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Cognitive style and gender differences in spatial abilities

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Abstract

Influence of cognitive styles on spatial abilities was a famous area of research. M.A. Holodnaya investigated idea about “clarity” of cognitive style features. The bipolar dimension of cognitive style explains how individual is dependent on or independent from the influence of a distracting visual field. In our study we analyzed connection between FD/FI and gender in mental rotation tasks. There were two respondent variables consisted of the field dependent/independent score provided by the Group Embedded Figures Test (GEFT) and the spatial test (compass). We analyzed 118 participants, and only 40 of them showed us typical FI and FD. A gender difference in cognitive styles wasn't significant. The important new feature of our study was the role of cognitive style in mental rotation ability. Males tend to spend less time and made less mistakes compare with females.

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1. Introduction

There have been at least two major reviews of perceptual differences among women and men in the past 30 years. Spatial abilities is the area where males usually show better results comparing with the females. Baker (1987) described in his research that visual acuity is greater in men than women.

Space perception - shaped reflection of the spatial characteristics of the surrounding world, the perception of the size and shape of objects, their relative position in which is particularly significant taking part visual, motor, and vestibular analyzers. At the cores of perception of the space are measuring distances and angles in the environment, performed by active movements under control exercised by organs of the senses. For the sensual distinction of up and down, forward and back, left and right directions is needed functional asymmetry of the human body. The human body plays a starting point in the space perception. In particular sensations forming perception of up and down directions, show a deviation from the position of the body when the body vertical axis is perpendicular to the to the ground plane. At the expense operation of mechanisms of the spatial vision is formed perception of depth and distance.

Space perception plays an important role in the interaction of a person with environment, being as a necessary condition for orientation. It is a reflection of the objectively existing space and includes the perception of shape, size and arrangement of objects, their topography, distance and direction in which they are located.

A special role in the spatial orientation performs motor analyzer by which is established interaction between the various analyzers. To special mechanisms of spatial orientation should be attributed nerve connections between both hemispheres in analyzing activity: binocular vision, binaural hearing, bimanual touch, etc.

According to Rybalko E.F. the role of spatial factors has an impact on both quantitative and qualitative changes in the process of structuring space among adolescents. Isigaki and Miyao (1994) found significant differences between boys and girls at 5 year of age describing these features.

Biyasheva Z.M. conducted experimental research of space perception, especially mental rotation. She used modified method of Lynn Cooper, type of 2D mental rotation test. As a result, she obtained the following data: spatial abilities of girls and boys were slightly different; thus there are some gender differences between them. The males tend to show better results.

2. Problem Statement

Currently, researches in the field of stylistic characteristics of personality's cognitive sphere (cognitive styles) occupy an important place in the system of psychological knowledge. One of the essential factors contributing to research of styles is an interest to human individuality and belief in the existence of individual distinctive forms of understanding the reality of the people. Development of cognitive psychology contributed to the formation of the cognitive style's concept that has stood apart as an independent psychological phenomenon. The idea of the existence of stable differences in perceptions and ways of thinking was accumulated in the term "cognitive style" which is understood as a hypothetical construct, reflecting different cognitive strategies.

The emergence of the concept of "cognitive style", determining individual ways of knowing, contributed the study of personality characteristics that determine the sensory activity of human knowledge of reality.

In cognitive psychology, the concept of "cognitive style" is used to highlight the inter-individual differences in the process of obtaining and processing information, as well as to highlight the types of people depending on the characteristics of their cognitive orientation. Cognitive style defines a method for processing by person information and how he uses different strategies when performing tasks.

Cognitive style, as well as other educational style of the person, performs the following functions:

1. Adaptation consisting in the adaptation to the individual requirements of the activity and the social environment.
2. Compensatory because its formation is constructed based on the individual strengths and taking into account the weaknesses.
3. System producing that allows, on the one hand, forming on the basis of the style of many previously existing characteristics of individuality, on the other hand, affects many aspects of human behavior.
4. The expression of individuality consists in the possibility to express them through a unique way of doing business or through the manner of behavior.

