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BRIEF RESEARCH REPORT

Inhibitory control and verb inflection in Italian preschool children

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Abstract
The study investigates whether Italian verbal inflectional morphology is associated with inhibitory control skills after controlling for receptive vocabulary and verbal working memory. A sample of Italian preschoolers aged 4;0 to 6;0 was assessed using a standardized inhibitory control task tapping two different inhibitory skills (response inhibition and interference suppression), and a morphological task requiring simple and complex inflections of verbs. The hierarchical multiple regression analyses showed that working memory and the interference suppression scores were significantly associated with complex inflections but not with simple inflections of the verbs.

Keywords: verb inflection; inhibitory control; Italian preschoolers

Introduction

The typological diversity of inflection processes makes some languages intuitively more complex than others (Marzi, Ferro & Pirrelli, 2019). Because of the richness of its verbal inflectional morphology, Italian is quite challenging to acquire. Indeed, the Italian inflectional system, as well as the inflectional systems of French, Spanish, Portuguese and other Romance languages, is extremely rich and complex compared to English, which is instead the language with the poorest inflectional morphology system among the other Indo-European languages (see Clackson, 2007; Guasti, 2017). The development of the Italian morphological system has been broadly studied, mainly focusing on categories that occur in early grammar (e.g., Caprin & Guasti, 2009; Dispaldro, Leonard & Deevy, 2013). In contrast, relatively few studies have explored the role of domain-general factors relating to Italian morphological acquisition, especially in typical development (see Gandolfi & Viterbori, 2020). The current study aims to investigate whether Italian grammatical morphology, in particular the ability to inflect verbs, is significantly explained by inhibitory control skills, with a unique contribution of variance over and above the effects of receptive vocabulary and verbal working memory, which have already been found to be associated with grammar (Verhagen & Leseman, 2016; but see Blom,

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Bosma & Heeringa, 2021). More specifically, the underlying idea of the current study is exploring whether the Italian morphological verbal system, given the great variety of verbal inflected morphemes, might involve inhibitory control processes that specifically address overcoming interference due to irrelevant and distracting characteristics of the stimulus, especially when language skills are not yet consolidated (see Gandolfi & Viterbori, 2020).

The acquisition of verb inflections in Italian

Italian has many verbal tenses, and as mentioned above, verb inflections are quite numerous (see Belletti & Guasti, 2015). In fact, there are fifteen tenses subdivided into four moods; these moods are finite and display different inflectional markers for different persons. There are also three nonfinite forms with present and past versions. To lay the groundwork for the core issue of the paper, Table 1 represents the main features of the Italian verb inflectional system. As the table shows, Italian verbs are suffixed with a thematic vowel or with a thematic vowel and an inflectional marker. The thematic vowel identifies one of the three conjugations (*-a*, as in *arriv-a-re*, 'arrive', I conjugation; *-e*, as in *perd-e-re*, 'lose', II conjugation; *-i*, as in *part-i-re*, 'leave', III conjugation); the inflectional markers provide some or all information about the person (first, second, third), number (singular and plural), tense (present, past, future) and mood (indicative, imperative, conditional, subjunctive, participle, gerund, infinitive). In addition, the auxiliaries *avere* ('have') and *essere* ('be') are irregular verbs, and they are also fully inflected; they are used in compound tenses, such as the *passato prossimo* ('present perfect'), and they are followed by a past participle verb.

Although the Italian inflectional verb system is extremely complex, it is very regular; this property might explain why Italian-speaking children partially master present indicative tense during early productions (approximately at age 2;6). With regard to the present tense, singular markers appear six months before plural markers, but they are both regularly produced almost error-free from age 3;0 (Caprin & Guasti, 2009). However, Italian inflectional verb morphology is gradually acquired (Leonard, Caselli & Devescovi, 2002); for example, among the finite verbs, present and imperative tenses emerge before other tenses, such as the *passato prossimo* and the *imperfetto* (two different forms of past), whose use has been shown to be quite challenging until age 5;0 (Van Hout & Hollebrandse, 2001). Additionally, the future tense is mastered later due to its morphological features and its references to future events, which require substantial symbolic skills (Bazzanella & Bosco, 2000). This gradual acquisition is determined by the greater morphological and structural complexity displayed by these tenses (Belletti & Guasti, 2015); for this reason, the ability to produce the inflectional morphemes that participate in agreement relations has been found to be difficult in preschool children.

Verb inflections and inhibitory control skills in Italian children

Studies that have focused on the role that domain-general cognitive factors play in explaining the acquisition of inflectional verb morphology in typical children are still sparse. Among the domain-general cognitive abilities, inhibitory control skills have been recently indicated as possible co-factors that support different aspects of language acquisition (Ibbotson, 2020; Kaushanskaya, Park, Gangopadhyay, Davidson & Weismer, 2017; Usai, Viterbori, Gandolfi & Zanobini, 2020; Woodard, Pozzan & Trueswell,

Table 1. Inflectional paradigm of the Italian indicative of three verbs (arrivare, 'arrive', perdere, 'lose', partire, 'leave') from the I, II, III conjugations.

