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Tracking development from early speech-language acquisition to reading skills at age 13

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Abstract

Objective—Previous studies have indicated a link between speech-language and literacy development. To add to this body of knowledge, we investigated whether lexical and grammatical skills from toddler to early school age are related to reading competence in adolescence.

Methods—Twenty-three typically developing children were followed from age 1;6 to 13;6. Parental checklists and standardized tests were used to assess the development of mental lexicon, grammatical and reading capacities of the children.

Results—Direct assessment of early speech-language functions positively correlated with later reading competence, whereas lexical skills reported by parents were not associated with this capacity. At (pre-)school age, larger vocabulary and better grammatical abilities predicted advanced reading abilities in adolescence.

Conclusion—Our study contributes to the understanding of typical speech-language development and its relation to later reading outcome, extending the body of knowledge on these developmental domains for future early identification of children at risk for reading difficulties.

Keywords

Grammar; longitudinal; mental lexicon; reading; speech-language development; vocabulary

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Declaration of interest

The authors report no declarations of interest.

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Introduction

The relationship between speech-language development and reading competence is commonly acknowledged across scientific disciplines [e.g. 1–6]. The underlying nature of this association is however matter of debate within and between disciplines. Language competence comprises of several different aspects of linguistic levels such as phonological awareness, vocabulary, grammatical, and narrative competency. Among these linguistic levels, phonological awareness has been intensively studied and hypothesized to be a precursor for successful reading acquisition or, if deficient, a potential marker for later difficulties in this domain [e.g. 3, 7, 8–10]. Vocabulary, grammatical and narrative competency was also discussed to potentially predict later reading competence [e.g. 3, 4, 6, 11–13].

In particular, early vocabulary competence in its receptive and expressive modalities has been of interest not only to studies focusing on reading outcomes, but is also one of the main topics of research on speech-language development itself. The toddler's vocabulary competence has been associated with the trajectory of subsequent speech-language development and achievement of milestones and skill levels [e.g. 14; for German: 15–17]. For example, it was demonstrated by several studies on children with typical or delayed language development, that vocabulary competence at two years of age correlated with vocabulary and grammatical competency a few years later [6, 16, 18, 19].

There is evidence that vocabulary competence and other aspects of language competence may be related to different parameters of reading competence such as word decoding, reading comprehension and reading speed at different stages of reading acquisition [2, 13]. Phonological awareness was found to be an important precursor for reading competence in early elementary school when children started to decode written words [2, 13]. Vocabulary, grammatical and narrative competency has been significantly associated with advanced stages of reading acquisition, that is, when reading tasks increasingly require reading comprehension skills [2–4, 13]. Among others, reading speed has been associated with mainly rapid automatized naming, that is, the ability to rapidly name serially presented familiar stimuli [8, 20, 21].

To date, only a handful of studies have investigated language development from toddler age to late elementary school age and beyond. Most longitudinal research has focused on the relationship between language competence at preschool age and reading competence in the first few years of formal reading instruction. However, previous studies have not taken into account the onset and trajectory of vocabulary acquisition. In addition, most of the studies on reading outcomes have focused on restricted samples such as children with a lower socio-economic background [2], children with a delay in early language development [18, 22, 23] and specific language impairment (SLI) [24], or children at familial risk for reading disorders [25–28] rather than typically developing children.

We are currently carrying out a prospective follow-up study on various domains in typically developing children. In this context we have the unique possibility to observe and delineate language and reading development over a period of 12 years, that is, from the first spoken

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words to a relatively advanced level of reading competence. This study aims to enhance the understanding of the relation between early language and later reading competence by answering the following questions: Is reading comprehension and reading speed at age 13 related to: (a) lexical skills during the second year of life; (b) the productive vocabulary at preschool age; (c) the receptive vocabulary at preschool age; and (d) the reception of grammar at early school age?

Methods

Participants

Sixty-two infants were enrolled in the Developmental Physiology & Developmental Neuroscience study that was launched in 1998 and focused on various aspects of neuromotor, cognitive and speech-language development. The participants were recruited at the Department of Obstetrics and Gynaecology at the University Hospital of Graz, Austria, and at three private maternity clinics in Graz. The inclusion criteria were singleton birth at term, normal birth weight, absence of pre- or perinatal complications, normal neonatal neurological findings [29, 30], middle- or upper-class social background (defined by parental education and living conditions) and living in or in the close surroundings of Graz.

