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**Influence of Preterm Birth on Early Lexical and Grammatical Acquisition**

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## **Influence of Preterm Birth on Early Lexical and Grammatical Acquisition**

### **Abstract**

This study compares early grammatical and lexical acquisition in 323 preterm and 166 full-term children at twenty four months. The French MacArthur-Bates parental report was employed for analysis. Gestational age and birth order showed a significant effect on vocabulary size and grammatical distribution. Preterm children showed fewer words and produced more games, routines and animal noises words. Except for the group of extremely premature children, first born children in each gestational age group produced more words than second born. In contrast, first born children exhibited more predicates than second born children. We conclude that preterm children show delayed rather than deviant language development.

### **Keywords**

Birth order, French CDI, Grammar, Lexicon, Prematurity

## **Influence of Preterm Birth on Early Lexical and Grammatical Acquisition**

Given the increasing number of preterm births and the improvement of neonatal intensive care, the cognitive and linguistic outcomes of this potentially at risk population has been intensively investigated. Many uncertainties about developmental outcomes remain because of contradictory findings across studies. The goal of this study is to examine lexical and grammatical development in a large group of French children born preterm.

### Introduction

#### *Definition, Prevalence and Risks related to Preterm Birth*

According to the World Health Organization, a birth is considered premature if it occurs before 37 weeks of amenorrhea or gestational age (GA). According to this definition, around 40 000 children are born preterm each year in France. Among preterm children, it is common to distinguish moderately preterm (from 32 to 36 GA), very preterm (from 28 to 32 GA) and extremely preterm infants (< 28 GA). Moderately preterm children represent the highest prevalence (80%) and also show the lowest death rate: under 5%. Very preterm children represent less than 2% and account for from 20% to 40% of preterm death rates. The prevalence of extreme prematurity is not precisely known, but the death rate exceeds 50%. A large body of literature reports developmental disabilities in preterm children including motor, cognitive, sensory and behavioral deficit areas (Buck *et al.*, 2000; Censullo, 1994; Magny & Rigourd, 2003; Marenne 1989; Mellier *et al.*, 1999; Stevenson *et al.*, 1988; Szatamri *et al.*, 1999).

Language development after premature birth has been found to be compromised in some children. Atypical development is observed as early as the prelinguistic period: preterm

infants tend to be delayed in their behavioral organization and consequently show lower social responsiveness and higher gaze aversion than full-term counterparts (Crnic *et al.*, 1983). Reported language disorders or delays in the preterm population encompass all linguistic levels of description: phonological, lexical, and morphosyntactic. Both language comprehension and production are likely to be affected (Siegel *et al.*, 1995). Bouyer *et al.* (1987) found articulatory impairments in 33% of preterm children vs. 14.3% in full-term children. Delfosse *et al.* (2000) observed delayed phonological development for place and manner of articulation dimensions of French consonants in children born preterm at 42 months. Lingual, labial, plosive, fricative and voiceless consonants were considered delayed relative to age matched controls.

Lexical development has also been described as delayed during the first three years of life. Preterm children's performance is noted to be generally inferior, for both receptive and productive vocabulary (Vohr, 1988). Bonifacio (1998) reported that Italian speaking preterm infants assessed at the ages of 15 and 18 months were 3 months behind their full-term peers. Le Normand *et al.* (1995) found that lexical diversity was lower in preterm than in full-term two-year-olds. Using the Peabody Vocabulary test, Zarin-Ackerman *et al.* (1978) reported specific language delays at 24 months (for both corrected and non corrected ages). The lexical spurt was also reported to occur between 21 and 24 months, later than in children born full term (Bonifacio, 1998). Grammar may also be impaired in preterm children. Stolt *et al.* (2006) found that the lexical development of very low birth weight children (GA between 24 and 34 weeks) generally followed the same pattern as in full-term children. They also found differences in the grammatical composition of the lexicon: with small lexicons, preterm children used fewer grammatical function words and more nouns, suggesting that morphology and syntax are difficult to acquire for very low birth weight children.

