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Factor Analysis of Deaf Persons Communication Systems

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***Abstract*— Deaf persons, in relation to their psychophysical abilities and their mindset, uses a non-verbal communication system spontaneously in which they are trained through their education, verbal communication system in which they are systematically educated through the process of education and re/habilitation, and a bilingual system of communication that implies simultaneous use of both verbal and non-verbal communication system. The aim of the study was to determine the latent space between the communication systems of the deaf and to define the factors indicating preference for the particular communication system. By the method of the main components, using the slanting latent solution (Ortoblique rotation), we evaluated the latent structure of sample patterns according to preference of certain forms of communication systems and PB criteria extracted five factors that define the latent space of preferred communication systems „Factor preferring nonverbal communication system", „Factor of bilingvistic orientation as preferred communication system", „Factor of segregation approach as approach to communication", „Bilingual communication factor", and „Factor of positive relations to all modes of communication".**

***Index Terms*— deaf persons, communication systems, verbal, nonverbal, bilingual.**

I. INTRODUCTION

Communication is the interaction of people in objective and subjective reality, whether it is about getting to know this reality or sharing already familiar communication contents (1). Communicational disturbances may arise as a result of difficulties in the proper transmission or understanding of communication content that occurs when communicating parties do not know the same code or do not know it or understanding it in inadequate manner (2). Language activity is the most primordial symbolic activity of mankind, and the language is a very complex system of signs that contains the rules of their use. The speaker of a given language must have symbolic ability to create and use signs (3). Hearing provides access to acoustic information necessary for oral-voice communication (4).

Many research in the world has shown that most children with hearing impairment, even children with a mild degree of impairment, have significant delays in language development and academic achievements. Delays are related to the development of all components of language, and thus conceptual knowledge and social conversational skills (5). Language skills of hearing impaired students are at a lower level compared to their listening peers (6). On the use of acquired language skills and communication with listening people, deaf people are „forced" also because of their daily interaction with listening people (7). Sign language is a natural, uncompromising communication model that provides security to people with impaired hearing in their communication. Sign language is a form of communication and understanding not only within the population of hearing impaired persons, but also between hearing impaired persons and listening people (8). Early intervention programs and courses for children and parents of deaf children need to be implemented to teach sign language so that these children adopt the sign language as the first language at a critical time for language development (9). Language learning has shown that bilingual learning cannot have a negative impact on the learning of another language (10). The use of bilingual, bicultural modules brings positive changes in the field of education for deaf and hearing-impaired persons (11). When it comes to the limitation of bilingualism, two warnings have to be made before adopting bilingualism. First, the development of bilingualism is prevented if one of the two languages is exposed to humiliation, and the second warning refers to the fact that teachers need to be cautious with deaf children and that their knowledge of the sign language is not taken unreserved, even though the deaf children use it every day (12). Deaf people in their everyday communication, both within the population and in communication with the hearers, use their non-verbal communication system, spontaneously educated through their education, a verbal communication system that is systematically educated through the process of education and re/habilitation in their everyday communication in relation to their psychophysical abilities, and a bilingual way of communication that implies simultaneous use of verbal and non-verbal communication systems. Which of the communication systems will develop as dominant depends on the nature of hearing impairment (13).

The subject of the study is to determine the preference of a verbal or non-verbal communication system or the bilingual mode of communication among deaf persons during the education and re/habilitation process and the deaf people who have undergone the process of education and re/habilitation through defining the latent space of the communication systems of the deaf and the separation of factors in the latent space that indicate the preference for the communication system.

The goal of the study is to determine the latent space between the deaf people communication systems and to define factors that indicate preference for particular communication system of deaf persons in social interaction.

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II. HYPOTHESIS

H_1. It is assumed that in the latent space of communication systems there are factors that determine the preference of deaf people to one of the communication systems.

H_2. It is assumed that in the latent space of communication systems there is a factor indicating the preference of deaf persons for the non-verbal communication system.

H_3. It is assumed that in the latent space of communication systems there is a factor indicating preference of deaf persons for bilingual communication.

