



34 organization they show surprisingly excellent performance in face recognition, which  
35 might indicate a dissociation in the involvement of the dorsal and ventral brain  
36 streams responsible for visual processing. Individuals with WMS also have specific  
37 brain morphological differences compared to controls: decreased overall brain and  
38 cerebral volumes, disproportionate volume reduction of the brainstem with a relative  
39 preservation of cerebellar and temporo-limbic structures (Reiss et al., 2000).

40 In the past decade WMS has attracted the attention of cognitive psychologists,  
41 being a population in which good linguistic skills stand in sharp contrast with serious  
42 deficits in other cognitive domains (for a survey see Bellugi, Lichtenberger, Mills,  
43 Galaburda, & Korenberg, 1999, and the special volume edited by Bellugi & St.  
44 George, 2000). Although language is a relative strength in WMS, it is not an intact  
45 faculty of the mind: both language development and linguistic performance deviate  
46 from the normal in several aspects. In our studies presented here we would like to  
47 focus on morphological development in WMS children. Our aim is to test the pro-  
48 posed within-language dissociation between the rule system of grammar and the  
49 associative network of the mental lexicon (e.g., Clahsen, 1999; Clahsen & Almazan,  
50 1998), focusing on performance on regular and irregular nominal inflection in a  
51 language with a rich morphology.

### 52 *1.1. Language in WMS*

53 After a late and difficult start of language development, people with WMS achieve  
54 remarkably fluent and grammatical speech by school age, with a conspicuously so-  
55 phisticated and large vocabulary containing many infrequent and unusual words,  
56 and a constant urge to chat. Their linguistic skills are in sharp contrast with the  
57 general level of their cognitive abilities. The linguistic profile of WMS people is  
58 uneven, too. Besides brilliant expressive language, we often find that language  
59 comprehension is much more limited, their speech is also often irrelevant and in-  
60 appropriate, and some of their words and phrases may lack semantic content. The  
61 cognitive and linguistic profiles of WMS people have received different accounts by  
62 different researchers and research groups. Ursula Bellugi and her colleagues em-  
63 phasize the dissociation between language and cognition, pointing to the semantic  
64 abnormalities in WMS language (e.g., Bellugi, Lichtenberger, Jones, Lai, & St.  
65 George, 2000). Another approach draws attention to the within-language dissocia-  
66 tion of grammatical rules and lexical processes. On this view, WMS children have a  
67 relatively intact grammar, combined with a much weaker lexical system. Therefore,  
68 regularizations are characteristic of their performance. This view is based on Pinker  
69 and Prince's (Pinker, 1991; Pinker & Prince, 1994) hybrid model of language, and is  
70 taken up by Clahsen in connection with WMS (Clahsen, 1999; Clahsen & Almazan,  
71 1998). A third view is developed by Annette Karmiloff-Smith and her research  
72 group. Their central claim is that it is not only the representations or processes of  
73 language that are impaired in the first place, but as cognitive impairments are a result  
74 of a complex epigenetic process, language development in WMS takes a different  
75 course, so we might find deviant mechanisms even behind apparently normal per-  
76 formance (e.g., Karmiloff-Smith et al., 1997).

### 77 *1.2. The mental lexicon of WMS people*

78 People with WMS generally perform at a relatively high level on standardized  
79 vocabulary tests (although their performance is still below their chronological age,  
80 see e.g., Grant et al., 1997; Jarrold, Baddeley, & Hewes, 1998; Karmiloff-Smith et al.,  
81 1998), but several tasks show that their semantic organization is different from that

82 of normal controls. Bellugi, Wang, and Jernigan (1994) found in a semantic fluency  
83 task that people with WMS produce more infrequent words than normal controls.  
84 Another observation revealing unusual organization of the lexicon is that of Vicari,  
85 Brizzolara, Carlesimo, Pezzini, and Volterra (1996a) and Vicari, Carlesimo, Bri-  
86 zzolara, and Pezzini (1996b): when subjects have to reproduce words from a word  
87 list, normal controls typically reproduce more high frequency words; in people with  
88 WMS no bias is shown towards frequent words in recall. According to the within  
89 language dissociation view (Marcus, Gary, Brinkmann, Clahsen, Wiese, & Pinker,  
90 1995; Pinker, 1991; Pinker & Prince, 1994) the two distinct systems can be selectively  
91 impaired. On this view, Williams syndrome is an example of an intact rule system  
92 with an abnormally operating mental lexicon. In morphology this means that reg-  
93 ularly inflected forms (e.g., talk → talked; purportedly generated by the rule system)  
94 are produced easily and correctly, but the retrieval of irregular forms (e.g., go → -  
95 went; stored as a whole in the mental lexicon) is impaired, with signs of overgen-  
96 eralization. In Clahsen and Almazan's study (1998) English-speaking WMS children  
97 could inflect existing regular stems virtually as well as unimpaired controls, while  
98 their performance on irregulars was poor; they often overgeneralize the regular suffix  
99 both to existing regular forms and to novel words rhyming with existing irregulars.  
100 This dissociation is also reflected in their performance on inflecting derivational  
101 forms. The results are interpreted as selective impairment of the lexical module of  
102 language, as an inability to retrieve information from subnodes of lexical entries.