Several studies revealed a shorter mean length of utterance in output than control full-term children (Field *et al.*, 1981; Le Normand *et al.*, 1995; Oller *et al.*, 1994). Bonifacio's (1998) study indicated that his preterm participants showed a 3 month delay in onset of word combination. These grammatical difficulties persisted. Le Normand *et al.* (1995 & 2000) observed 3 to 5 year-old preterm children. They found that compared to a control group, the preterm children employed determiners before nouns, function words and verbal inflections less frequently. Similarly, Le Normand & Cohen (1999) showed that at 42 and 60-months-old premature children used fewer verbs than controls.

In brief, a large body of data suggests that children born preterm are at risk for persistence of delays in various domains of language. However, this view is not supported by other studies of preterm children. Leroux *et al.* (1999) observed no delay at 2, 4 and 6 months old using the Bayley scale. Similarly, Greenberg & Crnic (1988) concluded that at 24 months, preterm children showed the same scores in comprehension, MLU and utterance frequency as full-term children. Deltour (1999) argued that the neurological status of preterm children needs to be taken into consideration. He noted that if children with severe neurological disorders are excluded, the language performance of the preterm population does not differ from full-term children. Similarly, Hediger *et al.* (2002) argued that if corrected age rather than gestational age is taken into account, receptive and productive skills of even very low birth weight preterm participants are not impaired. Stevenson *et al.* (1988) suggest superior performance in some premature children in the area of verbal comprehension. According to Deltour (1999), prematurity is not responsible for reported developmental disabilities. Other factors often associated with prematurity may play a bigger role. Language-external factors such as gender, socioeconomic background, birth order are known to affect language development in general and should logically impact language development in preterm children as well.

*Biological and Social Factors Potentially Influencing Language Development**Gestational age and birth weight*

Low birth weight and short gestational age have been shown to be good predictors of deficits or impairments. For instance (Bhutta *et al.*, 2002 and Hack & Fanaroff, 2000) showed that the probability of impaired development was inversely proportional to birth weight or gestational age. Similarly, cognitive impairments have been shown to be strongly correlated to gestation duration or birth weight. Again, consensus has not been reached. Lequin *et al.* (1986) assessed 4 functions in 80 24-month-old preterm children: 2 sensori-motor (posture and coordination) and 2 symbolic (sociability and language) functions. The children were divided into 3 gestational age groups. No significant difference was found between preterm children and control full-term children, regardless of gestational age. Le Normand & Cohen (1999) investigated the acquisition of verbs in 3 to 5 year-old children born preterm. The children were divided into 3 birth weight groups: 780 to 1200 grams, 1201 to 1500 grams and 1501 to 2210 grams. Globally, the group of preterm children produced less varied verbs than the control group, but no effect of birth weight was found.

*Gender*

Cognitive and linguistic developments in full-term children show differences as a function of gender. Many studies agree on the linguistic precocity of girls: in chronological age comparisons; they produce more words than boys (Bornstein & Haynes, 1998; Bornstein, Hahn & Haynes, 2004; Huttenlocher *et al.*, 1999; Fenson *et al.* 1994). Bornstein, Leach & Haynes (2004) have argued that these developmental differences lie in maturational and biological areas. However precocity of females is not universal, since it was not observed in studies of Swedish speaking children (Eriksson & Berglund, 1999), nor in English and Spanish speaking children (Jackson-Maldonado *et al.*, 1993). Fewer studies have focused on the relationships of gender to development in the preterm population. Provasi, Bloch &

Lequien (2004) observed that male preterm children show a lower IQ than female preterm children. Hoffman & Benett (1990) suggested that neurodevelopmental sequelae seem to be more important in males than in females. As far as language development is concerned, one study documented that at two years, preterm males show lower social communication scores than preterm females (Brothwood *et al.*, 1983).