H_4. It is assumed that in the latent space of communication systems there is a factor indicating the segregation approach of listening persons in communication with deaf persons.

H_5. It is assumed that in the latent space of communication systems there is a factor indicating the preference of deaf people for verbal communication.

H_6. It is assumed that in the latent space of communication systems there is a factor indicating that deaf people have a positive attitude towards all communication methods.

III. METHODS

A. Sample

The total sample consisted of 80 deaf respondents divided into two sub-groups. The first sub-group was consisted of students of older age, high school students (15-19 years old) who are in the course of or at the end of education and re/habilitation and who use the verbal communication system in the education and school environment and partly also the non-verbal. The second sub-group is formed from a group of deaf adults (from 19 to 55 years of age) who live and work in the environment with the hearers and have communication that is inherently unique to each individual. Due to the problem of study and the set goal, and to confirm the se hypotheses, it was necessary to homogenize the sample of respondents in the deaf population and the adult deaf population living and working in the environment of the hearing. Since in the selection of the first sub-group the random selection method could not be applied, a suitable sample was applied. A sub-sample of high school students can be declared as a population of deaf children because all the deaf students from Sarajevo, Unsko-Sanski, Zenica-Doboj, Bosansko-Podrinje, Tuzla and Central Bosnia Canton are included in the sample, covered by the educational – re/habilitation process at the Center for Hearing and Speech Rehabilitation in Sarajevo and the high school in Tuzla. The problem of sample in education - re/habilitation is known because of the relatively small population, and this sample is quite relevant for the subject of the study. The second sub-group was randomly selected and consisted of deaf persons who completed the educational-re/habilitation process and live and work in the environment of the hearers.

B. Measurement instrument and method of conducting research

For the purposes of this study, a questionnaire contains 19 variables with Likert's type responses (yes, yes/no, no) was constructed. The questionnaire refers to the use of verbal and non-verbal communication systems, as well as bilingualism as a combined approach in the education and communication of deaf persons. The respondents responded with the presence of the researchers support by explaining the content of the questionnaire. A variable pattern was selected by the system of questions relative to the preference of a particular communication system. The measuring instrument of the 19 applied variables, according to their uniformity in the process of verifying the representativeness of the variables for the applied measurement, met its coefficients with the criteria of reliability, validity, objectivity and sensitivity of the measurements, and the criterion of number of respondents was also compared with the number of variables applied.

Applied variables 1. I often talk to deaf persons and hearers. 2. I talk more to deaf persons than to hearers. 3. I talk more with the hearers than with deaf persons. 4. I prefer to talk to deaf persons than to hearers. 5. I do not like at all to talk with the hearers. 6. I'm talking to persons only if they use the sign language. 7. I do not understand the hearers. 8. I'm glad when hearers are talking using signs. 9. I try to understand people when they use oral-voice language. 10. I'm happiest when I'm in the company of deaf persons. 11. I am happy to learn the language of the hearers. 12. Hearing persons avoid us, deaf persons. 13. I'm not interested at all in the language of the hearers. 14. I communicate exclusively with the signs. 15. The language of the hearers is unacceptable for me. 16. I always like to be in the company of hearers. 17. I can only communicate with deaf persons. 18. I can only communicate with hearers. 19. I like to know both, the language of hearing and the language of the deaf.

C. Data processing methods

The data were processed by the method of parametric and nonparametric statistics. For the purpose of reaching the study goal, qualitative data processing was performed using multivariate factor analysis.

IV. RESULTS AND DISCUSSION

A. Analysis of results in the latent area of deaf persons in relation to the preference of certain communication system

A.A. The latent structure of the sample in relation to the preference of the communication system

To determine the latent area of estimation for preference of particular communication systems in social interaction of the deaf, the factor analysis method was used. In the application of factor analysis, two sub-groups of the respondents made a single sample. The latent structure of scales of sample estimates of respondents according to preference of certain forms of communication systems was carried out by the method of the main components, with the application of a truncated latent solution (Ortoblique rotation). According to PB criterion (Štalec, Momirović,

1971) of nineteen variables - claims that are relevant for determining latent space of preferred communication systems, five factors were extracted.

