

of the human-computer interface and a better design of adaptive strategies of automation. In a number of recent studies, we explored an alternative to traditional measure mental fatigue: the dynamics of saccadic eye movements. The relationships between the amplitude, peak velocity and duration of saccadic eye movements are described as the “main sequence”. A special purpose of our work was to explore the sensitivity of the main sequence, particularly saccadic peak velocity, to changes in the driver’s mental state, during and after two hours of driving. Saccadic peak velocity and other parameters of eye movements were examined as a diagnostic measure of mental fatigue in a virtual driving task. Changes in mental state were evaluated multidimensionally, using several subjective rating and oculomotor indices. We obtained a modification of the main sequence role: a reducing of saccadic peak velocity and an increasing of saccadic duration were found for increased time-on-task. No effect of the brief brake rest (15 min) was reliable on main sequence parameter while the same short pause significantly improved subjective ratings of fatigue.

We therefore demonstrated main sequence to be sensitive to variations in human functional state during ecologically valid driving task. Based on these findings and comparing ours results with the literature we can suggest that saccadic peak velocity could be a useful diagnostic indicator for assessment of driver’s attentional state in virtual as well as real environments. From the point of view of theoretical implications and for the objective analysis of human functional state, the

discovered dissociation between the eye movement data and subjective reports on recovery from the load after the pause is of particular interest. Similar effects have been already described in the literature as a dissociation of psychophysiological indices of stress and fatigue, on one side, and questionnaires data, on the other (Leonova, 1997). However, these earlier reports were rather concerned with long-term (chronic) effects of occupational stress. In the present study we address acute changes in the human functional state. In order to validate this short-term dissociation of oculomotor data on saccadic peak velocity from subjective reports as an authentic manifestation of fatigue, we plan further studies involving independent psychophysiological measures of human functional state.

Overall, these results could be a starting point for new guide-lines in design of driver fatigue countermeasure devices and vigilance screening tool, in order to help prevent driving accidents and errors (Di Stasi et al., 2010). A further perspective is to use this and similar on-line measure of mental load for developing interruption-management and task-switching tools in the next generation of conventional human-computer interfaces.

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WORD FREQUENCY AND MISSPELLING: EFFECTS OF PRESENTATION SPEED

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When we read text, there are frequently misspellings which experienced readers deal with easily. In fact they frequently fail even to

recognize the error (Assink et al, 1996). In the current experiment we investigated the way in which such misspellings are dealt with, concentrating on the cases in which the “misspelling” creates a real word, which are generally missed by spell-checkers. These cases tell us about how the language processing system resolves competition between candidate words (Davis and Lupker, 2006).

In two event-related potential (ERP) experiments differing in speed of presentation, participants read sentences with predictive contexts containing a correctly spelled or misspelled word. The predicted word was a

frequent or infrequent word. The nearly identical word which replaced it was either much more frequent (when the target was infrequent) or much less frequent (when the target was highly frequent). We expected that the high frequency words would be easier to recognize even when presented in an inappropriate context. This should be visible on the N400 component of the ERP response, which is sensitive to the ease of word activation and integration (Van Petten, 1995).

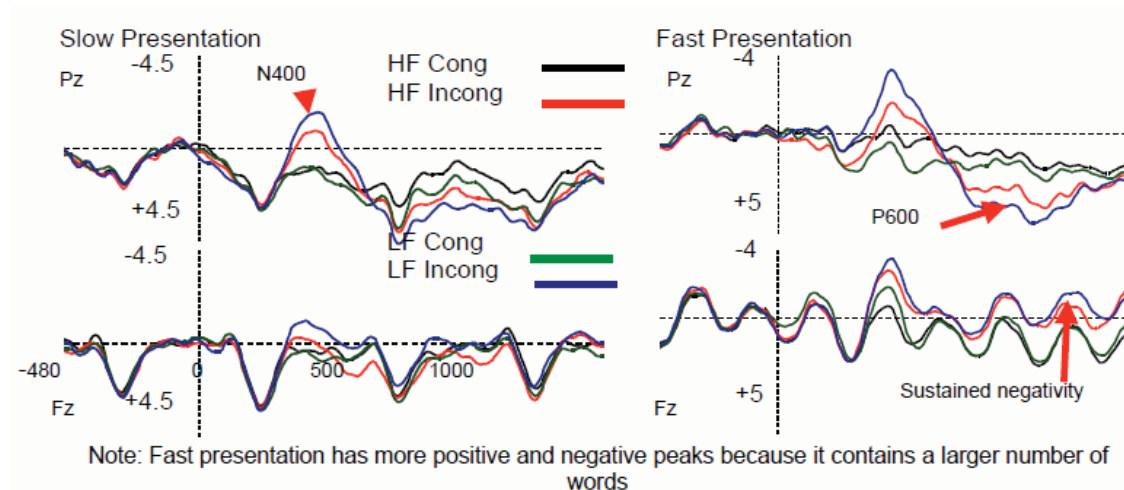
Methods

Participants: All participants were right-handed native speakers of Dutch studying at the University of Groningen who were paid to participate. Informed consent was obtained before participation. 32 participated in the first and 30 in the second experiment.