The concept of field dependence/ independence (abbreviated to FD / FI) (Witkin et al. 1971) is one of the processes contributing to spatial visualization. Further investigations showed that the method of spatial orientation is associated with the ability to isolate a single item or piece of holistic spatial context (complex shapes). Therefore, field independence has been regarded as the ability to overcome the apparent field and structure it, to allocate separate elements in it. Field dependence is opposite quality of cognitive activity, when all the elements of the visible field are rigidly connected, and the details - difficult to be separated from the space background. From this appeared and methods of diagnostics of field dependence - field independence, such as test pieces included in various versions. Fast and right detection of figure characterizes field independence, and slow and wrong - field dependence.

Later the ability to allocate successfully a separate part of the complex image was associated with a number of intelligent, and above all - non-verbal and abilities. On this basis, it was concluded that the existence of a more general features of cognitive style, dubbed "the ability to overcome organized context". Depending on the severity of it, began to allocate analytical, proactive approach to the field and the global passive approach. In the first case, in a person is manifested the desire to reorganize the field, divide it into separate elements.

FD/FI in the narrow sense of the word - is the ability to isolate a simple piece in a complex figure, while in the broad sense of the word - a measure of the level of psychological differentiation (and thus the nature of the cognitive orientation of the subject).

Witkin works led to the development of specific procedures, which later were used as operational definitions of FI/FD, including Rod and Frame Test, RFT, Test correcting the position of the body (Body Adjustment Test, BAT), a rotating test room (Rotating Room Test, RRT) and test of embedded figures (Embedded Figures Test, EFT).

Field independence (FI) - in contrast to the field dependence (FD) is manifested in the analyticity of cognitive images: the propensity to detail and differentiate their educational experience, while adhering to the relevant elements of the perceived material. Cognitive images of FI are more mobile and "three-dimensional" as evidenced the higher success of the performance of any spatial transformations, including mental rotation.

Witkin noted that males tend to represent field independence as their cognitive style. Johnson, Flinn and Tyer (1979) reported about compensation role of previous experience. They investigated effect of training in spatial abilities on student samples.

As for the gender factor, girls and women - compared with boys and men – tend to be more field dependent in all age groups and in different types of culture Miller (2001). Apparently more pronounced field dependence of women is explained as biological (specialization of women and men in their biological functions as a conservative or exploratory behavior) and social (type of upbringing of girls and expectations of normative behavior of women clearly contribute to the formation of field dependence behaviors) determinants. Voyer (1995) during his research couldn't find significant differences between males and females when participants were under 18 years old.

FD/FI is individual-typical feature of a person therefore it is characterized by age stability, ie, if an early age children are different from each other in this characteristic, and then subsequently in the same way they would differ from each other, and if someone was 9 years field dependent, then at 29 it is exactly field dependent. Although, at the same time, children with age are becoming more field independent, their perception becomes thinner and differentiated. This is especially observed in the field dependence reduction of 15-16 years.

As a result empirical researches of M.A. Kholodnaya noted some contradictions. Increasing of the researches' number in cognitive styles not only to resolve any issues, but, on the contrary, there were not consistent with each other facts. Outline the main contradictions stylistic researches. Productivity effects of cognitive styles. On the one hand, to obtain direct evidence linking stylistic parameters with indicators of intellectual success, as a rule, is failed not in all researches. On the other hand, many facts indicate that there is a pre-emptive effect of certain poles of a cognitive style on the productive aspects of intellectual activity.

Effect of the mobility of cognitive styles. By means of special techniques of style subject can be assigned to one of the two poles of the corresponding style. But using different techniques, diagnosing the same style, the subject can go from one pole to the other. In addition, it became clear that inherent to the subject cognitive style may change under the influence of the situation, instructions, training. So, I.G. Skotnikova notes that in the initial stages of planning decisions is under the dominant influence of cognitive style, which indicates its stability, but the problem of non-compliance can be a transition to a different strategy.

Effect of the extreme values of cognitive styles. The growth of the severity of a particular style property is usually accompanied by certain mental laws. For example, the higher the field independence, the higher the performance indicators memory. On the other hand, there is a limit of the expression of style properties, after which these relationships either decreases or turns into its opposite. Thus in individuals with the highest field independence is marked decline of memory's indicators.

