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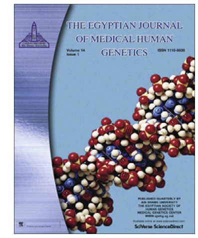

ORIGINAL ARTICLE

Language impairment in attention deficit hyperactivity disorder in preschool children

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Abstract Language impairment (Li) is a highly prevalent comorbidity in children with psychiatric disorders and behavioral problems. The most common psychiatric diagnosis among children with Li is attention deficit hyperactivity disorder (ADHD), and conversely, Li is a frequent comorbidity found in children with ADHD. Despite the frequent cooccurrence of these two common disorders, there have been few studies that specifically investigate language abilities of children with ADHD.

Therefore the main objective of this work was to evaluate language profile in ADHD children and to determine whether there is a specific ADHD related language profile in preschoolers in comparison with the control group with no ADHD. Fifty-three preschool children were diagnosed as ADHD and then they were evaluated for their language development. We recruited 36 children fulfilling our inclusion criteria and had delayed language development then we compared this case group to a sex and age matched group of children with delayed language with no ADHD ($n = 25$). Assessment of intelligence was done for both groups using the Stanford Binnet Test IV. Evaluation of ADHD was done for both groups using DSM-IV criteria for ADHD. Comprehensive assessment of language development was done using the Arab Linguistic Test (ALT). EEG was done for both groups. Our results revealed that children with ADHD showed a significant delay in language development. But there was no difference between ADHD children and the control group in total language age, semantics, pragmatics and expressive language age. The only scale that showed difference between children with ADHD and controls was the receptive language age and receptive age quotient. There was no significant difference between cases and controls in EEG. We

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concluded that it is important to take into consideration language abilities when assessing children with ADHD and it is informative to include ADHD screening tools when dealing with children with DLD.

1. Introduction

Attention deficit-hyperactivity disorder (ADHD) is characterized by severe deficits in attention control, impulsivity and hyperactivity. ADHD is mainly observed in childhood, but may exert continuous and residual effects in adults [1]. ADHD may be suspected in a child who demonstrates all of the core symptoms of ADHD, namely inattention, impulsivity, and hyperactivity. According to DSM-IV diagnostic criteria, symptoms should be present before 7 years of age and be more severe and/or frequent than those typically seen in children of the same age. Symptoms must be present for more than 6 months, pervasive, existing in at least two settings, typically at home and school, in addition to a significant clinical impact on the child's social, academic or occupational functioning [2]. The prevalence of ADHD is conservatively estimated as being from 3% to 7% of the school aged children in the United States. Boys with ADHD outnumber girls, but ratio varies significantly from 2:1 to 9:1. Gender differences are less obvious for inattentive type. Boys are more likely to be aggressive and to have other behavioral problems. ADHD children make up 30–40% of referrals to child mental health practitioners [3]. Delayed language development is a highly prevalent comorbidity in children with psychiatric disorders and behavioral problems [4].

The most common psychiatric diagnosis among children with delayed language development is ADHD, and conversely, delayed language development is a frequent comorbidity found in children with ADHD representing 48.6%. Since language development relates well to hearing and listening which is an active process, the delay can be attributed to difficulty with focused and sustained attention to the voice and sounds in the environment [5]. Speech-language pathologists frequently have children suspected for being ADHD referred to them because such children often exhibit problems in functional areas that are associated with deficits in language skills as sequencing difficulties, poor problem-solving skills, frequently switch topics of conversation, and give responses that are not related to questions asked. Many of these children also exhibit difficulty with pragmatic language skills and with following directions [6]. Early symptoms may cause inappropriate response from the parents which can aggravate the avoidable symptoms. Early treatment can reduce the severity of these symptoms and can help in managing the motor and language difficulties [7]. Despite the frequent co-occurrence of language impairment and ADHD, there have been relatively few studies that specifically investigate language abilities of children with ADHD [8]. Therefore the main objective of this work was to evaluate language profile in ADHD children and to be able to determine whether there is a specific ADHD related language profile in preschoolers in comparison with another control group.

