

Problems of aggressive human subject namely driver behavior as result of uncertain acting impacts

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Abstract:

Aggressive driver behavior is frequently a source of many traffic accidents.

Aggressive habits in human brain cause however difficulties in many other areas.

Though their reasons are investigated already many years, still a large number of problems remain open. One of them is the influence of randomly acting impacts on the body and brain of the human subject, which can be taken as uncertainly appearing factor.

In this contribution the influences of this factor is investigated, classified and some possible ways for its limitation based on the brain waves analysis are discussed.

• Key words:

Human aggressive behavior, driver aggressiveness, road accidents, electroencephallic waves, electro-encephalography, near infrared waves analysis, bio-feedback stimulation, random factors influence, uncertainty appearance effects.

1. Introduction

For quite long time is known, that the aggressive forms of human behavior have to be considered as one of the worse drain habits. Though a lot of work was made in the field of analysis of its reasons, still a lot is not known.

This concerns namely the possibilities of replacing these and of course also other bad habits.

In each human behavior exist many kinds of such habits which all together form a tool simplifying our activity. For habitual activity a large and long mentation is not necessary. This can be modeled as an increase realized habitual impacts which are transformed in automaticity. The process of habit formation can be however sometime considerably slow.

Such operation are important in many areas but especial significant are in road traffic, where the changes in driver behavior, appearing either suddenly or rising slow from many various reasons can be the cause of many quite ugly traffic accidents bringing large technical, economical, but also health and life losses. Such kind of human behavior called usually the driver aggressiveness can be considered as typical bad habit

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Lally *et al.* (2010) found that the average time for to reach the asymptote of automaticity realized habit was 66 days for one habit supporting event per day with the spread range of 18–254 days.

Of course the speed of habit creation depends on many factors, before all on habit supporting event intensity and on particular person sensitivity to habit (namely the bad ones) creation.

The habits can be formed principally in three kinds:

the cue,

the habitual tendency of behavior, and

heavy habit.

The cue is the thing that causes the habit to come about, the trigger of the habitual behavior. This could be anything that one's mind associates with that behavioral event and which will automatically let a habit come to the surface of respective person behavioral level.

The behavior than be so influenced by positive feeling, which can lead the respective person to continue in the "habit loop".

A habit may initially be triggered by some instant goal, but over time that goal becomes less necessary and the habit appearance becomes more automatic.

Many habits concern very often the process of vehicle driving as one of the most complicated kind of the human behavior.

The driver behavioral habits can be very often negative and can be the cause of many serious accidents.

In general, the driver behavior negative changes can be divided into two large categories:

The faults in driver vigilance and attention, namely the attention decreases,

The driver aggressive acts appearing either almost randomly or also systematically.

The faults falling in the category a) were investigated considerably very long and some almost acceptable effect in development of methods for their prevention was reached.

A quite large attention was given to them in many countries, including the Czech Republic.

The faults falling in the second category though appearing also very long time, have however more complicated reasons.

Though their investigation was started in some countries (namely Canada, Australia and also the Czech Republic) also already before quite long time, almost nowhere it was systematically supported and probably therefore the reached results remain generally on the surface of the necessary level.

This is the reason, why we suggest to refresh the research activity in this area, exploiting of course some from the in between reached knowledge and also of the disposability of some novel tools.

- Aggressive behavior of vehicle drivers causes in all countries daily a very high number of serious accidents.

The rate failures of vehicles in transportation are before all: caused by

a) The natural decreases of attention,

b) Influence of alcohol and other drugs,

c) Influence of non-tolerant and aggressive driver behavior.

- According to our estimation:

natural attention decreases cause about 50% of vehicle accidents on roads,

alcohol and other drugs cause about 25%,

Non-tolerant and aggressive driver behaviors cause about 25%..

The first two categories of accident causes were discussed at other opportunities.

Now we focus on the third one.

Therefore, we have to be very interested in minimization of the frequency of driver dangerous aggressive events.

For to reach this is however necessary to analyze the main kinds of driver aggressive behaviors and the problems of its appearance.

Though this is quite complicated task, in this paper we try to discuss it briefly.

