STSM COST Action TD0904

Scientific Report

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STSM title: Electrophysiological correlates of interval timing in humans and rodents

Reference: ECOST-STSM-TD0904-030313-027914

STSM dates: from 03-03-2013 to 29-03-2013

Location: University of Groningen Faculty of Behavioural and Social Sciences, Groningen, Netherlands

Host: Dr. Hedderik Van Rijn, University of Groningen Faculty of Behavioural and Social Sciences

Purpose of the STSM:

The main goal of this STSM at the psychological institute of University of Groningen (Netherlands) was to conduct an experiment, which focused on the question whether behavioral biasing can affect the contingent negative variation (CNV) in a temporal comparison task.

The CNV is considered to be strongly related to interval timing. However, it is discussed controversially whether certain properties of the CNV (e.g. peak amplitude or resolution) reflect timing itself and which underlying mechanisms contribute to temporal perception (e.g. Macar, Vidal, Casini, 1999; Van Rijn et al., 2011).

Description of the work carried out during the STSM:

In our study we designed an auditory temporal comparison task. First, the participants had to learn the duration of a standard interval with duration of 1200ms. The subsequent main task was to compare different comparison intervals to the standard interval trial by trial. These comparison intervals were slightly shorter (S3: 1036ms, S2: 1090ms, S1: 1147ms) or longer (L1: 1267ms, L2: 1330ms, L3: 1396ms) than the standard interval. Hence, there were three different levels of difficulty for discriminating shorter and longer comparison intervals from the standard interval. In a first block, in each trial of the comparison task a reward of two cents was paid if the respond was correct. If the respond was incorrect, no reward was paid. In a second block the payoff modalities for correct responses changed and 50% of the participants received more payoff for a correct "short' response (3 cents) than for a correct "long" response (1 cent). The other 50% of the participants received more payoff for a correct "long" response (3 cents) and less for a correct "short" response (1 cent) in this second block.

According to our hypothesis, these payoff structures should bias the participants' behavior to more often respond either "short" (first condition) or "long" (second condition) even if these responses sometimes are incorrect. When plotting the amount of "long" responses depending on the length of the comparison interval (S3, S2, S1, L1, L2, L3), this biasing should lead to a right shift (short response biased) or a left shift (long response biased) in the resulting psychometric functions (see fig.1).

After each of the two comparison task blocks, the participants were instructed to reproduce the standard interval several times. These data should provide evidence whether the biasing from the second comparison block affects the reproduction of the standard interval. Our hypothesis is that participants may adjust their representation of the standard interval according to a decision rule. For example, in the "more payoff for short condition" people are biased to response "short" and they do respond "short" more often. In order to legitimate their decisions, they may adjust their representation of the standard interval to be longer than it originally was.

An even more crucial point, however, was the question if the change in payoff modalities not only influences the participants' decision rules or their reproductions of the standard interval but also the point in time at which the CNV begins to drop. If, for example, in the "more payoff for short condition" the CNVs which are related to the processing of the comparison interval drop later in the second block than in the first block, the data could provide some evidence that the CNV reflects an (adjusted) mental representation of the interval. It this case, it would be assumable that the payoff manipulation affects timing itself.

Description of the main results obtained:

Totally, we ran 20 participants (10 in each group) and began to analyze the behavioral data as well as the EEG data. The first results suggest that the behavioral manipulation worked very well in most subjects. Generally, the participants tended to respond "long" more often in the long biased condition and "short" more often in the short biased condition (see fig.1).