I Conjugation (arrivare, 'arrive')				
	Presente	Imperfetto	Passato remoto	Futuro semplice
Io	arriv-o	arriv-avo	arriv-ai	arriv-erò
Tu	arriv-i	arriv-avi	arriv-asti	arriv-erà
Egli, Ella, Esso	arriv-a	arriv-ava	arriv-ò	arriv-erà
Noi	arriv-iamo	arriv-avamo	arriv-ammo	arriv-eremo
Voi	arriv-ate	arriv-avate	arriv-aste	arriv-erete
Essi, Esse, Essi	arriv-ano	arriv-avano	arriv-arono	arriv-eranno
	Passato prossimo	Trapassato prossimo	Trapassato remoto	Futuro anteriore
Io	sono arriv-ato	ero arriv-ato	fui arriv-ato	sarò arriv-ato
Tu	sei arriv-ato	eri arriv-ato	fosti arriv-ato	sarai arriv-ato
Egli, Ella, Esso	è arriv-at/ o/ a/ o	era arriv-at/ o/ a/ o	fu arriv-at/ o/ a/ o	sarà arriv-at/ o/ a/ o
Noi	siamo arriv-ati	eravamo arriv-ati	fummo arriv-ati	saremo arriv-ati
Voi	siete arriv-ati	eravate arriv-ati	foste arriv-ati	sarete arriv-ati
Essi, Esse, Essi	sono arriv-at/ i/ e/ i	erano arriv-at/ i/ e/ i	furono arriv-at/ i/ e/ i	saranno arriv-at/ i/ e/ i
II Conjugation (perdere, 'lose')				
	Presente	Imperfetto	Passato remoto	Futuro semplice
Io	perd-o	perd-evo	persi	perd-erò
Tu	perd-i	perd-evi	perd-esti	perd-erai
Egli, Ella, Esso	perd-e	perd-eva	perse	perd-erà
Noi	perd-iamo	perd-evamo	perd-emmo	perd-eremo
Voi	perd-ete	perd-evate	perd-este	perd-erete
Essi, Esse, Essi	perd-ono	perd-evano	persero	perd-eranno

Table 1. *(Continued)*

	Passato prossimo	Trapassato prossimo	Trapassato remoto	Futuro anteriore
Io	ho perso	avevo perso	ebbi perso	avrò perso
Tu	hai perso	avevi perso	avesti perso	avrai perso
Egli, Ella, Esso	ha perso	aveva perso	ebbe perso	avrà perso
Noi	abbiamo perso	avevamo perso	avemmo perso	avremo perso
Voi	avete perso	avevate perso	aveste perso	avrete perso
Essi, Esse, Essi	hanno perso	avevano perso	ebbero perso	avranno perso

III Conjugation (partire, 'leave')				
	Presente	Imperfetto	Passato remoto	Futuro semplice
Io	part-o	part-ivo	part-ii	part-irò
Tu	part-i	part-ivi	part-isti	part-irai
Egli, Ella, Esso	part-e	part-iva	part-ì	part-irà
Noi	part-iamo	part-ivamo	part-immo	part-iremo
Voi	part-ite	part-ivate	part-iste	part-irete
Essi, Esse, Essi	part-ono	part-ivano	part-irono	part-iranno

	Passato prossimo	Trapassato prossimo	Trapassato remoto	Futuro anteriore
Io	sono partito	ero partito	fui partito	sarò partito
Tu	sei partito	eri partito	fosti partito	sarai partito
Egli, Ella, Esso	è partit/ o/ a / o	era partit/ o/ a / o	fu partit/ o/ a/ o	sarà partit/ o/ a/ o
Noi	siamo partiti	eravamo partiti	fummo partiti	saremo partiti
Voi	siete partiti	eravate partiti	foste partiti	sarete partiti
Essi, Esse, Essi	sono partit/ i/ e/ i	erano partit/ i/ e/ i	furono partit/ i/ e/ i	saranno partit/ i/ e/ i

2016), including morphological abilities (Gandolfi & Viterbori, 2020) and the production of verb forms (Yuile & Sabbagh, 2020). Inhibitory control is conceptualized within the framework of executive function, which refers to a family of top-down mental processes needed to manage thoughts and actions (Miyake & Friedman, 2012); studies have agreed that there are three core executive function components, which are interpreted as inhibition, updating and shifting (see Miyake et al., 2000). Although this tripartite organization is described in adults, it is not found throughout development until middle childhood or after (Lee, Bull & Ho, 2013). In early childhood, inhibitory control has been identified as the main executive dimension (see Diamond, 2013; Garon, Bryson & Smith, 2008), and it has also been conceptualized as a multicomponent construct with different abilities already differentiated from age three (Gandolfi, Viterbori, Traverso & Usai, 2014).