The present study focused on various aspects of language and reading competence over a period of 12 years, i.e. from the participants' age between 1;6 and 13;6 (years;months). Out of the initial cohort of 62 children, we had complete data on all study-relevant age-specific language and reading assessments (see below) from 23 monolingual Austrian-German speaking participants (14 girls, nine boys). None of the children experienced life events or severe medical problems that could have affected their language or reading development. The remaining 39 children did not participate in all assessments, but their core data collected up to preschool age did not significantly differ from the data of the participating girls and boys.

The longitudinal study was approved by the ethics committee of the Medical University of Graz, Austria. All children assented to participate and their parents gave their written informed consent for inclusion in the study and for publication of results. All assessments took place at the BRAINtegrity Laboratory at the Institute of Physiology, Medical University of Graz.

Reading competence at age 13;6

The Reading Speed and Reading Comprehension Test for Classes 6 to 12 (LGVT) [31] was used to assess reading competence at age 13;6. Furthermore, each participant's school grade in German (range 1-5; 1 reflecting the highest level of achievement, 5 equivalent to failing) at age 13;6 was collected. The first author, who was the conductor of the LGVT, was naive to the history of language acquisition and general development of the participants.

Lexical skills during the second year of life

To assess the participants' lexical skills at ages 1;6 and 2;0, we asked the parents to fill in the toddler form of the Austrian Communicative Development Inventories (ACDI [15], adapted

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from the MacArthur-Bates CDIs [32]), an age-related parental report form to assess receptive and productive lexical, grammatical and communicative capacities. In addition, Subscale C of the Griffiths Developmental Scales (German version) [33] on “hearing-and-speech” abilities was applied at the same ages.

Productive vocabulary at preschool age

In order to assess productive vocabulary in response to pictorial stimuli we applied the following assessments: the Productive Vocabulary Test for Children Aged 3 to 6 Years (AWST) [34] at ages 3;5 and 4;7, the productive task of the subtest hypernyms (subtest 10) of the Patholinguistic Assessment of Developmental Language Disorders (PDSS) [35] at age 4;7 and the Noun-Verb-Test (NVT) [36] consisting of a subtest to label nouns and a subtest to label verbs at ages 4;7 and 5;7.

Receptive vocabulary at preschool age

Receptive vocabulary was assessed by the third edition of the Peabody Picture Vocabulary Test (PPVT-III) [37] at ages 4;7 and 5;7.

Reception of grammar at early school age

Grammar skills were derived from the German version of the Test for the Reception of Grammar (TROG-D) [38] at age 7;2.

Statistical analyses

Statistical analyses were conducted using SPSS 18 (SPSS Inc., Chicago, IL) with $p \leq 0.05$ considered to be significant. The data were not normally distributed. Pearson product moment correlation coefficient was applied to calculate the correlation between two continual variables.

Results

Reading competence at age 13;6

The participants achieved a median percentile rank (PR) of 57 (interquartile range (IQR): 26-87, Range: 5-100) in reading comprehension and a median PR of 44 in reading speed (IQR: 33-75, Range: 9-97), as assessed with the LGVT. One participant had a PR<20 in both reading comprehension and speed; three other participants had a PR<20 in reading comprehension and another three participants had a PR<20 in reading speed. Pearson correlation coefficient between LGVT reading comprehension and LGVT reading speed was $r = 0.72$ ($p < 0.001$).

The participants’ median school grade in German was 3 (IQR: 1-3, Range: 1-4). Participants with higher grades in German (higher corresponding to lower level of performance) achieved significantly lower PRs in LGVT reading speed than did those with better grades (Pearson correlation coefficient $r = -0.42$, $p < 0.05$).