### *Birth order*

Birth order has also been suggested as being a significant factor in language and cognitive development: first born or single children usually exhibit higher developmental scores (Raven, 1962) than subsequent children. For instance, Belmont & Marolla (1973) measured scores of a non-verbal intelligence scale in a population of 400,000 19-year-old adolescents in the Netherlands. When they separated the factors of birth order and family size, they obtained higher scores in first born children. Belmont, Wittes & Stein (1977) restricted the number of participants (200,000) but broadened the assessment by adding language evaluation. First born children still showed better performance. Several other studies suggest that first born children acquire language more rapidly and differently. Studies using parental reports revealed that first born children show larger vocabulary size during their first three years of life (Fenson *et al.*, 1994; Jones & Adamson, 1994). However, a more recent study (Bornstein *et al.*, 2004) indicated a lessened influence of birth order. Bornstein *et al.* (2004) assessed the vocabulary of first and second-born 20 month-old siblings using parental report and analysis of spontaneous data. Results were influenced by the method: assessment using parental report indicated a larger vocabulary in first than in second born children, while no difference was found when spontaneous data were used. In a longitudinal study, Siegel (1982) investigated the influence of diverse variables on cognitive and language development in preterm children from 4 months to 3 years of age. She found that birth order was one of the best predictor of subsequent development at age 3.



*Social environment*

Social factors have proved to be responsible for language development differences. Recent studies showed slower rate of receptive and productive vocabulary development in low SES children from the age of 2 years old (Arriaga *et al.* 1998; Basilioa *et al.* 2005; Dollaghan *et al.* 1999; Huttenlocher *et al.* 1991; Jin, 2002; Rescola & Alley, 2001). This slower development is explained by variations in maternal behaviours, which are themselves related to SES (Hart & Risley, 1995; Hoff, 2003; Hoff, *et al.*, 2002; Hoff-Ginsberg, 1998) and/or to parental education (Jin, 2002; Pan *et al.*, 2005). Low SES or low educated mothers speak less to their children, use a more restricted vocabulary and produce shorter utterances. Moreover, these mothers show more prohibitive and directive communicative styles. Mothers of preterm children have been found to exhibit different attitudes towards their infants in comparison to full-term's mothers. Barnard *et al.* (1984) observed a lower quality of home environment in preterm children's families. Field (1977) described less appropriate interactive behaviours in parents of preterm children. By contrast, other studies reveal that mothers of high-risk preterm infants respond to their children more positively than mothers of full-term children (Greenberg & Crnic, 1988). These mothers differ in their timing of child directed speech: they follow significantly more often their infants vocalizations with an utterance directed at the child (Reissland & Stephenson, 1999). They also appear to be more active in initiating and maintaining interaction across the first year (Crnic *et al.*, 1983). Sigman *et al.* (1981) also showed that the sickest preterms received the greatest amount of maternal interaction at 1 month. These positive attitudes have been found to potentially attenuate the negative effects of early birth (Greenberg & Crnic, 1988; Siegel, 1982).

In conclusion, it is difficult to achieve consensus on short and long term outcomes of prematurity due to methodological problems of definition including differences in gestational age, birth weight, socioeconomic background, neurological status, age of assessment, and

disparate experimental measures (Luoma 1998; Landry & Chapiesky, 1990). Two other methodological issues are the number of participants included in the studies as well as the lack of homogeneity in calculating the children's age (corrected vs. chronological age). This diversity in available literature in this area results in difficulty making comparisons and in limitations of the scope of the conclusions drawn.

The first purpose of this study is to investigate whether preterm children are delayed on the basis of a large sample of French children at 24 months. Lexicon size as well as the grammatical composition of produced words will be compared to those of French full-term children. Previous studies suggest that there are at least two reasons why prematurity should affect language development: biological and social. Thus, the second purpose will be to assess the role of these two types of factors on language production in preterm children. The large sample will enable formation of substantial sub-groups according to the severity of prematurity, gender, birth order and maternal level of education. Gestational age is a biological factor whereas birth order and maternal education are social factors. Gender has both a biological and a social component.

## Method

### *Data Collection*

The MacArthur-Bates Communicative Inventories (MCDI) are parental reports established and standardized on an English-speaking (US) population (Fenson *et al.*, 1993). These tools, generally employed by mothers to report words and gestures understood and used by their children, aim at a rapid assessment of language development during the child's first three years of life. There are two versions of these questionnaires: the first "words and gestures" applies to children ranging from 8 to 16 months-old; the second, "words and sentences" centers on children ranging in age from 16 to 30 months. Given the rapidity of

assessment and analyses, but also the reliability of this instrument, (Dale, 1991; Fenson, 1993; Kern, 2004) more than 30 adaptations in other languages have been made during the last decade (for an exhaustive list, see <http://www.sci.sdsu.edu/cdi/>).

