ESCOLA DE HUMANIDADES

DOSSIÊ: PSICOLINGUÍSTICA E NEUROLINGUÍSTICA EM INTERFACES

Task demands and executive function abilities in the comprehension of costly sentences by schoolchildren

Demandas de tarefas linguísticas e funções executivas na compreensão de sentenças de alto custo por crianças em idade escolar

Demandas de tareas lingüísticas y habilidades de las funciones ejecutivas en la comprensión de oraciones con alto costo en niños en edad escolar

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Abstract: This paper investigates the relationship between children's comprehension of syntactically costly sentences (passives, relatives and WH-questions) and their performance in inhibitory control (IC) tasks. 74 Brazilian Portuguese-speaking schoolchildren were tested with MABILIN, a linguistic battery with a picture-identification task intended to track language impairment, and two versions of the Flanker and Go/no-Go tests, designed for children. Image complexity was manipulated in the comprehension of right-branching relative clauses and WH+N questions. A positive correlation between children's overall performance in the language test and the IC tests was obtained. Moreover, children's performance in the analysis of complex images was positively correlated with IC abilities. The results suggest that demands of the sentence-mapping process in linguistic tasks can be crucially dependent on IC. The implications of the results for the tracking of DLD (Developmental Language Disorder) are discussed.

Keywords: DLD (Development Language Disorder). Inhibitory control. Long-distance dependencies. Relative clauses and WH questions. Picture-identification task.

Resumo: Este artigo investiga a relação entre compreensão de sentenças de alto custo sintático (passivas, relativas e interrogativas QU-) por parte de crianças e seu desempenho em tarefas de controle inibitório (CI). 74 crianças em idade escolar falantes de português brasileiro foram testadas por meio do MABILIN, uma bateria linguística com identificação de imagens que objetiva identificar crianças em risco de comprometimento linguístico, e por meio de duas versões para crianças do teste de Flanker e do teste Go/no-Go. A complexidade das imagens foi manipulada na compreensão de sentenças com orações relativas ramificadas à direita e interrogativas QU+N. Obteve-se uma correlação positiva entre o desempenho global no teste linguístico e nos testes de CI. Além disso, o desempenho das crianças na análise das imagens complexas também se mostrou correlacionado às habilidades de CI. Os resultados sugerem que as demandas do processo de mapeamento de sentenças em tarefas linguísticas podem ser dependentes de habilidades de CI. Discutem-se as implicações dos resultados obtidos para o rastreamento de crianças com TDL (Transtorno do Desenvolvimento da Linguagem).

Palavras-chave: TDL (Transtorno do Desenvolvimento da Linguagem). Controle inibitório. Dependências de longa distância. Orações relativas e interrogativas QU. Tarefa de identificação de imagens.

Resumen: Este artículo investiga la relación entre la comprensión de los niños de oraciones con alto costo sintáctico (pasivas, relativas y preguntas QU) y su desempeño en tareas de control inhibitorio (CI). Se evaluaron 74 niños en edad escolar que hablan portugués brasileño utilizando MABLIN, una batería lingüís-

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tica con tarea de identificación de imágenes, diseñada para identificar a los niños en riesgo de deterioro del lenguaje, junto con dos versiones adaptadas para niños de las tareas Flanker y Go/no-Go. Se manipuló la complejidad de las imágenes en la comprensión de cláusulas relativas bifurcadas a la derecha e preguntas QU+N. Se encontró una correlación positiva entre el rendimiento global en la tarea lingüística y en las tareas de CI. Además, el desempeño de los niños en el análisis de imágenes complejas también se correlacionó con las habilidades de CI. Los resultados sugieren que las demandas del proceso de mapeo de oraciones en tareas lingüísticas pueden depender de las habilidades de CI. Se discuten las implicaciones de los resultados obtenidos para la identificación de los niños con TDL.

Palabras-clave: TDL (Trastorno del Desarrollo del Lenguaje). Control inhibitorio. Dependencias de larga distancia. Cláusulas relativas y preguntas QU. Tarea de identificación de imágenes.

Introduction

The assessment of schoolchildren's language comprehension abilities is imperative in tracking Developmental Language Disorder (DLD) and other impairments that can jeopardise their performance in a number of school tasks.

Linguistic tasks present a variety of demands, such as those stemming from the syntactic processing and the semantic interpretation of the sentences, and from the mapping of semantically interpreted units onto referents and world events. Coping with these demands, though crucially dependent on linguistic knowledge and language-specific processing abilities, also requires executive control abilities beyond the language domain. This paper explores a possible correlation between children's performance on the comprehension of costly sentences in a picture-identification task intended to track those children at risk of DLD and their ability to cope with two non-verbal inhibitory control tasks. The aim of this study is to evaluate the extent to which coping with the particular demands of the processing of visual information in the sentence-mapping process is dependent on inhibitory control.