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Lexical skills during the second year of life and reading competence at age 13;6

ACDI scores at ages 1;6 and 2;0 were neither related to LGVT reading comprehension nor to reading speed at age 13;6 (r-values and p-values are provided in Figure 1a). No association was found between the participants' performance in Subscale "Hearing and Speech" of the Griffiths Developmental Scales at ages 1;6 and 2;0 and their reading comprehension at age 13;6 (see Figure 1a). Likewise, the participants' performance in Subscale "Hearing and Speech" of the Griffiths Developmental Scales at age 1;6 was not related to their reading speed at age 13;6 (see Figure 1a). However, participants with lower scores at age 2;0 had a lower reading speed at age 13;6 (see Figure 1b).

Productive vocabulary at preschool age and reading competence at age 13;6

The percentage of correct items achieved in AWST at ages 3;5 and 4;7 correlated significantly with the performance in LGVT reading comprehension (see Figure 1b), but not with reading speed (see Figure 1a) at age 13;6. Participants who scored lower in the productive task of the subtest hypernyms of the PDSS at age 4;7 achieved lower PRs in reading comprehension (see Figure 1b), but not in reading speed (see Figure 1a). As seen in Figure 1a, performance in NVT subtest nouns at ages 4;7 and 5;7 were neither related to reading comprehension nor to reading speed at age 13;6. Performance in NVT subtest verbs at age 4;7 was similarly not found to be associated with reading comprehension (see Figure 1a), but it correlated significantly with reading speed (see Figure 1b). Figure 1b shows that participants who scored lower on subtest verbs at age 5;7 performed worse in both reading comprehension and reading speed at age 13;6. NVT composite scores at age 4;7 correlated with reading speed (see Figure 1b), but not with reading comprehension (see Figure 1a); composite scores at age 5;7 correlated with both reading speed and reading comprehension (see Figure 1b).

Receptive vocabulary at preschool age and reading competence at age 13;6

Participants with lower PRs in PPVT-III at age 4;7 performed lower in LGVT reading comprehension (see Figure 1b), but not in reading speed (see Figure 1a). Figure 1a shows that PRs in PPVT-III at age 5;7 were not related to PRs in LGVT at age 13;6.

Reception of grammar at early school age and reading competence at age 13;6

As seen in Figure 1b, PRs achieved in TROG-D at age 7;2 were significantly associated with both reading comprehension and reading speed at age 13;6.

Discussion

To the best of our knowledge, this study is among the first to investigate the relationship between early language development and reading outcome focusing on typically developing children from toddlerhood to adolescence. There are, however, a number of studies relating speech-language capacities at preschool or early school age with later literacy proficiencies [e.g. 4, 8, 13, 39–41]. Similar to these studies we found an association of various aspects of lexical competences at preschool age and syntactical competences at early school age with later reading comprehension and/or reading speed. In particular, our results demonstrated a correlation between the productive mental lexicon at the ages 3;5, 4;7 and 5;7 and reading

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comprehension at age 13;6. Early semantic abilities assessed by the AWST (a vocabulary test predominantly focusing on objects) and the PDSS (subtest 10 to assess the ability to correctly name hypernyms) appeared to be an indicator for the comprehension of written information in adolescence. The ability to correctly name pictures showing actions (in order to elicit the productive lexicon of verbs, applying the NVT) at age 4;7, on the other hand, was only related to reading speed later on. A year later, at age 5;7, the same assessment was associated with both reading speed and reading comprehension in adolescence. In addition, the second modality of the mental lexicon investigated also revealed a positive correlation between receptive vocabulary competence (PPVT-III at age 4;7) and reading comprehension. Our findings are in line with a very comprehensive longitudinal study on more than 600 participants that showed a relation between preschool vocabulary competence and later reading comprehension up to the tenth grade [12, 42]. Almost 40% of poor readers in this study had preceding vocabulary deficits, whereas only 9% of the good readers had deficits in this domain [12]. Similar results have been shown by numerous studies focusing on productive and/or receptive vocabulary development [e.g. 4, 13, 39, 41]. These studies revealed that preschool vocabulary competence in typically developing children was related to later reading competence. Although our data showed a correlation between semantic/lexical abilities at preschool age and later literacy achievements, our study did not find a relation between these capacities and reading speed with the exception of one assessment, NVT, at ages 4;7 and 5;7. Currently, we do not have an accurate explanation for why this assessment at age 4;7 is only related to reading speed, whereas at age 5;7 it is related to both reading speed and comprehension. The study of Puolakanaho and colleagues [27] also revealed a weak correlation between expressive vocabulary and reading fluency. Puolakanaho et al., however, assessed reading fluency (counting the correctly read words and pseudo-words within a given time) whereas our design checked for silent reading.