More specifically, in toddlers and in early preschoolers, a distinction exists among some inhibitory control skills, such as the ability to suppress prepotent behavioral responses and to execute a novel conflicting response preventing impulsive behavior (conflict inhibition or response inhibition) (Carlson & Moses, 2001; Gandolfi et al., 2014; Garon et al., 2008) and the ability to overcome interference due to irrelevant distracting characteristics of the stimulus or competitive response options (interference suppression) (Gandolfi et al., 2014; Traverso, Fontana, Usai & Passolunghi, 2018).

These different inhibitory control dimensions could account for morphological acquisition in different ways. For example, recently, Ibbotson and Kearvell-White (2015) highlighted the key role of response inhibition in the acquisition of verb inflection in 5-year-old English children, showing that immature inhibitory control skills explained the overgeneralization errors in the irregular past tense (for example, *flyed* instead of *flew*), which are frequent in English-speaking preschoolers' speech. Children who successfully address a response inhibition task that required responding "sun" to a picture of a moon, and vice versa, were the same that correctly inflected the past tense of the irregular verbs, which suggests a role of common cognitive faculty – namely, inhibition (see also Ibbotson, 2020). Similarly, Yuile and Sabbagh (2020) found associations between higher inhibitory control skills and the rate of correct irregular past tense production in 3;5- to 4;5-year-old English-speaking children. Additionally, this study considered a single inhibitory component (namely, response inhibition) and assumed that it could assist children in suppressing the prepotent tendency to produce a regular form and producing instead the correct irregular form.

Concerning the Italian language, Gandolfi and Viterbori (2020) longitudinally explored the role of both response inhibition and interference suppression skills in younger children aged 24-32 months in explaining early morphological production and receptive morphosyntax taken one year later. The main results showed that interference suppression was the only predictor, even when early lexical and grammatical abilities, age, and the mother's education were checked. Such findings suggest that in language with rich inflectional morphology, when morphological skills are emerging, the ability to detect and filter out irrelevant or interfering information to resolve a conflict (i.e., interference suppression) might play a key role in selecting and correctly integrating different elements of the sentence by monitoring morphological inflectional contrasts or gender and number agreement. Conversely, in language with less verbal morphology (e.g., English), when the task demand is only to complete a sentence by producing the correct past tense irregular form, it is possible that other inhibitory processes, such as the ability to suppress the prepotent tendency to apply regular inflection in favor of the irregular construction (i.e., response inhibition), might be mainly involved (see, e.g., Ibbotson &

Kearvell-White, 2015; Yuile & Sabbagh, 2020). Taken together, these studies indicate that different inhibitory control processes might be associated with different morphological abilities at different developmental stages; in particular, interference suppression skills might be mainly engaged in language with rich inflectional morphology, especially when language skills are not completely acquired, because they support children in managing the interference that comes from conflicting features of various morphological inflectional markers. However, while studies on English language specifically investigated the role of inhibitory control in verb acquisition, especially in the production of irregular past tense verb forms with no specific inspection on different inhibitory components (Ibbotson & Kearvell-White, 2015; Yuile & Sabbagh, 2020), the existing literature on Italian language considered only the relationship between inhibitory control skills and early comprehensive measure of grammatical skills (Gandolfi & Viterbori, 2020). To the best of our knowledge, in languages with rich verb inflectional morphology, such as Italian, studies that specifically assess individual differences in verb inflection in relation to different inhibitory control skills in preschoolers are still missing.

The current study

The main goal of the current study was to explore the role of different inhibitory control skills in the acquisition of inflectional morphology of verbs in Italian preschoolers between 4;0 and 6;0. In particular, we aimed to investigate whether the inhibitory control processes specifically addressed overcoming interference due to irrelevant and distracting characteristics of the stimulus (i.e., interference suppression) are specifically involved in Italian verb inflection compared to response inhibition processes, which enable the execution of a novel conflicting response while suppressing impulsive behaviors. Based on previous literature on Italian-speaking children that showed interference suppression as the inhibitory control component mostly associated with morphology in toddlers (Gandolfi & Viterbori, 2020), we assume that interference suppression, more than response inhibition, might also have a role in Italian verb inflection, especially with regard to those Italian tense inflections that are acquired later in development, such as past and future tense inflections (see Belletti & Guasti, 2015). Indeed, while response inhibition could support children in suppressing dominant responses to execute sub-dominant responses (for example, suppressing the dominant tendency to apply regular verb inflection in favor of irregular construction; see Ibbotson & Kearvell-White, 2015; Yuile & Sabbagh, 2020), interference suppression could enable children to select the correct representation and to overcome a conflict due to having many interfering stimuli (for example, selecting the right representation of the verb mood and tense and checking one out of six different endings of the three Italian conjugations that vary in person and number).

