

# Spatial Abilities, Memory and Intellect of Drivers with Different Level of Professional Experience

N. Khon, A. Kim, T. Mukhitdinova

**Abstract**—The aim of this research was to reveal the link between mental variables, such as spatial abilities, memory, intellect and professional experience of drivers.

Participants were allocated to four groups: no experience, inexperienced, skilled and professionals (total 85 participants). The level of ability for spatial navigation and indicator of nonverbal memory grow along the process of accumulation of driving experience. At high levels of driving experience, this tendency is especially noticeable. The professionals having personal achievements in driving (racing) differ from skilled drivers in better feeling of direction, which is specific for them not just in a short-term situation of an experimental task, but also in life-size perspective. The level of ability of mental rotation does not grow with the growth of driving experience, which confirms the multiple intelligence theory according to which spatial abilities represent specific, other than logical intelligence type of intellect. The link between spatial abilities, memory, intellect and professional experience of drivers seems to be different relating spatial navigation or mental rotation as different kinds of spatial abilities.

**Keywords**—Memory, spatial abilities, intellect, drivers.

## I. INTRODUCTION

THE aim of the research was to reveal the link between mental variables, such as spatial abilities, memory and intellect and professional experience of drivers. There are different opinions and contradictions in the literature relating to this subject [1]-[3], [5]-[7]. Our hypothesis was that the link between spatial abilities, memory and intellect from the one side and professional experience from the other side could be different regarding to the kind of spatial ability: spatial navigation or mental rotation.

The topic is rather new to Kazakhstani psychology, which experiences a lack of experimental research as well as methodology, or tools applicable for the studies in this field. There is a paradox – so much space, but a few research of spatial abilities in Kazakhstan. At the same time, there is a range of spatial jobs in the Kazakhstani job market and urgent need in recruitment, professional selection and professional development of these kinds of job. We consider spatial navigation and mental rotation as two different types of spatial abilities and professional experience as an important factor related to them.

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## II. METHODOLOGY AND PARTICIPANTS

### A. Methodology

Both quantitative (experimental procedure, tests) and qualitative (interview) tools were used.

### B. Participants

85 men with different driving experience (among them: 23 participants with no driving experience, 43 – with low experience (5000-10000 km), 14 – experienced, or mature drivers (more than 11000 km), 5 professionals. The first three groups of participants were between 20-35 years old while the last group of professionals was from 33 to 47 years old, 2 of them were champions of Kazakhstan in rally sport.

### C. Procedure

The research was conducted individually; it took 40-50 minutes per each participant. The procedure looked as follow:

After short general acquaintance, the aim of the research was clarified. The diagnostics of memory and intellect was conducted. The participant should fill in the “The Feeling of direction” [4] questionnaire of 14 questions and instruction to use “yes/no” answers. Then the “Mental Rotation Test” was conducted.

Instruction: “There are 16 cards, there are two figures on each of them. The figures are turned under different angles. Your task is to compare them and to make a decision if they are quite different figures or the same figure, given in different positions. Mark your answer on the sheet”.

### D. Non-Verbal Memory Test

Instruction: “The table of figures will be presented to you. You must memorize as many figures as possible for 20 seconds. Write them on the sheet as soon as the table will be removed.”

For the “Point of direction” task 4, experimental procedures with specific landmarks of Almaty city were chosen.

The instruction for the 1st session was as follows: “Imagine yourself standing directly opposite the Abay (famous Kazak poet) Memorial. Let the Memorial be the center of a circle, and the circle be a map of Almaty. Find out the point of the “Tselinny” cinema on the circle. Draw a line connecting this point with the circle’s center”.

Instruction to the 2nd task: “Imagine yourself standing at the entrance to the “Almaty-2” railway station. Let the railway station be the center of a circle. The circle is a city map. Point out the place of “Tselinny” cinema on a circle. Draw a line connecting “Tselinny” cinema with the middle of the circle”.

Instruction to the Task 3: “This is the test for spatial thinking. Read instruction first. Can you navigate on the city map?” If the answer was negative, the experimenter could explain the following – “the upper part of the city, where the mountains are located, is South, the bottom part on the map – North, there are “Aksay”, “Mamyr” districts to the west and “Samal” and “Palace of Republics” to the East. Can you navigate on the map now? If yes, the first picture could be presented.