M.A. Kholodnaya suggested that considered aspects of style behavior are linked. In addition, in the researches process it was found that examinees can apply if necessary opposite pole cognitive style. This allowed them to make a preliminary conclusion that cognitive styles are related to the

mechanisms underlying the basis of the productive intellectual functioning. Since cognitive styles are sensitive to the subjective and situational factors, they may vary in adapting the cognitive abilities of a person to the demands of its current environment; cognitive styles is not linear, ie, bipolar measurable.

M.A. Kholodnaya formulated a hypothesis about that "... in the style research find themselves not two, but four poles. Accordingly, at diagnostics a particular cognitive style, getting two opposite in their numerical values of the index, we are actually dealing with four subgroups of subjects, significantly differing mechanisms of its stylistic behavior. Thus, cognitive style - it's not bipolar, and quadripolar dimension".

There are definite theoretical and empirical basis which allow us to talk about the psychological heterogeneity poles basic cognitive styles. Their cleavage manifested in the fact that each pole style actually masks the two different types of subjects with various forms of intelligent behavior.

As the deployment of stylistic researches progressively accumulated facts showing that cognitive styles are among the basic characteristics of individuality, as evidenced their close relationship with both biological and social factors. One of the biological and at the same time, social factors are the concepts of "gender" and "sex" representing another facet of personality, as well as with related features are individual and personal.

3. Research Questions

T. Hilton, S. Witelson conducted a study confirming the fact that men are better at spatial tests and spend less effort. However, at the same time there is a direct antithesis of research, in particular Maccoby, Jacklin, came to the conclusion that, in fact, there are no fundamental differences in the innate psychological characteristics of men and women in many areas where these differences are recognized earlier.

The most sharp polemic about the existence of gender differences exist in the field of cognitive maps reflecting the ability to spatial reproduction of environment and its objects, the method of navigation. Women prefer to specify directions, using reference points and turning left (egocentric reference point strategy), while men prefer to use the information found on the distance. At the same time McFadden, Elias and Saucier (2003) established that gender is not affected on memorization routes on the map and attention. Cognitive map of men are "map-scheme" in which the most important are the direction and distance. Silverman (2006) binds the existence of two types of cognitive maps with different evolutionary strategies in spatial orientation. Men, being "hunters" were able to find a wildfowl, and to be guided in the open space without bright landmarks. Their strategy was aimed at identification and fixation of the cardinal variables (Euclidean strategy). Women in its turn existed in a confined space, for them it was vital to be able to locate places of interest (egocentric strategy).

Also of interest is research related to the influence of age on the severity of the differences between men and women. Jocelyn B. Aubrey, Allen R. Dobbs, 1990 in their experiment studied the understanding and perception of maps by older people at the age of 50-60 years. They note that women are much more likely to showing difficulties in assessment of distances, angles and

mentally map rotation. At the same time, comparing the obtained results with those young people, researchers pay attention to the fact that gender differences are more pronounced in young subjects.

This information about the psychological gender differences naturally generates quite question about the nature of these differences. All the variants of possible interpretations may be combined into two groups:

- the influence of biological factors on the differentiation of cognitive abilities of men and women;
- the impact of social and psychological factors on the development of cognitive abilities.

4. Purpose of the Study

In our research we investigated the influence of cognitive style in particular FI/FD on the perception of space. However, such a study would not be complete without taking into account gender differences in the perception of space.

Despite the fact that spatial abilities traditionally considered an area where men tend to show better results, we believe that style factors may have a compensatory effect. We would like to investigate how gender socialization can influence the development of spatial abilities.

5. Research Methods

The experiment took place from 20/10/09 to 22/03/10. It consisted of two phases, the first step is the detection of cognitive style and with a strong style of the FD/FI, and examinees were further testing.

Thus at the first stage in the experiment took part 90 people. The approximate age of the examinees is 17-19 years. In our research 56 females and 34 males have been participated. These were the students of the 3rd course of the Linguistic Lyceum College by KazSUIRIL.