In addition to preschool vocabulary/semantic abilities and their substantial relation to reading competence, grammatical abilities of our participants also seemed to facilitate later reading competence. We found an association between receptive grammatical skills at early school age and reading speed as well as reading comprehension at age 13;6. This is again in line with Muter and colleagues' study [13] who reported that grammatical competence at school entry was related to reading competence two years later. Also, more than half of the poor readers in second grade of Catts and colleagues' study [12] had a history of grammatical deficits at preschool age, whereas only 10% of good readers had deficits in this domain. This was confirmed by Liu and colleagues [43] who found a significant relationship between reading competence and receptive grammar skills at age 4. These findings describe a developmental pathway, which assumes that a critical mass of lexical items are required in order to establish more significant grammatical abilities, that are in turn needed to develop a high level of reading competence [e.g. 44].

Our study extends the current evidence on the relationship between early language development and reading outcomes to the toddler period and aspects of speech-language development at this age. However, the gain of knowledge is limited as we only found a correlation between the Griffiths Subscale C "Hearing and Speech" at age 2;0 and reading speed at age 13;6. Lexical skills during the second year of life, as reported by the parents, were not associated with later reading competence. This is in contrast to Lee's [6] finding in

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an English speaking cohort. Lee reported a correlation between CDI scores at age 2 and certain parameters of reading competence such as word recognition and reading comprehension at age 11. It is unclear whether our extended follow-up (i.e. an additional two years) may explain the different results, but we are almost certain that the different inclusion criteria influenced different outcomes. Lee [6] excluded children scoring around the median at age 2 and focused on children with CDI scores in the top and in the bottom one-third of CDI percentiles. Also, Rescorla [18, 22, 23] followed a group of typically developing children and late talkers (i.e. children identified with a delay in expressive language at age 2) up to age 17. The late talkers scored significantly lower than the control group in a considerable amount of language and literacy assessments throughout the study suggesting that weak language skills at age 2 reflect persistent lower performance in several aspects of language and literacy competence up to adolescence. In this study, typical talkers and late talkers differed in reading competence at ages 8, 9 and 13 but not at ages 6, 7 and 17 [18, 22, 23]. There are several limitations to the present study. First, comparing of present results to previous research assessing similar parameters is difficult due to differences in languages, differences in assessments and tests and differences in entry and outcome ages. Furthermore, our findings are based on a small sample (n = 23) focusing only on vocabulary and grammatical competency. Additional assessments of other aspects of language competence, such as phonological awareness, rapid automatized naming or narrative competence might confirm other studies indicating a relation to reading acquisition [2–4, 7, 8, 10, 13, 45, 46]. Because the present study was part of a comprehensive project on typical development focusing also on the gross and fine motor domains, time was restricted to assess only the parameters reported above. The application of parental report forms has additional limitations such as parental over- and underestimation of the toddler's lexical capacities [14]. Still, there is a large body of evidence on the validity of the CDI from comparisons of parental checklists and children's performances on direct language assessments [e.g. 15, 47–49]. An advantage of parental report forms is that the child's cooperation is not required unlike laboratory assessments. Further, the toddler's language used in his/her natural surroundings forms the basis for the completion of the parental report.

The present study found that early vocabulary and grammatical competency was related to certain parameters of reading competence in typically developing girls and boys as old as age 13;6. Reading competence is, however, a complex phenomenon that cannot be (easily) predicted by a single aspect or the assessment of one specific linguistic level. It might be valuable to combine a larger variety of domains and linguistic levels to strengthen these findings in future research. Importantly, vocabulary and grammatical competency at preschool age has been discussed to be more powerful in the prediction of reading competence at advanced stages of reading acquisition, whereas phonological skills were identified as predictors for reading competence at early stages of reading acquisition [e.g. 2–4, 13]. Our study contributes to the understanding of typical speech-language pathways and their relation to later literacy development thereby extending the broad body of knowledge on these developmental domains for future early identification of children at risk for reading difficulties.