2. Classification of drivers aggressive defects in behavior

The detours of driver behavior from the standard, modest and careful form to the aggressive one can appear:

- Exceptionally, stimulated by some unusual coincidence of not normally existing internal and external conditions,
- Randomly, when some set of specific stimuli impact the driver mind, which is sensitive on them,
- Systematically, when the drivers mind is defected so that he reacts aggressively also on the standardly appearing external stimuli.

The dangerousness of these three main groups of the driver behavior detours is of course different.

The lowest is evidently in the case a), nevertheless that it does not mean that the eventual losses cannot be very high, even if their frequency is rare.

More problematic is to decide between the dangerousness of the second and third group because though the second case can be of lower frequency.

The uncertainty in aggressive behavior appearance can cause higher losses than the almost ever evident tendency to aggressive behavior in the case three.

The aggressive behaviors appearing unexpected as uncertain effect can be more dangerous than those which provides the chronic aggressive driver from the first moment of the move of his vehicle, because his/her aggressive nature is usually quite easy observable.

This is unfortunately the reason why the analysis and the search for identification methods and tools must be focused on both the groups two and three.

3. Randomly appearing aggressive behavior of drivers.

Suppose that some driver has certain slight tendency to aggressive behavior, however in normal conditions he/she is able to compensate it and drives standardly.

Nevertheless, under influence of some specific factors – which can be of many various kinds and number, in various combinations and time intervals, he/she starts to be stimulated to realize some aggressive event.

Its realization, ***if it is without any accidental result***, can be for him/her as outlet for ventilation of actually in their body, before all the brain existing psychological pressure which by realization of this aggressive act this act decreases.

Usually, after that the behavior of particular driver is again standard, till the next possible state when eventually cumulate the aggressive stimuli above for him/her actual critical level.

Therefore, in the course of the particular driver further driving, such process can have random character and is quite uncertain if and when the next his/her aggressive event appears. The prediction is very problematic and the situation has to be considered as typically uncertain.

- There are two possibilities for improvement such situation.

One is in advance made neurological investigation if exist some symptoms in particular driver body, before all in the brain, significant for stimulation his/her aggressive behavior. This is of course possible, but is expensive and time consuming.

Theoretically, such investigation can be worth for all drivers, not only for those who had already the experience with aggressive events. Unfortunately, this is however quite unrealistic.

As concerns the measurement, there is necessary to measure quite accurate the time for driver reactions together with his/her basic humoral data (breath frequency, heart beets, blood pressure, eye blinking, hand vibrations on wheel, sitting movements etc.) and also his/her electroencephalographic (EEG) signals and signals in near infrared region (NIRS).

All this has to be carefully recorded while from the combination of these records can skilled neurologist recognize the eventually tendency of particular driver to spontaneous aggressive behavior.

Some examples of specific symptoms are presented further.

However, before it some limiting aspects have to be mentioned.

The second possibility is to try change the level of cumulating aggressive stimuli impacting the particular driver, at which his/her aggressive behavior starts.

By the use of combination of specific neurological investigation and training on the base of specific bio-feedback methods this is possible. Of course this also requires high expenses and lot of time, but still it can be cheaper then the next eventual accident.

Later in this contribution, we present some approaches which can be used in this respect.

4. Systematically appearing aggressive behavior

There exist some specific groups of people who have the tendency to react aggressively in almost all situations.

This must not to be only the case of drivers, such aggressive reacting people exist in all parts of human society. For some professions of regional communities this can be typical and somewhere more over required (e.g. for certain groups of military or police people).

As concerns drivers there is possible to recognize the overall tendency to aggressive behavior of almost everybody when he/she sits behind the wheel and starts driving. This is considerably easy possible on advanced driving simulators, equipped by specific virtual scenarios and specific measuring equipment.

In the scenarios must be included both scenes requiring fast reactions and also those in which the tested driver has to be very careful for considerably long time.

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5. Limitations of possibilities to analyze systematic aggressive behavior

The detection of systematic aggressive effects seems to be at first glance

quite easy, however there exist several significant barriers which have to be replaced.

