MORPHOLOGICAL SKILLS IN PRESCHOOL CHILDREN BORN AFTER ASYMMETRICAL INTRAUTERINE GROWTH RESTRICTION

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Abstract

The study assessed and compared morphological knowledge between a group of children born after asymmetrical intrauterine growth restriction (IUGR) and a group of children with adequate birth weight (BW).

IUGR participants were born at full term with BW under the 10th percentile for gestation age, parity and gender. There were 40 examinees in each group matched according to chronological and gestational age, gender and mother's educational level. All children were born at term and they were native speakers of the Croatian language.

Results confirmed statistically significant differences at the level of inflection of morphological knowledge. Variables of dual of nouns and plural of pseudowords had the most discriminatory power.

According to findings from this research, IUGR has a negative impact on the development of morphological knowledge. The results indicate the necessity to follow up on children with IUGR for the purpose of detecting language difficulties and early intervention.

Key words: IUGR, morphology, language

INTRODUCTION

Intrauterine growth restriction (IUGR) is usually defined by weight (BW) below the 10th percentile for gestational age (GA), gender and parity, or <2 SD (standard deviation) for GA. The incidence for IUGR is between three and ten percentage of births (Romo, Careller & Tobajas, 2009).

According to the pregnancy period, IUGR is divided into early and late onset. Late onset can be asymmetrical or symmetrical. The most common etiology of the asymmetrical IUGR is uteroplacental insufficiency which accounts for 70-80% of total IUGR (Nawaz, 2002).

The etiology of IUGR is multifactorial and may include maternal/uterine, fetal, placental, and external factors. It is associated not only with increased perinatal morbidity and mortality, but also with long-term outcome risk (Rizzo & Arduini, 2009). According to this study, there are negative impacts of asymmetrical IUGR on neurodevelopmental outcome of those children. Mostly, these findings were explained with placental dysfunction, which caused difficulties in transmission of nutritive elements and oxygen to the fetus, as the IUGR mechanism (Cosmi, Fanelli, Visentin, Trevisanuto & Zanardo, 2011; Fattal-Valevski, Toledano-Alhadef, Leitner, Geva, Eshel & Harel, 2009; Shenkin, Starr, Pattie, Rush, Whalley & Deary, 2001).

The development of the neural system begins in the third week of gestation in an optimal intrauterine environment for normal brain development (Volpe, 2000).

In children with intrauterine growth restriction (IUGR), a suboptimal intrauterine environment lead to the underdevelopment of both the body and the brain (Borradori-Tolsa et al., 2004; Saenger, Czernichow, Hughes & Reiter, 2007).

De Bie et al. (2011) conducted a study investigating differences in brain anatomy of children born after IUGR and control examinees. According to their results, there are significant differences in brain organization between the groups. Children born after IUGR displayed reduced cerebral and cerebellar grey and white matter volumes, smaller volumes of subcortical structures and reduced cortical surface. Regional differences in prefrontal cortical thickness suggest a different development of the cerebral cortex.

The negative influence of IUGR could be long-term and short-term. Long-term consequences deserve special attention, because they continue into the preschool and school period and could cause learning difficulties and consequently lower academic achievement (Geva, 2012; Kok, den Ouden, Verloove-Vanhorick & Brand, 1998). Most of the authors emphasized possible changes in structure and organization of the brain which probably leads to the aforementioned poorer cognitive and language abilities.

A great number of studies assessed different aspects of children's development regarding the IUGR status. Some of them assessed motor and adaptive abilities, others cognitive and language development. In all the above mentioned studies, children with IUGR had lower motor, cognitive and language outcomes. Major discoveries from these studies will be discussed in the following paragraphs.

Savchev et al. (2013) have found that neurodevelopmental disorders like lower language, cognitive, motor and adaptive abilities at the age of two were present even in children born after IUGR without placental insufficiency. Similar findings were obtained in research conducted by Šimić Klarić, Kolundžić, Galić and Mejaški Bošnjak (2012). Research done by Šimić Klarić, Galić, Kolundžić and Mejaški Bošnjak (2013) confirmed statistically significant differences in motor variables, developmental quotient and imitation of arm positions between children born after IUGR and control participants. Yet, fine motor skills had the most discriminatory power (Šimić Klarić et al., 2013).

Lower performances on cognitive development were confirmed in research conducted by Geva, Eshel, Leitner, Fattal-Valevski and Harrel (2006). They studied cognitive development of children with IUGR at the age of nine and found that children with asymmetrical IUGR have significantly lower intelligence quotient (IQ), as well as more difficulties in executive functions, creativity and language. The results showed that functional coherency depends on earlier established organization and structure of the central nervous system assuming that asymmetrical IUGR negatively affects neural network function resulting in the impaired development of executive functions.