As a result of a pilot experiment were revealed 9 examinees with the FI cognitive style and 15 people with the FD. From among them with the FI style - 8 boys and one girl, with the FD style - 8 girls and 2 boys.

For improving of the representativeness of the data were tested students of the Faculty of Romance and Germanic Philology, masters of FPhPs, 3rd year students of Psychology, 4th year students of social work, as well as pupils of the 11 grade of Linguistic Lyceum College by KazSUIRIL.

As a result, the number of subjects is 118 persons. Only 41 people of them participated in the re-testing of, including 18 girls and 23 boys. The approximate age of girls is from 17 to 22 years, boys from 17 to 23 years.

The experimental group consisted of 20 participants whose cognitive style was defined as FI (9 girls and 12 boys). Participants in the control group showed FD as their cognitive style, 9 girls and 11 boys.

Research methods:

- "Compass" test is a type 2D Mental Rotation Test (MRT), where participants should find one of the cardinal compass direction.
- Method for determining cognitive style FI / FD ACT-70 K.U. Ettrih.
- Bem Sex Role Inventory (BSRI).

6. Findings

As a result of the pilot and main experiment in the analysis of 118 persons were allocated 41 people with the expressed manifestations of field independence and field dependence.

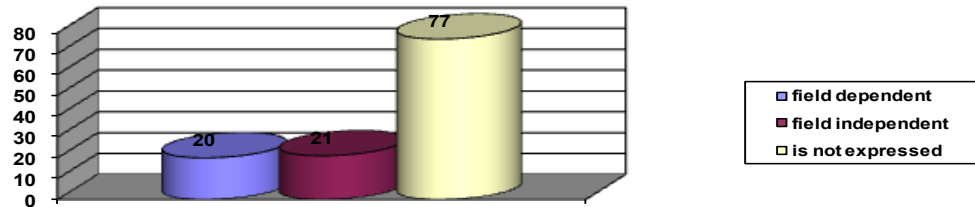


Figure 1. Diagram of distribution of cognitive style field independence / field dependence

It should be noted that most often manifested style of field dependence, rather than field independence. However, in the course of the experiment, there was no confirmation of the fact that men have more pronounced manifestations of field independence. There was a definite difficulty connected to the fact that tasks had to be done in a certain time limit ($t = 3,5$ minutes). On the other hand, many participants perceived the test as a test of intellectual ability, which also made it difficult to conduct the experiment.

It is important to note the fact that the level of spatial abilities in individuals with severe style FI significantly higher than those with severe field dependence.

Statistical analysis of the data for all indicators revealed the relationship between indicators of field independence/ field dependence and the level of spatial discrimination. The results are shown in the following table.

Table 1. Value the Pearson correlation coefficient

		Compass	Gender	FI / FD test
Compass	Pearson Correlation		,685(**)	-,340(*)
	Sig. (2-tailed)		,000	,042
	N		41	41
Gender	Pearson Correlation	,685(**)		
	Sig. (2-tailed)	,000		
	N	41		
FI / FD test	Pearson Correlation	-,340(*)		
	Sig. (2-tailed)	,042		
	N	41		

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

However, it should be noted that the successful completion of “Compass” could be associated with a higher rate because it is not excluded that field independence could pass it faster, but at the same time could prevent more mistakes. On the other hand, the FD participants spend more time on the development of instructions and to perform the test, but showed great care.

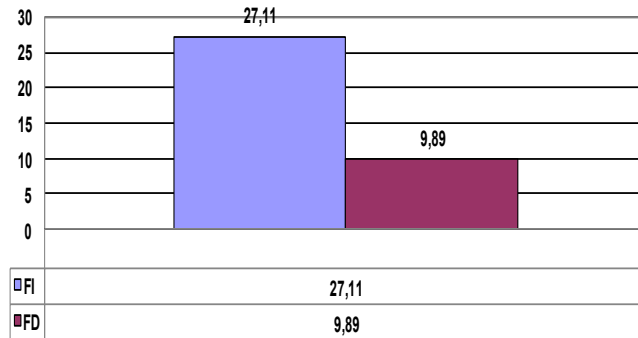


Figure 2. The average results of Compass test among FI and FD participants.