### 103 1.3. Working memory and languages organization in WMS

104 Another cognitive system relevant to language in WMS is working memory.  
105 According to Baddeley and colleagues the real function of the phonological loop is  
106 not to remember familiar words but to help learn new words (Baddeley, Gathercole,  
107 & Papagno, 1998). From this point of view the rate of vocabulary development is  
108 influenced by working memory capacity. In agreement with this conception, in  
109 childhood large individual differences are found in phonological loop capacity  
110 (Gathercole & Adams, 1993). Many studies have found strong correlation between  
111 STM performance and vocabulary knowledge, and STM span was found to be a  
112 strong predictor of later vocabulary knowledge (Gathercole & Adams, 1993, 1994;  
113 Gathercole, Hitch, Service, & Martin, 1997; Gathercole, Willis, Emslie, & Baddeley,  
114 1992). Neuropsychological evidence comes from studies of children with specific  
115 language impairment (SLI). SLI children usually lag behind their age in terms of  
116 vocabulary development (Bishop, 1992). They show poor performance on both digit  
117 span and non-word repetition tasks and recall much fewer phonologically novel  
118 names than control children (Taylor, Lean, & Schwartz, 1989). There is also an  
119 increasing amount of data concerning the association between working memory and  
120 language development in genetic syndromes associated with some mental handicap  
121 (Grant et al., 1997; Jarrold, Baddeley, & Hewes, 1999). Wang and Bellugi (1994)  
122 compared digit span in individuals with Williams and Down syndrome, using groups  
123 matched on overall IQ. Williams syndrome children had a mean digit span of 4.6,  
124 whereas the mean span of the Down syndrome group was only 2.9.

125 Our Hungarian studies are relevant for several reasons. One of the central issues  
126 with regard to language is the proposed contrast between a rule-based and an item-  
127 based system, or Grammar and Lexicon within the language faculty, which, ac-  
128 cording to a strong domain specific view, are associated with different brain areas  
129 and can be selectively impaired, (Clahsen, 1999; Pinker, 1991). We show data from  
130 an agglutinative language with different stem types fit this model. Besides replicating  
131 studies adapted to a typologically different language, we are applying new methods

132 as well in the framework of a longitudinal study, the Hungarian Williams Syndrome  
133 Research Project. We are gathering data from a single WMS subject pool on dif-  
134 ferent aspects of language, spatial cognition, elementary vision, visual integration,  
135 implicit and explicit rule extraction, and memory (for some preliminary data, see  
136 Lukács, Racsomány, & Pléh, 2001).

137 Our three aims in the study presented here are all related to the debated issues of  
138 the nature of language in WMS subjects:

- 139 1. Is there a clear dissociation between regular and irregular morphology in Hungar-  
140 ian WMS subjects? Hungarian with its rich morphology and competing suffixa-  
141 tion patterns provides a more suitable ground to contrast rule-based and item-  
142 based processes than languages studied previously, with more possibilities to vary  
143 and control for frequency effects.
- 144 2. We wanted to clarify possible frequency effects in morphological overgeneraliza-  
145 tions in Hungarian WMS subjects. This has relevance to the issue whether WMS  
146 data support a dual system (Clahsen & Almazan, 1998) or basically a simple sys-  
147 tem of language representation (Thomas et al., 2001).
- 148 3. We also looked for possible relationships between phonological short-term mem-  
149 ory and morphological performance.