The picture-identification task is one of the most widely used experimental techniques for the assessment of children's language comprehension abilities. The module I of MABILIN, applied in the present investigation, makes use of this type of task.[3] Given an orally presented sentence, the child is expected to identify the picture depicting an event that corresponds to the semantic interpretation of the sentence in a set of pictures. The visual information is manipulated in such a way that it is the correct parsing of the test sentence that will enable the target picture to be identified. For instance, given the passive sentence (1), the target picture is in Figure 1c, even though the other pictures (Figures 1a and 1b) present the same characters referred to in the sentence.

(1) O leão foi chamado pelo elefante.

The lion was called by the elephant.

Figure 1 – Image from MABILIN – Block 1

A　　　　B　　　　C
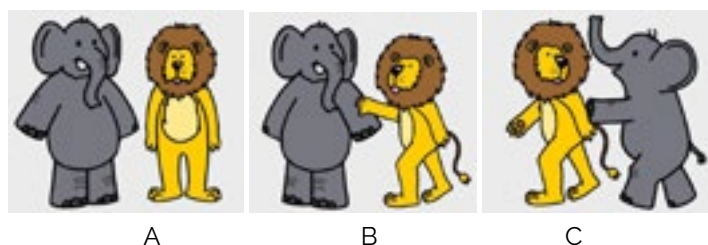
Source: MABILIN.

Hence, although this linguistic task crucially depends on children's ability to conduct the sentence parsing and the semantic interpretation of a passive sentence, the mapping task involves other cognitive abilities. Children have to analyse the visual stimuli while keeping the sentence representation and its interpretation in the working memory, and possibly inhibit the immediate mapping of the sentence subject with the actor of the event since reversible actions

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[3] The Module I of MABILIN is presented in Section 1.

(when the roles of actor and patient can in principle be ascribed to any of the characters in the pictures) can make the decision task particularly hard, even in the processing of active sentences (Corrêa, 2012).

The role of image complexity in the comprehension of subject and object relative clauses (RCs) and bare subject and object WH interrogatives was investigated by Corrêa and Augusto (2019). Given the background information visually presented, children had to choose among three characters the one corresponding to the referent of the complex DP (determiner phrase) or to the referent of the interrogative pronoun. The background information was manipulated as a function of image complexity. Simple images presented a single actor-action-object event and a third character standing by the scene. Complex images presented two similar actor-action-object events: the target one and another one with characters of a similar type in reversed roles. Figures 2a and 2b illustrate the simple image condition for object RCs and WH-interrogatives, respectively. Figures 3a and 3b illustrate the complex image condition for each of these sentence types.

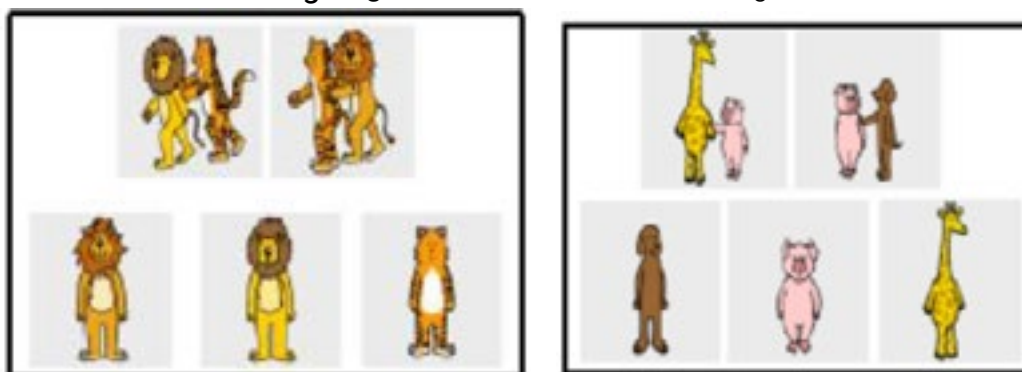**Figure 2 –** Slides from MABILIN – Block 2
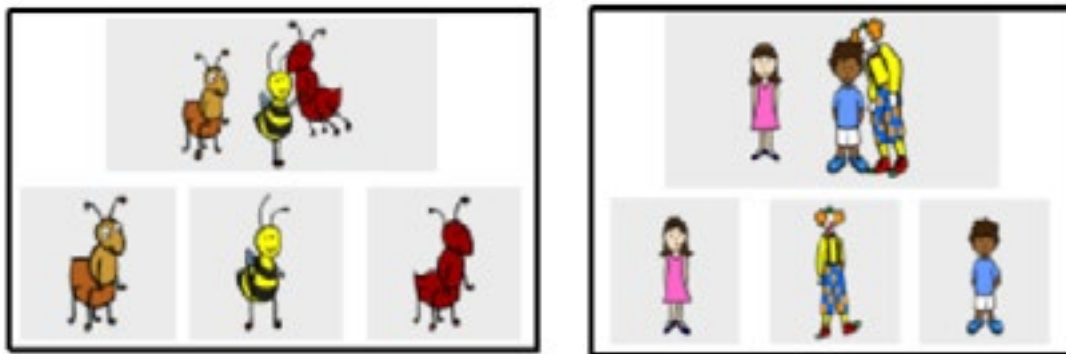
A. Mostra a formiga que a abelha levantou.
Show the ant that the bee raised.