At first, many tendencies to systematic aggressive behavior can be kept by the particular driver as hidden behind the curtain of his/her will and intellect.

This effect appears especially when the particular driver is tested on any advanced driving simulator, where usually in the course of few several rounds the tested person is able to keep successfully his/her tendency to be aggressive as secret.

For lifting up of this his/her psychical curtain is usually necessary to provide much more testing rounds, so long till the tested driver will lose his/her carefulness and starts behave as it is in his/her natural. This can be however sometimes after very long time and the transition to this psychically free state, must not be stable. Such psychical variations can repeat several-times.

Of course, this tendency to keep the private aggressive natural hidden, increase the expenses of such investigation.

Some possibility how to detect the investigated driver approaching to his/her natural psychical state can be seen in analysis of the development of variations of his/her reactions in the course of repeated testing rounds. However this is very expensive way.

Another one can be these tendencies partial compensation by some his/her stimulations on clear detection of respective natural stage. Some experts recommend to use for this the way of rewards and punishment, however the finding of proper kind of this is not easy.

Another complication in this aggressive tendencies analysis consist in its quite large time variability.

Many subjects being in principle systematic aggressive can change in the course of time of driving the level of their aggressive behavior without the driver will. This appears both at simulator testing and also in real driving.

Therefore, the structure of the spontaneous aggressive driving can be almost similar like structure of driving with random appearing aggressive behavior. The only difference is in the set of the aggressive state stimulating impacts. In the case of randomly appearing aggressive behavior these must exist and eventually cumulate, while in the case of systematic provided aggressive behavior these can be very few or even no.

6. Some specific symptoms of spontaneous at driving aggressive behavior

As simple example of symptoms for spontaneous aggressive behavior can be mentioned before all the impulsive reactions and their high speed also out of road vehicle. Such people have very often the tendency to behave aggressively also driving the road vehicle.

Such circumstance is hardly measurable, but the skilled investigator can recognize it considerably easy observing the general type of investigated person behavior.

Another factor which appearance can signalize the possibility of eventual spontaneously aggressive driving is the too high sovereignty and masterfulness of respective person.

Such people very often very easy fall in the feeling to be the so called kings of the road, having in their deformed psychology the right to punish other participants of traffic if the made even the small fault or eventually also without any such event.

On simulator such stage is not easy to detect but the too high tested driver feeling to know everything can be a good warning that respective person can belong to this category.

This concerns also the tendency to neglect the in on simulator projected scenario included warning signals. Such tested person behavior can be detected considerably easy and fast and has to be taken as recommendation to be careful in dealing with this particular person.

Aggressive behaviors can be taken also as bad habits. In general many unpleasant behavior habits are created by very complicated neural mechanism, the block structure is sketched in Fig 1. The forming of habit can have several subsequent phases of neural stimuli impacts between central brain paths and certain specific parts of cortex.

In Fig. 1 which was adapted from the paper Graybiel A.M., Smith K.S.: Good habits, bad habits, published in Scientific American, vol.310,, June 2014, No.6, p.22-27 are shown three of them, participating on forming the habit.

As the first are taken the impacts acting between thalamus and prefrontal cortex (solid red line) and striatum and amygdale (dashed red line). These neuronal paths form positive feedback loops influencing the composition of behavior components.

The habit forming is than stimulated by repeated circulation of impacts between striatum, thalamus and senso-motoric part of cortex (yellow solid line in Fig.1) and between striatum and amygdale (dashed yellow line).

How Habits Form

We use three steps to learn and lock in habits: explore a new behavior, form a habit, then imprint it into the brain (colored numbers). Although scientists have not refined all the details, the striatum (center) coordinates each step. Even though we seem to carry out habits “without thinking,” the infralimbic cortex (bottom right) still monitors what we are doing.

2 Habit forms: As we repeat a behavior, a feedback loop between the sensorimotor cortex and the striatum becomes strongly engaged, which helps us stamp routines into a single unit, or chunk, of brain activity. The chunk partly resides in the striatum and relies on dopamine input from the midbrain.