To explore this relationship, we assessed inhibitory control using a Stroop-like task with multiple inhibitory demands tapping different inhibitory control skills related to response inhibition and interference suppression, and a morphological task requiring children both to produce plural present tense inflection verbs (third person) (i.e., simple inflection items) and to produce singular past and future tense inflection verbs (third person) (i.e., complex inflection items).

Given that the present tense inflections are mastered early in the development and they are consistently used almost error-free by age 3;0 (Belletti & Guasti, 2015), we hypothesized better performance in the simple inflection items than in the complex inflection

items and, as a result, that the production of present tense inflection verbs does not tax inhibitory control skills.

We considered a wide age range (4 to 6 years of age) to ensure enough variability in performance. Moreover, we checked for receptive vocabulary and verbal working memory, given their substantial role in grammar acquisition (Marchman & Fernald, 2008; Verhagen & Leseman, 2016). Due to the scarce literature on Italian preschoolers in this research field, the current study is exploratory in nature.

Method

Participants

Ninety-six children between the ages of 4;1 and 5;11 (years; months) were recruited in three public preschool educational services serving families with a range of socioeconomic backgrounds in Italy. A total of 11 children were excluded from the initial sample for the following reasons: poor comprehension of Italian and/or exposure to another language in addition to Italian at home (n = 7), ascertained developmental disorder (n = 2), and a score below the 10th percentile in the Colored Progressive Matrices Test (n = 2), which was used with the aim of screening for children's nonverbal reasoning skills. The final sample included 85 typically developing children (49% females) from 4;1 to 5;11 months of age ($M = 58.42$ months; $SD = 6.08$). Parents provided informed consent for participation. This study was conducted in accordance with the recommendations of the National Psychology Association for Research and was approved by the Ethical Committee of the local Department.

Procedure

Each participant was assessed individually in two sessions (each lasting approximately 20-30 minutes) on different days to prevent testing fatigue. In the first section, fluid intelligence, receptive vocabulary and verbal working memory tasks were administered; in the second section, inhibitory control and expressive morphology measures were provided. The tasks were administered in the same order (Carlson & Moses, 2001). All of the assessments were conducted in a quiet room of the preschool service by a trained experimenter.

Materials

Fluid intelligence

The Colored Progressive Matrices Test (Raven, 1947). The task includes 36 items that represent a pattern with a missing piece. Six alternative pieces are located below each pattern, and the child must point the target piece to complete the pattern. The score is the total number of correct responses (range 0-36).

Receptive vocabulary

The Peabody Picture and Vocabulary Test (PPVT, Stella, Pizzoli & Tressoldi, 2000) was administered to assess receptive lexical skills. The examiner produces a word, and children must indicate which picture among a set of four corresponds to the word uttered.

The task continues until children reach an error rate of 6 on the last 8 items. The score is the sum of correct responses (range: 0-175).

Verbal working memory

The Backward Word Span (Ciccarelli, 1998) is a standard working memory task in which the child is asked to recall a sequence of spoken words in reverse order. The task includes three items (words) at each level. After an illustration trial, the test begins with three items of two words. The number of words increases by one every level until three items are recalled incorrectly. The words were pronounced one per second. The number of passed levels was recorded (range 0-8).

Inhibitory control

The Color/Shape Stroop task is the inhibition subtest from NEPSY-II (Nepsy Second Edition, Korkman, Kirk & Kemp, 2011, Italian version) and evaluates different inhibitory control skills (see Miller, 2010). The task is divided into three phases: naming, inhibition and switching. In each phase, the child is shown a display with a cardboard table that has a series of black and white shapes that represent 20 circles and 20 squares arranged in five rows (eight figures per row). In the naming phase, the child is instructed to correctly name the shapes regardless of their color (e.g., "circle" for the shapes of circle and "square" for the shapes of square); in the inhibition phase, the child is required to label the circles as "squares" and the squares as "circles"; in the switching phase, the child is instructed to correctly name "circle" for the black circles and "square" for the black squares and to name "circle" for the white squares and "squares" for the white circles.

   In the inhibition phase, the child is required to inhibit a dominant response in favor of a less dominant response as it is in the response inhibition tasks; therefore, the inhibition phase score was used as a proxy for response inhibition, and we called it the "response inhibition" score. In the switching phase, the child is asked to alternate from one response type to another by managing the interference coming from two conflicting couples of rules as it is in the interference suppression tasks; therefore, the switching phase score was used as a proxy for interference suppression, and we called it the interference suppression score. The score is the sum of the correct responses in each of the three trials (range 0-40).

Expressive morphological measure

The Sentence Completion task from the Italian version of the battery for the assessment of language in children aged 4 to 12 (BVL_4-12, Marini, Marotta, Bulgheroni & Fabbro, 2015) was used to assess verb inflection. The children are instructed to listen to a sentence that is orally produced by the examiner and to complete the subsequent sentence, assigning the correct morpheme to the verb and/or other expected morphological elements. Items 1 to 6 are constituted by stimulus sentences that include present tense singular inflection verbs (third person); the child has to complete the subsequent target sentences by producing present tense plural inflection verbs (third person), e.g., (1) *La mamma cucina. Le mamme* (*cucinano*). / 'The mum cooks. The mums (cook).'.