B. Quem o palhaço beijou?
Who did the clown kiss?

Source: MABILIN.

Figure 3 – Slides form MABILIN – Block 3

A. Mostra o leão que o tigre pegou.
Show the lion that the tiger caught.

B. Quem o porco chamou?
Who did the pig call?

Source: MABILIN.

The results revealed that complex images were more challeging to process for both types of sentences than simple ones and that a subject-object asymmetry favouring subject sentences could be mainly detected in RCs. In Corrêa, Rodrigues and Augusto (2022), the effect of image complexity in the comprehension of RCs was also obtained when the simple image presented two different

actor-action-object events in contrast with two reversible events in the complex image condition. This result seems to indicate that it is the visual processing of reversible events in relation to the linguistic processing of reversible sentences that creates additional demands in the decision task. If so, inhibiting the canonical subject-actor mapping or, more generally, the immediate thematic mapping between the sentence's DPs and their referents may be a requirement for the task to be successfully accomplished. In that study, this hypothesis was preliminarily explored. It predicted a correlation between children's behaviour in the comprehension of costly sentences, such as passives, relative clauses and WH-questions in a picture-identification task and their performance in executive functions tests focusing on inhibitory control. This exploration was conducted with a sample of 15 six-year-old children whose overall performance in the MABILIN syntactic battery was suggestive of risk of DLD[4] and 15 matched control children. The results were compatible with this hypothesis. The present study increases the sample of children at risk of DLD and their matched controls at the same time as the age range is amplified. Before presenting these results, DLD, costly structures and the role of executive functions in linguistic tasks will be considered.

1 Developmental Language Disorder

Developmental Language Disorder (DLD) is the term replacing the widely previously used term Specific Language Impairment (SLI), referring to children whose language development does not follow the usual course despite typical development in other areas. This disorder is clinically diagnosed, based on the presence of impaired/delayed language development and the absence of other specific conditions such as neurological deficits, cognitive delay, hearing disabilities, and emotional or behavioural problems (Leonard, 1998). As mentioned, the term DLD has recently been endorsed for use by a Delphi consensus study with a panel of specialists, an effort of The

CATALISE Consortium (Bishop et al., 2017), which has also broadened the range of clinical aspects encompassed by an DLD diagnosis:

> The term, 'Developmental Language Disorder' (DLD) was endorsed for use when the language disorder was not associated with a known biomedical aetiology. It was also agreed that (1) the presence of risk factors (neurobiological or environmental) does not preclude a diagnosis of DLD, (2) DLD can co-occur with other neurodevelopmental disorders (e.g., ADHD), and (3) DLD does not require a mismatch between verbal and nonverbal ability (Bishop et al., 2017, p. 1068).

Children with DLD follow an atypical pattern of language acquisition and use. Difficulties may pertain to different domains of language, word finding, phonology, morphology, syntax, semantics, and pragmatics (Bishop, 2000, 2006; Hestvik et al., 2022; Leonard, 2016; Messer; Dockrell, 2013), giving rise to subtypes of DLD/SLI (Friedmann; Novogrodsky, 2008). Grammatical or syntactic difficulties are reported for historically unrelated languages, including problems with passive structures, WH-questions and relative clauses, suggesting that costly computational operations appear to put a considerable burden on these individuals' language processing.

WH-questions and relative clauses are long-dependency structures, that is, two positions in the structure are to be related. In generative theory, this is equated to the notion of movement, that is, an element is generated in its canonical position and is moved to the position where it is pronounced.

