Continuing a previous study (Bull. Math. Biophysics, 28, 645–654, 1966), the biophysical mechanism of a corrective turn is investigated for the case where the stimulus for the corrective turn is produced not only by the perception of the nearness of an edge of the lane, but also by the rate of approach of the car towards the edge. In that case it is found that the tracking curve of the car may consist of a series of damped sinusoids and safe driving would be possible at any speed if it were not for the endogenous fluctuation in the driver’s central nervous system. If the effect of the rate of approach increases sufficiently rapidly as the distance to the edge of the lane decreases, then a stable undamped oscillating tracking curve is possible. The case is also studied where the driver makes a corrective turn in response to a direct perception of the angle between the direction of the lane and the longitudinal axis of the car.

In line with the discussion in a preceding paper (Rashevsky, 1966, referred to as loc. cit.) we shall study here the mechanism of a corrective turn when the latter is caused by stimuli other than the distance between the car and the edge of the lane. Dr. Nathaniel Ehrlich suggested that some kind of “anticipation” of a forthcoming corrective turn must play a role in driving. There are several ways of expressing such an “anticipatory” effect. We choose here the simplest one. We assume that the driver is induced to make a corrective turn not only when he notices that the car is too close to an edge, but also when he perceives that the distance between the car and the edge is decreasing. We shall use the same method and the same notation as in loc. cit.
We still shall consider zero thresholds and, as in loc. cit., we shall assume the reaction $R$ as given by $d\theta/dt$ [loc. cit., eq. (6)]. We also put again

$$R = \beta \phi,$$

(1)
as in equation (11) of loc. cit. Equations (3), and (5) to (14) inclusive of loc. cit. remain valid. Equation (4) will, however, be modified. Denoting by $c$ a constant, we shall write, instead of (4) of loc. cit.:

$$S_R - S_L = 2bx + c \frac{dx}{dt}.$$ 

(2)

Putting

$$\frac{c}{2b} = \gamma,$$

(3)

we find by the same argument as in loc. cit. instead of equation (23) of loc. cit., the following one:

$$\frac{d^3x}{dt^3} + k \frac{d^2x}{dt^2} + \gamma B \frac{dx}{dt} + Bx = 0; \gamma > 0; B > 0.$$ 

(4)

The characteristic equation of (4) is

$$\nu^3 + k\nu^2 + \gamma B\nu + B = 0.$$ 

(5)

In order that the real parts of all the roots of (5) be negative, it is necessary (Uspensky, Appendix 3, 1948) that all three determinants

$$D_1 = k; \quad D_2 = \begin{vmatrix} k & 1 \\ B & \gamma B \end{vmatrix} = k\gamma B - B; \quad D_3 = \begin{vmatrix} k & 1 & 0 \\ B & \gamma B & k \end{vmatrix} = k\gamma B^2 - B^2,$$

(6)

be positive. The first one is always positive. The other two are positive when $\gamma > 1/k$, that is when either $c$ is sufficiently large or the reaction time is sufficiently small.

Under these circumstances the car will exhibit damped oscillatory movement around the center line of the lane, coming closer and closer to it. In the absence of endogenous fluctuations (Rashevsky, 1964), the car would move practically along the center line. The endogenous fluctuations cause (Rashevsky, 1964) random shifts parallel to the center line. Therefore the track will consist of a series of stretches of damped sinusoids broken in a random manner.

The "anticipatory" effect may increase as the distance of the car from the edge decreases. This will make $c$ an increasing function of $x$, introducing thus a non-linearity into (4). Such a non-linear equation could be approximately