Materials: We created 120 Dutch sentences in which two type of target noun were highly predictable: (1) high frequency words (HF: mean Log lemma frequency 2.2), e.g., *When Johnny fell off the slide, he had a broken arm, so that he had to be in a cast for three weeks*, target word underlined), and (2) low frequency (LF: mean log lemma frequency 0.6) orthographic neighbor of the HF words, e.g., *When Noah heard that the world would be flooded, he built an ark in which he could take along two of each species of animal*. Predictability as measured by the Cloze procedure was equivalent for the two sets of sentences (HF contexts = 0.54, sd. 0.07; LF

contexts = 0.54, sd. 0.11). To create the "misspelled" items, 120 additional sentences were constructed in which the target pairs (e.g. *ark* and *arm*) of these sentences were exchanged. To avoid repetition of context and targets, two lists were created each containing 30 sentences in each condition, with the alternative version of the sentence occurring on the other list.

Procedure and Data Analysis: In both studies we presented sentences one word at a time visually (480 ms per word in the first and 200 ms in the second) while registering EEG. Subjects were asked to read for comprehension, checked by asking content questions after a random subset of trials. After filtering, the continuous EEG signal was segmented from 480 ms before the presentation of the target noun and continuing for the following 1400 msec. After artifact rejection, the average response was calculated for each electrode in each condition per subject. The average amplitudes of the waveforms for the time windows 300-500, 600-800 and 800-1000 were analyzed (the most typical time windows for language comprehension). Ten regions of interest (Left and right anterior frontal, frontal, central, parietal and occipital) were then created, leading to the following factors: Hi/Lo frequent target word, +/-congruent, left/right and 5 levels anterior to posterior in a repeated measures ANOVA. Significance was corrected with the Greenhouse Geisser procedure when appropriate.



Results and Discussion: In the slow presentation, there are clear and significant main

effects on the N400 component of congruency with the context and frequency. Similar effects

have been reported frequently (e.g. Kutas and Hillyard, 1980; Van Petten, 1995). The main effects are significantly modified by an interaction, with the largest negativity for the low frequency word in the incongruent context. The larger N400 effect may result from greater competition from the predicted high frequent word. The difficulty of incongruent or infrequent words continues to manifest as itself later as an increased positivity (P600). This is sometimes found for incongruent sentences, but not consistently; that it is so strong here may be because the competing incongruent words are similar. See the figure above for the effects as seen on a central parietal electrode, Pz.

Globally the results are similar with the faster presentation, although there are differences in the exact manifestation of the interaction between congruency and frequency. The most prominent difference is that a frontal

negativity surfaces for the incongruent sentences. This is similar to the sustained negativities found in some studies addressing working memory and may suggest that with faster presentation working memory demands are greater for incongruent sentences than congruent ones. See the figure above for the effects as seen on a central frontal electrode, Fz.

To conclude, when people read, they have to deal with misspelled words frequently and the way in which they do so can tell us about how factors like context and frequency affect processing. From the results of the current study it is clear that both factors contribute, but that the conflict between the predicted word and the one which is actually present leads to a greater effect when the incongruent word is an infrequent one. Faster presentation appears to have greater demands and lead to an additional type of processing.

BRAIN MECHANISMS OF OBSERVATION AND EXECUTION OF DIFFERENT HAND ACTIONS AND GESTURES: A HIGH DENSITY EEG STUDY

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Recent studies have shown that human electroencephalographic sensory-motor alpha rhythm (8-13 Hz) is suppressed during the performing of actions and the observation when performed by others. It was proposed that event-related alpha desynchronization (ERD) in central areas could reflect the activity of the mirror neurons in premotor cortex and therefore provide the neurophysiological basis for action understanding. In the current study we investigated differences of intensity and temporal pattern of sensory-motor alpha ERD modulation during the observation of a hand grasping, a hand grasping within social context, communicative gestures and meaningless hand movements. 128 channel EEG was used to measure the brain activity in 13 healthy volunteers. Spontaneous EEG was recorded in order to determine participants' individual alpha frequency band. The experimental task was

either to press the key button or to passively observe video clips of hand actions and gestures presented on the computer screen. Wavelet analysis was performed for the frequencies from 1 to 30 Hz for the baseline, observation and execution tasks. ANOVA repeated-measures analyses revealed the effect of Condition as well as a significant Condition Time interaction. Post-hoc Fisher comparisons showed that all stimuli were effective to trigger sensory-motor alpha suppression and that the temporal pattern of alpha ERD modulation differed across the stimuli. Communicative gestures and social grasping showed a dynamic pattern of ERD modulation while alpha suppression was greater and stable in time for meaningless movement and grasping. Our findings allow to suggest that observation of socially relevant stimuli might trigger more complex motor resonance mechanisms and that these mechanisms could be modulated by the goal of the observed action. These results shed more light on further properties of mirror-neuron system and its relatedness to inter-subjectivity and social cognition.