2. Patients and methods

2.1. Study design

This study was an observational prospective study done in the period from October 2009 to October 2012 and comprised of 53 children diagnosed as ADHD then they were screened for delayed language development (DLD). 36 children were found to have ADHD, DLD and fulfilled our inclusion criteria (Cases). They were compared to 25 children age and sex matched who had DLD with no ADHD (Controls). Both groups were further subdivided into two subgroups according to their IQ. These included below average subgroup (IQ 70–89) and average subgroup (IQ $\geqslant$ 90). The studied children were presented to Neuropediatric and Phoniatric clinics, Sohag University hospital.

Written consent was taken from the parents after explaining the purpose of the study and the research was approved by Faculty of Medicine, Sohag University Ethics Committee.

2.2. Inclusion criteria

Children aged 3–6 years old who were diagnosed as attention deficit hyperactivity disorder using the ADHD Test (ADHDT) [9] based on Diagnostic and Statistical Manual Disorders, Fourth Edition (DSM-IV) [10] with normal hearing, IQ $\geqslant$ 70 and normal motor activity.

2.3. Exclusion criteria

Children younger than 3 years or older than 6 years, mentally retarded, with impairment of hearing or speech problems (as stuttering) and brain damaged motor handicapped children (as cerebral palsy).

3. Methods

3.1. Both groups underwent the following protocol

3.1.1. Elementary diagnostic procedures

It included parents' interview, prenatal history, perinatal and postnatal history, developmental milestones, general examination, vocal tract examination (for the lip, tongue and palatal mobility) and neurological examination. Assessment of current communicative abilities was done and included evaluation of semantics at two levels.

a- At the word level: at the receptive and expressive levels using synonyms, antonyms, hyponyms, and analogy b- At the sentence level: at both the receptive and expressive levels using: sentence formulation cards, sequencing cards and stories. Syntax and phonology were also evaluated. Quasi- objective evaluation of pragmatics was done during conversation with five items: topic (e.g., maintenance), turn taking (e.g., interrupting), paralinguistic characteristics (e.g., vocal intensity), nonverbal characteristics (e.g., physical position and eye gaze) and narrative cohesion.

3.1.2. Clinical diagnostic aids

Psychometric evaluation was done by the Stanford Binet test (IV version) [11] and Vineland social maturity scale [12]. Evaluation of Attention Deficit Hyperactivity Disorder was done by the Attention Deficit Hyperactivity disorder Test (ADHDT) [9]. A range of values for the subtest standard scores (Hyperactivity, Impulsivity, Inattention) and the ADHD Quotient are provided for estimating the probability of ADHD. Evaluation of peripheral hearing by tympanometry and pure tone audiometry (when needed) and assessment of language by Arabic language test [13] and Articulation test [14] were also done.

Electroencephalography (EEG) was done using conventional EEG machine (Nihon Kohden) with 12 channel placement scalp electrodes. The technique was conducted during sleep under sedation with Chloral Hydrate. Auditory brainstem response (ABR) was also done if needed.

3.1.3. Statistical methodology

Analysis was done using a Statistical Package for Social Sciences (SPSS) version 15. Student's T test was used for quantitative data and the chi square test was used for qualitative data. P value was used to indicate the level of significance; $p > 0.05$ was considered insignificant, $p < 0.05$ was considered significant and $p < 0.01$ was considered highly significant.

4. Results

4.1. Demographic data of the patients

Fifty-three cases with ADHD were examined. Seventy-six percent (76%) of these cases ($n = 36$ case) were diagnosed having delayed language development (DLD). Twenty-five controls (DLD with no ADHD) were recruited. Sex and age distribution of cases and controls is presented in Table 1.

There was no significant difference between cases and controls in different aspects of child development except for sitting ($P = 0.047$), uttering the 1st word ($P = 0.03$) and in toilet training ($P = 0.046$) (Table 2).

There was a significant difference between both groups as regards family history of ADHD ($P = 0.02$) which was present in 19% of patients with ADHD.

4.1.1. Semantics

There was no significant difference between cases and controls in the receptive and expressive level. On the other hand, when cases and controls were divided into two subgroups according to the I.Q, results showed no significant difference between them for both reception and expression in below average group (IQ < 90). On the other hand results showed a significant difference between cases and controls when the IQ ⩾ 90 in the expression of sentence formulation as 90% of cases have good expression versus 58% of controls. $P = 0.05$ (Tables 3 and 4).