1 New behavior explored: The prefrontal cortex communicates with the striatum, and the striatum communicates with the midbrain, where dopamine aids learning and assigns value to goals. These circuits (solid and dashed lines) form positive feedback loops, which help us figure out what does and does not work in the behavior.

3 Habit imprinted and permitted: Once a habit is stored as a chunk of actions, the infralimbic cortex seems to help the striatum further imprint the habit as a semipermanent brain activity. Aided by dopamine, the infralimbic cortex also seems to control when to allow us to engage in a habit; shutting down this region can suppress deeply ingrained routines.

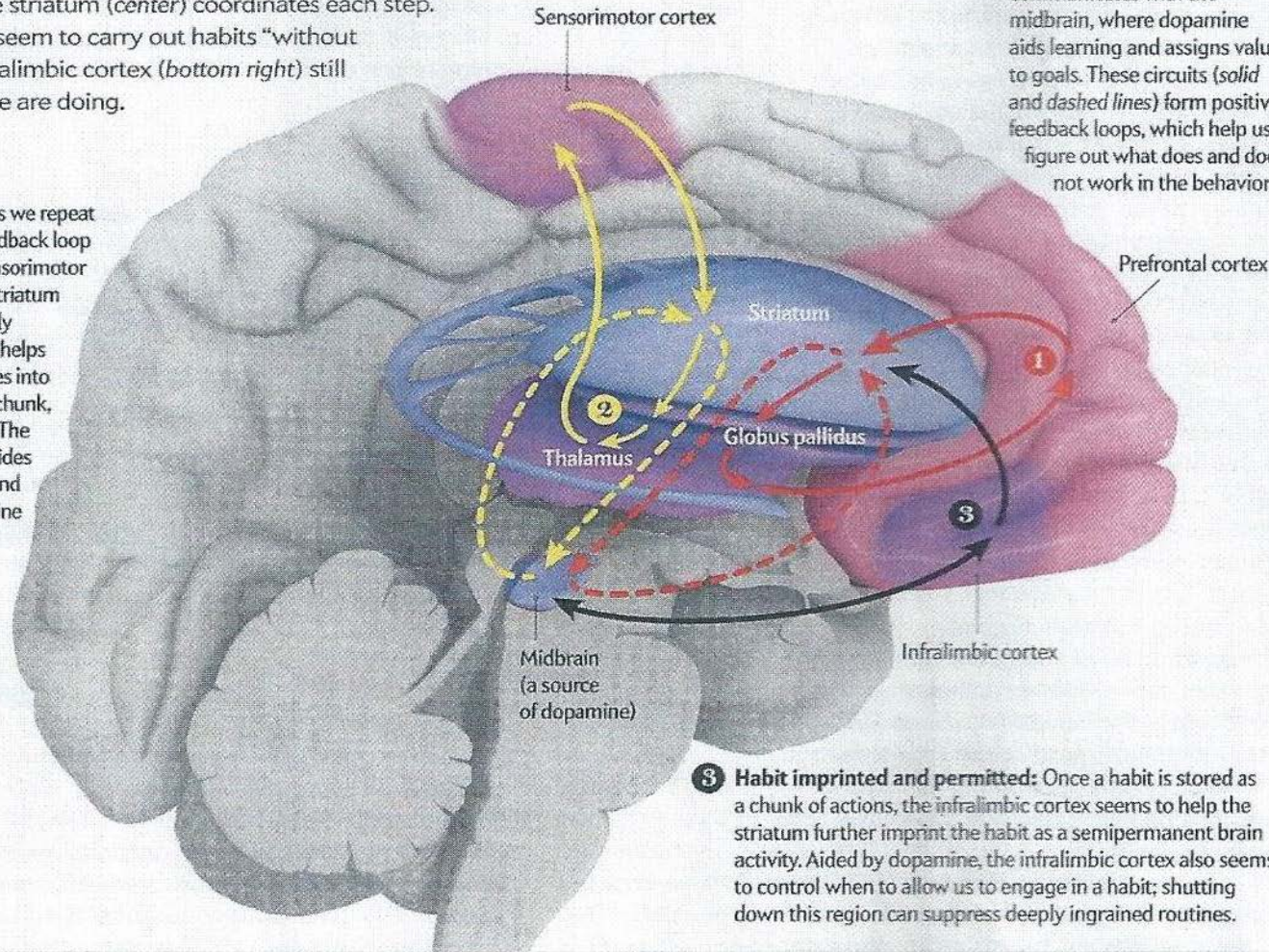


Fig.1:Mechanism if forming habit (adapted from [1]).

