USING THE EFFECTS OF FOREPERIOD-VARIATION ON READINESS TO BREAK IN DRIVING SIMULATION

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Abstract

Range and frequency of varying foreperiods in reaction time experiments affect the expectancy of the reaction signals and the readiness to react in a systematic manner. In a study investigating braking safety as a function of the driver´s footwear we made use of this regularity. In order to provoke unforeseeable situations which require speedy brake applications at first the time intervals between consecutive braking signals (interstimulus interval; ISI) were varied so as to establish a time-reference-system. At later stages of the experiment, a few ISI at considerably lower durations were presented. These ISI perceived as too short significantly increased breaking times if the subjects wore flip-flops compared to foot-covering shoes.

Reaction times are influenced by the foreperiod (FP) which is the interval between a warning signal applied to direct attention to an upcoming reaction signal and the stimulus. If the FP is kept constant within a range of 1 to 7 s in single reaction experiments, we find reaction times (RTs) nearly linearly decreasing with increasing length of FP (Fig. 1). When we present variable FP, however, reaction time follows a typical pattern as shown in Fig. 2 with relatively slow reactions at the shortest FP and decreasing RT up to the median FP. For longer than medium FPs the RT remains constant (Müller, 1980). These data are in line with results shown by Baumeister et al. (1967) and Niemi (1979).

For Fig. 2 the RTs are averaged over the relative length of FPs out of 4 series each consisting of equally spaced FPs ranging from either 1 to 4 s; 2.5 to 5.5 s, 4 to7 s or 1 to 7 s. The effect of FP on RT is less pronounced if FPs are presented in random order compared to a condition where the same sequence of FPs is repeatedly presented.

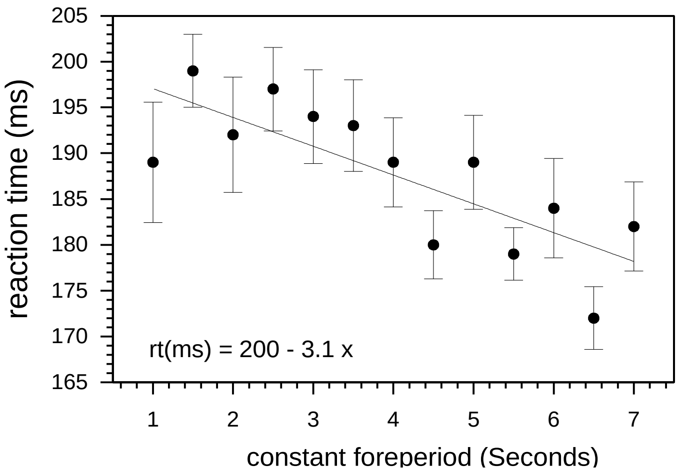

Fig: 1: RT to signals of white light at constant foreperiods between 1 and 7 s.

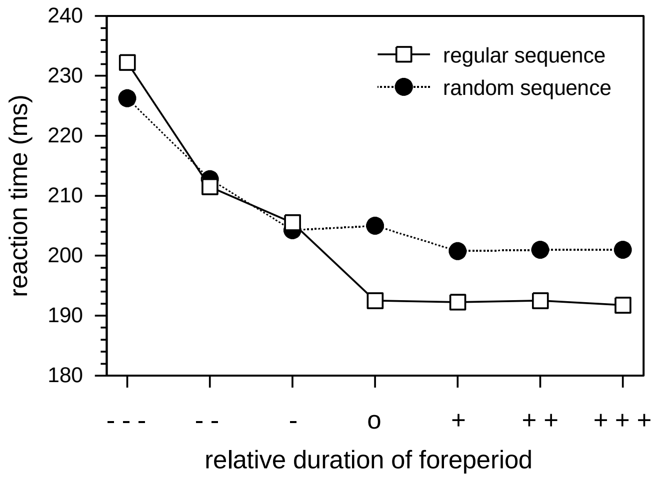

Fig. 2. RT to signals of white light at relative positions of the foreperiods in time-reference-systems