   Items 7 to 14 are constituted by seven stimulus sentences, including present tense singular inflection verbs (third person), and by one sentence, including past tense

(*imperfetto*) singular inflection verbs (third person); of these sentences, two include passive voices and three reflective and personal pronouns. The child has to complete the following:

- four target sentences by inflecting singular past tense verbs (third person), e.g., (2) *Il papà parte spesso per lavoro. Anche ieri il papà* (*è partito*) / 'Dad often leaves for work. Even yesterday, dad (<u>left</u>)';
- two sentences by inflecting singular past or future tense verbs (third person), e.g., (3) *La mamma arriva sempre tardi. Oggi però* (*è arrivata / arriverà*) /'Mum always arrives late. However, today (<u>she has arrived/she will arrive</u>)';
- one sentence by inflecting singular present or future tense verbs (third person), e.g., (4) *Lui si perde spesso nelle grandi città. Anche qui* (*si è perso/si perderà*)./'He often gets lost in big cities. Even here (<u>He got lost/He will get lost</u>)'
- one sentence by inflecting singular past or future tense verbs (third person, e.g., (4) *Un tempo a Pietro il formaggio non piaceva. Ora però* (*gli piace/gli piacerà*)" / 'Once Peter didn't like cheese. However, now (<u>he likes it</u> / <u>he will like it</u>)'.

Given the increased complexity of the latter group of sentences due to the request of producing past and future tense inflections, which are consolidated later in development compared to present tense inflections, we subdivided the items into two groups: the "simple inflections", which refer to the items from 1 to 6 requiring the child to inflect plural present tense verbs (third person), and the "complex inflections", which refer to the items from 7 to 14, requiring the child to inflect singular past or future tense verbs (third person). Because of the difference between the number of items of the simple inflections and the complex inflections, two separate scores were considered: the mean score of the correct responses provided in the simple inflection items (range 0-1) and the mean score of the correct responses provided in the complex inflection items (range 0-1). A sentence is considered to be complete if it contains all of the arguments that are necessarily required by the verb and no omissions or substitutions of free or bound morphemes.

Statistical analyses

Descriptive statistics were calculated for all variables. To explore whether the children's performances were different between the simple inflection items and the complex inflection items, a repeated measure analysis of variance (ANOVA) was computed on the mean scores of both groups of items. Zero-order (Pearson) and partial correlations controlling for age were calculated to evaluate the bivariate associations among the independent variables (receptive vocabulary, verbal working memory and inhibitory control measures) and the dependent variables (both the simple and complex inflection scores).

To investigate the contribution of inhibitory control skills on Italian inflectional verb morphology with a unique contribution of variance over and above the effects of receptive vocabulary and verbal working memory, a series of multiple hierarchical regression analyses were provided. The simple and complex inflection scores were considered to be dependent variables in separate regression models. The independent variables were included in four blocks of analysis: age in months (first block), receptive vocabulary (second block), verbal working memory (third block) and both inhibitory control measures (fourth block). All of the necessary assumptions of a regression analysis were met, and the inspection of variance inflation factors and tolerance values, as well as the

condition index and the Durbin-Watson index, indicated that there were no collinearity problems.

Results

Descriptive statistics are reported in Table 2. No missing values or outliers were identified. All of the variables displayed adequate distributional characteristics, except for the naming phase of the Color/Shape Stroop task, whose mean score, as expected, showed a ceiling effect; for this reason, this variable was not considered in the subsequent analyses. The repeated measure ANOVA calculated on the simple inflection and the complex inflection scores revealed a significant difference between item types; in particular, children's task performances were higher in the simple inflection items (i.e., producing three present tense plural inflection verbs) than in the complex inflection items (i.e., producing three past and future tense singular inflection verbs) [$F(1,84)$ = 281.578, $p < .0001$].

Zero-order (Pearson) and partial correlations controlling for age in months among the measures are reported in Table 3. Considering the bivariate correlations among the variables (see the upper triangle), both the simple inflection and the complex inflection scores showed significant associations with the receptive vocabulary and with both the Color/Shape Stroop response inhibition and interference suppression scores, whereas only the complex inflection score significantly correlated with the verbal working memory score. These correlations also remained significant when age was partialized out (see the lower triangle), except for the Color/shape Stroop response inhibition score, which was no longer associated with either the simple inflection or the complex inflection scores.