## 150 2. Materials and methods

### 151 2.1. Subjects

152 The target group tested in this study consisted of 14 children and young adults  
153 with Williams syndrome; their mean age was 13.2 years (ranging from 5.9 to 19.6  
154 years at the time of testing). Subjects were recruited through the Hungarian Williams  
155 Syndrome Association, and most of them were assessed in a summer holiday camp  
156 for WMS children and their families. Children were tested individually; all of them  
157 were assessed on the digit span and a morphology task. In this paper we obtained  
158 control data on primary school 1st, 2nd and 3rd graders, altogether from 29 subjects,  
159 in the age range of 7–10. This age range broadly corresponds to the verbal mental  
160 age range of the WMS group as measured by the Hungarian version of the Peabody  
161 Picture Vocabulary Test (PPVT). The average PPVT performance of the WMS  
162 group was 95.55 (SD = 26) points, which corresponds to the average performance of  
163 normal children between the age of 84 and 120 months, according to Hungarian  
164 standard scores (Csányi, 1976).<sup>1</sup>

### 165 2.2. Procedure

#### 166 2.2.1. Verbal short-term memory

167 A standard measure of verbal short-term memory was taken by the digit span  
168 task. In this test, subjects hear digit sequences of increasing length and attempt to  
169 repeat them immediately. Digits were taken from those between 1 and 9, and none of  
170 them are repeated within one sequence. The score is the amount of digits in the  
171 longest sequence correctly repeated; there were two token series with each length.

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<sup>1</sup> Normal children are used as a reference group instead of a proper control group, as we are trying to decipher differences in the patterns of performance. The issue of proper controls is much debated in the literature: in our study choosing either age-matched or mental age-matched controls would have led to reduction in variance as most of the children in the relevant age groups perform at ceiling level on the morphology task.

172 The subject was given the score if she/he could repeat any of them; if the subject  
173 failed both trials of one length, testing terminated.

#### 174 2.2.2. Morphology task

175 This task contrasted regular versus irregular inflectional forms on the one hand,  
176 and frequent versus infrequent items on the other. 32 color drawn picture pairs were  
177 used in this experiment, those of Pléh, Palotás, and Lorik (2002), complemented by  
178 new picture pairs to adjust the test to our question concerning frequency effects in  
179 regular and irregular suffixation. The test had 4 items in each of the 3 regular and 4  
180 irregular classes, 2 frequent and 2 rare. The ‘irregularity’ issue in Hungarian is related  
181 to the type of alternations a given stem undergoes. MacWhinney (1978) gives a  
182 psycholinguistic exposition of them, together with basic experimental data on their  
183 unfolding in children. Frequency estimates were based on Füredi and Kelemen  
184 (1989). Table 1 shows examples for each stem type. The first 4 lines are non-pro-  
185 ductive, ‘irregular’ items. These items are non-productive, therefore, in their case the  
186 saturation of the paradigm (how many items follow the pattern) is indicated with the  
187 numbers in the first column.

#### 188 2.3. Procedure

189 The picture depicting an individual object shown first from each pair. After asking  
190 the child to provide the name for the object, they were shown the second picture  
191 from the pair, and were asked questions prompting either a plural (‘What are these?’)  
192 or an accusative (‘What is the boy eating?’) forms (accusative and plural questions  
193 are alternating, one is requested for each word, and the two forms are taken to be  
194 equivalent, as they result in the same stem allomorph). There was no time limit on  
195 the response of the subject. Responses were tape-recorded. The independent vari-  
196 ables were the stem type and the frequency of the word, the dependent variable was  
197 the correctness of the response. A response was coded as correct if it was properly  
198 inflected; it was considered incorrect if it was overregularized or unmarked.

Table 1  
Examples of stimuli used in the morphology task

Stem class and item number	Examples	
	Frequent	Rare
1. Epenthetic <i>n</i> = 104	majom–majmok ‘monkey–monkey acc.’	bagoly–baglyot ‘owl–owl acc.’
2. Lowering <i>n</i> = 71	hal–halak ‘fish–fish pl.’	sál–sálak ‘scarf–scarf acc.’
3. Shortening <i>n</i> = 222	kenyér–kenyerek ‘bread–bread pl.’	bogár–bogarak ‘beetle–beetle pl.’
4. v-insertion <i>n</i> = 8	kő–követ ‘stone–stone acc.’	távcső–távcsövet ‘telescope–telescope acc.’
5. ‘Low V’-final	kutya–kutyát ‘dog–dog acc.’	teve–tevék ‘camel–camel pl.’
6. C-final	asztal–asztalok ‘table–table pl.’	pingvin–pingvinek ‘penguin–penguin pl.’
7. ‘Non-low V’-final	cipő–cipőt ‘shoe–shoe acc.’	hattyú–hattyút ‘swan–swan acc.’