The third part of these neuronal impacts, forming the habit imprinting and repetition permission exists between amygdale, lower part of prefrontal cortex and striatum (black lines).

Of course that interactions shown in Fig.1 are only very simplified. In reality these can be much more complicated, influencing also some other parts of cortex. However in any case the dominant role have the influences between amygdale and striatum, which self depends on activity neural nuclei located in midbrain, which are not shown in Fig.1, but are sketched in Fig. 2

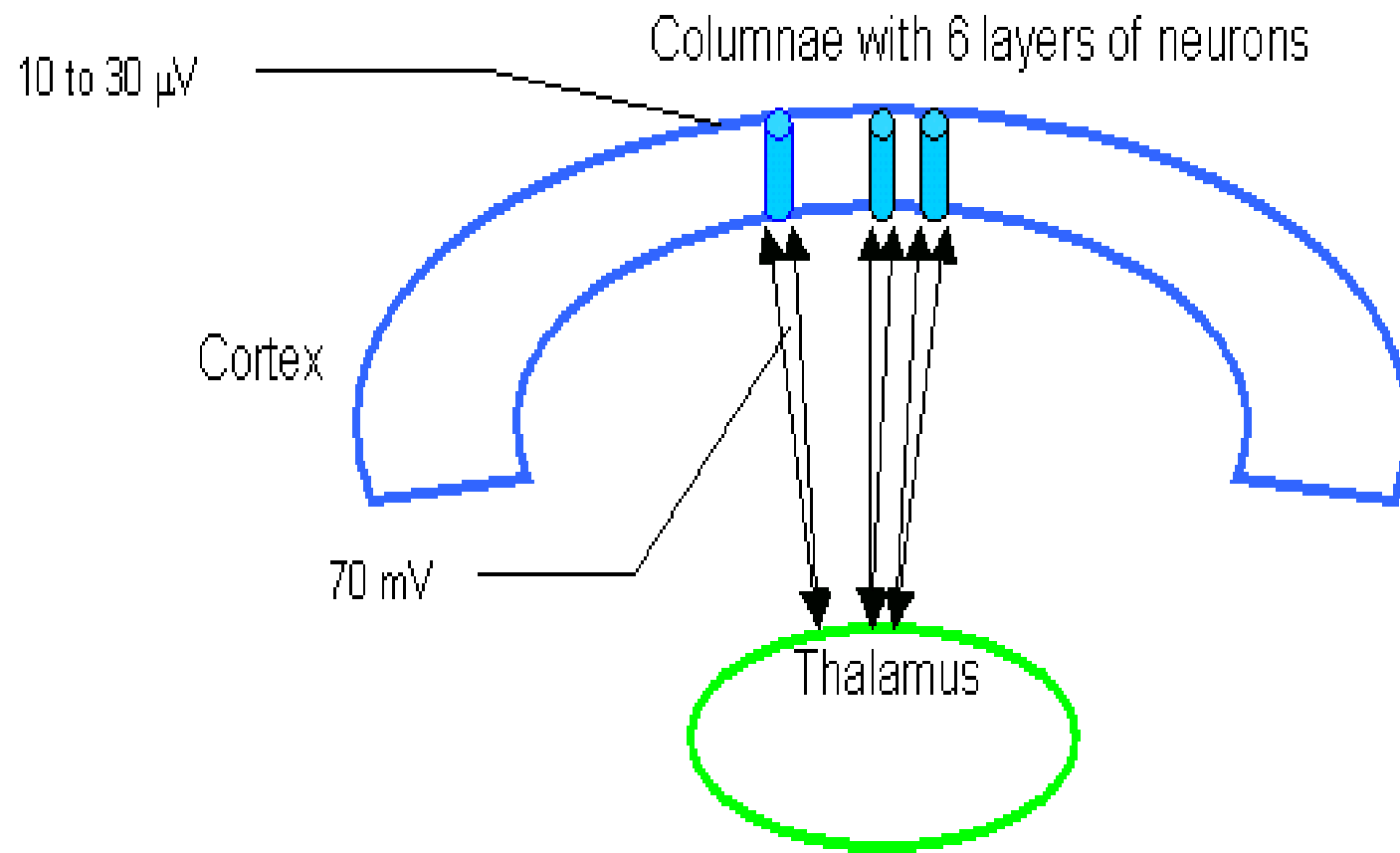


Fig.2: The rough scheme of thalamus - cortical reverberation

There is now for many years known that such permanent exchange of signals between internal brain parts and cortex is the basis of all the behavioral aspects.

As sketched in Fig.3, besides thalamus here play significant role also many other brain internal smaller parts, cooperating in very complicated communication system.