To determine whether variance in Italian inflectional verb morphology could be significantly explained by inhibitory control skills, with a unique contribution of variance over and above the effects of receptive vocabulary and verbal working memory, a series of hierarchical multiple linear regression analyses (enter method) were conducted (Table 4). The simple and complex inflection scores were considered to be dependent

Table 2. Descriptive statistics for receptive vocabulary (Peabody Picture and Vocabulary Test), verbal working memory (Backward Word Span), inhibitory control (naming, response inhibition and interference suppression scores from the NEPSY – II Color/Shape Stroop) and the Italian verb inflection from Sentence Completion task (i.e., production of three present tense plural inflection verbs - simple inflection mean score – and the production of the three past and future tense singular inflection verbs - complex inflection mean score).

	N	Min	Max	Mean	S.D.	Skewness	Kurtosis
Receptive Vocabulary	85	23	112	68.31	19.15	0.05	−0.48
Verbal WM	85	2	3	2.02	0.62	−0.01	−0.29
Stroop Naming	85	27	40	39.07	1.91	−4.00	20.66
Stroop Response inhibition	85	10	40	34.86	5.81	−1.77	3.77
Stroop Interference suppression	85	13	40	31.18	8.20	−.66	−1.07
Simple inflection verbs	85	0	1	0.78	0.27	−1.39	1.20
Complex inflection verbs	85	0	1	0.27	0.24	0.95	0.57

Table 3. Zero-order (Pearson) and partial correlations controlling for age (lower triangle) among receptive vocabulary (1), verbal working memory (2), inhibitory control response inhibition and interference suppression scores (3 - 4) and simple inflection and complex inflection scores (5 - 6).

	1	2	3	4	5	6
1. Receptive Vocabulary	—	−.333**	.293**	.326**	.315**	.534**
2. Verbal WM	.220*	—	.267*	.140	.197	.354**
3. Stroop Response inhibition	.107	.174	—	.453**	.231*	.255*
4. Stroop Interference suppression	.266*	.089	.417**	—	.301**	.355**
5. Simple inflection verbs	.289**	.166	.194	.282**	—	.404**
6. Complex inflection verbs	.327**	.307**	.181	.323**	.385**	—

*p <.05, **p < .01

variables in separate regression models. In each regression model, age in months was included in the first block of analysis, receptive vocabulary was included in the second block of analysis, verbal working memory was included in the third block of analysis, and Color/Shape Stroop response inhibition and interference suppression scores were included together in the fourth block of analysis, to determine whether they accounted for an additional amount of variance in the model.

Regarding the simple inflection score, the regression model was significant and accounted for 11% of the variance; however, no independent variable turned out to be significant in predicting the simple inflection score. In this model, only receptive vocabulary was a significant predictor in blocks 2 and 3 of the analysis; nevertheless, when inhibitory control variables were added to the model, it was no longer significant. It is important to note that although the receptive vocabulary did not reach significance in block 4 of the analysis, the beta value was only slightly reduced compared to blocks 2 and 3, and it was near to the significant value (Beta = .248, p = .059). The regression model predicting the complex inflection score was significant and accounted for 22% of the variance. More specifically, the significant predictors were verbal working memory (Beta = .240, p = .024) and the interference suppression variable from the inhibitory control task (Beta = .237, p = .037); by contrast, age (Beta = .015; p = .800) and receptive vocabulary (Beta = .240, p = .050), did not predict the complex inflection scores.

Discussion

The study explored the role of different inhibitory control skills in the acquisition of Italian verb inflection. Given the richness and the variety of the Italian verb inflectional system, the ability to inflect verbs takes a long time to be acquired (Guasti, 2017). In particular, the three present tense inflections are acquired early in development with singular markers already mastered before the plural markers (Dispaldro, 2012), whereas different types of past (e.g., *passato prossimo* and *imperfetto*) and future tenses are less employed in child speech (Caprin & Guasti, 2009).

More specifically, regarding present tense, Leonard et al. (2002) indicate that the third person is correctly produced by 98% of children between 2;5 and 3 years of age. The third plural person needs more time to be used as correctly as the singular even though the

Table 4. Hierarchical multiple regression analysis with age, receptive vocabulary, verbal working memory and inhibitory control (response inhibition and interference suppression scores) predicting simple inflection and complex inflection scores.

Dependent variables		Simple inflection verbs $F(5,84) = 3.003, p = .016$ $R^2 = .16; R^2\text{adj} = .11$				Complex inflection verbs $F(5,84) = , 5.70, p = .001$ $R^2 = .27; R^2\text{adj} = .22$			
Independent variables		B	SE	Beta	$R^2\Delta$	B	SE	Beta	$R^2\Delta$
Step 1	Age	.006	.005	.138	—	.009	.004	.237*	—
Step 2	Age	−.002	.006	−.043	.082 $p = .008$	.001	.005	.036	.101 $p = .002$
	Receptive vocabulary	.005	.002	.338**		.005	.001	.376**	
Step 3	Age	−.003	.006	−.060	.011 $p = .323$	.000	.005	−.003	.055 $p = .020$
	Receptive vocabulary	.004	.002	.310*		.004	.001	.313*	
	Verbal WM	.049	.049	.111		.096	.040	.251*	
Step 4	Age	−.004	.006	−.092	.048 $p = .111$	−.001	.005	−.015	.054 $p = .062$
	Receptive vocabulary	.004	.002	.248		.003	.001	.240	
	Verbal WM	.041	.049	.093		.092	.040	.240*	
	Stroop Response inhibition	.004	.006	.085		.001	.005	.018	
	Stroop Interference suppression	.006	.004	.187		.007	.003	.237*	