199 **3. Results**

200 Fig. 1 shows errors of WMS children by regularity and frequency. In accordance  
201 with previous observations, WMS children seem to regularize exceptional items, and  
202 they err less on regulars (for previous research on the issue in Hungarian see Lukács  
203 & Pléh, 1999; Lukács, 2001).

204 A two-way analysis of variance on errors with the factors of REGULARITY and  
205 FREQUENCY, regularity had a significant main effect ( $F_{1,52} = 8.74, p < .05$ ),  
206 while the frequency effect was not significant ( $F_{1,52} = 0.97, n.s.$ ), and the interaction  
207 of the two factors was not significant either ( $F_{1,52} = 0.46, n.s.$ ). Results of the  
208 analyses performed over the errors on different subtypes of regulars and irregulars  
209 only show a significant effect of frequency in the case of -v inserting stems (an ir-  
210 regular type).

211 Performance on irregulars is poorer, but interestingly enough overgeneralizations  
212 also appear in one of the regular stem classes, in consonant ending stems, specifi-  
213 cally. In irregulars, beside the general effect of regularity there is a clear frequency  
214 effect in -v insertion stems (but none of the other irregular classes). This is also re-  
215 lated to age: younger WMS children (under 10 years) are especially prone to over-  
216 generalizations here, their mean errors being 0.3 and 1.6 for regulars and irregulars,  
217 respectively, while in the older group the values are 0.6 and 0.6 both (see Fig. 2).

218 A two-way analysis of variance on control data has shown a significant main  
219 effect for FREQUENCY ( $F_{1,104} = 9.8, p < .01$ ), REGULARITY also had a sig-  
220 nificant main effect ( $F_{1,104} = 41.7, p < .01$ ) and interaction between the two fac-  
221 tors was also significant ( $F_{1,104} = 4.1, p < .05$ ). So while WMS children did not  
222 seem to be affected by item frequency on the morphology task, frequency did prove  
223 to be a predictor of performance in control children. In irregulars, the mean error  
224 rate for frequent items was .44, and for infrequent items .96,  $t = 3.85, p < .001$ .

225 Some interesting relationships hold between short-term memory measures and  
226 morphological performance. Table 2 shows that low-span children made more  
227 morphological errors both on regulars and irregulars. Following our earlier division,  
228 low- and high-span subjects in the Digit span task were identified on the basis of a  
229 median division. Subjects with a span of 3 and below versus groups of 4 and more,

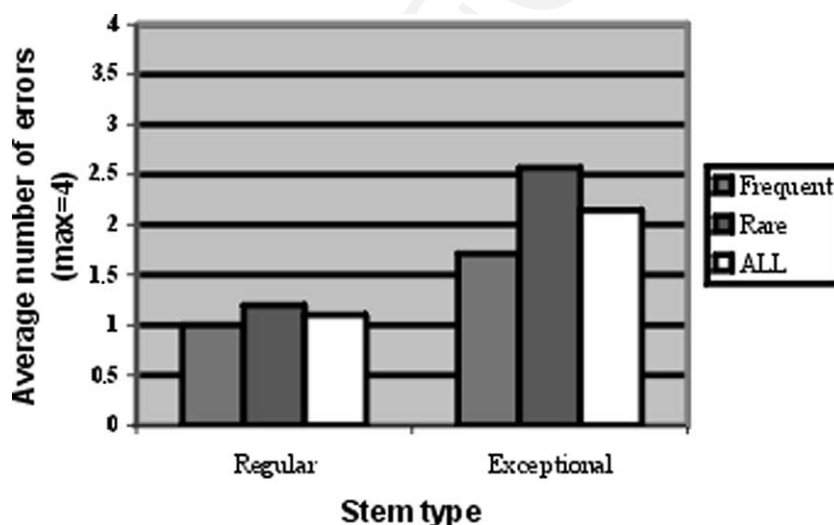


Fig. 1. Frequency and regularity effects on errors in WMS subjects.