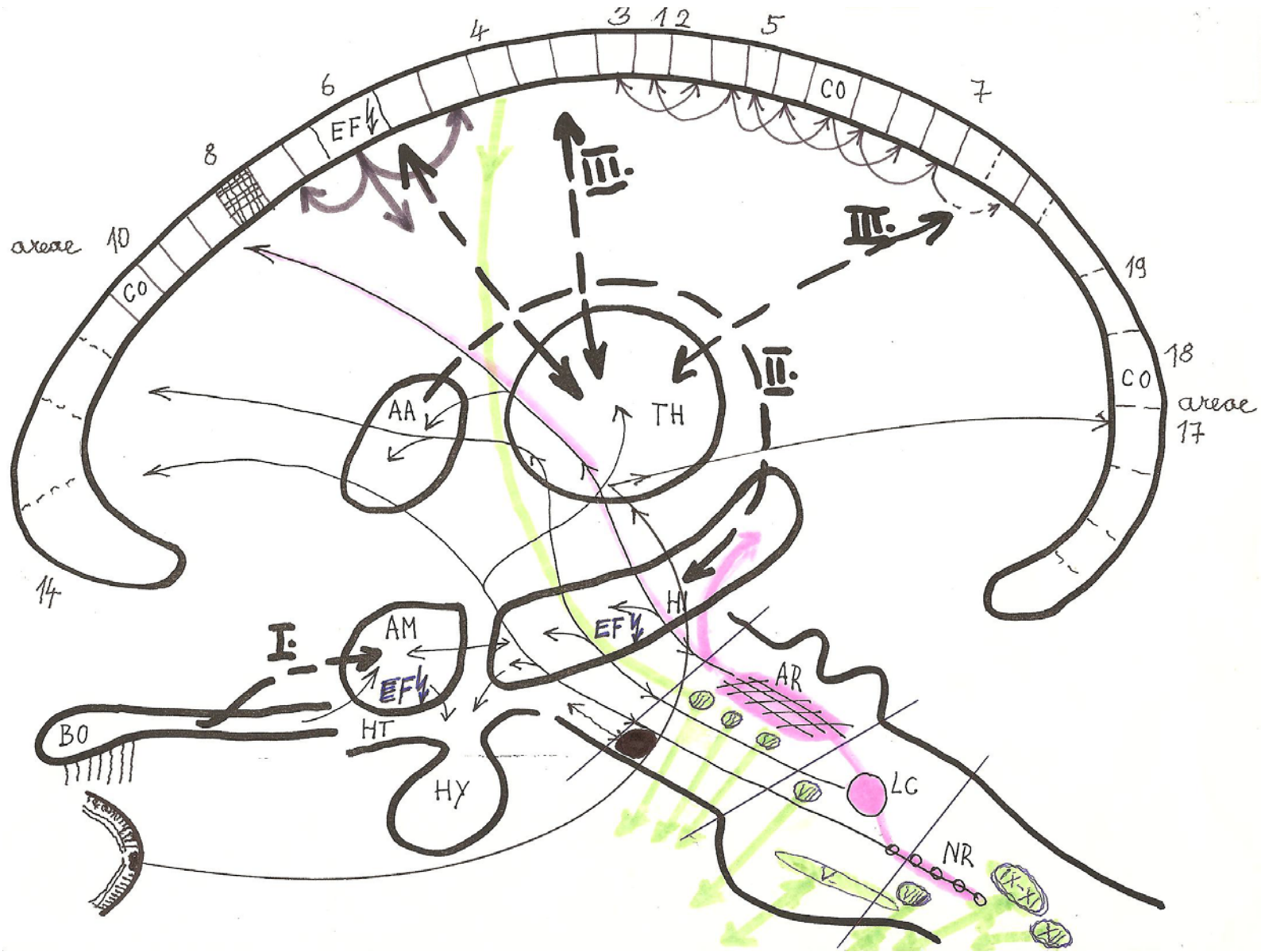


Fig.3: The sketch of main parts participating on brain internal communication.

As concerns the aggressive behavior the dominant role is played besides thalamus (TH) also by amygdale (AM) and striatum .

Of course(all these preprimary stimulated by many other smaller neuronal nodes located in spinal chord and pons.

7. Possibilities of anti-aggressive training

In general, the systematically provided aggressive behavior has to be taken as much more dangerous as the two previously mentioned types, i.e. the exceptionally and randomly appearing. These two can be tried to minimize by the use of some physical tools but for the third one another approach has to be used.

This consists in long lasting anti-aggressive training made either after some aggressive event with fatal results or preventively.

Such training is in any case long lasting and expensive.

As very good can be used the methods of so called bio-feedback, provided on special furnished simulators.

The rough principle of its simple original form is sketched in Fig.4.