Both the so-called A-movement (in passives) and A-bar movement (in RCs and WH-questions) are considered to be computational possibilities that satisfy particular discourse demands, though creating additional cost in relation to the canonical order (Corrêa; Augusto, 2007). The nature of the cost is somewhat controversial. Corrêa and Augusto (2007, 2011) have ascribed it to the online computation of the constituent dislocation. Friedmann and Costa (2010) consider that movement per se does not add cost. The cost would stem

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[4] We used the expression "at risk of DLD" to refer to children whose behaviour in the comprehension of syntactically costly sentences is an alert for the possibility of their being affected by DLD – a diagnosis that requires further assessments.

from the implications of this operation to the interfaces, given that there are conditions where measurable cost is not obtained in these structures. The relative ease of irreversible passives and subject RCs would corroborate this view. Hence, it would be long-distance dependencies with an intervening element, as in object RCs (see 2a), and the formal similarity between the intervening element and the moved one that would cause additional cost (Friedmann; Belletti; Rizzi, 2009; Grillo, 2009; Lima, 2020; Lira; Augusto, to appear). Given this argument, and the fact that not only the properties of the intervening element can account for the relative difficulty of these sentences (Corrêa; Augusto, 2019; Augusto; Corrêa, 2024), Corrêa and Augustos (2007) proposal can be better read as follows: syntactic movement is a potential source of additional cost, given its implications for the reactivation of the moved element and thematic role assignment at the interfaces. It is based on this view of processing cost that passives, relative clauses and WH-questions are considered to be, in principle, costly structures. The ability to cope with these implications of syntactic movement in the processing of these sentences can contribute to differentiating children at risk of DLD.

The MABILIN (Módulos de Avaliação de Habilidades Linguísticas) battery was created with the aim of tracking Portuguese-speaking schoolchildren at risk of DLD (Corrêa, 2000; 2011). The syntactic module (MABILIN I)[5] consists of 3 blocks of costly sentences, each of them in a less demanding and in a more demanding condition (Block 1: simple irreversible and reversible passives, having simple reversible actives, as the baseline; Block 2: right branching subject and object relative clauses, bare-WH-questions, and WH+N questions; Block 3: subject and object centre-embedded RCs in sentences with main clauses containing an intransitive or a transitive verb). Eight sentences are presented in each of these 13 conditions. Each correct response is scored 1 and the total score sums up 104

points. This syntactic battery makes use of the picture-identification task, with the options as in Fig. 1, in block 1. The images in blocks 2 and 3 contain visual background information that varies in complexity, as illustrated in Figs. 2 and 3. The task is conducted with children at schools, individually, in an isolated room. The sentences are orally presented interactively and the visual stimuli are presented on a computer screen per block in semi-randomized order, by the MABILIN software. This software provides the indication of the sentence conditions in which the child's performance was 2 standard deviations below the mean of their age group (in a sample of 289 6-to 12 year-old schoolchildren without acknowledged language difficulty) and the degree (light, moderate, severe) of the overall difficulty in the test, based on the number of conditions in which the child's performance was below the standard.

In the present study, children's overall performance in the syntactic module of MABILIN, i.e. the total number of correct responses, is initially considered. Then, their responses in the most demanding sentences of block 2, namely RCs and WH+N questions[6] are categorised as a function of image complexity. It is based on these quantitative data that a correlation will be established with the same children's responses in executive function tests. Before presenting these results, the rationale of the inhibitory control hypothesis will be presented.

2 Executive functions and linguistic skills

Executive functions (EFs) is an umbrella term used to refer to a number of cognitive processes related to thought and behaviour control (Diamond, 2013; Miyake et al., 2000). EFs are involved in self-regulation, decision-making, planning and problem-solving (Friedman et al., 2006). Inhibition, working memory and cognitive flexibility are considered the core components of

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[5]   The MABILIN Battery consists of 03 modules: syntactic (MABILIN I), morphosyntactic (MABILIN II) and grammar-pragmatic interface (MABILIN III, under development). For the MABILIN at Web, see: https://mabilin.biobd.inf.puc-rio.br/.

[6]   WH+N questions (Which student did the professor call?) are considered more complex than bare-WH questions (Who did the professor call?).

EFs (Diamond, 2013).

Many studies have explored the relationship between language processing and EFs (Mazuca; Jincho; Onishi, 2009; Novick; Trueswell; Thompson-Schill, 2005; Rodrigues, 2011; Woodard; Pozzan; Trueswell, 2016). There are pieces of evidence of the role of the components of EF in the development of oral language in both DLD and typically language developing children (TLD) (Henry; Messer; Nash, 2012; Lukács et al., 2016; Ullman; Pierpont, 2005).