In a paper given at Fechner Day 92 (Müller, 1992) it was shown that the RT is linearly related to category-scaled psychological tension. It was argued that in each case the set of FPs forms an orienting time reference system *(Zeitbezugssystem)* according to Witte (1966) and Heller (1990) wherein subjects try to maximize readiness for the midpoint between shortest and longest FP of the system. If the reaction signal appears at this point readiness will be optimized, resulting in short RT. If the signal appears later, a reactive increase of psychological tension is mobilized (Düker, 1963) which prevents a slowing of RT for longer than medium FP (Müller, 1981).

Prompting critical reactions using a foreperiod-reference system

If the above outlined thoughts hold, we expect participants being astonished and unprepaired if unexpectedly a FP appears which is clearly shorter than the shortest in an established time reference system. In experiments designed to evaluate the effect of different footwear on the brake application time (Backhaus & Müller, 2016) in a driving simulator (following an cross-modal ABBA-design), 40 participants each executed 84 braking actions when using enclosing footwear and when wearing flip-flops. In order to provoke critical braking manoeuvres at first 5 different ISI of either 10, 12.5, 15, 17.5 and 20 s between upcoming braking signals (yellow light, red light or a person suddenly appearing on the street) were presented three times in succession in irregular order. Then the 16^{th} signal appeared unexpected already after 4 s. During the time course of the entire experiment this pattern (15 time system conforming ISI followed by an unusual short period) was repeated 8 times; interrupted by two breaks which were used to change footwear. The driving task required to follow an imagined, hence not visible pathway directed by two laterally displayed arrows which indicated the direction of deviations from the track. This task alone absorbs a high degree of attention, which overall causes relatively long reaction times.

Despite the fact that attention of the participants was focussed on the tracking task and various aspects of the experimental setup, as the change of stimuli and footwear interrupted and altered the flow of the experiments, the overall recorded RTs (960 trials/foreperiod) given with Fig. 3 show a foreperiod-dependency near to the one described in Fig. 2. The intention to provoke a critical break-condition by introducing a FP outside the time reference system was achieved as shown in the very left mark in Fig. 3. For this critical ISI it was clearly demonstrated that breaking time, defined as the interval between signal-onset and full application of the brake pedal, is longer if subjects wear flip-flops (mean = 1110 ms; SD = 287) compared to foot-covering shoes (mean = 1017 ms, SD = 177); (t = 2,665 $p < 0.01$).

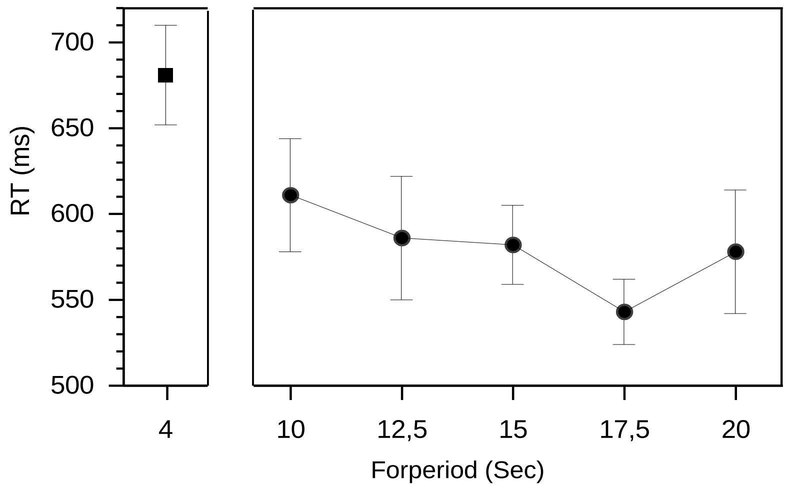

Fig. 3. On the right: Breaking response to traffic lights and persons on the road at variable ISI. Left: Reaction to rare ISI outside the time reference system.

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