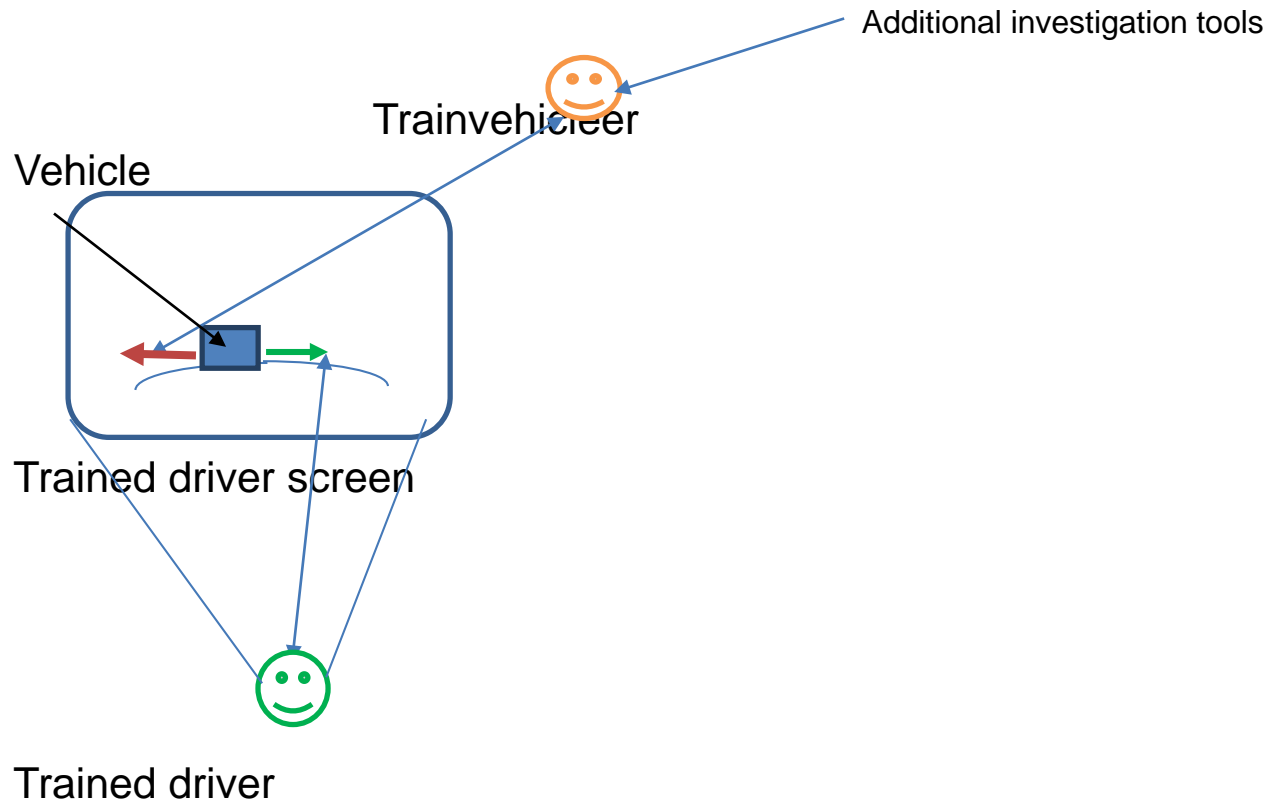


Fig. 4: Simple bio-feedback training. In this figure are not presented the parts serving for analysis of the trained person reactions and for decision if he/she has to be rewarded or punished.

In the well use of rewards and punishment is however the key to well efficient bio-feedback training. The choice of these acts, its sequence, frequencies and intensity is very important and must be done by very skilled supervisor.

In general in this project all experiences with human subjects education and the good knowledge of this art has basic influence on the efficiency of the mentioned training for bad habits minimization.

These mentioned bio-feedback methods are based on presenting the special adaptable scenario to the tested person, which he/she can modify according the trainer hints for to reach either the reward or to be punished.

Such training can lead after many to subsequently improving repetitions the trained person resistivity to decease of his/her attention reductions and also to decrease of tendency to aggressive driving.

In simple version, developed by prof Sterman and Friaer.(1972) in the USA already at end of nineties on the tested person screen is projected a profile of road in which runs a schematic picture of car, which has the tendency to decline to the left side of road. The driver task is to keep it in the middle and if possible to overtake the picture of the car ahead.

If he/she succeeds, is rewarded, if no is punished.

The not neglect-able role of trainer is to evaluate the driving quality and according it to adjust the difficulty of training and the intensity of reward or punishment.

However, in more advanced bio-feedback methodologies also the whole set of other kinds of impacts on the trained person behavior can be used.

In novel versions of the fundamental bio-feedback the investigation of other driver neurophysiological factors can be added, namely the breath, hearth beats analysis, the EEG and eventually also the NIRS signals analysis, temperature measurement etc.

Such more complex bio-feedback investigations are of course more laborious, however allows much deeper investigations and higher effectivity of training.

8. Conclusion

What has to be underlined at the end of this paper is, that in all these investigations of driver tendencies to aggressive behavior behind the wheel, even in their training to limitation of these trends play extraordinary important role the factors of uncertainties.

Their low or no respecting can highly disregard all the credibility of all reached results.

The aggressive behavior of driver appears often from quite in time uncertain reasons, which significantly complicates both their detection and investigation.

These facts lead to the necessity take high care to these uncertainty factors especially because the level of knowledge of them is still not high enough and must be improved a lot.

In further research we hope to be able to continue in this respect.

Thank you for your attention

References

- [1]... Graybiel A.M., Smith K.S.: Good habits, bad habits, Scientific American, vol.310, June 2014, No.6, p.22-27
- Network World 1991, I, p. 13-31
- [2]...Faber J.:Neurokybernetic analogies. Triton, Praha, 2008, pp.113.
- [3]...Faber J.: Associative Interneuronal Biological Mechanism. Neural Network World 1991, I, p. 13-31
- [4]... Faber J., Novák M., Tichý T., Svoboda P., Tatarinof V.: Driver psychic state analysis based on EEG signals. In: Neurodynamic and neuroinformatics studies, Second book on micro-sleep. Ed. M. Novák, ČVUT, Praha 2005. pp.265.
- [5]... Bouchner P., Novák M., Novotný S.: Aggressive behavior and stress on roads
- Faculty of Transportation Sciences, CTU in Prague, October 2015