It should be noted that in persons with expressed style of the FI usually level of spatial distinction is much higher than those whose cognitive style FD. For comparison, in FI participants on the average it corresponds to a high level of spatial differentiation (7), while the FD - 4. However, it should be noted one point that successful completion of the compass is connected to one not unimportant fact, namely, the velocity of the methods of "Compass" because FI can pass it faster, but at the same time could prevent more mistakes. On the other hand, the FD people spent more time on the development of instructions and to perform the test, but showed great care. These findings are consistent with theoretical studies, in which the main characteristic of FI participants is regardless of the context and the good performance of space perception.

Table 2. Average values of spatial distinction level among men and women

Gender	The average value A (level of spatial distinction)
Men	6,833
Women	3,899

After spending comparative analysis of the mean values among females and males were obtained the following results.

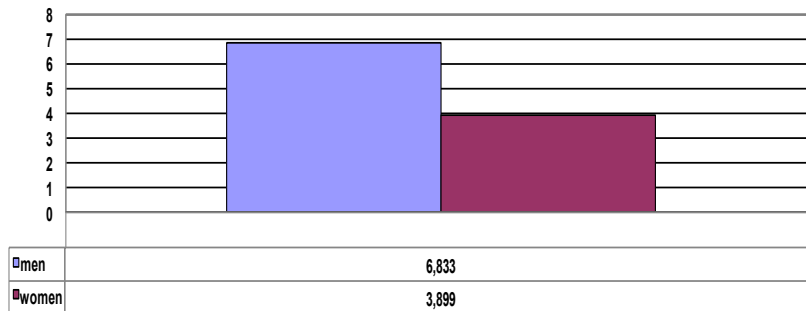


Figure 3. The average values of spatial of distinction's indicators of level among men and women.

It should be noted that the method of "Compass" determines the ability to distinguish cardinal direction and is a sort of kind of mental rotation test. Considering this fact, it is reasonable to assume that women show poor results in this method due to the fact that, firstly, they are weak in mental rotation, and secondly, use an egocentric strategy. Subjects with egocentric reference point strategy prefer to indicate the direction of using benchmarks and rotations relative to its body (left, right). Geocentric reference point strategy involves the use of information that is not available directly and requires reliance on the direction of the compass and distance (geocentric reference point strategy).

BSRI by Sandra Bem was created to measure gender identification of the person. The BSRI investigated how people identify themselves psychologically. The Bem Sex-Role Inventory offers four different possible resulting categorizations: masculine, feminine, androgynous and undifferentiated. According Bem S. theory androgyny was the best type of gender socialization which would let to use both sex-orientated models of behavior.

Most of participants (83.4%) in our research showed androgyny. The results of present study did not reveal significant correlation between gender role and spatial abilities. We didn't find a significant correlation between cognitive style and gender identification.

