MORPHOLOGY AND DEVELOPMENTAL LANGUAGE DISORDERS: NEW TOOLS FOR RUSSIAN

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We describe preliminary data from two studies aimed at investigating the psychometric properties and validity of newly developed measures of morphological knowledge and skills in Russian, namely, the Word Structure subtest, and the Test of Morphological Awareness, in two samples of young Russian-speaking children. Overall, both instruments demonstrated good psychometric properties when analyzed using both classical test theory and a Rasch-modeling IRT approach, and were positively associated with the criterion measures (i.e., the number of grammatical errors in elicited speech samples, spelling, and reading comprehension).

Keywords: morphology, morphological awareness, word structure, language disorders, reading, spelling.

Clinical psycholinguistics, an interdisciplinary area of research at the intersection of cognitive psychology, clinical psychology, neuroscience, and (psycho) linguistics is a relatively new subfield of psycholinguistics. It has undergone important developments in the last two decades, when, in addition to detailed studies of language processing in patients with aphasia, a major focus has been placed on understanding precise areas of

deficits found in children with developmental language disorders. These disorders include Specific Language Impairment (SLI) – a disorder of language acquisition in the absence of obvious explanatory factors (such as hearing impairment, autism, frank neurological abnormalities or genomic syndromes), and dyslexia or Specific Reading Disability (SRD) – difficulties in acquiring word decoding skills unexpected by the child's cognitive development or education background. The major goal of the field is to describe which aspects language are impaired and which ones are spared in order to 1) provide a basis for developing effective intervention strategies; and 2) understand the cognitive structure of the human oral and written language capacity in general, as part of our global understanding of human cognition.

The logic of research in this area has been and is still mostly guided by the insights from the aphasiology research formulated before the 1980s (e.g., Luria, 1969). Thus, according to the *fractionation* assumption (Caramazza, 1984), brain damage can result in the selective impairment of specific sub-components of language. The *transparency* assumption maintains that the components unaffected by the brain damage will continue to function normally, and the output of the language system will selectively reveal the impairment in the affected component rather than a generally malfunctioning system as a whole. The same logic has been (implicitly) applied to developmental disorders, where, however, identifying a precise locus of impairment in the brain is greatly more challenging than in the case of brain lesions, and behavioral deficits are rarely as selective as in aphasia. In addition, genetic research in the etiology of developmental language disorders has led to a realization that these disorders are complex and are likely to involve multiple genetic and environmental factors acting in concert (e.g., SLI Consortium, 2002, 2004; Grigorenko, 2009). The search for the genetic bases of developmental disorders, despite some spectacular successes (such as the discovery of the *FOXP2* gene and its mutation in the three-generational KE family, Lai et al., 2001), has seen a number of setbacks, including pervasive non-replications.

A major hurdle in the psychological, neurological, and genetic research of language developmental disorders is the substantial heterogeneity of these disorders and the significant overlap of their symptoms. Thus, children with SLI may display mild to severe problems in production and comprehension in all major domains of language, particularly in inflectional morphology, complex syntactic constructions, such as rel-

ative clauses or other types of subordinate clauses, and lexicon (Leonard, 1998; Leonard, Caselli, Bortolini, & McGregor, 1992). Some may also have phonological deficits, a delayed development of Theory of Mind and pragmatics, and many go on to develop difficulties in learning to read and spell. The aforementioned fractionation and transparency assumptions do not appear to be productive and thus require the development of new theories and hypotheses.

In this context, developing research tools able to isolate basic, more precise, and theoretically based psycholinguistic traits for characterizing children with developmental disorders is one of the major goals of clinical linguistics. At the same time, it is very important to broaden the empirical base of clinical psycholinguistics to include data from cross-linguistic studies in order to gain a deeper understanding of the cognitive underpinnings of the disorders and be better equipped in the search for the pathways between genes, brain, and human behavior.