Speech and language were also assessed to determinate whether there were differences in this developmental area. Šimić Klarić et al. (2012) confirmed statistically significant differences in favor of children born with corresponding birth weight (BW) in the following language elements: language comprehension, vocabulary, structure and content of the statement measured by the Reynell Developmental Language Scales (comprehension and production), naming skills and phonological coding and decoding. Also, later slower postnatal growth of head circumference had a negative effect on language comprehension and oral expression. The authors concluded that lower outcomes of children with IUGR were due to the negative influence of neurobiological changes. The study pointed out IUGR as an important risk factor for motor impairments, as well as lower language and speech abilities.

Some studies assessed reading and writing skills (Gutbrod, Wolke, Soehne, Ohrt & Riegel, 2000; Kisilevsky & Davies, 2007; Low et. al., 1992) and found better results in the group of children born without IUGR. Also, significantly more children with IUGR had learning difficulties resulting in lower grades, repeating a school year, or been enrolled in special school programs. The authors pointed out that this was due to lower cognitive abilities, as well as specific difficulties in the domains of language, speech, memory, attention, perceptive-motor abilities, non-verbal skills and problem solving skills (Cepanec, Šimleša, Gojmerac, Ljubešić & Mejaški-Bošnjak, 2005).

A small number of studies of IUGR children examined the course of morphological development. Wasson (2000) emphasized that morpho-syntactic knowledge is mostly exposed to slowing and interference in the presence of risk factors like IUGR. Atypical brain morphology is considered a risk factor for language disorders,

but the nature, heaviness and persistence of disorders significantly depends on non-biological factors (Bishop, 2006; Ivšac Pavliša, 2009). Cognitive abilities, but also other elements of language (e.g. vocabulary, syntactic and semantic knowledge) may even induce compensatory mechanisms aiming to replace the limitations in morphological knowledge, as well as induce its development.

The Croatian language belongs to the group of morphologically-rich languages, where morphology in many ways determines language abilities. A morphologically rich language demands more effort for the development of morphology but, on the other hand, enables different forms of word production, and increases exposure to different morphological forms in everyday communication. The morpheme is a carrier of meaning, so every morpheme deficit may have negative consequences on message comprehension as well as on syntactic knowledge and vocabulary (Kolundžić & Blaži, 2011).

According to Kuna (2006), derivation morphology is a tool for creating new words, used as a connection between inflection morphology and vocabulary. Inflection morphology includes, among others, the creation of dual and plural of nouns. That processes includes sound changes, different types of paradigms in creating a plural of nouns, specific knowledge regarding the use of neuter nouns due to its reduced frequency in the Croatian language. The aforementioned processes and rules make the development of morphological skills more demanding.

Although some morphological skills are to be expected at the age of six or seven (Hržica & Lice, 2013), errors made by children without language problems in earlier school age (e.g. errors due to not applying additional rules or using a more transparent paradigm), are considered as proof that the development process is still active (Kuvač & Cvikić, 2003).

With regard to the Croatian language, there was no research on morphological knowledge of children born after IUGR. Therefore, this study can be considered an important contribution to the understanding of language variation in this specific population of children.

Continuing this study on the aforementioned research (Šimić Klarić et al.2012), the aim was to estimate the possible differences in morphological knowledge between the group of preschool children born after asymmetrical IUGR and the control group of children born at full term without IUGR.

METHOD

Participants

Participants in this study were 80 children born at full term in the maternity ward of General County Hospital Požega. Participants consisted of two groups (40 children in each group): children born after IUGR (asymmetrical IUGR) with birth

weight (BW) below the 10th percentile for gestation age (GA), parity and gender according to Croatian percentile curves. GA was calculated according to the date of the last menstrual period. Antenatal ultrasound measurements showed that children had middle second trimester to third trimester onset intrauterine growth restriction that was assumed to be due to placental dysfunction.

Exclusion criteria were central nervous system infections, chromosomopathies, congenital infections, major malformations, severe asphyxia and the presence of recognizable genetic syndromes, hearing impairments, intellectual disability, articulatory structure impairment and also children from bilingual families. The control group consisted of children (N = 40) born in the same maternity ward with normal BW. They were matched to IUGR children according to chronological and GA, gender and maternal education. At the time of examination, children were aged between six and seven years, of average cognitive abilities.