Table 1 Sex distribution and mean age in the studied groups.

		Cases ($n = 36$)	Controls ($n = 25$)	P value
Sex	Female	9 (25%)	9 (36%)	0.35
	Male	27 (75%)	16 (64%)	
Age(mean ± SD)		51.14 (11.54)	53.52 (11.38)	0.43

Table 2 Aspects of child development in cases and controls.

	Cases ($n = 36$)	Controls ($n = 25$)	P value
Sitting (mean ± SD)	7.06(1.31)	7.88(1.87)	0.047*
Walking (mean ± SD)	15.29(5.29)	16.04(4.72)	0.57
1st word (mean ± SD)	15.6(4.57)	19.39(8.08)	0.03*
1st sentence (mean ± SD)	29.66(8.26)	32.00(7.04)	0.35
Self feeding (mean ± SD)	22.97(9.54)	23.09(7.99)	0.96
Self dressing (mean ± SD)	42.6 (10.98)	44.93(12.78)	0.57
Toilet control (mean ± SD)	29.29(10.38)	23.45(9.23)	0.046*

*P value <0.05 was significant.

Table 3 Sentence formulation (Receptive and Expressive) between cases and controls.

Sentence formulation	Cases ($n = 36$)	Controls ($n = 25$)	P value
Receptive			
Good	33 (91.67%)	25(100%)	0.14
Poor	3 (8.33%)	0	
Expressive			
Good	27(75%)	13(52%	0.063
Poor	9(25%)	12(48%)	

4.1.2. Syntax and phonology

Poor syntax and phonology in both cases and controls were detected with no significant difference between both groups in syntax ($p = 0.15$) and phonology ($p = 0.24$).

4.1.3. Pragmatics

Poor pragmatics in both cases and controls was detected with no significant difference between them as regards topic maintenance ($p = 0.39$), turn taking ($p = 0.45$), vocal intensity ($p = 0.38$) and narrative cohesion ($p = 1.00$). But there was a highly significant difference between them as regards non verbal characteristics (physical position) ($p < 0.0001$) and eye gaze ($P = 0.01$). This showed that ADHD children are more hyperactive with poorer eye gaze than the controls (Table 5).

4.1.4. Arabic language test [13]

Children with ADHD had a significant delay of their total language age, receptive language age, semantic language age, and pragmatics. There was no significant difference in the total language age between cases and controls ($p = 0.71$).

There was a significant difference between cases and controls in the receptive age and the receptive age quotient. So children with DLD + ADHD had poorer reception than children with DLD + no ADHD. There was also no significant difference between cases and controls as regards expressive age, semantics, pragmatics and expressive age quotient (Table 6).

Furthermore, when cases and controls were divided into two subgroups according to the I.Q, there was a significant

Table 4 Sentence formulation (receptive and expressive) between cases and controls in their subgroups.

	I.Q 70–89 (below average)			I.Q $\geqslant$ 90		
	Cases $n = 15$	Controls $n = 8$	*P* value	Cases $n = 21$	Controls $n = 17$	*P* value
Sentence formulation (Receptive)						
Good	13(86.67%)	8(100%)	0.53	20(95.24%)	17(100%)	0.36
Poor	2(13.33%)	0(0.00%)		1 (4.76%)	0 (0.00%)	
Sentence formulation (Expressive)						
Good	8(53.33%)	3(37.50%)	0.67	19(90.48%)	10(58.82%)	0.05*
Poor	7(46.67%)	5(62.50%)		2 (9.52%)	7 (41.18%)	

* *P* value 0.05 was significant.

Table 5 Pragmatics in cases and controls.