One aspect of language important for the study of developmental language disorders is morphology, or the study of word structure. Typically, the study of morphology differentiates between inflectional (i.e., a system of markings used to express grammatical information) and derivational (i.e., a system of affixes used for word formation) morphology. In the study of SLI, deficits in all aspects of morphology have been attested to in a number of languages, with a special emphasis on inflectional morphology. In English-speaking countries, children with SLI have been consistently shown to underperform on a number of grammatical morphemes compared to age-matched controls (Leonard et al., 1992; Leonard, Eyer, Bedore, & Grela, 1997; Oetting & Horohov, 1997; Oetting & Rice, 1993; Rice & Wexler, 1996; Rice, Wexler, & Cleave, 1995) and to younger typically developing (TD) children matched for mean length of utterance (MLU) (Bliss, 1989; Hadley & Rice, 1996; Leonard, 1995; Leonard et al., 1997; Oetting & Horohov, 1997; Rice & Wexler, 1996; Rice et al., 1995). In addition to English, deficits with grammatical morphology have been reported in children with SLI in German (Clahsen, 1989), Swedish (Hansson & Nettelbladt, 1995), Italian (Leonard & Bortolini, 1998), French (Hamann, et al., 2003; Jakubowicz & Nash, 2001), Spanish (Bedore & Leonard, 2001), Hebrew (Dromi, Leonard, Adam, & Zadunaisky-Ehrlich, 1999), Japanese (Fukuda & Fukuda, 1994; Ito, Fukuda, & Fukuda, 2009), Greek (Dalalakis, 1999), Inuktitut (Crago & Allen, 2001), among others.

Morphological deficits in Russian-speaking children with SLI have not been widely studied outside of mostly qualitative descriptive studies within the Russian field of *logopaedia*, even though the rich morphological structure of Russian makes it an important avenue for clinical linguistic research. In particular, Russian can provide valuable information about the role of properties of the inflectional system, such as its richness and regularity.

Previous cross-linguistic research has found that the differences in the complexity of the inflectional system between languages affect the precise manifestation of the morphological deficit. Thus, morphological deficits may be realized either as errors of omission if the language permits bare stems as possible words, or as errors of substitutions (with an unmarked or default form substituting the correct form) in languages that do not permit bare stems as words, such as in Italian (Penke, 2009). In addition, it was found that the rate of substitution errors depends on the size of the inflectional paradigm: the more forms a paradigm contains, the higher the rate of substitution errors (Dromi et al., 1999).

Research has indicated that classes of inflectional categories can be affected selectively (e.g., an observation that the third person singular –s is affected in English-speaking children, while the plural –s is not; Leonard, 1998) and that the classes of inflectional elements affected in SLI may vary across languages. In particular, it was shown that the area of weakness for children with SLI in many languages is verbal morphology (i.e., the morphemes that mark finiteness, such as tense and agreement), but in some languages, namely Greek, Spanish and French, children with SLI have difficulty with noun-related morphemes, such as adjectival concord and direct object clitics (Bedore & Leonard, 2001). Another line of SLI research has been comparing children's performance in regular versus irregular inflections, with respect to such phenomena as English past tense. The traditional claim is that children with SLI have a greater deficit with regular forms (i.e., derived by a rule application) than irregular ones (i.e., stored in the lexicon). This generalization, however, has not been supported by research in other languages, such as Dutch, German, Italian, and Spanish. Thus, many open questions of theoretical importance relative to clinical and linguistic description of language disorders in cross-cultural terms still remain.

One reason why data from Russian can be very informative in this line of research is due to its rich inflectional system within both verbal

and nominal domains. Thus, Russian has an extensive case system, concord between nouns and their modifiers, verbs marked for both tense and aspect, and a system of subject-verb agreement in which different features are expressed depending on the verb's tense. In addition to its richness, Russian inflectional paradigms are characterized by much quasi-regularity and irregularity. Unlike in languages like English, in which verbs can simply be classified as regular and irregular, in Russian, in addition to multiple inflectional classes of nouns and two classes of verbs, there are a number of morphological phenomena blurring the regular/irregular distinction.