Cognitive abilities were tested with the RTČ test (Razvojni test Čuturić, Čuturić, 2000). Each group had 22 girls and 18 boys. All children were born at full term and were native speakers of the Croatian language. None were included in speech and language therapy at the time of the study.

This study has been done in accordance with the Declaration of Helsinki and in accordance with the policy of the Ethics Committee of the General County Hospital.

Measuring instruments

Tasks for examination of dual and plural nouns and plural pseudowords (inflection morphology), with small changes made for this study, were taken from the study of Ljubešić (1997). The list of tasks contained 20 nouns (five female, nine male and six neuter nouns). Examination was performed using image material. Images (one task on A4 paper) contained pictures that needed to be indicated morphologically. Every task included basic categories of noun declination in the Croatian language (Ivšac Pavliša, 2009).

Tasks were to create a plural nominative for female nouns with extension /e/ without any sound changes; allomorphic basis – noun that ends on /k/ with sound changes sibilarisation – to /c/ at the end; nouns with long plural where nominative is formed by inserting –ov/-ev in front of extension i; nouns of short plural and neuter nouns. Extensions for nouns that are determined with number two, three or four are similar, and because of that, this isn't actual noun duality, in comparison to English (Brozović, 1998).

Tasks for forming plurality of pseudowords were formed with analogy on actual nouns. These examples were also taken from Ljubešić (1997) and they contained 14 pseudowords which reflected typical forms for indicating plural in the Croatian language as well as noun frequency: six pseudowords were female, five were male

and three pseudowords were neuter gender. Examination was performed using the image material with abstract pictures representing a pseudoword.

Lists of tasks for examination of derivation morphology were made exclusively for this study because there are no standardized measuring instruments in the Croatian language. The aim was to estimate morphological skills in the process of making a particular noun from a given verb. These tasks were used to examine skills of making formation units and patterns that are applied in creating words. The list of tasks consisted of ten verbs from which nouns were to be made by adding morphemes to verbs (e.g. pjevati – pjevač).

Procedure

During examination, all tasks were individually performed by a speech and language therapist (SLT). SLT explained the procedure to the child with practice tasks (four examples for every task). The whole examination lasted for twenty minutes. First tasks were for derivation morphology, followed by tasks which assessed dual and plural of words. Last tasks administrated during the examination session were the creation of nonwords plural.

Statistical analysis

For the statistical analysis, nonparametric statistical methods were used to compare non-normally distributed variables. Normality of distributions was tested using Kolmogorov–Smirnov test. The Mann-Whitney test was used to compare the 2 groups on numerical variables. Discriminant analysis was used to determinate differences between groups and to determinate which variables had the most discriminatory power. The analysis was conducted using SPSS with the level of statistical significance set at $p < 0.05$.

RESULTS

The aim of this study was to estimate possible differences in morphological knowledge (derivation and inflection morphology) between a group of preschool children born after asymmetrical IUGR and the control group of children born full term without IUGR.

Results from descriptive statistical analyses (Table 1) confirmed differences between groups on some variables. On the variable Derivation morphology, both groups of children achieved similar mean result. On the variables Noun dual and Noun plural, children in the control group achieved better mean results with smaller discrepancies in standard deviation (SD). The biggest differences between groups were on variable plural of pseudowords.

Table 1. Descriptive statistics for variables Derivation morphology, Noun dual, Noun plural, Pseudowords plural in both groups

	Variables	Min	Max	Mean	SD
Control participants	Derivation morphology	7	10	8.62	1.27
	Noun dual	12	19	15.27	1.58
	Noun plural	17	20	19.14	0.82
	Pseudowords plural	10	14	10.69	1.42
Children born after IUGR	Derivation morphology	6	10	8.32	1.65
	Noun dual	5	18	13.29	2.91
	Noun plural	10	20	18.21	1.85
	Pseudowords plural	6	13	7.02	2.63

According to the Mann-Whitney test, there was no statistical difference between groups on variables Derivation morphology (Table 2). Statistically significant differences between groups were observed on the following variables: noun dual, noun plural and pseudowords.).

Table 2. Statistical differences between two groups of participants

	Pseudowords plural	Noun Dual	Noun Plural	Derivation morphology
Mann-Whitney U	538.500	684.000	584.000	709.500
Wilcoxon W	1279.500	1387.000	1287.000	1237.500
Z	-3.537	-2.172	-2.966	-0.584
Sig.	**0.000**	**0.030**	**0.003**	0.559

Discriminant analysis is statistically significant on the level of significance of 0.00 with the centroid value of -0.636 for children born after IUGR and 0.636 for the control group. Results confirm good discrimination between groups regarding morphological knowledge (Table 3).