A.A.A. Characteristic values of variables

Table 1. Proprietary values (Lambda), cumulative variance (percentage of variables intercorrelation matrix), percentage of common variance

Factors	Proprietary values	Cumulative Variance	Percentage of common variance
1	4.49	22.48	22.48
2	2.95	37.22	14.75
3	1.74	45.92	8.69
4	1.54	53.61	7.69
5	1.17	59.44	5.83

Table 1 shows how much the common variability is explained by each factor. According to the PB criterion which, when determining significant characteristic values, extends as many components as possible as a common variant of the entire measuring instrument system, it can be determined that there are 5 significant characteristic values. Five factors deplete 59.44% of the total variability of the 19 variables of the subject measurement. The first eigenvalue of 4.49% take 22.48% of common variance in the metering system. The following eigenvalues by mathematical logic of the method deplete an ever smaller percentage of common variance so that the last extracted value take 1.17% of common variance, and all of the following components have eigenvalues less than 1, and thus their variability does not participate in defining this space measurements. The first factor, the first major component of measurement, carries the largest amount of variance with respect to the other 4 components, and its meaning plays the largest role in defining the space of deaf subjects, defined as the „Deaf between oralism and sign language“ space. How many variables are involved in the creation of a common space is determined by 5 orthogonal factors can be seen from the tables that show us the communalities of variables, orthogonal and parallel projections on the variables.

A.A.B. Communalities of variables

Table 2. The percentage of common variance of the variables that define the measurement space

Variables	Communalities
1	0.61
2	0.74
3	0.66
4	0.61
5	0.61
6	0.63
7	0.49
8	0.61
9	0.57
10	0.52
11	0.59
12	0.50
13	0.60
14	0.61
15	0.57
16	0.47
17	0.65
18	0.45
19	0.63

Communalities represent the magnitude of the variance of each variable, which is explained by isolated factors, and by looking at the utilities it is possible to see how many variables, with their own variance, participate in defining a common space determined by five factors. From Table 12 it can be concluded that the communalities are relatively high, which in this research is quite satisfactory. Municipalities range from 0.45 for variable 18 to 0.74 for variable 2. Highest communalities have: variable 2, whose utility is 0.74, which reads „I am talking more with deaf persons than with hearers“, the variable 3, whose utility is 0.66, which reads „I talk more to hearers than to deaf persons“ and variable 17, whose utility is 0.65, which reads „I can only communicate with deaf persons“. The lowest communality (0.45) has a variable 18, which reads „I can only communicate with hearers“, while the other variables have approximately equal communalities.

A.A.C. Parallel and orthogonal projections of factor Variables

Table 3. Coefficients of parallel (PAP) and orthogonal (ORP) projections of variables at first factor

Variable No.	Variable	PAP	ORP
14	I communicate exclusively with the signs	0.78	0.72
6	I'm talking to persons only if they use the sign language	0.75	0.71
9	I try to understand people when they use oral-voice language	0.67	0.69
7	I do not understand the hearers	0.63	0.62
5	I do not like at all to talk with the hearers	0.55	0.63

By looking at Table 3 it can be noticed that the first factor defines 5 variables whose content suggests that deaf persons generally communicate with use of the sign language in communication. It also points to the conclusion that deaf persons do not like talking to hearers, not understanding them, but they are still struggling to understand the oral and speech language and language used in their environment. The largest orthogonal and parallel projections of the first factor have variables 14 and 6 whose content is defined by the communication system of the sign language, and this first

factor can be called the ***Factor of preferring the nonverbal communication system***.