	IQ 70–89 (below average)			IQ 90 (average)		
	Cases	Controls	*P* value	Cases	Controls	*P* value
Topic maintenance						
Not present	13(86.67)	7(87.50)	0.96	14(66.67)	9(52.94)	0.39
Present	2(13.33)	1(12.50)		7(33.33)	8(47.06)	
Turn taking						
Not present	1(6.67)	2(25.00)	0.27	0(0.00)	1(5.88)	0.45
Present	14(93.33)	6(75.00)		21(100.00)	16(94.12)	
Vocal intensity						
Loud	3(20.00)	0(0.00)	0.53	7(33.33)	0(0.00)	0.38
Not loud	12(80.00)	8(100.0)		14(66.67)	17(100.0)	
Physical position						
Hyperactive	11(73.33)	0(0.00)		7(33.3)	0(0.00)	
Fidgeting	3(20.00)	0(0.00)	< 0.0001*	11(52.38)	0(0.00)	< 0.0001*
Calm	1(6.67)	8(100.0)		3(14.29)	17(100.0)	
Eye Gaze						
Poor	11(73.33)	0(0.00)	0.0001*	10(47.62)	1(5.88)	0.01*
Good	4(26.67)	8(100.0)		11(52.38)	16(94.12)	
Narrative cohesion						
Not present	15(100.0)	8(100.0)		18(85.71)	14(82.35)	1.00
Present	0(0.00)	0(0.00)		3(14.29)	3(17.65)	

* *P* value < 0.05 was significant.

Table 6 Subtest standard scores of Arabic language test in cases and controls.

	Cases ($n = 36$) Mean ± SD	Controls ($n = 25$) Mean ± SD	*P* value
Receptive age	28.78 (13.03)	39.6 (15.68)	0.005*
Expressive age	34 (16.14)	33.76 (15.88)	0.95
Semantics	26 (8.92)	26 (7.46)	1.00
Pragmatics	24.16 (8.66)	26.4 (9.17)	0.34
Receptive age quotient	55.46 (16.36)	72 (21.54)	0.001*
Expressive age quotient	65.3 (21.95)	63.03 (27.48)	0.72

* *P* value < 0.05 was significant.

difference between cases and controls in average I.Q group as regards receptive age ($P = 0.02$) and a highly significant difference in receptive age quotient ($P = 0.005$). These results showed that children with group I had poorer reception than group II in average and above cognitive ability subgroup. There was no significant difference between group I and group II in the below average I.Q subgroup ($p = 0.06$) (Table 7).

There was a positive strong relation between ADHD quotient and total language age ($P = 0.0007$) as shown in Fig. 1.

There was also a statistical significant difference between ADHD quotient and language parameters of Arabic language test (reception, expression, semantics and pragmatics). When subtests of the ADHD Test (hyperactivity, impulsivity, inattention) were compared with language parameters in the Arabic language test, it was found that there was a highly significant difference between subtest hyperactivity and total language age ($P = 0.002$), reception ($P = 0.0003$) and semantics ($P = 0.0005$). This showed that hyperactivity was the most important factor affecting language in ADHD (Table 8).

4.1.5. EEG

There was no significant difference between cases and controls ($P = 0.56$) or between the three subgroups of ADHD which were hyperactivity, impulsivity and inattention (obtained from a range of values for the subtest standard scores of ADHDT).

Table 7 Arabic language test in cases and controls in their subgroups.

	I.Q 70–89 (below average)			I.Q ⩾ 90 (average)		
	Case mean ± SD	Control mean ± SD	*P* value	Case mean ± SD	Control mean ± SD	*P* value
Total language age in months	22.67 (2.79)	21 (6.50)	0.39	32.57 (10.77)	33.41 (10.53)	0.81
Receptive age	22.13 (5.60)	27.75 (7.81)	0.06	33.53 (14.76)	45.18 (15.46)	0.02*
Expressive age	25.73 (7.21)	22.25 (9.22)	0.33	39.90 (18.20)	39.18 (15.61)	0.89
Semantics	21.73 (5.18)	21.25 (2.12)	0.80	29.05 (9.85)	28.24 (8.06)	0.79
Pragmatics	18.4 (1.55)	21 (9.62)	0.31	28.26 (9.32)	28.94 (8.00)	0.82
Receptive age quotient	45.73 (8.80)	53.93 (10.14)	0.06	62.42 (17.09)	80.51 (20.27)	0.005*
Expressive age quotient	52.96 (13.46)	45.78 (15.46)	0.26	74.11 (22.82)	71.15 (28.44)	0.72

* *P* value < 0.05 was significant.