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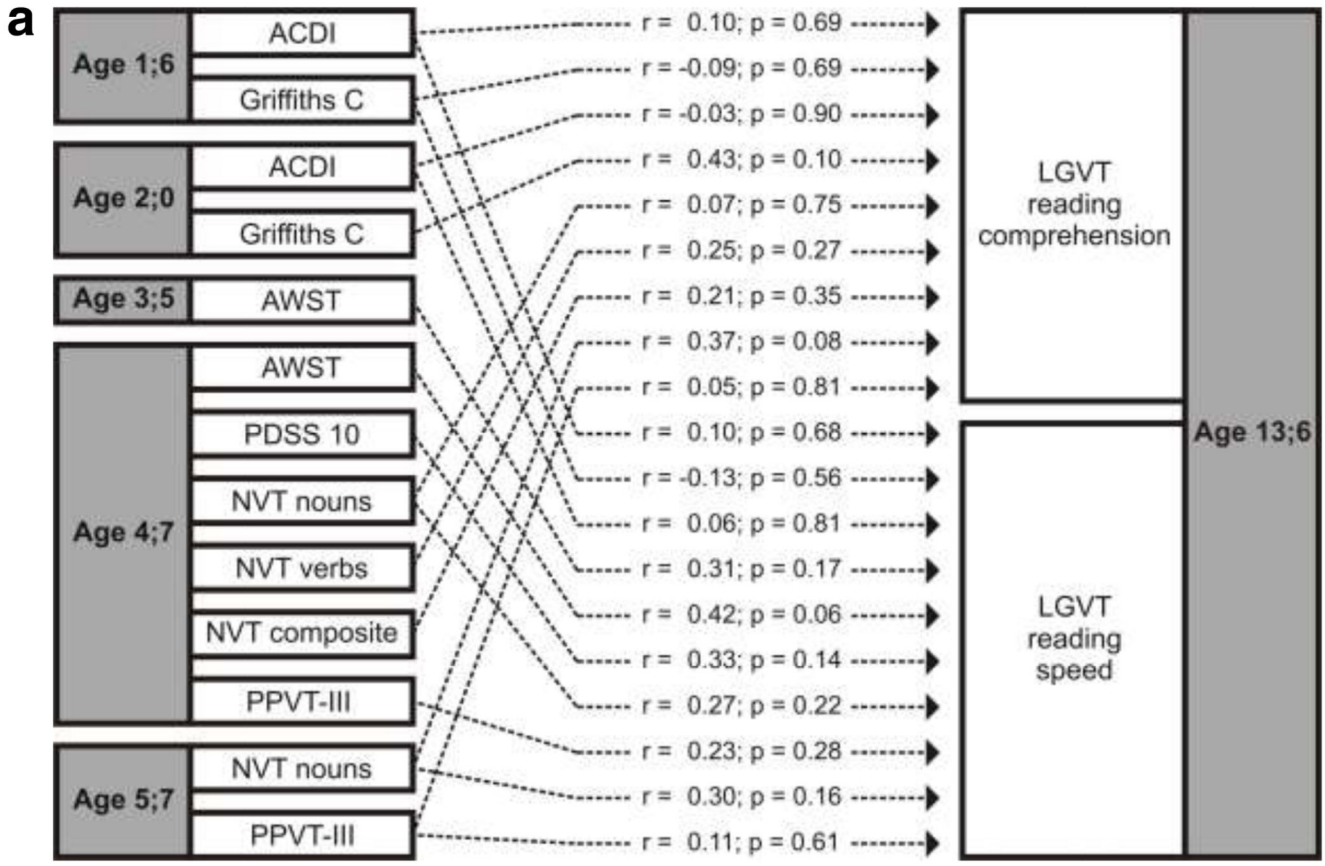

Figure 1a.