Table 4. Coefficients of parallel (PAP) and orthogonal (ORP) projections of variables to second factor

Variable No.	Variable	PAP	ORP
8	I'm glad when hearers are talking using signs	0.73	0.73
4	I prefer to talk to deaf persons than to hearers	0.69	0.70
18	I can only communicate with hearers	0.66	0.66
17	I can only communicate with deaf persons	0.52	0.58
11	I am happy to learn the language of the hearers	0.49	0.48

By looking at table 4 tt can be seen that deaf people do not ignore the verbal communication method, as the variables define this factor. Deaf people express joy when they hear spoken language and are happy when they can learn the language of the hearers. The content of these variables with the highest coefficients of parallel and orthogonal projections indicates the preference for bilingualism, and this second factor can be called the ***Factor of bilingual orientation of the deaf in preferring the communication system***.

Table 5. Coefficients of parallel (PAP) and orthogonal (ORP) projections of variables on the third factor

Variable No.	Variable	PAP	ORP
2	I talk more to deaf persons than to hearers	0.85	0.84
3	I talk more with the hearers than with deaf persons	0.78	0.77
13	I'm not interested at all in the language of the hearers	0.60	0.62
12	Hearing persons avoid us, deaf persons	0.48	0.48

By looking at Table 5, it can be seen that deaf people are talking to both hearing and deaf people, but the opinion is that the language of the hearings is not interesting and that hearers mostly avoid deaf people. According to the coefficients of parallel and orthogonal projections defining this factor, it can be concluded that the deaf in the communication with the hearers generally positively declare, but there is also a segregation relationship, and this third factor can be called the ***Factor of segregation approach in communication interaction***.

Table 6. Coefficients of parallel (PAP) and orthogonal (ORP) projections of variables on fourth factor

Variable No.	Variable	PAP	ORP
1	I often talk to deaf persons and hearers	0.69	0.67
15	The language of the hearers is unacceptable for me	0.47	0.54

By looking at Table 6, whose factor defines two variables, it can be seen that they indicate that deaf often talk to hearers and deaf people, but that the language of hearing is difficult and, in some way, unacceptable. Therefore, we can notice a certain balance in communication, as evidenced by their unclear relationship when it comes to communication with the hearers and vague space of the communication chain in communication interaction. It can be assumed that deaf respondents are somehow adapted to the conditions of communication but cannot be clearly defined when it comes to the mentioned interaction, which is why the fourth factor is named as a ***Factor of bilingual communicator***.

Table 7. Coefficients of parallel (PAP) and orthogonal (ORP) projections of variables on fifth factor

Variable No.	Variable	PAP	ORP
19	I like to know both, the language of hearing and the language of the deaf	0,73	0,69
16	I always like to be in the company of hearers	4,22	0,51

The variables of this factor suggest that deaf people like to be in the company of hearers and they like to know the language of the hearer in addition to their natural sign language, which is why the fifth factor can be called the ***Factor of positive relation to all modes of communication***.

V. HYPOTHESIS VERIFICATION

Hypothesis H_1. which reads ***„It is assumed that in the latent space of communication systems there are factors that determine the preference of deaf people to one of the communication systems“*** can be confirmed with certainty because by the method of the main components, with the application of the slanted latent solution (Ortoblique rotation), the latent structure of sample samples was evaluated according to preference certain forms of communication systems and PB criteria extracted five factors that define the latent space of preferred communication systems: ***„Factor preferring nonverbal communication system“, „Factor of bilingual orientation of the deaf in preferred communication system“, „Factor of segregated approach in communication interaction“, „Factor of bilingual communication“ and „Factor of positive relation to all communication modes“***.

Hypothesis H_2. which reads ***„It is assumed that in the latent space of communication systems there is a factor indicating the preference of deaf persons for the non-verbal communication system“*** can be safely ***confirmed*** by the isolated factor, the ***Factor of preference to nonverbal communication system*** (first factor) defined by five variables

with isolated coefficients of parallel and orthogonal projections of nonverbal communication system variables.

Hypothesis H_3. which reads ***„It is assumed that in the latent space of communication systems there is a factor indicating preference of deaf persons for bilingual communication“***, we can ***confirm*** with certainty on the basis of two isolated factors ***„Factor of bilingual orientation of the deaf in preference of communication system“*** (second factor) defined by five variables with isolated coefficients of parallel and orthogonal projections of the bilingual mode of communication variables and ***„Factor of bilingual communication“*** (fourth factor) defined by two variables with isolated coefficients of parallel and orthogonal projections of variables describing the bilingual mode of communication.