According to the classification system used by World Atlas of Language Structures (WALS, http://www.wals.info), Russian is concatenative, i.e., grammatical formatives are always bound (i.e., must be attached to a host word) and as a result undergo various phonological adjustments based on the phonological properties of the host stem, such as stress placement or the palatalization feature of the stem-final consonant creating much variation within paradigms. It is also polyexponential, i.e., one morphological formative combines multiple grammatical categories (e.g., gender/number/case are expressed by a single morpheme and these categories cannot be isolated) unlike agglutinative languages, such as Turkish, in which all grammatical categories are expressed as a chain of isolable affixes, giving the system greater regularity. In addition, Russian, is characterized by case syncretism (i.e., multiple cases can be expressed by the same case form, e.g., the dative and prepositional case for feminine nouns) and suppletion (unpredictable pattern of morpho-phonological change within a paradigm). For example, in Russian, verb stems undergo sound alternations based on the temporal and aspectual distinction in the paradigm (e.g., prikho**zh**-u / prikho**d**-il / pri**s**h-el). Also, although in Russian, in most cases, bare stems cannot function as possible words (words of all major categories must have morphological markers expressing syntactic relations within the sentence), in some categories, the inflections are not phonologically expressed (e.g., for certain classes of nouns, such as 1st declension masculine in nominative singular or 2nd declension feminine in genitive plural, the inflection is null and the word is a bare stem). Given these complexities, Russian provides a good test case for resolving various controversies in the field of SLI etiology and manifestation.

The role of morphology has also received a lot of attention in recent cross-linguistic research of reading development and SRD (for a review

see Verhoeven & Perfetti, 2011). In some models of visual word recognition, morphological processing plays a central role, particularly in reading morphologically complex words (which would be the case with a majority of words in Russian). Such models assume that along with assembling words by building grapheme-phoneme correspondences, word recognition involves a parallel direct lexical access. It has been proposed that direct access also consists of a dual-route parallel and interactive process, with access to words in their full morphological form, as well as to their morphological constituents stored in a fully decomposed form as separate lexical entries (e.g., Caramazza, Miceli, Silveri, & Laudanna, 1985). On the other hand, in connectionist models, instead of parallel routes of phonological and morphological assembly and full lexical access, all representations are fully distributive and all levels are fully interactive. In this approach, morphological structure is viewed not as information stored in the lexicon, but as an emergent property of the system, which develops sensitivity to the systematic relationships among the surface forms of words and their meanings through experience (Plaut & Gonnerman, 2000).

Given the important role of morphology in word recognition, reading research has been shifting its focus from predominantly studying the role of phonology to investigating morphological processing in typical reading development and reading disability. It has been found that intermediate-level readers begin to recognize new words by morphologically decomposing them into their constituent parts (for a review see Templeton & Morris, 2000). It was also reported that children's morphological awareness increases as a result of their exposure to reading education (e.g., see Anglin, 1993). Furthermore, individual differences in word reading ability, linked to the child's ability to form strong high-quality connections between orthographic, phonological, and semantic features, in the case of intermediate and advanced readers, are also closely related to the child's morphological ability, with morphological knowledge being shown to be a good predictor of word decoding accuracy (Leong, 2000), spelling (Grigorenko, Boulware-Gooden, & Rakhlin, in press), and reading comprehension (Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003). Whether the ability to develop morphological awareness (i.e., the ability to segment and manipulate morphemes) is compromised in children with dyslexia/specific reading disability and whether this deficit is a result of their deficit in phonological processing or an independent area

of impairment is still an open question. Given significant differences between languages in morphological richness and regularity, it is crucial to include data from a diverse group of languages, and particularly Russian, in the cross-linguistic study of reading (dis)ability.

One reason that Russian remains an understudied language in clinical linguistics is the lack of diagnostic instruments developed with a close regard to the linguistic properties of Russian. Thus, the goal of this paper is to attempt to fill this gap by describing two newly developed assessments designed to evaluate children's knowledge of Russian morphology in both the spoken and written domains. In the remainder of this text, we will first present some preliminary data on the psychometric properties of the morphology related subtest of the Assessment of the Development of Russian (ORRIA; Babyonyshev et al., unpublished manuscript, 2007) and its relationship to another method of expressive language measurement in children with language deviations; we will then present some preliminary data on psychometric properties and validity of the Test of Morphological Awareness (TMA) and its role in explaining individual differences in reading skills in primary school children.