Non-significant correlations ($p > 0.05$) between the participants' ($n = 23$) performance in language assessments between ages 1;6 and 5;7 (years;months) and reading comprehension and reading speed at age 13;6 as assessed by Reading Speed and Reading Comprehension Test for Classes 6 to 12 (LGVT) [31]. ACDI = Austrian Communicative Development Inventories [15], Griffiths C = subscale "Hearing and Speech" of Griffiths Developmental Scales [33], AWST = Productive Vocabulary Test for Children Aged 3 to 6 Years [34], PDSS 10 = subtest hypernyms of the Patholinguistic Assessment of Developmental Language Disorders [35], NVT = Noun-Verb-Test [36], PPVT-III = Peabody Picture Vocabulary Test [37], r = Pearson correlation coefficient.

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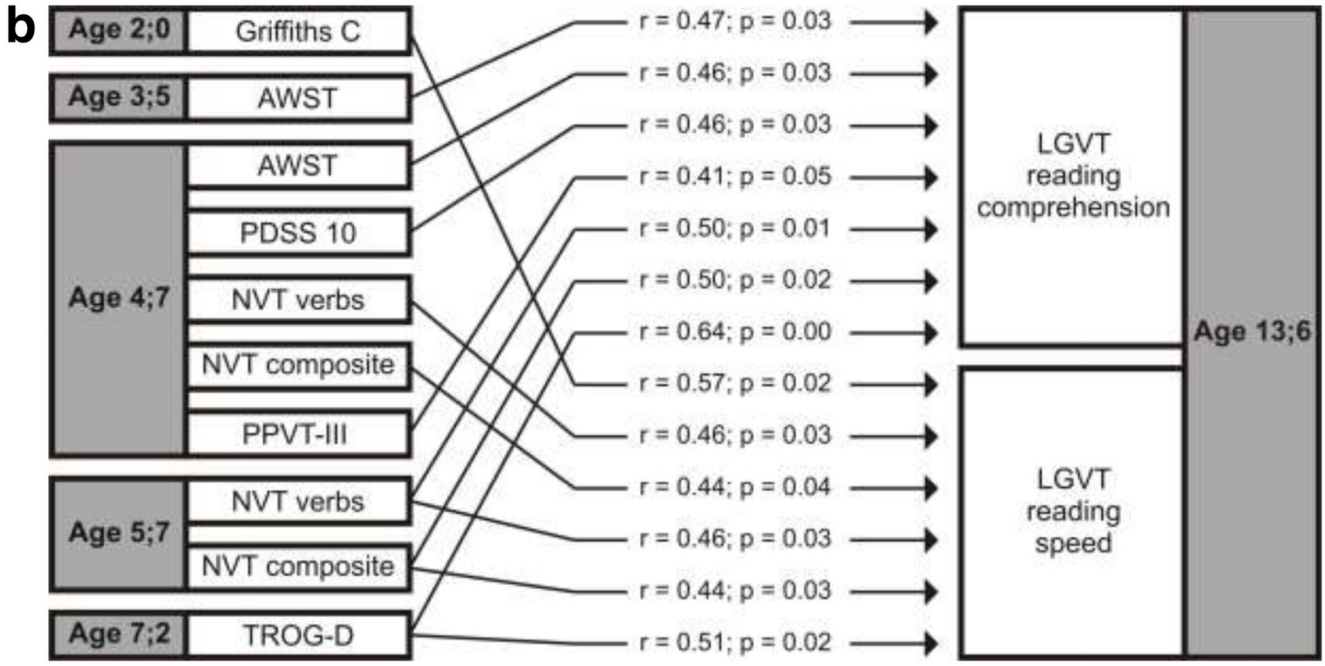

Figure 1b.

Significant correlations ($p \leq 0.05$) between the participants' ($n = 23$) performance in language assessments between ages 2;0 and 7;2 (years;months) and reading comprehension and reading speed at age 13;6 as assessed by Reading Speed and Reading Comprehension Test for Classes 6 to 12 (LGVT) [31]. Griffiths C = subscale "Hearing and Speech" of Griffiths Developmental Scales [33], AWST = Productive Vocabulary Test for Children Aged 3 to 6 Years [34], PDSS 10 = subtest hypernyms of the Patholinguistic Assessment of Developmental Language Disorders [35], NVT = Noun-Verb-Test [36], PPVT-III = Peabody Picture Vocabulary Test [37], TROG-D = Test for the Reception of Grammar [38], r = Pearson correlation coefficient.

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