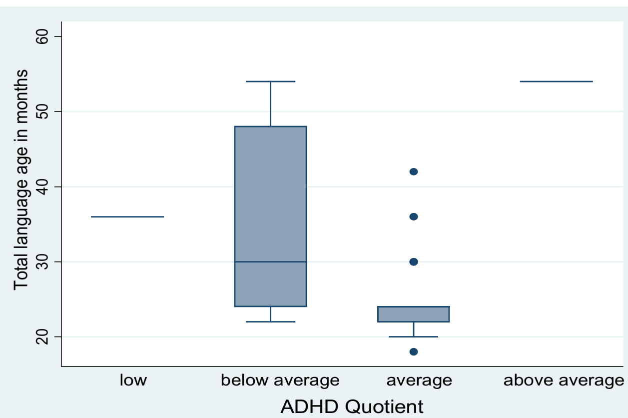

Figure 1 Relation between ADHD Quotient and total language age.

5. Discussion

In this study, boys to girls ratio was 3:1. This was in accordance to Curran et al. [15] who found that boys are 2–3 times more frequently affected with ADHD than girls. This was further supported by Tahir et al. [16], in a sample of Turkish children and by Fayyad et al. [17] who found that the boys to girls ratio of ADHD was 3:1. Boys diagnosed with ADHD are usually clinic-referred because of oppositional, aggressive, and conduct behaviors. The male predominance probably reflects both referral bias because boys tend to display more disruptive behavior than girls do as well as a true sex difference in prevalence. In another view, the excess male to female ratio is consistent with the sex ratio of many other developmental disorders [18].

The positive family history of ADHD in 19% of cases versus 0% in controls suggested the genetic component of ADHD. All twin studies of ADHD reported that concordance rates were significantly higher among Monozygotic (MZ) pairs (58–82%) than same-sex Dizygotic (DZ) pairs (31–38%), providing further evidence that ADHD is significantly heritable [19,20].This study also showed that children with ADHD did not have a delay in the onset of talking. It is more likely that they are less organized in their speech as reported by Ring et al. [21]. Tannock & Schachar [22] showed that the only aspect of language that is likely to come under the influence of inhibitory control, such as narrative discourse and pragmatics, is deficient in ADHD children generally rather than the onset of talking. This is not consistent with other studies which showed that children with ADHD are more likely to have a

Table 8 Relation between language and attention in cases.

ADHD Quotient (probability of ADHD)	Total language age mean ± SD	Reception mean ± SD	Expression mean ± SD	Semantics mean ± SD	Pragmatics mean ± SD
Low	36(0.00)	42(0.00)	54(0.00)	30(0.00)	42(0.00)
Below average	35(12.87)	36.75(16.0)	43.5(25.56)	30(9.44)	29.25(11.3)
Average	25.15(5.63)	25.08(10.13)	29.31(9.31)	23.31(5.18)	21.23(6.16)
Above average	54(0.00)	48(0.00)	60(0.00)	60(0.00)	42(0.00)
P value	0.0007*	0.03*	0.02*	< 0.0001*	0.0007*
Hyperactivity	30.0(8.49)	36(8.48)	38(22.63)	26(5.66)	30(16.97)
P value	0.002*	0.0003*	0.08	0.0005*	0.15
Impulsivity	35.14(11.71)	37.71(16.87)	46(25.22)	30.28(9.34)	30(12.0)
P value	0.11	0.13	0.09	0.37	0.10
Inattention	27.14(6.82)	27.14(7.73)	30.28(15.03)	24(4.32)	24.88(10.06)
P value	0.12	0.33	0.23	0.46	0.10

* *P* value < 0.05 was significant.

delay in the onset of talking (6–35%) in comparison to children without ADHD (2–5.5%([23].

In this study, all cases and controls were divided according to the intelligence quotient into two groups: below average cognitive abilities (group I) and average cognitive abilities (group II). The only parameter in semantics that showed a better score in group I (average cognitive ability subgroup) was expression of sentence formulation. Watching television may explain this finding as many mothers may resort to television watching in order to control hyperactivity and to get rid of the disturbance of the hyperactive child although television is a passive stimulation and may add to the problem. Yet, reception of sentence formulation was affected in cases and controls when the cognitive abilities were average. This showed that cognitive abilities are very important factors in evaluating language as when cognitive abilities are improved, ADHD children showed better expression of sentence formulation despite their language delay in comparison to the control group (average cognitive ability subgroup).