In this study, French children were administered the French adaptation of “words and sentences” (Kern, 2003). This questionnaire consists of three main parts. The first part gathers information about the child and his/her family (gender, birth order, child care arrangements, level of education and profession of parents). The second is composed of a list of 691 different words. Mothers are asked to check if their child is able to spontaneously produce the words at the time of examination. Words are grouped into 22 semantic categories (clothes, animals, action words, persons) and 4 main grammatical categories (nouns, predicates (verbs and adjectives), closed class items (henceforth CCI), and “others” (noises and animal sounds, games and routines). This last category does not reflect uncodable responses but generally early acquired items (Fenson et al., 1993). Finally, the last section addresses morpho-syntactic development. The maximum length of utterance (henceforth MaxLU) and the use of some grammatical morphemes are assessed. The mother also is asked to describe the three longest utterances produced by her child.

### *Participants*

323 preterm and 166 full-term children ranging in age from 24 to 26 months participated. The preterm population is a subgroup of the cohort the DOMINO study (Principal investigators Dr. Picaud and Pr. Claris, Neonatology intensive care unit, Hôpital Edouard Herriot in Lyon, France). The full-term population is a subgroup of the children studied for the French standardization of the MacArthur-Bates CDI (Kern, 2003). In both groups, bilingual or multilingual children, or multiple birth children were excluded. Table 1 presents the distribution of children according to gender and birth order.

<Insert Table 1. about here>

As can be seen from Table 1, the groups are balanced for gender and birth order. The preterm population was divided into 3 gestational age groups (henceforth GA): extremely preterm (EPT) under 28 weeks of gestation; very preterm (VPT) between 28 and 32 weeks of gestation and moderately preterm (MPT) from 33 to 36 GA. The full-term children all have a gestational age exceeding 36 weeks of gestation.

### Results

Initial analyses revealed no main effects for gender or maternal education, and no interactions involving gender or maternal education. As a result, data were pooled across these factors for the analyses to be reported below.

#### *Vocabulary Size*

A 4 (Gestational age: EPT, VPT, MPT, FT) x 2 (Birth Order: first-born, later born) ANOVA revealed a main effect of Gestational age ( $F(3,481) = 4.863$ ;  $p=.0024$ ) and of Birth Order ( $F(1,481) = 13.095$ ;  $p=.0003$ ). *Post-hoc* testing (Fischer PLSD) at the 0.05 level revealed that EPT children had a smaller vocabulary size than VPT, MPT and FT children. VPT children also showed a smaller vocabulary size than FT children. For Birth Order, *post-hoc* testing at the 0.05 level revealed that first-born children had a larger vocabulary size than later-born children.

<insert Table 2. about here>

#### *Proportion of Nouns*

The ANOVA performed using the same factors yielded a non-significant tendency for Gestational Age ( $F(3,481) = 2.602$ ;  $p=.0515$ ), but no effect for Birth Order. *Post-hoc* analysis revealed that FT children produced significantly more nouns than EPT and VPT children.

#### *Proportion of Predicates*

For predicates, a main effect of Birth Order ( $F(1,478) = 11.387$ ;  $p=.0008$ ) was observed. First born children use more predicates than later born children. A main effect of Gestational Age ( $F(3,478) = 4.541$ ;  $p=.0038$ ) was also observed. EPT produced significantly fewer predicates than VPT ( $p=.0076$ ), than MPT ( $p=.0036$ ), and than FT ( $p<.0001$ ). Conversely, FT children produced more predicates than VPT ( $p=.0273$ ). Similarly, first born children produced more predicates than later born children ( $p<.0001$ ).

#### *Proportion of CCI*

For CCI, an effect of Gestational Age ( $F(3,478) = 3.628$ ;  $p=.0130$ ) was shown. EPT children produced fewer CCIs than the other GA groups ( $p=.0225$  compared to VPT;  $p=.0020$  compared to MPT and;  $p=.0009$  compared to FT).