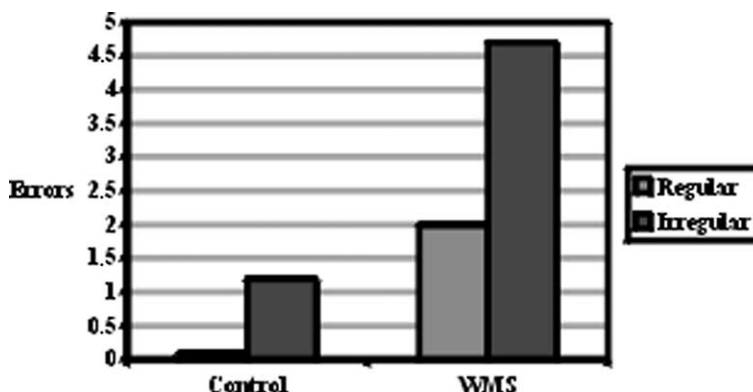


Fig. 2. Number of morphological errors in WMS and normal control subjects.

Table 2  
Effects of digit span differences on morphological errors in WS subjects

Stem type	Low-span	High-span	<i>F</i>	<i>p</i>
Regular	2.75	0.40	5.72	.05
Exceptional	6.25	1.60	6.61	.05
All	9.00	2.00	8.83	.01

230 with 8 and 6 members, respectively. This implies that working memory capacity is  
 231 related to grammatical proficiency as well. Low-span WMS subjects in general had  
 232 more morphological errors, but their error rate was especially high with exceptionals.  
 233 At the same time, in the control group no significant relationships were obtained  
 234 comparing low- and high-span subjects. Low-span subjects (with the span of 4) had  
 235 an average of 1.47 errors with irregulars, while high-span subjects (5 and over) had a  
 236 mean of 1,  $F < 1$ . Thus, in a control group with comparable mental age morpho-  
 237 logical overgeneralization seems to be insensitive to differences in working memory.  
 238 The same pattern emerges in correlations between digit span and results on the  
 239 morphology task in the two groups. In WMS children, the correlation between digit  
 240 span and number of errors was significant in both regulars ( $r = -.52$ ,  $p < .01$ ) and  
 241 irregulars ( $r = -.63$ ,  $p < .02$ ). Control data do not show any correlation between  
 242 verbal short-term memory and morphological performance (regulars:  
 243  $r = .05$ ,  $p > .1$ ; irregulars:  $r = -.04$ ,  $p > .1$ ).

#### 244 4. Discussion

245 Regarding the three issues raised in designing the experiment, our results gave the  
 246 following answers. In the morphology task we obtained the usual superiority of  
 247 performance on regulars over performance on irregulars, which corresponds to the  
 248 proposal made by Pinker (1991) and Clahsen and Almazan (1998), that WMS people  
 249 have an intact rule system and an impaired lexicon. There was no overall effect of  
 250 frequency. A strong main effect of frequency would challenge this view: if perfor-  
 251 mance on regulars had been affected by frequency, it would be a symptom of regulars  
 252 being treated by the same memory system as irregulars. In WMS many irregulars are  
 253 regularized, i.e., treated by the rule system, and show no frequency effects. Within  
 254 this overall picture, a moderate item frequency sensitivity was observed in some stem

255 types (one regular and one exceptional). Normal controls seemed to follow a similar  
256 pattern in that they also had more errors on irregulars, but in their case overregu-  
257 larization of irregulars decreased with age. This may be interpreted as evidence for a  
258 retarded language development in WMS as suggested by Thomas et al. (2001), at the  
259 same time maintaining a basic dual system.

260 In the WMS population, working memory span of children seemed to be a more  
261 central modulator than token or type frequency of words. Working memory span  
262 which was shown to be related in WMS to the knowledge of rare words (Lukács et  
263 al., 2001), was also, and not trivially, related to performance on the morphology  
264 task. It is too early to draw conclusions, but this may suggest that grammatical  
265 proficiency has some intricate relations to working memory, too. Working memory  
266 might help to move irregular items to the item-based storage system, as a general  
267 mechanism supporting learning new words (Baddeley et al., 1998). As a more general  
268 implication of our results relevant to WMS research, we suggest that some of the  
269 non-homogeneity of WMS children on cognitive and behavioral measures (empha-  
270 sized by Bellugi et al., 2000; Jarrold et al., 1998) might reduce, at least in linguistic  
271 aspects to differences in verbal working memory capacity. This is especially war-  
272 ranted by the fact that no similar working memory effects were observed in normal  
273 controls. Our further studies broadening the age-range within both our clinical and  
274 especially in our control samples might help to articulate this suggestion.

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