Study 1: Assessment of the Development of Russian: Word Structure

Participants

One hundred ninety one Russian-speaking children aged 3.4 to 9.9 participated in the study (M = 7.41, SD = 1.78; 107 boys). They were administered the Word Structure and the Passive Vocabulary assessments. In addition, 45 children from this sample, who participated in a clinical study of developmental language disorders (see Rakhlin et al., in press, for more details) were administered the Universal Non-verbal Intelligence Tests and a narrative task.

Measures

Word Structure (WS). WS is part of a comprehensive Assessment of the Development of Russian language currently under development (ORRIA; Babyonyshev et al., unpublished instrument, 2007; see Rakhlin et al., 2011, for a more detailed description). It is an individually administered assessment for children aged 3 to 9. WS is aimed at assessing expressive grammar skills using a sentence completion task. Thus, the

child is shown a pair of pictures and read a sentence describing the content of the first picture, followed by an incomplete sentence that the child completes based on the second picture. In the process of completing the sentence, the child has to manipulate morphological categories, such as changing a singular noun into a plural or an adjective to its comparative form. The subtest includes 24 items that target inflectional morphology related to pronouns, nouns, and their modifiers (i.e., case, gender and number, comparative and superlative forms of adjectives) and verbs (i.e., aspect, tense, and agreement), as well as derivational morphology.

Passive Vocabulary (PV). PV is a subtest of ORRIA aimed at assessing the development of vocabulary knowledge in a multiple-choice picture choice task. The subtest includes 31 items targeting vocabulary stratified by the syntactic category (i.e., nouns, verbs, adjectives, and prepositions) and semantic classes (i.e., household items, professions, animals, colors, shapes, body parts, buildings, actions).

Universal Non-Verbal Intelligence Test (UNIT). UNIT (Bracken & McCalum, 1998) is a non-verbal test battery for ages 5-18 designed to be a fair assessment of general cognitive functioning, especially in individuals with speech, language and hearing impairments and from differing cultural and linguistic backgrounds, since the administration procedure is fully non-verbal. The extended battery includes six subtests: Object Memory, Spatial Memory, Symbolic Memory, Cube Design, Analogic Reasoning, and Mazes. The full-scale nonverbal IQ (FSIQ) scores were used based on the norms provided in the test manual.

Expressive measures of grammatical development. The children were assessed at school using two wordless storybooks (*The Frog Book* series, Meyer, 1969). The narratives were recorded, transcribed and analyzed by two linguists. The measure of Wellformedness was based on two subscales: the number of grammatical errors and the number of incomplete (interrupted) utterances combined and divided by the number of words to control for the narrative length. The errors included case and declension, tense, and so forth. In addition, we used two measures of syntactic complexity: Mean Length of Utterance in Words (MLU_W) and the number of complex structures (including complex and compound sentences, *wh*-questions and passive voice) divided into the number of words in a story.

Results and Discussion

To evaluate the psychometric properties of WS, the data were analyzed using the IRT approach and the Rasch model for dichotomous responses in the FACETS computer program (Linacre, 1994). The analysis of the local fit indices (i.e., Infit MnSq) revealed that they did not exceed 1.30 for any of the items, suggesting that the subtest items have good psychometric properties (Bond & Fox, 2007), a result further corroborated by the analysis of item discrimination indices using the classic test theory (CTT) approach (α = .87, average inter-item r = .23, average correct item-total r = .45). The model explained 35.41% of the variance in the item performance, and indicated that the subtest can be used to reliably place the children along the performance continuum (person reliability index = .76; separation index = 1.79).

The examination of the results of the correlational analysis of the relationships between the study measures indicated that the WS performance was significantly and positively related to PV (r = .70, p < .01), yet the correlation was not perfect (far from 1.00), suggesting that WS measures aspects of language development not limited to vocabulary. Moreover, WS was not related to nonverbal intelligence (r = -.01, p > .05). Crucially, although WS was not related to either the number of complex structures in a narrative (r = .05, p > .05) or MLUw (r = .02, p > .05), it was negatively related to the number of grammatical errors produced by the children (r = -.35, p < .05) suggesting the overlap between the two expressive morphology-related measures and providing preliminary evidence for the criterion validity of the WS measure.