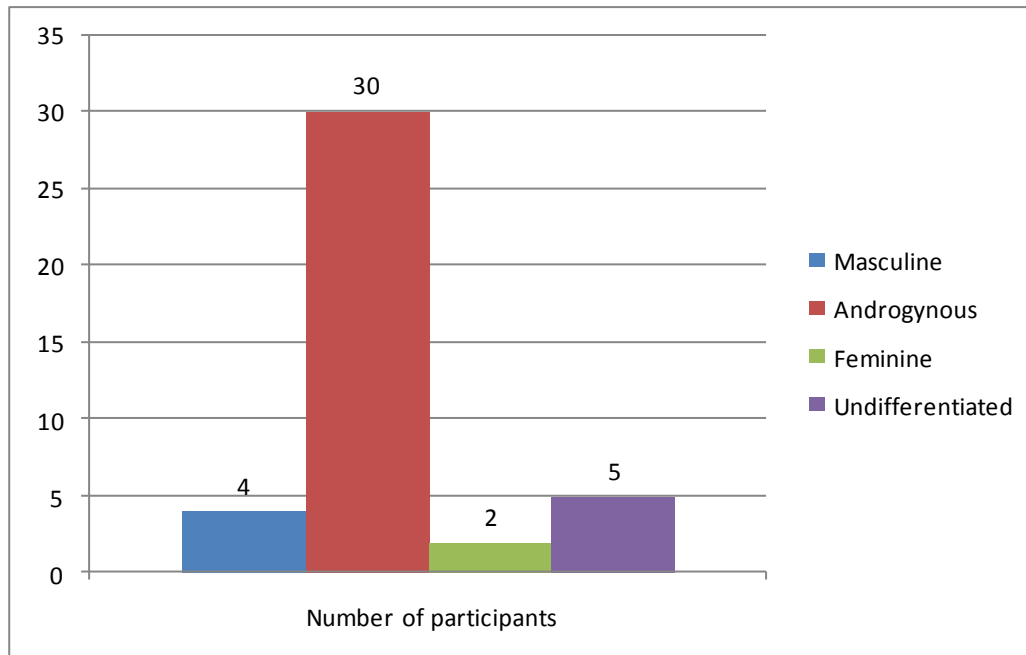


Figure 4. The gender identification.

Thus, we see that there a definite relationship between indicators of field independence / field dependence and the level of spatial distinction.

7. Conclusions

In the psychological literature, the problem of the perception of space is closely connected with the personality, the individual characteristics of a person, such as gender and cognitive style. There are researches confirming the role of gender in the spatial abilities. Cognitive style is an information processing method, the perception - receiving information.

Expressed indicators of cognitive style exist only by a limited range of subjects. During the experiment there were found significant differences between men and women in the spatial abilities (mental rotation). So men have higher levels of spatial distinction and higher indicators of velocity in a space perception.

During the experiment there were identified differences in the spatial abilities between field independence and field dependence individuals.

According to our research the influence of gender identification on spatial task performance in both samples females and males didn't reveal any significance. The previous research in this area (Bernard et. Al 1990) found that among women, high masculinity – low femininity was associated with significantly better GEFT test. So masculine females tend to show more field independence as their cognitive style. Recent research by Massa et. al. 2005 described differences in spatial task performance between females and males as impact of individual differences associated with gender role. Massa (2005) found a positive correlation between types of instruction (masculine or feminine) with gender.

Gender characteristics influence on sex-related behavior of participants. Androgyny as a result of combination of masculinity and femininity would be a best strategy.

The significance of our research is due to the fact that the relationship of cognitive style, gender and space perception can reveal the mental process with its subjective side; show the activity of the subject. Researches of modern psychologists suggest that cognitive style varies somewhat with age, which allows updating the compensatory function in the perception of space.

We conducted our review and analysis of the existing literature on this point, it is worth noting the fact that the Western study of the problem of cognitive style are very numerous, but the issue among researches of the national psychology, unfortunately not enough disclosed. A similar situation occurs with the study of the perception of space, in particular spatial distinction.

In recent years, the majority of psychological researches are conducted in line with the person-centered paradigm of personal development, and the stylistic characteristics of the individual more not relate to the activities and with a specific person, giving it a personal orientation and inherent to personal meaning. Accordingly, in recent years has developed a new personality-oriented direction, to the forefront in the study of the person which goes where style processes are considered in the context of the procedural component of a person's behavior.

As the deployment of stylistic researches progressively been accumulating facts showing that cognitive styles are among the basic characteristics of the individual-majoring, as evidenced their close relationship with both biological and social factors.

Gender refers directly to the level of the individual in person and represents a set of cultural elements (norms, values and ideals), acting as a motivation daily activities. Therefore, if the concept of gender is related to the concept of the individual and the living space, which is characterized mainly sensual character interactions, the concept of gender is related to the concepts of identity and cultural space, based mainly on the ideal (immaterial) interactions.

Integral concept of person, connecting the individual and the person enters into the unity of sex and gender, singular and universal, and this unity is involved in social interactions. The latter have both sensual and perfect character, combining both sensory information available, and perfectly preserved (in cultural forms) sociocultural experience of previous generations.

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