Kaushanskaya et al. (2017) investigated the relationship between nonverbal EF skills and language performance in English-speaking typically developing school-age children (n=71, ages 8-11), using the latent variables approach for measuring nonverbal EF skills and examining the relationship between these skills and language performance. The linguistic tests used were the Clinical Evaluation of Language Fundamentals–Fourth Edition (CELF-4), Peabody Picture Vocabulary Test–Fourth Edition (PPVT-4) and the Morphological Comprehension subtest of the Test of Language Development–Intermediate: Fourth Edition (TOLD-I:4). Non-verbal executive functions evaluated were inhibition (measured by versions of Flanker and Go/no-Go tasks); updating of working memory (measured by the N-back and Corsi blocks tasks), and task shifting (measured by the Dimensional Change Card Sort). The results of multiple regression analyses showed that Nonverbal updating was associated with the Receptive Language Index on CELF-4, and that inhibition predicted children's syntactic abilities.

Marini et al. (2020) investigated the relationship between two components of EFs (inhibition and updating) and linguistic and narrative skills of Italian-speaking DLD preschoolers (n-16), matched with TLD children (n=24). The two groups were matched by age (5.43 – TLD; 5.10 – DLD), education (the 3rd year of preschool), gender (M=15 – TLD; M=12 – DLD) and raw scores for Raven's Matrices (22.33 -TLD; 18.75 – DLD). Inhibition was assessed by administering the Developmental Neuropsychological Assessment (NEPSY-II) and updating by the forward and backward digit recall subtests of the Wechsler Scales. Linguistic skills were assessed by a set of subtests of the Batteria per la Valutazione del Linguaggio in bambini dai 4 ai 12 anni (Batteria per la Valutazione del Linguaggio; BVL_4-12). This battery was designed to assess a range of linguistic skills, from articulatory and phonological discrimination skills to lexical and grammatical skills (both in production and comprehension), and narrative production skills. DLD children's performance on both updating and inhibitory tasks was lower than the control group. DLD children had difficulties on phonological and grammatical tests and on lexical informativeness on narrative production. Significant correlations were verified between linguistic and narrative measures and the measures of EF tasks.

A similar study was conducted with 4–to 5-year-old Greek-speaking children with DLD (N=53) and TLD peers (N = 62) (Kalliontzi et al., 2022). The authors examined the relationship between language and EFs, assessed respectively by a standardised psychometric battery (the psychometric digital tool Logometro – Mouzaki et al., 2017; see also Antoniou et al., 2022) and a series of 6 online EFs tasks. The language battery taps on phonological and morphological awareness, oral language comprehension, vocabulary knowledge, narrative speech and pragmatics, by means of 24 tasks. The EFs tasks are an adaptation of the experiments originally used in Yang and Gray's (2017) study and included a series of verbal (v) and non-verbal (nv) tasks, measuring updating, inhibition and cognitive flexibility. Children with DLD performed significantly lower than their TLD peers across all oral language measures. The DLD group results on EFs tasks were also worse than that of TLD children in updating nv task and cognitive flexibility (v and nv). Linear regression analyses, performed for each group separately, showed that, for the DLD children, updating (nv), inhibition (nv) and cognitive flexibility (v) predicted oral language comprehension; for the TLD group, updating (v and nv), inhibition-reaction time (nv) and cognitive flexibility (v and nv) predicted phonological and morphological awareness, oral language comprehension, narrative speech as

well as total language score. The authors argued that interdisciplinary groups of professionals need to assess both EFs and oral language skills of children and that interventions on preschool DLD children should also target deficits in EF skills.

In a study with native French-speaking children - 32 children with DLD (M = 9;0) and 18 with TD (M = 8;5), Delage, Stanford and Durrleman (2021) verified that training cognitive function (working memory) improved significantly verbal WM (direct effects) in both TD and DLD groups, and in sentence repetition (transfer effects) in the DLD group. According to the authors, the most pronounced improvements were obtained for complex syntactic structures.

In the present study, two versions of the Flanker and Go/no-Go tasks designed for children were used. In order to engage children, the two tasks were designed as a game, in which the participants had to achieve an objective. There was a training phase in the two tasks with feedback regarding the speed of response and accuracy. In the experimental phase, no feedback was provided.[7]

According to Kaushanskaya et al. (2017), although the two tasks have been related to different aspects of inhibition - the Flanker task is considered to index resistance to interference, and the Go/no-Go to index response inhibition -, there is evidence that the two measures are strongly correlated and fall into a single factor (Friedman; Miyake, 2004).

The Flanker task requires the participant to respond to a target stimulus in a congruent and an incongruent condition. Accuracy and response time are the dependent measures. In our version of the task, children were invited to play the game of the fish. They were told that there was a fish family with 5 members that lived at the bottom of the sea and that, when the family swims together, the leader fish always stays in the middle of the group. Sometimes the whole family swims in the same direction, but there are occasions in which the middle fish is in a divergent position. Children had to press, as quickly as possible, one of two keys on a computer keyboard (i.e., left vs. right) to indicate the direction of the middle fish. We also added a neutral condition, in which fish members with the exception of the middle fish were replaced by some sea plants. 25% of the trials were incongruent. Figure 4 illustrates the three conditions of the task: neutral, congruent and incongruent.