Table 1

Intercorrelations between Study 1 measures

	1	2	3	4	5
1. WS					
2. PV	.70**				
3. FSIQ	-.01	.25			
4. Wellformedness	-.35*	-.49**	-.13		
5. Complex structures	.05	.02	-.23	-.09	
6. MLUw	.11	.07	.12	-.15	.47**

Note. * – p < .05; ** – p < .01; WS – Word Structure; PV – Passive Vocabulary; FSIQ – full-scale nonverbal IQ.

In sum, these data indicate that the newly developed individually-administered spoken language measure of morphological skills has good psychometric properties, high internal consistency, and can differentiate between children with different levels of morphologic abilities. Our study has also demonstrated that our subtest was negatively related to the measure of deviations in expressive grammar development. This is evidence of convergent and criterion validity of the subtest aiming to assess grammatical competence, which is separable from general cognitive and language development, as indicated by the relevant correlation coefficients.

Further work in the development of WS would require two major steps: first, in order to make the instrument available to the educational, psychological and clinical practitioners, the instrument should be normed (using the co-norming procedure with other subtests of ORRIA) on a representative sample of Russian children; second, the diagnostic utility of the instrument needs to be further investigated with respect to its sensitivity and specificity, which can be obtained using clinically-referred samples of children with atypical language development. Some of this evidence has been recently reported by Rakhlin et al. (2011), who used WS and other ORRIA subtests to identify children with SLI and showed that grammatical competence was uniquely related to the mastery of Theory of Mind over and above the contribution of general cognitive and language development.

Study 2: The Test of Morphological Awareness

Participants

Ninety-six Russian-speaking children attending public primary schools in Saint-Petersburg aged 7.17 to 10.42 participated in the study (M = 8.85, SD = .61; 56 boys).

Measures

The Test of Morphological Awareness (TMA). TMA consists of two subtests: Morphological Derivation and Morphological Decomposition. Both subtests are paper-and-pencil and include 28 items each. The Morphological Derivation (MDR) task assesses the child's ability to use the root of a word to derive a new morphologically related word. The Morphological Decomposition task (MDC) assesses the ability to decompose

a morphologically complex word by segmenting out a morpheme to create a new word. For example, in the former, the participant would read a priming word such as *водить* ("drive") and then would have to complete the sentence, *"Мой отец* –_____." ("My father is a _____."). In the latter, the participant would read a word like *обсуждение* ("discussion"), and would have to complete the sentence *"Друзьям есть что* _____" ("The friends have something to _____". The task includes various pairings between morphologically related words, including nouns derived from verbs, other nouns and adjectives, verbs derived from nouns and adjectives, and so forth.

The Culture-Fair Intelligence Test, Scale 2 (CFIT). The CFIT (Cattell & Cattell, 1973) is a group administered paper-and-pencil test for individuals aged 8 and above. It is a measure of non-verbal fluid intelligence, which is thought to be relatively independent of verbal fluency, cultural background and educational level. The battery consists of four subtests and allows measuring general IQ score.

Spelling. The Dictated Spelling measure was modeled after the spelling component of the WRAT-4 (Wilkinson & Robertson, 2006). The measure included 56 items that differed in orthographic complexity, frequency, and syllabic length.

Reading Comprehension. The measure of Reading Comprehension included three written paragraphs of various complexity with a set of 16 free-answer questions and multiple-choice tasks aimed at assessing children's ability to draw conclusions from reading passages and to analyze it according to a specific communicative goal. In addition, it contained tasks in which the child had to establish a correct temporal sequence of events based on the scrambled elements of the passage and to write a mini-composition using a provided passage as a prompt.

Results and Discussion

To evaluate the psychometric properties of the TMA, the data were analyzed using a Rasch model within the IRT approach separately for the MDR and MDC subtests. The analysis of the Infit MnSq indices revealed that they did not exceed 1.35 for any of the MDR and 1.23 for any of the MDC items, suggesting that the subtests' items have good psychometric properties, a result further corroborated by the analysis of item dis-

crimination indices using the CTT approach: for MDR, $\alpha = .92$, average inter-item $r = .28$, average correct item-total $r = .51$; for MDC, $\alpha = .91$, average inter-item $r = .24$, average correct item-total $r = .47$. The model explained 39.24% and 46.33% of the variance in the item performance for MDR and MDC, respectively. Further analyses indicated that both TMA subtests can be used to reliably place the children along the performance continuum (person reliability index = .83 for both MDR and MDC) and separate them into multiple performance groups (separation index = 2.20 for MDR and 2.19 for MDC). Moreover, MDR and MDC were highly correlated ($r = .82$, $p < .001$) indicating that they measure closely related and overlapping sets of skills that are, however, separable as evidenced by the amount of shared variance (~67%).