The significant delay of their total language age, receptive language age, semantic language age, and pragmatics may be explained by the fact that ADHD is a disorder that affects attention, thinking, learning process, and social interaction of the child, which are all essential in the development of language [24]. In addition to negative parenting style, the ADHD child is neglected with negative maternal comments and negative expressed emotions which exacerbate ADHD symptoms and so the child will not have proper stimulating environment for proper language development [25]. Also impairments in the working memory which is highly related to language impairments can be a cause [26].

Another explanation is the common pathological basis which is of neurological origin, as the frontal lobe and basal ganglia involvement were claimed to affect both ADHD and language disorders [27]. Also, neurotransmitters such as dopamine and norepinephrine play a central role in the interconnection of different subsystems in the brain, and it is this interrelationship that likely underlies the common comorbid conditions associated with ADHD and its linkage to language.

The poor reception of cases more than controls is due to working memory (WM) deficits as WM requires storing information from previous sentences, while concurrently processing new information. People with a lower WM capacity not only take longer to process syntactically complex information, but they also have considerably lower accuracy in comprehension [28].

Cases had poor pragmatic skills: this was explained by the fact that children with increased levels of hyperactivity and inattention may experience pragmatic language difficulties because ADHD involves poor behavioral inhibition, which affects executive control and is related to problems with attention, impulsivity, and hyperactivity [29].

Both cases and controls shared some poor pragmatic skills such as topic maintenance, turn taking and vocal intensity with no significant difference. This was explained by other studies which showed that pragmatic ability is probably affected by structural language skills, impulsivity and vice versa [30]. Most likely these aspects constantly potentiate each other, without being able to reliably distinguish the underlying core behavior. It is important to repeat that there is an overlap between structural language and pragmatic abilities [31]. For instance, it was found that for all children a composite measure of expressive language structure predicted pragmatic competence whereas impairments in auditory verbal memory predicted poor pragmatic competence among children with language impairment [26]. These findings suggest that language processing deficits associated with language impairment can manifest themselves as poor pragmatic competence. Vallance & Cohen [32] also had observed that structural language impairments are associated with immature social cognitive reasoning, which is a component of pragmatic language skill. Therefore, focusing solely on pragmatics without taking into account other language and cognitive skills and deficiencies will not tell the complete story of the child and might, therefore, result in too narrowly defined treatment goals[30].

EEG was done to 32 children in cases and six children in controls. In cases we found that twenty-two of them (68%) had epileptic activity. This is higher than the results of Millichap et al. [33] who managed to make a Meta analysis of eight studies of non-epileptic children with ADHD. The prevalence of epileptic EEGs varied from 6% to as high as 53% with an average 23.4%. The wide range of abnormal records may be attributed to several factors, including duration of recording, sleep, method of recording (conventional or digital) and differences in interpretation. In this study, it was done using the conventional EEG system, short duration of recording with different interpreters in addition to a small number of controls (six children). In our study the parents of four cases and 19 controls refused the EEG technique thinking that it is harmful for their children. Hemmer et al. [34] pointed out that an epileptiform EEG in neurologically normal children with ADHD is predictive of a significantly increased risk of seizures associated with stimulant therapy.

Based on the Diagnostic Statistical Manual-fourth edition (DSM-IV; APA 2000) [10] it is not evident which specific symptoms should be present and whether they already interfere with the child's language abilities at this young age. In this study, hyperactivity was the most important factor affecting language in ADHD children. Hyperactive children were so distracted that they had great difficulty in sitting still, planning ahead, or attending to what is going on around them. They often find it impossible to consider and conform to expectations and requirements of the world around them. The delay in development of certain brain structures such as the frontal cortex and temporal lobe is believed to be responsible for inhibitory control [35] which its deficiency influences language in ADHD [22]. In contrast, the motor cortex in ADHD patients was seen to mature faster than normal, suggesting that both slower development of behavioral control and advanced motor development might be required for both hyperactivity and language disorder in ADHD [35].

To conclude; this study implied that it is important to take into consideration language abilities when assessing children with ADHD and it is informative to include ADHD screening tools when dealing with children with DLD. Also assessment of working memory is mandatory in ADHD with DLD to apply a specific program in language therapy. In addition a detailed standardized test for evaluation of pragmatics with a scoring system is needed for preschool and school aged Egyptian children.

Declaration

The authors declare that there was no conflict of interest.

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