#### *Proportion of 'Others'*

For this category, a main effect of Birth Order ( $F(1,478) = 6.774$ ;  $p=.0095$ ) and of Gestational Age ( $F(3,478) = 7.660$ ;  $p<.0001$ ) was shown. First-born children used fewer 'others' than later born children ( $p=.0035$ ). For Gestational Age, EPT children tended to produce more 'others' than VPT ( $p=.0197$ ). They produced significantly more 'others' than MPT ( $p=.0004$ ) and FT ( $p<.0001$ ). Similarly, VPT children produced more 'others' than FT ( $p=.0005$ ).

<Insert Table 3. about here>

#### *MaxLU*

For MaxLU, there was a main effect of Birth Order ( $F(1,478) = 14.495$ ;  $p=.0002$ ) and an effect of Gestational Age ( $F(3,478) = 2.950$ ;  $p=.0324$ ). *Post-hoc* comparisons showed that first born children were reported to have a longer MaxLU ( $p<.0001$ ) than later born and that EPT children's MaxLU was significantly shorter than MPT ( $p=.0036$ ) and than FT ( $p=.0079$ ).

Similarly, VPT's MaxLU was significantly shorter than MPT ( $p=.0293$ ) and tended to be shorter than FT's ( $p=.0654$ ).

<insert Table 4. about here>

To summarize, if gestational age is taken into consideration, important differences are revealed between EPT, VPT and other children, MPT children show no difference from full-term children.

### Discussion

Our first goal was to determine if preterm children were delayed in important indices of language acquisition in comparison to full-term children. If gestational age is taken into consideration, we are able to identify different performances in the group of preterm children. Our data suggest that MPT children did not differ from FT children for any studied factors. However, EPT children and to a lesser extent VPT children recurrently showed significantly inferior scores to FT. Moreover, if we exclude the extremely preterm group, preterm children do not fundamentally differ from full term children in the measures analyzed here. Similar results were obtained in a study by Sansavini et al. (2006): only very low birth weight children were delayed in lexical and grammatical development.

We observed that preterm children obtained scores similar to those of younger full-term children. This result suggests that observed differences are delays rather than deviances from the typical course of language development. Another study in which corrected age was taken into consideration showed that preterm children obtained scores analogous to full-term children's at the same age (Kern & Gayraud, 2006). These findings can explain contradictory results stemming from research considering preterm children as a homogeneous group (Bonifacio, 1988; Le Normand *et al.* 1995; Stevenson *et al.* 1988) as well as research considering corrected or non corrected age (Zarin-Ackerman *et al.*, 1978).

In typically developing full term children, the grammatical composition of the lexicon undergoes qualitative changes depending on the total lexicon size: small lexicons are mainly composed of nouns and items belonging to the category ‘others’ (onomatopoeia, games and routines) while closed class items emerge later and are more represented in larger lexicons (Bassano *et al.*, 2005; Caselli *et al.*, 1995; Fenson *et al.*, 1993).

Among the different linguistic features under examination, some showed a greater sensitivity than others to prematurity. The sensitive features were vocabulary size and the proportions of predicates and ‘others’ categories. EPT and second born children produced significantly fewer words, fewer predicates and more ‘others’. Since, the ‘others’ category contains items that are typically acquired at earlier stages of development, this large proportion suggests a delay in these groups. By contrast, the proportion of nouns and CCI are less revealing. Concerning nouns, a possible explanation for this lack of sensitivity is that since this study focused on a developmental stage (24 months) that follows the lexical spurt, the important proportion of nouns in all participants increases less than the other categories. Concerning CCI, the developmental stage under focus precedes their emergence in typical development, so that they are equally underrepresented in all of these children. These results can be explained in terms of the restructuring in the lexicon that is observed in typically developing children between 18 and 30 months (Fenson *et al.*, 1993).

Our second goal was to study the potential role of biological and/or social factors on early language development. Among the four factors taken into consideration, only gestational age (biological factor) and birth order (social factor) showed a significant effect. For gestational age, EPT children obtained inferior scores on all of the measures. Concerning birth order, later born children obtained lower scores on all measures except for the proportion of nouns and CCIs. The weight of the biological factor seems to be more important than the social factor. This result is compatible with findings of Sansavini *et al.*

(2006). This result does not confirm previous studies showing the influence of social factors compensating biological at risk status (Greenberg & Crnic, 1988; Siegel, 1982; Sigman *et al.*, 1981).