16-PF Cattell test (Scale B): There are 13 questions in this test. The participant should choose one of three options, trying to avoid indefinite answers or omitting any question. No socially desirable answers were asked for, just the participant's opinion. Time of performance was limited to 7 min.

Verbal memory test, where the variable was the score of words memorized correctly.

Feedback to the participants was given in oral or by SMS/email.

List of positions:

1. Abay Memorial
2. Railway station «Almaty -2»
3. Hotel «The Regent Ankara»
4. Wedding palace «Zhasotal »

List of objects:

1. “Tselinny” movie
2. Independence Memorial
3. Television tower
4. Bus station «Sayakhhat»

We used both with/without pictures of objects and positions experiment.

There were four photos, (further designated as pictures) which were shown to the participants in certain subtests:

- Photo of “Tselinny” movie,
- Photo of Independence Memorial,
- Photo of Hotel «The Regent Ankara»,
- Photo of Wedding Palace «Zhasotal».

In the pilot experiment, we checked a validity of applied indicators on a small group of participants (5 people in each of 3 groups). As a result of the pilot experiment the allocation of drivers according to the driving experience in kilometers and an assessment of an indicator on the “Pointing direction test” as a real deviation in degrees was accepted.

### III. RESULTS

The data obtained as a result of research were exposed to statistical processing using the computer SPSS-10.0, a program of the disperse analysis that corresponded to the character of the obtained data and a research objective.

In our case the independent variable – a driving experience / professional experience had 4 degrees of gradation: 1,00 - the persons which don't have experience of driving the car, 2,00 persons having experience of driving from 5 to 10 thousand kilometers, 3,00 - the persons having experience of driving over 11 thousand kilometers, 4 professional - the persons having personal achievements in motor racing. So, all participants could be allocated to one of four groups: without

experience, inexperienced, skilled and professionals. In the fig. 1 growth of an indicator of verbal memory in-group of professionals is presented. Significant distinctions in comparison with a group of qualified drivers are established.

TABLE I  
VARIABLES

Var	Description
1,00	Nocar driving experience
2,00	Beginners (5000-10000kmdriving experience)
3,00	Skilled (more than 11000 km of driving experience)
4,00	Professionals (with high personal achievements in driving).
MRT	Percentage of right answers in Mental Rotation Test
IQ	Percentage of right answers in 16PF (scale B),
VMEM	Percentage of right answers in verbal memory test
NVMEM	Percentage of right answers in 12 – Figure memorizing test
SOD	Percentage of right answers in “Feeling of direction test”.
PD1	“Pointing direction test”, or PD-test. Subtest 1.1 “(Abay Memorial- “Tselinny” movie)
PD2	PD 1.2 (Abay Memorial– Independence Memorial).
PDWP1	PD 1.3 (Abay Memorial-Television tower)
PDWP2	PD 1.4 (Abay Memorial – bus station«Sayakhhat»)
PD3	PD 2.1 (railway station «Almaty-2» - “Tselinny” movie)
PD4	PD 2.2 (railway station «Almaty-2» - Independence Memorial)
PDWP3	PD 2.3 (railway station «Almaty-2» - Television tower)
PDWP4	PD 2.4 (railway station «Almaty-2» - bus station«Sayakhhat»)
PD5	PD 3.1 (Hotel «The Regent Ankara» - “Tselinny” movie)
PD6	PD 3.2 (Hotel «The Regent Ankara» - Independence Memorial)
PDWP5	PD 3.3 (Hotel «The Regent Ankara» - Television tower)
PDWP6	PD 3.4 (Hotel «The Regent Ankara» - bus station«Sayakhhat»)
PD7	PD 4.1 (Wedding Palace «Zhasotal» – “Tselinny” movie)
PD8	PD 4.2 (Wedding Palace «Zhasotal» – Independence Memorial)
PDWP7	PD 4.3 (Wedding Palace «Zhasotal» – Television tower)
PDWP8	PD 4.4 (Wedding Palace «Zhasotal» – bus station «Sayakhhat »)