Figure 4 – Flanker task conditions
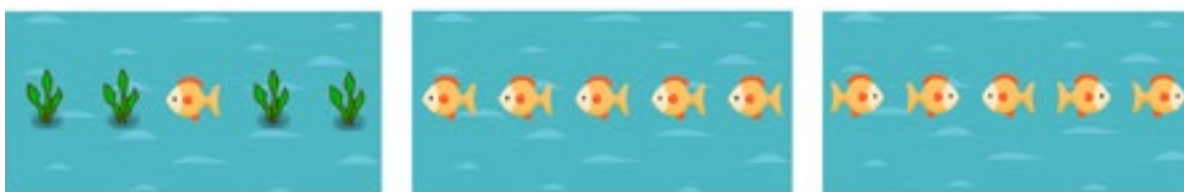
Source: First author's own elaboration.

The Go/no-Go task requires the participant to respond to a target stimulus and ignore (inhibit the response to) a non-target one. In this task, total accuracy, no-go responses and reaction time in the go condition were the dependent variables.

In our version of the task, children were invited to play a game in which they had to help a little boy to tidy up his toys. The boy's mother asks him to store all the toys except the one he is going to play with. The toys presented in the task are a small bucket, a cart, a teddy bear and a ball. In the game, the participants are told that the boy will play with the ball only. Children are instructed to press a space bar every time a non-ball stimulus is shown on the screen and not press it when the target stimulus (the ball) is presented. Figure 5 shows the commands given to the children:

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[7]   Both tests were programmed using PsyToolkit (https://www.psytoolkit.org/#_why_use_psytoolkit), a free website designed for demonstrating, programming, and running online psychological experiments and surveys.

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Figure 5 – Flanker task instructions

Source: First author's own elaboration.

1. The game is as follows: Pedro is a very messy boy. His mother always asks him to store the toys he will not play with anymore. A little car, a small toy bear, a little bucket and a colourful ball are among his dearest toys.

2. Today Pedro decided to play with his ball. You shall help him to store the other toys. To do that, you have to press the space bar on the keyboard.

3. But remember! Pedro wants to play with the ball. So, when you see the ball, you can't press the space bar.

The go and the no-go stimuli are presented in the center of the computer screen, one object at a time, against a black background.

3 The current study

In this current study[8], we explore a possible correlation between children's performance in MABILIN and in the Flanker and Go/no-Go executive control tasks. The total number of correct responses in MABILIN and the number of correct responses in two particularly costly structures - relative clauses and WH+N questions, in two image complexity conditions (simple image: SI; complex image: CI) are analysed. Two groups of children were considered: one with children whose performance in MABILIN was suggestive of language impairment and a matched control group, with children identified as without language difficulties in that battery.

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[8] This study was approved by the Ethical Committee of PUC- Rio (Opinion 2017-39, July 26, 2017).

3.1 Method

3.1.1 Participants

Seventy-four children from two public schools in the north zone of Rio de Janeiro (low/middle class) participated in this investigation, forming two groups: thirty-seven children (28 girls) with no difficulty in the MABILIN (mean age: 9;1 years old; age range: 7;2 - 10;6 years old) and thirty-seven children (11 girls), who showed some degree of difficulty in the MABILIN (mean age: 8;8 years old; age range: 7;3 - 11;0 years old). The exclusion criteria were diagnosis of any neurodevelopmental disorder such as Autism Spectrum Disorder (ASD) or school report concerning Attention Deficit Hyperactivity Disorder (ADHD).

3.1.2 Material and Procedure

For the language assessment, children were invited to play a computer game in an isolated room at school. The MABILIN program (syntactic module) was then run on a laptop (see section 1 for the MABILIN presentation). The sentences were orally presented by the experimenter, and children were asked to choose the picture that matched what the experimenter had said among the three pictures displayed on the computer screen. The order of presentation was varied for each child and their choice was registered by the program. An answer sheet was also used for specific observations. The whole test took about 20 minutes. In a subsequent session, in the same week as the linguistic assessment, the same children were submitted to the inhibitory control tasks (see section 2). The two tasks (Flanker and Go/no-Go) were conducted in one session. The order of presentation of the two inhibitory control tasks was counterbalanced. The whole session took about 10 minutes.

4 Results

Table 1 presents the descriptive statistics of the two groups of children classified as at risk of DLD (with difficulty) and the typically developing children (without difficulty - the control group) based on their performance in the MABILIN battery: their overall performance (MABILIN columns) and their performance as a function of image complexity in the comprehension of right-branching subject and object RCs and subject and object WH+N interrogatives.