Table 3. Results of discriminative analysis (C1 – centroid for the children with IUGR group; C2 – centroid for the control group.

Function	Eigeenvalue	Canonical Correlation	CHSQ	Wilks' Lambda	DF	Sig	C1	C2
1	0.294	0.476	20.080	0.773	4	**0.000**	-0.636	0.636

Plural of pseudowords and noun dual had the most discriminatory value while the least discriminatory value came from the variable of derivation morphology (Table 4).

Table 4. Structure Matrix

	Function
Pseudowords plural	0.882
Noun dual	0.772
Noun plural	0.470
Derivation morphology	0.259

According to the results of discrimination variables, we can classify 32 (82.5%) controls and 28 (72.5%) children with IUGR, which represents significant benefit opposite to classification according to case.

Table 5. Posterior classification probabilities

	Control participants	Children born after IUGR
Control participants	32 (82.5%)	8 (17.5%)
Children born after IUGR	12 (27.5%)	28 (72.5%)

DISCUSSION

Results of previous research confirmed the negative impact of IUGR on different parts of language development. Results from this study also confirmed differences in morphological knowledge between the group of preschool children born after asymmetrical IUGR and the control group of children born at full term without IUGR. Results confirmed statistically significant differences between groups on variables noun dual, noun plural and pseudowords. There were no significant differences between groups on variable derivation morphology.

Both groups performed similarly on the task Derivation morphology. We can draw a tentative conclusion that creation of a new word is easier due to fact that this word is used in everyday language. This morphological level is probably easier to adopt because it draws from the vocabulary. Also, the errors of derivation morphology are determined exclusively by morphological rules and some aspects of derivation morphology used in this study could have been mastered at the age of examinees (Hržica & Lice, 2013). Results from this study showed that this aspect of morphology development (derivation morphology) was not affected by IUGR. Therefore, this variable lacks the discriminatory power between the specified groups. Production of noun dual and plural and plural of pseudowords as well,

should be adopted by the age of six (chronological age of our participants) because these skills are essential for systematic education of reading and writing (Cole, Royer, Hilton, Marec & Gombert, 2005). Unfortunately, we still lack standard norms for the Croatian language.

Man-Whitney test results showed statistically significant differences in variables Noun dual, Noun plural and Pseudoword plural (Table 2). An almost double standard deviation in the group of children with IUGR confirmed interindividual variations on these tasks. On the variable Noun plural, the control group achieved the highest results (range between 17 and 20) which confirmed good knowledge of creation of plural.

During previous studies (Ivšac Pavliša, 2009), tasks for examining plurality of words and pseudowords were found to be variably difficult in the Croatian language (the task for pseudoword plurality was the most difficult). According to the fact that good morphology development depends on frequency, complexity of sound changes, perceptive notion and meaning of particular morphological forms in language, different forms couldn't be accepted at the same time (Brozović, 1998). These are the most important reasons that make the course of some morphology characteristics universal, some typological for language groups and some individual for specific languages. Extensions for female nouns, which are the most frequent in the Croatian language, are adopted earlier than nouns of neuter gender, whose frequency in the language is lower. Because of that, tasks of creating plurality of nouns for neuter gender nouns or pseudowords are more difficult. There is no possibility of memorizing certain words together with their morphological forms, so a child needs to generate them from their own language knowledge. Due to a lack of experience with these types of words, the process of acquiring a specific knowledge is slowed or impaired. The group of children with IUGR made more errors, especially on neuter nouns which have the lowest frequency in the Croatian language (e.g. *lane – lana* instead *lanad)*.

It was surprising that variable Noun dual proved to be a good discriminator between these two groups due to fact that the morpheme for number is the same as the morpheme for noun (Table 3). The fact that an indicatory number for dual helps in creating words with its form and extension (e.g. jedan slon – dv*a* slon*a;* jedna lutka – dvij*e* lutk*e*) lead us presume that this kind of task will be equally performed in both groups. A similar pattern does not exist while indicating plurality of nouns and pseudowords, so the possibility of mistakes in these tasks was much greater (e.g. jedan slon – slon*ovi*; jedna lutka – lutk*e*). This is the kind of help that could make solving the task easier even for children with modest morphological knowledge. But it seems that this kind of help was not very useful for children with IUGR.