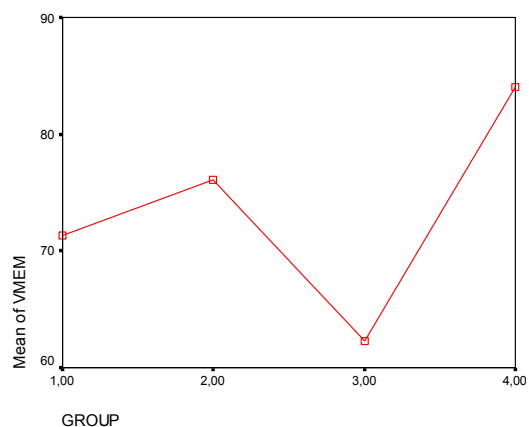


Fig. 1 Growth of an indicator of verbal memory in group of professionals

Similar results are received on an indicator of nonverbal memory (Fig. 2). Nonverbal short-term memory at professionals is higher than at skilled drivers, and at skilled ones is higher, than at inexperienced ones. Thus, the indicator of nonverbal short-term memory fixes steady distinctions in the group of drivers differing in professional experience while the indicator of short-term verbal memory indicates

distinctions only between skilled drivers and professionals.

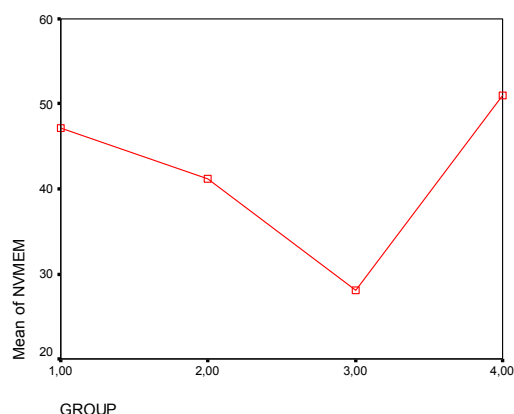


Fig. 2 Growth of an indicator of nonverbal memory in group of professionals

The professional experience starts affecting, first of all, such six indicators of spatial perception as MRT, PD1, PDWP1, PD3, PDWP5, PDWP6, PD7, PDWP8. Among these indicators, there is an indicator of mental rotation, three indicators of pointing direction with the picture and four indicators of pointing direction without the picture.

The majority of indicators belong to pointing direction without the picture. Therefore, in such imagined situations when the driver does not see real objects and has no images of them his first professional experience is important. It is possible to conclude that situations when the pointing direction is carried out with a support of the picture of a real object, also may have diagnostic value. The existence of distinctions by an indicator of mental rotation between inexperienced and experienced drivers attracts our attention.

There is an increase of significant distinctions on indicators of pointing direction with and without the picture, as well as indicators of feeling of the direction and nonverbal memory and the tendency of excess of indicators of an pointing direction without the picture over number of indicators of pointing direction with the picture. Thus, a total number of statistically significant distinctions between inexperienced participants and skilled persons in driving reaches 12 indicators.

The data obtained shows that with an increase of professional experience the quantity of indicators of the dependent variables testifying to distinctions between groups increases.

In an overall picture of the received distinctions two indicators according to the "pointing direction" test - with the picture and without it - are allocated. Those indicators of pointing direction with the picture that keep the statistical importance are visible, testifying to distinctions between all groups. Such indicators were PD1 and PD3. They can serve for early diagnostics of spatial perception at drivers with a miscellaneous professional experience. The indicator of PD4 characterizes distinctions between inexperienced participants and skilled drivers, and also between inexperienced

participants and professionals.

Data on stable indicators of distinctions between all groups can help at a solution of the problem of creation of tools for express diagnostics of distinctions of spatial abilities depending on professional experience. Such express methods are useful in situations of a lack of time, in practical work.

In a picture of the general influence of professional experience on the spatial perception of drivers a number of indicators sensitive to this influence begin with an average level of professional experience attract attention.

Among all indicators of dependent variables, the distinction between skilled drivers and professionals are shown only between feeling of direction and nonverbal short-term memory. It is reasonable as the indicator of feeling of the direction testifies to those distinctions that steadily accompany features of spatial behavior, characteristic manifestations in daily situations of life. This indicator says that increase of professional skill to more super level - the professional having personal achievements in this activity as a sport are best of all shown not in a short-term situation of the solution of an experimental task, and on the scale of life. Nonverbal memory is apparently closer to the nature of spatial abilities than verbal memory.

