of a functional network that is involved in verbal action planning and attentional control (Hagoort, 2005). The source localization results suggest that brain areas involved in estimating the timing of a turn-end are part of the same functional network that subserves sentence and discourse-level comprehension processes and control.

References: