

Mechanisms of Compensation of the Driver's Sense of Dimensions

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Abstract: The research paper analyzes the peculiarities of training candidates for drivers for certain subtypes (components) of combined driving. The work is focused on the analysis of opportunities to improve the quality of training of drivers for such subtypes of driving as orientation on the road, which, in particular, is the basis for mastering parking manoeuvres. Based on the analysis of a number of works, less confidence of women in driving a vehicle in a limited space (as opposed to men) is shown, which is manifested in the choice of simpler tasks for this subtype of activity.

The psychological nature of the sense of dimensions is analyzed, the importance of visual sensations and long-term memory for the formation and development of this feeling is shown. The hypothesis about the possibility of compensating for the insufficiently developed and worsening with age sense of dimensions due to reliance on visual figurative memory and subject reflection is formulated.

The results of the empirical study, which found the relative independence of the level of development of linear and angular eye estimation and confidence in parking with different driving experience, are presented. The results of the analysis of the tasks for reflection of driving in a limited unstructured space by 100 drivers are presented, which confirm the hypothesis of the study: visual landmarks for parking in non-standard conditions, in percentage terms, are more often identified by older drivers with longer experience but with poorer indicators of linear and angular eye estimation, being no different in terms of parking confidence from young drivers with better eye estimation, which can be considered as a manifestation of the compensation mechanism.

Keywords: Multicomponent combined driving, road orientation, sense of dimensions, teaching method, driving style, parking confidence, gender, visual sensations, image memory, reflection.

INTRODUCTION

Driving in Soviet-Russian psychology has traditionally been regarded as an activity: technicians still focus on the driver's work with information [1, 2], and physicians offer an option of analysing driving as a multicomponent combined activity, which includes 6 subtypes of driving activity (see Table 1) [3].

It should be noted that the current methodology for training drivers is still based on the understanding of driving as working with information [4]. The analysis of the approved methodology of training of drivers and particular exercises which, in accordance with the methodology, should be mastered by the candidate for drivers, allows finding out their actual direction towards the formation of two or three components of driving activity - the solution of traffic situations according to the traffic rules (anticipation behaviour), vehicle handling (impact on vehicle dynamics through vehicle controls and - in part - orientation on the road - through mastering a number of exercises when driving on the site) [4].

The driver's solution to a driving special situation is provided by theoretical training in a driving school. Driving a vehicle is mastered by the candidate for drivers through practical training at the race track and in the city [4].

As for the rest of the above components of driving, both the methodology and practice of training in driving schools is aimed at their formation to a much lesser extent (or not aimed at all), which is not least due to the peculiarities of conducting and taking examinations of candidates for drivers by the traffic police [4, 5].

Theoretical Analysis

In this paper, the focus is on the study of such a subtype of driving as orientation on the road, which is associated with the determination of the location on the road (including in the lane) and relative to other traffic participants, which is primarily necessary for the driver during parking manoeuvres or when driving in a limited and poorly structured space (in yards, on dirt roads, when parking in places not equipped for this purpose).

On the one hand, it should be noted that there is a methodology (aimed at training driver candidates for parking manoeuvres) for teaching certain aspects of this subtype of activity [4]. There are also special exercises that help train drivers to teach two types of parking without fail.

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Table 1: Subtypes of Combined Multicomponent Driver Activity

Subtypes of activity	Subject	Objective	Content
Driving	Ensuring the movement of a vehicle	Driving	Maintenance of parameters of movement and operation of vehicle systems
Anticipation behaviour	Complying with traffic regulations and preventing hitting people and colliding with objects	Caution	Finding objects that regulate traffic and objects that can impair safety, adjusting vehicle location in accordance with the requirements of regulatory means or relative to the object which may impair safety
Traffic situation orientation	Ensuring the specified location of a vehicle on the road	Road orientation	Determining the current vehicle location relative to road landmarks
Navigation orientation	Ensuring the specified location of a vehicle	Terrain orientation	Determining the current vehicle location and its adjustment
Interaction with other traffic participants	Organization of interaction with traffic participants	Creating optimal conditions for drivers and pedestrians	Proper use of alarms, driving taking into account other traffic participants
Decision-making in an emergency situation	Preventing catastrophic development of a special situation on the road	Countering emergency situations	Detection of a dangerous situation, decision-making and performance monitoring

On the other hand, there is empirical evidence concerning the study of typical driving styles of men and women [6], clearly demonstrating some features of task selection by separate subgroups of amateur drivers when driving in a limited space and when parking.

The Driving Style questionnaire used to conduct the study was designed on the basis of a structural approach in which driving style was determined through five characteristics: safety-risk, planning-impulsivity, attitude to means of safety, driving culture, parking confidence.

Driving style meant typical (usually peculiar) well-established characteristics of the road behaviour of a driver, as well as a system of ways and means of carrying out their activities, emotional experiences typical for the driver and interactions with other road users, which determine the level of safety (accident rate) of the driver (on the one hand) and determined by a number of stable and variable (including situational) factors (on the other) [7, 8]. Driving style was determined by changing five characteristics: safety-risk, planning-impulsiveness, attitude to safety, driving culture, parking confidence.

The study found that the driving styles of female amateur drivers and male professional truck drivers have a significant difference in only one of the measured characteristics: parking confidence. Although the groups themselves were radically different in a number of social characteristics, they had a pronounced similarity in terms of style (see Table 2).

When comparing the women's group with amateur men (this time the social parameters of the groups were the opposite – close, the groups had no significant differences either by age, by training level, by social status, or by educational level). Differences were also found in terms of three stylistic characteristics out of five, and one of them again was parking confidence (see Table 3).

It should be noted that it was the female group of amateur drivers who showed less confidence during parking manoeuvres. There were no significant differences between male professional and amateur drivers in terms of this characteristic.

Let's clarify that drivers show parking confidence in the peculiarities of choosing and setting tasks when performing manoeuvres in a limited space (above all, when parking the vehicle): more "confident" drivers set more difficult tasks, do not refuse to drive when a hypothetical need arises to move in a limited space.

Based on the available data, it should be concluded that in Russia, female amateur drivers obviously feel less confident when performing manoeuvres in a limited loosely structured space compared to male drivers.

Other Russian authors [9] also described the differences between the candidates for drivers and drivers in terms of features of orientation in space, predetermining stylistic features of driving a vehicle.

Are the identified features of a purely Russian national nature? According to the analysis of foreign

Table 2: Significant Differences between Groups of Drivers (Female Amateur Drivers and Male Professional Drivers) in Terms of Social and Style Characteristics [6]

Comparable characteristics	Mean value	Standard deviation	Significance level	Mean difference
Age	32.85	8.36	0.000	-8.94
	41.79	12.45		
Safe age	1.84	0.37	0.011	0.19
	1.64	0.48		
Attitude to the transport sphere	1.47	0.95	0.000	-3.25
	4.72	0.92		
Driving experience	6.90	5.36	0.000	-14.077
	2.98	11.86		
Period of training	2.37	1.06	0.000	-8.029
	10.40	10.99		
Training program	1.26	0.59	0.000	-1.274
	2.53	0.96		
City	1.24	0.56	0.001	0.241
	1.0	0.00		
Parking confidence	6.89	1.93	0.012	-0.816
	7.70	1.65		

Table 3: Comparison of Two Groups of Drivers: Female Amateur Drivers and Male Amateur Drivers [6]

Comparable characteristics	Mean value	Standard deviation	Significance level	Mean difference
Attitude to the transport sphere	1.47	0.95	0.009	-0.45
	1.92			
Safety-risk	29.87	1.19	0.020	2.01
	27.86			
Driving culture	30.24	4.46	0.007	2.14
	28.10	5.10		
Parking confidence	6.89	1.93	0.001	-1.01
	7.89	1.80		
Family	2.28	0.67	0.005	0.349
	1.93	0.77		
Children	0.81	0.51	0.013	0.237
	0.57	0.44		

works, researchers from different countries pay attention to the study of the role of motivational, personal [10], gender and age factors both in determining the effectiveness of learning to drive and in determining the safe (accident-free) driving [11, 12].

Swedish scholar [13] noted differences in the success of passing the theoretical test by candidates for drivers of different sexes (priority on the women's side). Turkish authors [11] have drawn attention to better indicators of sensorimotor coordination in men with higher levels of safe driving skills in women.

Studies by foreign authors indicate that driving behaviour (driving style) is influenced by gender and age [11, 12], socio-professional [14], and situational (number of passengers in the car, listening to music) [15] factors, and features of family education [16], and driving styles of parents themselves [17].

Thus, the answer to this question is rather negative, as in other countries, in addition to studying the specific features of road behaviour and the factors that determine them, innovative methods of driver training are being developed and implemented [11-13, 18-24].

Computer software that simulates traffic situations are of great interest, which provides candidates for drivers the opportunity to gain experience in predicting the development of traffic situations [24], and attempts to develop a sense of fear (sense of danger) [19, 21, 25] for drivers with unsafe driving behaviour are made (this software is currently more effective for candidates for drivers or for drivers with low driving experience) [19].

In any case, we can say, at least, that the methodology of training drivers in the Russian Federation in terms of training parking manoeuvres, orientation on the road is not effective enough. Both the search for reasons and the creation of a methodology for overcoming these differences are urgent.

Psychologists and technical specialists are quite in agreement with each other to attribute a number of properties and qualities to professionally important qualities of a driver, for example: reflexometry, time of response to a moving object, accuracy of perception of time segments, accuracy of estimation of linear and angular distances (linear and angle visual estimation), separate attention characteristics (stability, concentration, switching), motor coordination, etc. [2, 26].

Professional educators (working in the field of professional sports) [27, 28] also attribute a linear and angular visual estimation to drivers' professionally important qualities, but in addition to the above list also add a number of senses: sense of speed, dimensions, clutch, whose diagnostics and development is a separate scientific problem.

In a number of papers, we have already explored the possibility of compensating of such a quality as the speed of switching attention due to the planning style of activity [29, 30]. As for the linear and angular visual estimation, according to a number of specialists, they are important for developing a sense of dimensions and are essential for the driver when it comes to manoeuvring in a limited space.

Therefore, an underdeveloped visual estimation (in candidates for drivers) or deterioration of visual estimation (such as caused by age-related changes) may adversely affect the performance of some manoeuvres (primarily parking) in the future. And their development or compensation could also be quite urgent.

Let's try to understand in more detail the psychological nature of visual estimation. Let's analyze

what mental processes (including cognitive ones) are most closely related to the sense of dimensions.

Thus, in attempting to develop this feeling in professional drivers, in work [27] was proposed to perform the following exercise: drivers approach with a vehicle to a vertical post. In the beginning, this post has a great height, gradually its height decreases. The driver shall be instructed to stop at a strictly determined distance with respect to this post. Drivers shall perform the exercise guided by their own sensations. Upon completion, they shall exit the vehicle and check accuracy. After a while, drivers learn to stop in an accurately determined place. The driver is not given an explanation of the mechanism of forming a sense of dimensions. (Maximum - after the post acquires the dimensions at which the driver needs to stop when it disappears from the field of view, it is suggested to count time in seconds). In other words, reliance is transferred to a sense of speed and time intervals. However, in this case, there is a problem of diagnosis and development of these qualities.

So, what else can a driver rely on when performing this kind of exercise? The answer to this question should be sought with a focus on creating a universal methodology for the development of a sense of dimensions.

Perception as an integrated reflection of an object or phenomenon is based on such cognitive processes as attention, sensations and memory [26]. What kind of sensations can be not only useful for the driver during parking manoeuvres but also the easiest to be realized, verbalized - and ideally - translated into an algorithm? The answer is obvious: the visual ones.

What can the driver see in the process of manoeuvring: on the one hand, a number of elements of the external environment. On the one hand, other vehicles, road elements (marking lines, vertical objects, etc.), houses and trees, pedestrians, etc. On the other hand, the driver sees the interior of the car (a part of the windscreen, its corner, a part of the side door, mirror lines, in some cases - a part of a hood, car stands, steering wheel, windshield wipers, etc.).

And most of the interior elements remain constant, unchanged (at a certain position of the driver's body). Bringing the vehicle to a certain position, with a certain adjustment of the seat and mirrors, the driver sees a certain (even more correct to say - a specific) combination of elements of the environment and

interior. Apparently, using the method in [26], the drivers, after reaching the required position in space, memorize (rather involuntarily) the necessary "combination" of elements and rely (again often involuntarily, perhaps even unconsciously) in the future on the image stored in memory when performing manoeuvres.

The main problem in the activation of this mechanism is to find landmarks to be used to determine the position of the vehicle in the road environment, given the high likelihood of reliance on the activities aimed exactly at involuntary memorization.

The main possibility of "detection" of these landmarks is the appeal of experienced drivers to the reflection of activities in determining the position of the vehicle in space, and first of all - in a limited space. For the sake of solving this problem, a task was designed for reflection of the driver's actions when driving in a limited space (in five typical traffic situations).

The objective of the research paper: to show the compensating role of reflection and reliance on visual sensations and image memory in mastering parking manoeuvres in particular and in orientation on the road as a whole.

Hypotheses of Empirical Research:

1. Characteristics of driving style, such as "Parking confidence", which is manifested in the tendency to set and perform complex tasks for this subtype of activity is determined not only by the level of development of the linear-angular eye estimation.
2. The deterioration (or insufficient level of development) of the linear and angular eye estimation, which are important for the formation of a sense of dimensions, can be compensated. Compensation mechanisms for an underdeveloped eye estimation may be: reliance on memorization (voluntary or involuntary) by drivers (candidates for drivers) of specific (key) images of combinations of interior and elements of the external environment (when the vehicle is located at a certain distance from these elements) and on the subject reflection.
1. The stylistic characteristic of "Parking Confidence" is determined not only by the level of development of the linear-angular visual estimation.

2. The deterioration (or lack of development) of the linear and angular visual estimation can be compensated for. The mechanisms of compensation for an underdeveloped visual estimation may be, reliance on memorization (voluntary or involuntary) by drivers (candidates for drivers) of specific (key) images of combinations of interior elements and elements of the environment when the vehicle is located at a certain distance to these elements and the subject reflection.

MATERIALS AND METHODS

Four main methods were used:

- 1) Linear visual estimation test
- 2) Angular visual estimation test (visual estimation was assessed in accordance with the recommendations of the methodological guidelines of the Institute of Vocational Education) [26].
- 3) The scale of the author's Driving Style Questionnaire [8].

The process of creating and testing the Driving Style Questionnaire is described in detail in the monograph Psychology of Safe Driving [7]. During the empirical study referred to, respondents' data obtained from the processing of one out of five scales of the Parking Confidence Questionnaire were used.

- 1) The task for reflection of a subtype of driving (orientation on the road) in five typical traffic situations.

According to [7], reflection means the reflection of the principles of action and personal meanings, which underlies self-control and self-regulation of activity and behaviour, by determining the links between a particular situation and the worldview of an individual.

It is assumed that there are two different types of reflection: subject and social-psychological. The subject type is related to the ability of a person to reflect the principles and ways of performing their activities. Socio-psychological type is related to the ability to reflect the meanings of activities (for themselves or for others) [7]. The task assumed reliance on subject reflection (see Appendix A).

The task was designed to, on the one hand, identify the respondents' ability to the reflection of the driving

experience and, on the other hand, to promote observation and realization of visual landmarks that can be used by trainees to successfully complete parking manoeuvres.

The test subjects were initially explained the term “subject reflection”. Then it was suggested to use subject reflection to describe the methods used to solve the problems of orientation on the road and the adjacent territory (in a limited space) when driving in the questionnaires (the questionnaire is attached).

Research Sample

An empirical study was carried out using a sample of 100 people. Two groups of drivers were considered separately: young drivers (with experience of up to 3 years), the average age of 19.5 years – 51 people; candidates for practical driving instructors (with more than 3 years' experience, the average age of 28.7 years) – 49 people.

The task was offered as part of practical training on the subject “Transport Psychology”, which students of the technical higher educational institution studied as a selected course, and candidates for instructors – as compulsory. The theme of the lesson “Teaching to Drive. Driving Teaching Techniques.”

RESULTS

The study found that high parking confidence in young drivers (with experience of less than 3 years) correlates with good linear ($r=0.35$ at $t=0.01$; $n=51$) and angular ($r=0.36$ at the level of significance of 0.01) visual estimation, whereas such a correlation is practically absent in the group of drivers with long experience. Thus, the first hypothesis was confirmed: parking confidence is determined not only by a good linear and angular visual estimation.

The analysis of tasks for reflection of actions in movement in a limited space performed by the respondents of two groups was carried out as follows:

1. The percentage of tasks for reflection completed in groups with less than 3 years of experience was calculated.
2. Content analysis of the received answers for the detection of specific visual landmarks in them (calculation of the percentage of substantive answers).
3. Content analysis of the most typical answers.

The data provided in Table 4 clearly show that most of the respondents (more than 90%) in the group of inexperienced drivers were not able to complete the proposed task, while there were three to four times less of even those who did not try to complete it in the group of experienced drivers.

In terms of content, the picture was even more revealing: there were only single answers among young drivers, in which respondents tried to specify key points to rely on in their parking manoeuvres (Table 5).

Among the more experienced drivers, the percentage of those who specified relevant landmarks was again higher (2-4 times).

The respondents mentioned the following as typical visual landmarks for the first of the proposed situations:

1. The coincidence of the visible line of the hood of the vehicle with the tire contact spot of the vehicle in front with the roadbed - corresponds to a distance of about 1.8 - 2 meters to the front of the vehicle in front (47% of answers).
2. The license plate of the vehicle in front is closed by the visible line of the hood of your vehicle – a distance of about 1 meter (49% of answers).
3. Closed marker lights – a distance of about 10 cm (4% of answers).

Respondents also answered the third question relatively easily: depending on the type of parking they

Table 4: Percentage of Respondents' Completion of a Road Orientation Reflection Task (when Driving in a Limited Space)

Task No.	Young drivers group	Group of drivers with a driving experience over 3 years
1	9.8	32.7
2	5.8	23.5
3	9.8	32.7
4	3.9	15.7
5	3.9	15.7

Table 5: Percentage of Substantive Answers (Containing Specific Visual Landmarks) of Respondents in Groups of Drivers with Different Driving Experience

Task No.	Young drivers group (driving experience for up to 3 years)	Group of drivers with a driving experience over 3 years
1	5.8	20.4
2	3.9	15.7
3	5.8	20.4
4	3.9	7.8
5	3.9	7.8

determined the required distance based on the correlation with the sizes of typical passenger vehicles – 1, 5 or 2 lengths of the standard size passenger car.

The smallest number of answers was received when asked about the position of the vehicle between two other landmarks already located on the road to determine the possibility of with the oncoming vehicle on the road (provided that the road has a non-standard size and no marking). Most of the respondents who tried to answer these questions wrote that they were based on a “sense of dimensions” but failed to give a substantive answer about landmarks they rely on when deciding on the possibility of movement in a given situation.

DISCUSSION

The results of the empirical study showed that candidates for masters and instructors in practical driving (who had more driving experience – from 3 years and more) who completed the task of parking reflection:

1. Had poorer indicators of the linear visual estimation compared to younger and less experienced ones respectively: 90.5 drivers with 3 years of driving experience and only 62.5% of older drivers with more than 3 years of driving experience demonstrated complete fitness in terms of visual estimation); the differences were insignificant in terms of angular visual estimation (57.14% of young drivers and 66.67% of older drivers showed full fitness). In this case, more experienced drivers in some cases demonstrated unfitness by one or another indicator – recorded in 4.1% of respondents).
2. Have proven to be more productive in completing the tasks for reflection of actions during movement in a limited space compared to novice drivers.

However, there were no significant differences between the groups for parking.

The results obtained allow reasoning on the compensatory mechanisms that are formed in more experienced drivers, possibly contributing to compensation of declining psychophysiological abilities and contributing to maintaining confidence when driving in a limited space. (Compensation implies reliance on well-developed qualities (which can influence the success of an activity) instead of underdeveloped ones [30, 31].

Apparently, when driving in a limited space, reliance on memorization (involuntary or arbitrary) of combinations of elements of the road environment and interior to determine the correct position of the vehicle in space and the inclusion of these images in self-control when performing parking manoeuvres contributes to the compensation of older and experienced drivers in case of deterioration of their psychophysiological characteristics with age.

In other words, compensation for the deteriorating (or initially poor) visual estimation may be due to reliance on visual sensations, image memory and subject reflection (as confirmed by the results of empirical research).

The same mechanism could contribute to the more efficient development of parking manoeuvres by persons with insufficient levels of development of linear and angular visual estimation. Especially urgent is the search for visual landmarks for solving the tasks of training and retraining for female drivers.

CONCLUSION

The research paper shows the shortcomings of the existing methodology for training drivers in the Russian Federation and one consequence that follows - less confidence of women when driving a vehicle in a limited space (compared to men).

Based on a theoretical analysis, it is recognized by experts that the level of development of a linear and angular eye estimation is important for mastering driving in a limited space. The psychological nature of the sense of dimensions is analyzed, the importance of visual sensations and long-term memory for the formation and development of this sense is shown. A hypothesis is formulated and tested about the possibility of compensating for the underdeveloped linear and angular eye estimation by relying on visual figurative memory and subject reflection and ensuring a proper level of development of a sense of overall dimensions.

The results of an empirical study are provided, where the relative independence of the level of development of the linear and angular eye estimation and the parking confidence with different driving experience is established. The results of the analysis of tasks for the reflection of the movement in a limited unstructured space by 100 drivers are presented, confirming the hypothesis of the study: visual landmarks for parking in non-standard conditions, in percentage terms, are more often identified (and therefore used in the process of driving in a limited space) by older drivers with more experience, worse indicators for linear and angular eye estimation, which in terms of parking confidence do not differ from young drivers with small driving experience and better eye estimation indicators, which can be regarded as a manifestation of the compensation mechanism as a reliance in the activity on the well-developed qualities instead of underdeveloped ones.

APPENDIX A

Task

Reflection (subject) is a reflection of man's principles and (or) ways of carrying out a particular activity.

Instructions: please try to remember and reflect, how you solve the tasks presented in the questionnaire in the course of driving:

How do you determine (what landmarks do you rely on?) the place of stop behind the vehicle which stops in front of yours (You approach the vehicle which stopped at a stop line when the traffic lights turned red: how do you determine the moment of final step on a brake?) (What do you see at the moment of final stoppage of your vehicle?)

When approaching to two vehicles in front of yours at a certain distance from each other (there is no road marking), how do you determine (what evidence do you rely on) that you can take place between them?

1. When choosing the place for parking (by parallel backing or forward motion), what evidence (landmarks) do you rely on when determining that there is enough place for it?
2. On a narrow (rural, unsurfaced) road when missing an oncoming vehicle), what evidence (landmarks) do you rely on when determining that there is enough (not enough) space?
3. Can you, when driving your vehicle, estimate the distance to the vehicle in the next lane (to the right and left of you)? What evidence (landmarks) do you rely on when determining this distance?

Additional instructions (for those who find it difficult to complete the task): try to remember what you see at the time of making decision, in one case or another, how the fixed elements inside the car and the dynamically changing elements of the external environment (one or other parts of other vehicles, elements of marking, border, etc., etc.) combine.

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