mean percentages of correct production are rather high (86% between 2;5 and 3; 96% between 3;5 and 4; 98% between 4;5 and 5). This finding means that the use of the present tense is highly mastered by age 4. In contrast, other tenses, such as past tenses (*passato prossimo* and *imperfetto*), are acquired later (see Guasti, 2017) and need a long time to be consolidated, especially when they require the use of pronouns or some temporal devices (e.g., adverbial syntagms), which are delayed until the age of 5;0 in typically developing children (Belletti & Guasti, 2015).

In line with this evidence, the current findings showed that between 4;0 and 6;0, Italian children achieved better performances in producing three present tense plural inflection verbs (i.e., simple inflection items) than in producing three past and future tense singular inflection verbs (i.e., complex inflection items). Moreover, it is important to consider that the complex inflection items include two passive sentences, which have been found to be difficult to process (see Contemori & Belletti, 2014), and two reflective pronouns, which make verbal inflection even more challenging.

The main findings of the current study concerned the relationship between different inhibitory control skills and both the simple and complex inflection scores, while accounting for the concurrent contribution of age, vocabulary and working memory. First, the correlation analyses showed that verbal working memory and the interference suppression score from the Color/Shape Stroop task were significantly associated with complex inflection scores but not with simple inflection scores, revealing that in Italian, at this age range, processing sentences that include verbal tense inflections other than present tense ones (i.e., past and future tenses) requires working memory load as well as substantial inhibitory control skills, especially the ability to manage interference among different elements (i.e., interference suppression). Moreover, although it goes beyond the goal of this study, the analyses also showed no significant association between both the inhibitory control scores and working memory scores when age was partialled out, which indicates that inhibitory control skills and working memory are quite different (see Traverso, Viterbori, Malagoli & Usai, 2020) and are differently related to the production of verb inflections. Indeed, the role of working memory in grammar abilities has been proven (see Verhagen & Leseman, 2016); nevertheless, findings about the specific relationship between working memory and verb inflection are mixed (Blom et al., 2021; Fleischhauer & Clahsen, 2012). In language processing, working memory allows us to store verbal information briefly while keeping it accessible for mental manipulation and transformation, whereas inhibitory control skills, especially interference suppression, were found to be particularly important, especially in rich inflectional morphology systems such as Italian, when complex and infrequent structural morphosyntactic patterns occur and when it is necessary to coordinate and monitor several different morphological elements and their related functions (see Gandolfi & Viterbori, 2020). In language with poor verbal morphology, such as English, inhibitory control (i.e., response inhibition) was found to be necessary to inhibit the tendency to produce a regular past tense form to rightly produce the irregular form (Ibbotson & Kearvell-White, 2015; Yuile & Sabbagh, 2020).

In this regard, the main findings of the regression analyses showed that the morphological ability that appears to involve inhibitory control skills is the production of complex inflection items (i.e., the production of three singular past and future tenses); in contrast, the production of three plural present tense inflections (i.e., simple inflection items) did not require inhibitory control skills. Interestingly, only the Color/Shape Stroop interference suppression score, which assesses the ability to pass from one

response type to another by managing the interference coming from two conflicting couples of rules, was one of the significant predictors of complex inflection items, in addition to working memory variable. In accordance with our assumptions, this result suggests that in Italian speaking children, the past and future tense inflections, which are consolidated later in the development compared to present tense inflections (Belletti & Guasti, 2015), could require especially those inhibitory abilities that allow us to manage interference from conflicting features of the stimulus and competitive responses. For example, to correctly solve the Italian item *La mamma arriva sempre tardi. Oggi però è arrivata / arriverà* ('Mum always arrives late. However, today she has arrived / she will arrive'), the child has to select the verb *arriv-are* ('to arrive') and integrate the right inflection, conveying information about person and number in addition to mood and tense, mainly by filtering out one of six different misguided endings to link to a fixed verb stem, and to resolve a conflict due to interfering verbal tenses. This example suggests that in languages with rich morphological inflection systems, to produce proper verb infection, the child is required not only to suppress the prepotent tendency to apply regular inflection to produce an irregular form, as previous literature on English-speaking children has shown (e.g., Ibbotson & Kearvell-White, 2015; Yuile & Sabbagh, 2020), but also to select a certain stimulus presented among other stimuli (distracters) that must not be considered, as it is in an interference suppression task.