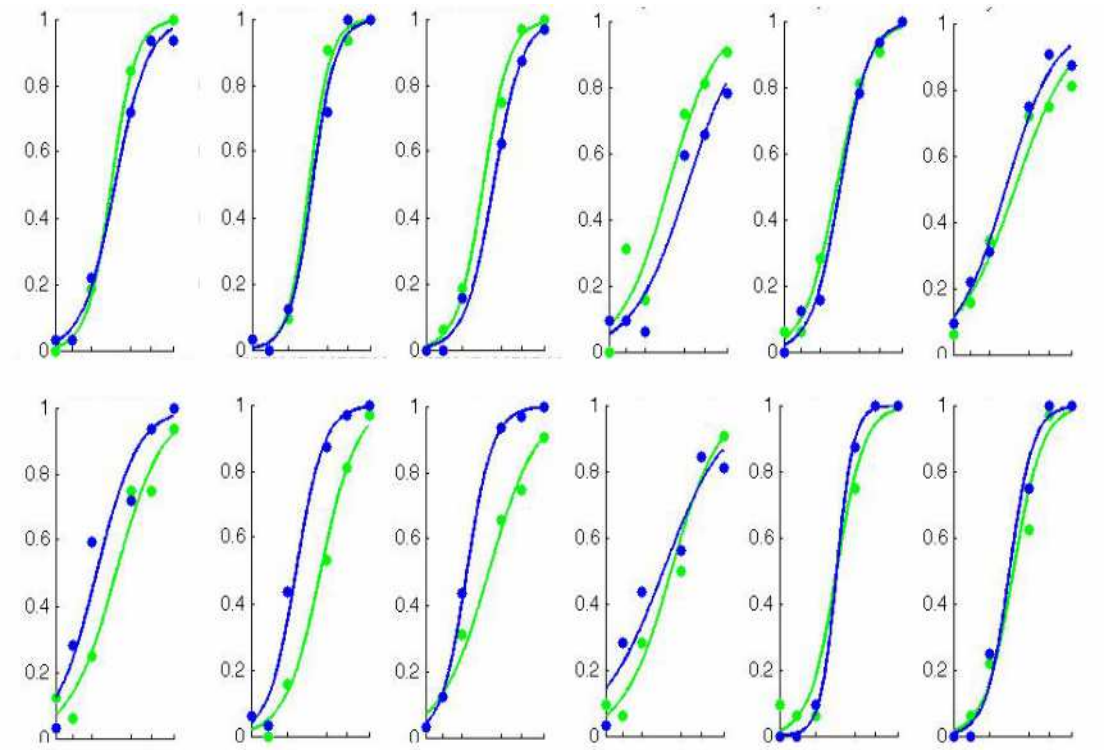

Fig. 1: Plots showing the amount of “long” responses depending on the length of the comparison interval (from left to right: S3, S2, S1, L1, L2, L3) in single subjects. The upper plots are related to the short biasing condition, the lower ones to the long biasing condition. The green graphs represent the participants’ behavior from the first block (unbiased) and the blue ones from the second block (biased). A right shift from the first to the second block indicates more “short” responses in the second block (effective short biasing), while a left shift indicates more “long” responses in the second block (effective long biasing). These data are related to the first 14 subjects. The datasets of two participants were excluded from the analysis because their performance did not meet the criteria of at least 25% correct responses in S3 and L3 trails in both blocks.

These differences between the two conditions can not be explained in terms of training effects and are most likely the result of our payoff manipulation. With regard to the EEG data, our first analyses revealed that the drop of the CNV also appears to be affected by the payoff manipulation. According to our hypotheses, the CNV seems to drop later when the participants are biased to respond "short". We interpret this prolonged CNV as a marker for prolonged internal processes of temporal accumulation, which may lead to the subjective impression that the interval duration is

shorter. In order to draw final conclusions from our data, more sophisticated statistical analyzes will follow. Therefore, I will visit Groningen again in May.

Description about how the results contribute to the Action aims:

If we find more evidence for the influence of reward modalities on CNV dropping (and timing performance), this could contribute to a better understanding of the role of the CNV in temporal processing, which is an important topic in recent timing research (e.g. Van Rijn et al., 2011, Ng, Tobin, Penney, 2011).

Beside the experimental results, this STSM gave me the opportunity to gain more experience with EGG methods in the context of temporal processing. The research group in Groningen uses different methods for running and analyzing EEG experiments than the research groups I am working with in Dortmund and Duesseldorf. Moreover, the results may contribute to the data I have collected for my Master's thesis, which focusses on temporal resolution in human information processing and its relation to individual characteristics of the CNV.

References:

Macar, F., Vidal, F., Casini, L. (1999). The supplementary motor area in motor and sensory timing: Evidence from slow brain potential changes. *Experimental Brain Research*, 125, 271-280.

Ng, K.K., Tobin, S., Penney, T.B. (2011). Temporal accumulation and decision processes in the duration bisection task revealed by Contingent Negative Variation, *Front. Integr. Neurosci*. 5, 77.

Van Rijn, H., Kononowicz, T.W., Meck, W.H., Ng, K.K., and Penney, T.B. (2011). Contingent negative variation and its relation to time estimation: a theoretical evaluation. *Front. Integr. Neurosci.* 5, 91.

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