As expected, the variable plural of pseudowords had the most discriminatory power (Table 4). Due to the fact that creation of the plural of pseudowords is a complicated task, even for children whose language development was intact, it was expected that this task will have an excellent discriminatory power for the purposes of this research.

According to exact posterior classification, 82.5% of children without IUGR belong to its group in contrast to the children with IUGR , were the percentage is lower, amounting to 72,5% (Table 5).

According to results from this study and the study conducted by Šimić Klarić et al. (2012), we can conclude that IUGR has significant impact on language development. IUGR could lead to changes in the neurobiological basis important for language development. This difference can cause difficulties in phonological analysis which place language and speech development at risk. A similar negative pattern in Croatian language was confirmed in children with other neurological risks (Ivšac Pavliša, 2009; Kolundžić, 2009). We can conclude that the basic risk factor for neurological development could have a serious impact on the acquisition of the language system.

Also, we can assume that morphological knowledge deficits will negatively affect reading and writing skills, but also other language components, especially vocabulary (Cole et al., 2005; Kolundžić, 2009). Sublexical analysis and morphemes are easy to provide during the acquisition of new words. Adequate knowledge of morphemes provides easier comprehension of new words as well as their usage in different contexts.

IUGR is in many languages known as a risk factor for language and speech difficulties (Gutbrod et al., 2000; Kisilevski & Davies, 2007; Low et al., 1992). The results from this study confirmed the existence of significant differences in the morphological knowledge with lower outcomes in children born after IUGR in performing tasks for examining noun duality and plurality and plural of pseudowords. According to the results of this study, IUGR seems to have a significantly higher impact on inflection than on derivation morphology. We can draw a tentative conclusion that derivation morphology is easier due to the fact that errors in inflection morphology are determined from morpho-sintactical rules unlike inflection errors which are determined by morphological rules (Hrtica & Lice, 2013).

According to our clinical experience, but also to the achievements of control participants from this study, we can assume that acquisition time for derivative morphology can be expected by the age of six to seven years. Significant differences between these two groups lead us to the conclusion that delayed or impaired inflection morphological skills in children with IUGR can disturb their language development, i.e. have a negative impact on other components of the language system. Consequently, this can result in a poorer development and acquisition of reading and writing skills and overall academic achievement.

CONCLUSION

Research in the area of neurodevelopmental pattern of children with IUGR is needed to establish their strengths and weakness in different areas, especially in the

area of speech and language development. It is needed to prevent later consequences for academic achievement. Findings from this study lead us to the conclusion that IUGR has a negative influence on the level of morphological knowledge in pre-school children in the Croatian language. This study showed quantitative differences between these two groups of children. Future research should address qualitative differences. A detailed description of differences is needed for the development of specific diagnostic and therapy procedures.

The results from this study referred to the need for monitoring children (follow up) with IUGR with the aim of discovering language difficulties on time and thus possibly preventing reading and writing difficulties and other consequences later on in life, like underachievement in the school setting. Also, addressing the question when and how the morphological developmental trajectory is achieved is an important precondition for language assessment and therapy not only for this specific group of children but for all children with language disorders regardless of etiology.

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MORFOLOŠKE VJEŠTINE KOD PREDŠKOLSKE DJECE ROĐENE NAKON INTRAUTERINOG ZASTOJA RASTA

Sažetak

U istraživanju su ispitana i uspoređena morfološka znanja između djece rođene nakon intrauterinog zastoja rasta i kontrolnih ispitanika.

Djeca s intrauterinim zastojem rasta rođena su u terminu, ispod desetog centila za gestacijsku dob, red rođenja i spol. Kontrolni ispitanici su ujednačeni s djecom rođenom nakon inutrauterinog zastoja rasta prema kronološkoj i gestacijskoj dobi, spolu i stupnju obrazovanja majke. Svi ispitanici su rođeni na termin i hrvatski jezik im je materinji.

Statistička analiza potvrđuje značajne razlike u korist kontrolnih ispitanika na zadacima za ispitivanje infleksijske morfologije. Najveći doprinos razlikama daju dvojina imenica i množina lažnih riječi.

Prema rezultatima istraživanja možemo zaključiti kako intrauterini zastoj rasta može imati negativan utjecaj na usvajanje jezičnih sposobnosti u dijelu morfoloških znanja. Rezultati upućuju na potrebu praćenja ove skupine neurorizične djece kako bi se mogući zastoji ili usporavanja u usvajanju jezičnih sposobnosti uočili u ranoj dobi, što bi omogućilo pravovremenu intervenciju.

Ključne riječi: intrauterini zastoj rasta, morfologija, jezik