Table 1 – Descriptive statistics of children at risk of DLD and control in the MABILIN battery

	MABILIN		Simple image		Complex image	
	With difficulty	Without difficulty	With difficulty	Without difficulty	With difficulty	Without difficulty
Valid	37	37	37	37	37	37
Median	80.00	96.00	14.00	16.00	11.00	15.00
Mean	79.03	96.05	14.05	15.76	11.03	14.41
Std. Deviation	7.38	5.04	1.54	0.49	2.22	1.40
Minimum	54.00	87.00	10.00	14.00	6.00	11.00
Maximum	90.00	104.00	16.00	16.00	15.00	16.00

Source: Created at JASP 2023 (Version 0.18.0).

The two groups differed for type of image in the MABILIN data, with a higher median for the control group both for SI (Mdn = 16 for the control group vs. Mdn =14 for the DLD group; U= 188,50, p <0,001; effect size - rrb = 0,72) and for CI (Mdn =15 for the control group vs Mdn =11 for the DLD group; U=140, p <0,001, effect size - rrb = 0,80).

Table 2 presents the results for DLD and control group on the Inhibition tasks (Go/no-Go and Flanker). The dependent variables analysed were accuracy (total of correct responses) and reaction time (RT). For the Go/no-Go task, we report the total score (GonoGo_total score), the number of correct responses for the no-go stimuli (Gono-Go-Nogo score = the ball), and the RT for the go condition. For the Flanker, in addition to the total

score (Flanker_total score), we report the score for the incongruent stimuli - the most difficult condition (Flanker_INC_score), and the RT cor-

respondent to the total score (Flanker_time) and to the incongruent condition (Flanker_INC_time).

Table 2 – Descriptive statistics of children at risk of DLD and control on the inhibitory control tasks

		Valid	Median	Mean	Std. Deviation	Minimum	Maximum
GonoGo_total score	With difficulty	37	57.00	55.35	4.55	38.00	60.00
GonoGo_total score	Without difficulty	37	58.00	57.70	2.43	50.00	60.00
GonoGo_Nogo_score (ball)	With difficulty	37	14.00	12.86	2.24	5.00	15.00
GonoGo_Nogo_score (ball)	Without difficulty	37	14.00	13.43	1.75	8.00	15.00
GonoGo_time go	With difficulty	37	613.82	654.25	119.53	470.64	944.06
GonoGo_time go	Without difficulty	37	647.53	649.79	103.48	445.96	927.33
FLANKER_ total score	With difficulty	37	59.00	54.30	13.48	16.00	64.00
FLANKER_ total score	Without difficulty	37	62.00	58.35	7.89	30.00	64.00
FLANKER_time	With difficulty	37	858.38	856.62	167.27	579.63	1203.28
FLANKER_time	Without difficulty	37	779.25	807.23	162.05	588.41	1335.83
FLANKER_INC_score	With difficulty	37	14.00	12.78	4.08	4.00	15.00
FLANKER_INC_score	Without difficulty	37	15.00	13.73	3.45	1.00	15.00
FLANKER_INC_time	With difficulty	37	891.19	905.29	206.24	293.00	1387.25
FLANKER_INC_time	Without difficulty	37	814.73	837.36	147.62	604.07	1271.86

Source: Created at JASP 2023 (Version 0.18.0).

Contrasting the performance of the two groups of children in the IC tasks, a Mann-Whitney Unpaired test revealed that children at risk of DLD (with difficulty) differed from the control group (without difficulty) only on the Go/no-Go score, with the DLD group presenting a lower number of correct

responses (Mdn= 57 vs. Mdn =58); U= 419,50; p = 3,73 x 10-3; effect size - rrb = 0,39)

We examined the correlation between the participants' results on MABILIN and on the Inhibition tasks. Table 3 presents the results.[9]

TABLE 3 – Correlation between the performance of the children with and without difficulty in MABILIN and on the inhibitory control tasks

Sperman's Correlations

		Spearman's rho	p
MABILIN	- GonoGo total score	0.45	<.001
MABILIN	- GonoGo Nogo score (ball)	0.27	0.02
MABILIN	- FLANKER total score	0.39	<.001
MABILIN	- FLANKER time	-0.30	9.86e-3
MABILIN	- FLANKER INC score	0.31	6.38e-3
MABILIN	- FLANKER INC time	-0.31	8.03e-3
GonoGo total score	- Simple Image	0.37	1.38e-3
GonoGo total score	- Complex image	0.46	<.001
GonoGo Nogo score (ball)	- GonoGo time go	0.30	9.45e-3
GonoGo Nogo score (ball)	- Complex image	0.33	4.43e-3
FLANKER total score	- Complex image	0.35	2.11e-3
FLANKER time	- Simple Image	-0.26	0.02
FLANKER time	- Complex image	-0.31	6.93e-3
FLANKER INC score	- Simples Image	0.19	0.10

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[9] Only significant results are presented in the table.