Table 2

Hierarchical regression models for Study 2

DV: Spelling				DV: Reading Comprehension		
IVs	β	*t*	Parameters	β	*t*	Parameters
Model 1			$R^2 = .05$			$R^2 = .01$
Gender	-.09	-.86	$F(2,87) = 3.08$, $p = .05$	-.11	-1.06	$F(2,87) = 1.51$, $p > .05$
Age	.25*	2.42		.16	1.51	
Model 2			$R^2 = .03$			$R^2 = .00$
Gender	-.09	-.86	$F(3,86) = 2.03$, $p > .05$	-.11	-1.04	$F(3,86) = .99$, $p > .05$
Age	.25*	2.38	$\Delta R^2 = .00$, $p < .05$	.16	1.49	$\Delta R^2 = .00$, $p < .05$
IQ	.01	.11		-.00	-.01	
Model 3			$R^2 = .27$			$R^2 = .20$
Gender	-.05	-.54	$F(5,84) = 7.66$, $p < .001$	-.09	-.89	$F(5,84) = 5.31$, $p < .001$
Age	.21*	2.25	$\Delta R^2 = .25$, $p < .05$	.09	.89	$\Delta R^2 = .21$, $p < .05$
IQ	.02	.18		-.01	-.12	
MDR	.38*	2.30		.09	.53	
MDC	.14	.87		.29*	2.20	

Note. * – $p < .05$.

To investigate the contribution of the morphology skills to literacy skills, two hierarchical regression analyses were run, with Spelling and Reading Comprehension as dependent variables. For both analyses, the demographic characteristics were entered in step 1, followed by IQ in step 2, and the two TMA subtests in step 3. The analyses are summarized in Table 2. Overall, the results indicated that the TMA measures were significantly associated with Spelling and Reading Comprehension, and explained approximately 20 to 25% of additional variance in the reading skills beyond the minor contribution of the demographic characteristics and intelligence.

The reported data indicate that the TMA subtests have good psychometric properties, high internal consistency, and can reliably differentiate between children with different levels of the morphological awareness. The results of the study also indicate that the skills assessed by MRD and MRC contribute meaningfully to the measures of spelling and reading comprehension, supporting some of the recently published results (e.g., Grigorenko, Boulware-Gooden, & Rakhlin, in press; Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003). It is of note that this relationship is far from trivial in magnitude with a relatively large proportion of spelling and reading comprehension variance being explained by the two TMA subtests.

The validity of the TMA should further be assessed in the context of its diagnostic utility in identifying children with SRD and predicting their reading skills and their development; furthermore, the construct validity of both of the subtests should be investigated with respect to the nomological network of their relationship to other reading-related processes and cognitive skills (e.g., rapid automatized naming and phonological awareness) in Russian.

Conclusion

Here we reported on our recent efforts in developing two Russian measures of morphological knowledge in both spoken and written language. We believe that the presented results are promising in that they demonstrate high psychometric properties of both of the developed instruments and their criterion validity with respect to the measures that can be used to identify children with disorders of spoken and written language. We also believe that, given the linguistic properties of Rus-

sian, studies of Russian morphology can enhance not only the field of Russian psycholinguistics, but the field of clinical linguistics in general. While additional work is warranted, we view these data as an important step in providing both researchers and clinicians with instruments that can aid us in the understanding of the componential skills involved in spoken and written language disorders and the establishment of a measurement framework for potential cross-linguistic studies of these disorders. This will facilitate a new approach, when instead of searching for selective impairments and clear-cut subgroups of children with the developmental language disorders, the search is for the precise and theoretically-based linguistic and cognitive traits. As a result, new mutifactorial models of the disorders in question can be tested. Such approach may be more productive in the quest for the cognitive underpinnings of developmental language disorders and vertical pathways between the genome, brain and behavior that lie at the basis of the etiology of these disorders.

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