Let us pass to the analysis of comparative dynamics of the influence of professional experience in all groups of participants, and also to the comparative analysis of the nature of this influence. In Fig. 3, dynamics of an indicator of mental rotation is shown. On this indicator success increase between inexperienced and experienced, and also between skilled and professionals who are statistically significant is observed. Significant distinctions between inexperienced and qualified on this indicator are not revealed.

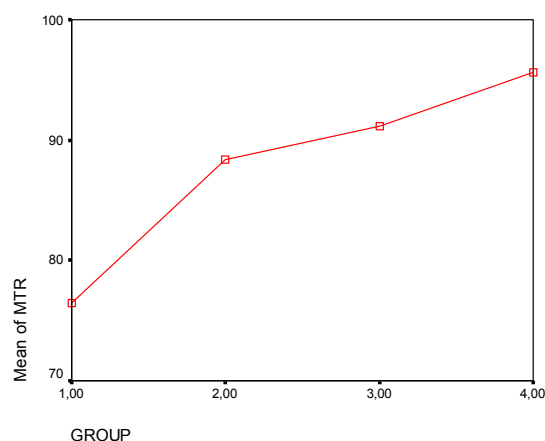


Fig. 3 Dynamics of an indicator of mental rotation on all groups of participants

It is obvious that the test of mental rotation accurately shows this influence of professional experience at early and late stages of development of professional experience.

In Fig. 4, dynamics of an indicator according to the Feeling of the Direction test between all groups of participants is shown. Dynamics of this indicator covers only drivers and doesn't cover persons without experience of driving. As this

indicator is present at all groups of drivers, it is suitable and perspective for the creation of test of express diagnostics of spatial abilities at drivers with a different level of professional experience.

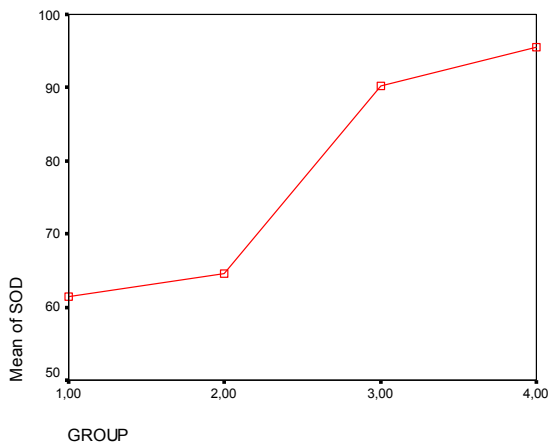


Fig. 4 Dynamics of an indicator of feeling of the direction on all groups of examinees

Statistically, significant distinctions between groups of inexperienced and all other groups of drivers are revealed.

Significant distinctions between groups of inexperienced participants and skilled drivers, and also between inexperienced participants and professional drivers are found.

Let us pass to the analysis of dynamics of indicators of spatial perception in situations "without the picture", that is when examinees had no opportunity to see an object photo. Statistically, significant distinctions between inexperienced and skilled drivers are found. Skilled and professionals on this indicator do not differ. This indicator can be used at creation of an express method of diagnostics of spatial abilities of drivers.

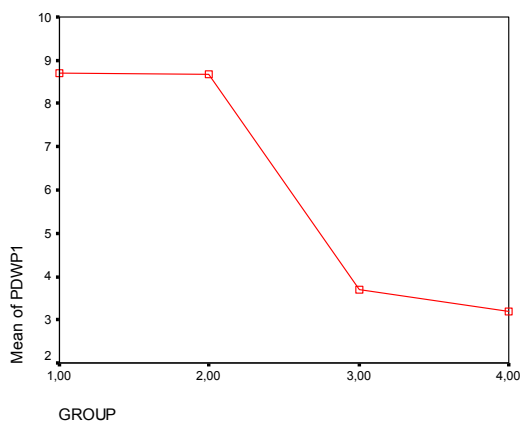


Fig. 5 Dynamics of an indicator of PDWP1 of pointing direction without the picture on all groups of examinees

Statistically, significant distinctions between inexperienced examinees and all groups of drivers, from the first to the third are found. Besides, distinctions in a group of drivers between

inexperienced and skilled drivers are found. It makes the indicator suitable for further use in the creation of test of express diagnostics of spatial abilities at drivers with a different level of professional experience (Fig. 6).