Sperman's Correlations

FLANKER INC score	- Complex image	0.31	7.27e-3
FLANKER INC time	- Simple Image	-0.28	0.02
FLANKER INC time	- Complex image	-0.29	0.01

Source: Created at JASP 2023 (Version 0.18.0).

There was a positive significant correlation between the total score in MABILIN and both the Go/no-Go and the Flanker scores. That is, those children who gave more correct responses in MABILIN also gave more correct responses in the IC tests. There was also a significant correlation between the total score in MABILIN and the Flanker RT (both for total RT and the incongruent condition). In this case, it is a negative correlation -- the more correct responses in MABILIN, the shortest RT in Flanker.

Regarding children's responses in the simple and complex image conditions, those children with the highest scores in the Go/no-Go test also had the highest scores in MABILIN in both image conditions. The rho value was higher for complex images, particularly in the Go/no-Go test, showing a moderate correlation. There was also a negative correlation between the number of correct responses and RT in Flanker. That is, those who have the shortest RTs are those who perform better in MABILIN, regardless of image type. The no-go condition (=the ball) correlated positively with complex images. There was also a positive correlation between Flanker's scores (total score and incongruent condition) and correct responses in the complex image condition.

In sum, the overall performance in MABILIN correlates with IC abilities. Regarding image complexity, it is children's performance in the inhibitory conditions of both IC tasks (No-go and incongruent condition in Flanker) that correlates with their performance in the most demanding image condition in the language comprehension task, that is, when there is a complex image in the background information for the identification of the target character.

5 Final remarks

This study evaluated the extent to which coping with the demands of a picture-identification language comprehension task correlates with inhibitory control abilities. The language task used (in MABILIN battery) assessed the comprehension of syntactically costly sentences (passives, relative clauses and WH-questions) and, for relative clauses and WH-questions, two image conditions were presented: simple image (a single actor-action-object event) and complex image (two reversible actor-action-object events). In the present study, the overall performance in the MABILIN battery, in right-branching RCs and WH+N questions in the two image conditions, were analysed in relation to children's performance in the Flanker and Go/no-Go tasks.

The present results are compatible with the view that children whose language assessment is suggestive of risk of DLD have a poorer performance than typically developing children in IC tasks. This difficulty is particularly manifested in coping with complex images as the background information for a picture-identification task. Regarding EFs, when comparing the two groups, a statistically significant difference between children at risk of DLD and typical children was observed only for the Go/no-Go total score. As mentioned in section 2, while the Go/no-Go task is more directly associated with inhibitory responses, Flanker is more directly associated with resistance to interference. So it is possible that the ability to inhibit representations is more relevant to differentiate the two groups in the MABILIN picture identification task, mainly in the complex image conditions, in which children have to inhibit an immediate sentence-image mapping, given the need to analyse two reversible events.

Notice that we verified that children with the worst performance on the MABILIN are the ones with the lowest success rate in the EF tasks and

the highest reaction times. These results are congruent with what had been obtained for children speaking other languages (see Section 2) and provide further evidence for the role of executive functions on linguistic processing.

In future research, it is important to consider the effects of other measures of executive function, such as working memory and cognitive flexibility, as far as EFs are concerned, and the relation between these abilities and the structural properties of each type of costly sentences (such as subject and object RCs). It would also be interesting to evaluate DLD performance on linguistic inhibitory control tests - such as the Stroop test.

The findings, taken together, allow for two reflections: one methodological, related to linguistic assessment for DLD children, and another concerning linguistic/cognitive interventions in clinical practice. Children's difficulties in the simple image conditions are more likely to directly reflect a specific language impairment whereas their performance in complex image conditions seems to be more dependent on executive control abilities. In fact, the results show a higher correlation between complex images and both the Go/no-Go and the Flanker total scores. The use of both types of stimuli may facilitate the identification of the particular difficulties children face in coping with the task (Corrêa; Rodrigues; Augusto, 2022).

Regarding clinical practice, the correlation test's results suggest that linguistic and executive skills should be worked conjointly. Training executive functions may benefit the linguistic processing of complex structures and vice-versa, as suggested in Delage, Stanford and Durrleman (2021). Understanding the interplay between the demands of linguistic tasks and EFs may contribute to the development of intervention procedures that help not only children with DLD but those whose difficulties in language tasks stem more directly from non-language specific cognitive abilities.

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