Hypothesis H_4. which reads ***„It is assumed that in the latent space of communication systems there is a factor indicating the segregation approach of listening persons in communication with deaf persons“*** can be ***confirmed*** based on isolated factor ***„Factor of segregation approach in communication interaction“*** (third factor) defined by four variables with isolated coefficients of parallel and orthogonal projection of variables.

Hypothesis H_5. which reads ***„It is assumed that in the latent space of communication systems there is a factor indicating the preference of deaf people for verbal communication“*** can be safely ***rejected*** as there is no isolated factor defining the preference for verbal computation of deaf communication but isolated factors ***„Bilingual orientation of deaf in preference of communication system“*** (second factor), ***„Factor of bilingual communication“*** (fourth factor) and ***„Factor of positive relationship to all communication modes“*** (fifth factor) indicate that deaf people do not reject the verbal communication mode and use it in their communication but they do not prefer it .

Hypothesis H_6. which reads ***„It is assumed that in the latent space of communication systems there is a factor indicating that deaf people have a positive attitude towards all communication methods“*** can be safely ***confirmed*** on the basis of the isolated factor ***„Factor of positive relationship to all communication methods“*** (fifth factor) defined by two variables with isolated coefficients of parallel and orthogonal projections of variables that define a positive relation to all modes of communication.

VI. CONCLUSIONS

Factor analysis defines the latent space of the deaf people's communication systems and the five factors are isolated in the latent space that define the preference and the relation of the deaf persons to the verbal, nonverbal and bilingual mode of communication.

Deaf persons in their communication prefer the nonverbal communication system. Factor analysis found that five variables with the highest degree of variability participated in defining the Factor preference for the nonverbal communication system. The content of isolated factor variables suggests that deaf respondents generally communicate and talk to persons who use the sign language in communication, that deaf respondents do not like talking to hearers and not understanding them, but they try, however, as hard as they can, to understand the oral-voice language and language used in their environment.

Two isolated factors in the latent space of the deaf communication systems, which define the bilingual mode of communication „Factor of the bilingual orientation of the deaf in the preferences of the communication system“ and the „Factor of bilingual communication“, confirm that deaf people in their communication prefer the use of bilingual communication. The content of variables with isolated coefficients of parallel and orthogonal projections of bilingual variants of communication on the basis of which these factors are isolated indicate that deaf people do not ignore the verbal communication mode, express joy when they hear spoken language, that they are happy to learn the language of hearing, to deaf they often talk to hearers and deaf people, but that the language of hearing for them is difficult and in some ways unacceptable. There may also be some noticeable balance in communication indicating unclear deafness when it comes to communication with the listening and vague space of the communication chain in communication interaction. It can be established that deaf adapt to the conditions of communication, but cannot be clearly defined when it comes to the mentioned interaction.

Deaf people in their communication do not ignore the verbal communication mode and use it in accordance with their capabilities but do not prefer it, regardless of long-term education and re/habilitation. The variables' contents with isolated coefficients of parallel and orthogonal projection variables indicate that deaf people express joy and are happy to learn the language of hearing, to talk often with listening and deaf people, but that the language of their hearing is difficult and, in some way, unacceptable.

The Isolated Factor the „Factor of positive relation to all communication modes“ affirms that deaf people have a positive attitude towards all forms of communication. The variables of this factor indicate that deaf people like to be in the company of listening people and to love the language of the listening in addition to their natural, sign language.

Deaf person communicates with the hearers mostly positively, but states that the segregation relation is present by the hearers towards them. According to the variables that define the isolated factor pointing to this conclusion of the „Factor of segregation in communication interaction“, it can be seen that the deaf speak to both listening and deaf people,

but the opinions that the language of their hearings is not interesting and that listening mostly avoid communicating with to them.

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