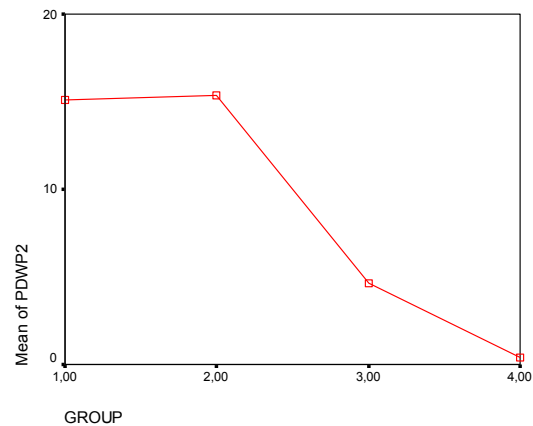


Fig. 6 Dynamics of an indicator of PDWP2 of pointing direction without the picture on all groups of examinees

The PDWP5 indicator shows the existence of statistically significant distinctions both between inexperienced and skilled drivers. On PDWP7 indicator, statistically significant distinctions between inexperienced examinees and skilled drivers were obtained. On PDWP8 indicator statistically significant distinctions between inexperienced examinees and all other groups of drivers – from inexperienced to professionals are recorded.

Let us pass to the analysis of more subtle differences in a group of indicators of PDWP differing with the existence and lack of a photo of a position at pointing direction.

Only an indicator of PDWP1 is included into the group of the indicators characterizing distinctions between groups of drivers, namely, between group inexperienced and inexperienced. So, the most prognostic is the situation of pointing direction from an Abay Monument to a television tower.

#### IV. DISCUSSION

Summing up the analysis of statistically significant distinctions between the examinees who have no experience of driving, and also three groups of drivers – inexperienced, skilled and professionals, it should be noted the following:

1. With an increase of professional experience the quantity of indicators of the dependent variables testifying to distinctions between groups increases. These distinctions are received on indicators of feeling of direction, pointing direction, nonverbal memory. Thus, confirmation of known regularity on the growth of the level of abilities to the spatial perception of communication with the growth of professional experience is obtained.
2. Professionals differ from skilled drivers only in indicators of short-term verbal and nonverbal memory. The group of professionals has a higher level of ability to short-term

saving information even in a situation when there is no specifically set operational purpose.

3. Participants with no driving experience and inexperienced drivers differ in mental rotation, as well as in pointing direction without the picture.
4. Skilled drivers and professionals differ by the variables of short-term verbal and nonverbal memory. Nonverbal memory is apparently closer to the nature of spatial abilities than verbal memory. Memory is a storage of our experience, and this experience of drivers has, first of all, nonverbal character.
5. The indicator of nonverbal short-term memory fixes steady distinctions in all groups of drivers differing with professional experience while the indicator of short-term verbal memory indicates distinctions only between skilled drivers and professionals.
6. Pointing direction task with Abay Monument to a Television Tower without picture seems to be of most prognostic value in terms of development of express tools.
7. The indicator of mental rotation found significant distinctions only between no driving experience participants and drivers with various experience of driving, but no differences within the group of drivers were obtained.
8. The indicator of feeling of direction shows distinctions between inexperienced and skilled drivers but doesn't show distinctions between skilled and professionals.
9. Significant distinctions in intelligence indicator were not found. Apparently, spatial abilities actually represent special, other from logical intelligence type of intellect according to H. Gardner's theory of multiple intelligence.

#### V. CONCLUSIONS

1. The level of ability to spatial navigation and indicator of nonverbal memory grows in the process of accumulation of professional experience of drivers. This tendency at high levels of professional skill is especially noticeable. The professionals having personal achievements in this activity as a sport differ from simply skilled in better feeling of direction that characterizes them not in a short-term situation of an experimental task, but in life-size perspective.
2. Nonverbal memory is apparently closer to the nature of spatial abilities than verbal memory. The indicator of nonverbal short-term memory fixes steady distinctions in all group of the drivers differing with professional experience while the indicator of short-term verbal memory indicates distinctions only between skilled drivers and professionals.
3. The pointing direction task with an Abay Monument as a position and Television Tower as an object in Almaty city without a picture is of most prognostic value.
4. The level of ability of mental rotation does not grow with the growth of professional experience of drivers.
5. Spatial abilities represent special, other than logical intelligence type of multiple intelligence according to H.

Gardner. The data obtained are one more confirmation in favor of this theory.

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