According to Sameroff (2003), biological determinism is not justified. Several studies found that among children raised in poverty by parents with limited education, there were differences in outcome between children with and without birth complications. However, there were no differences between groups of children raised in more affluent families. In other words, the environment can amplify or minimize some early biological characteristics. Children with high-risk births can end up with subsequent developmental problems not because of damage to the brain at birth but because of the negative effect such children have on their caregivers. On the contrary, some biologically at risk children develop normally because their caregivers compensate for their differences. In our study, although EPT later born children exhibited the lowest scores, the interaction GA by Birth Order never reached statistical significance. A possible explanation is the type of measure used to characterize the social environment. In most studies, social environment is defined in terms of SES, income, parental education, or style of interaction. In our case, only maternal level of schooling and birth order were taken into consideration and only the latter played a significant role. This result confirms that first born children get better scores on a number of developmental measures. It could be explained by the fact that they are exposed to a different amount and quality of input (Fenson *et al.*, 1994; Jones & Adamson, 1994). However, other studies suggest that these results could be due to a methodological artifact. Bornstein (2004) for example, pointed out that there is no influence of birth order if spontaneous data are collected. The superiority of first born would appear only when parental reports are used. Indeed, one could imagine that mothers pay more attention to the language abilities of their first children.



In conclusion, the large sample available for comparative analysis enabled us to explain some contradictory findings by constituting different groups of preterm children according to gestational age. Only EPT children were delayed on all linguistic measures. This result underlines the necessity to consider preterm children as a heterogeneous group with potentially diverse developmental trajectories. Moreover, biological factors such as gestational age predominate over social factors in measurements of linguistic abilities at 24 months.

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Table 1.

Percentage of Participants in each Gender, Birth Order Category.

Factors	Group	
	Preterm N = 323	Full-term N = 166
Gender		
Female	45%	48%
Male	55%	52%
Birth order		
1 <sup>st</sup>	45%	58%
> 1 <sup>st</sup>	55%	42%
Level of education		
Unknown	0.3%	3%
< High school	33%	20.5%
High school diploma	20.7%	18.5%
High school+1, +2, +3	31%	28%
≥ High school +4	15%	30%
GA		
>36		100%
32-36	35.5%	
28-32	44%	
<28	20.5%	

Table 2.

Mean Number of Words (SD) according to Gestational Age and Birth Order.

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	First born	Second born
FT	263 (142.31)	197.47 (137.87)
MPT	250.88 (169.9)	182.56 (128.14)
VPT	233.9 (163.7)	175.86 (143.16)
EPT	166.3 (114.8)	135.5 (146.5)

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Table 3.

Percentages of Grammatical Categories (SD) as a function of Gestational Age and Birth Order.

Grammatical Category		Birth Order	
		First born	Later born
%NOUNS	FT	60.14 (8.24)	61.89 (9.93)
	MPT	59.31 (11.43)	59.22 (13.05)
	VPT	57.24 (15.25)	56.92 (16.86)
	EPT	59.88 (12.69)	54.48 (18.78)
%PREDICATES	FT	18.36 (6.39)	15.09 (7.02)
	MPT	16.18 (9.21)	14.71 (9.19)
	VPT	16.18 (8.91)	13.92 (7.87)
	EPT	14.13 (6.89)	10.45 (8.81)
%CCI	FT	9.34 (3.65)	8.59 (5.41)
	MPT	9.68 (6.00)	8.37 (5.09)
	VPT	7.86 (4.81)	8.52 (7.71)
	EPT	6.83 (4.07)	6.07 (5.75)
%OTHERS	FT	12.16 (10.95)	14.44 (11.03)
	MPT	14.82 (12.37)	17.70 (15.94)
	VPT	18.71 (21.25)	20.65 (19.41)
	EPT	19.17 (13.41)	29 (24.87)

Table 4.

Mean MaxLU (SD) according to Gestational Age and Birth Order.

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	First born	Later born
FT	4.20 (3.00)	3.05 (2.14)
MPT	4.35 (3.31)	3.46 (1.86)
VPT	3.60 (2.46)	2.88 (1.68)
EPT	3.34 (1.77)	2.46 (2.00)

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