Additionally, we can also consider the time of verb acquisition and the specific characteristics of verb morphology in Italy. Studies of vocabulary growth in Italian children indicate that verbs enter into children's lexicon when their vocabulary is quite large, and that even with a large vocabulary (of approximately 500 words), the lexical category of common nouns is still the most frequent (D'Odorico, Carubbi, Salerni & Calvo, 2001; D'Odorico & Fasolo, 2007). The delayed emergence of verbs compared with nouns in early vocabulary suggests that the use of this lexical category is less consolidated in children under three years of age and that it is progressively consolidated during preschool years. Furthermore, whereas nouns and adjectives inflect by gender (masculine and feminine) and number (singular and plural), verbs are inflected to convey grammatical information about both person and number in addition to mood and tense, primarily by adding one of six different endings to a fixed verb stem. This inflectional complexity is likely one reason that verbs are acquired later than nouns and because they need to be gradually acquired. These two aspects (late emergence and inflectional complexity) suggest that the processing of verb inflections could generally involve a significant cognitive load for children between two and three years of age, especially for tense inflections not yet consolidated.

Nevertheless, this study presents some limitations that call for further research. First, the use of inhibitory control scores taken from a single verbal task could have reduced the task reliability; however, it should be noted that the Color/Stroop task is a standardized task taken from the Nepsy-II battery tapping inhibition skills. Moreover, the validity of our results is strengthened by Yuile and Sabbagh (2020), who similarly found a significant relationship between inhibitory control and verb inflection by using truly nonlinguistic inhibitory control measures. Second, the use of a morphologically standardized task suitable especially with the clinical population could not have allowed a specific inspection of different Italian verbal inflections in relation to inhibitory control skills; however, the division of the items based on tense inflection types allowed us to perform a preliminarily useful investigation.

In conclusion, the study has the value of exploring the role of different inhibitory control skills in the inflection of various verb forms. To our knowledge, no studies have specifically investigated the relationship between different inhibitory control skills and verb inflection in the Italian morphological system. Further research should include both nonverbal inhibitory control measures that allow to control for confounding factors, such as speed processing, and specific assessment of separate inhibitory control skills involved in sentences specifically designed to assess different types of verbal tense inflections, with the aim of further deepening the interplay between language development and domain-general cognition accounts (see Ibbotson, 2020).

References

Bazzanella, C., & **Bosco, C.** (2000). Morphological future in Italian children. In: M. Perkins & S. Howard (eds), *New Directions In Language Development And Disorders* (pp.179–188). Springer, Boston, MA. https://doi.org/10.1007/978-1-4615-4157-8_17

Belletti, A., & **Guasti, M. T.** (2015). *The Acquisition of Italian: Morphosyntax and its interfaces in different modes of acquisition* (Vol. 57). John Benja. Amsterdam: John Benjamins.

Blom, E., **Bosma, E.**, & **Heeringa, W.** (2021). Regular and irregular inflection in different groups of bilingual children and the role of verbal short-term and verbal working memory. *Languages*, **6**, 56. https://doi.org/10.3390/languages6010056

Caprin, C., & **Guasti, M. T.** (2009). The acquisition of morphosyntax in Italian: A cross-sectional study. *Applied Psycholinguistics*, **30**, 23–52. https://doi.org/10.1017/S0142716408090024

Carlson, S. M., & **Moses, L. J.** (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development*, **72**, 1032–1053. https://doi.org/10.1111/1467-8624.00333

Ciccarelli, L. (1998). *Language comprehension, processing and working memory: A study with preschoolers.* Unpublished dissertation thesis. University of Padua, Italy.

Clackson, J. (2007). *Indo-European linguistics: An introduction.* Cambridge University Press.

Contemori, C., & **Belletti, A.** (2014). Relatives and passive object relatives in Italian-speaking children and adults: Intervention in production and comprehension. *Applied Psycholinguistics*, **35**, 1021–1053. https://doi.org/10.1017/S0142716412000689

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, **64**, 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

Dispaldro, M. (2012). Acquisizione della morfologia grammaticale italiana in bambini con sviluppo tipico: una rassegna sugli articoli determinativi, pronomi clitici oggetto e flessione verbale. *Giornale Italiano di Psicologia*, **39**, 261–288.

Dispaldro, M., **Leonard, L. B.**, & **Deevy, P.** (2013). Real-word and nonword repetition in Italian-speaking children with specific language impairment: A study of diagnostic accuracy. *Journal of Speech, Language and Hearing Research*, **56**, 323–336. https://doi.org/10.1044/1092-4388(2012/11-0304)

D'Odorico, L., **Carubbi, S.**, **Salerni, N.**, & **Calvo, V.** (2001). Vocabulary development in Italian children: A longitudinal evaluation of quantitative and qualitative aspects. *Journal of Child Language*, **28**, 351–372. https://doi.org/10.1017/S0305000901004676

D'Odorico, L., & **Fasolo, M.** (2007). Nouns and verbs in the vocabulary acquisition of Italian children. *Journal of Child Language*, **34**, 891–907. https://doi.org/10.1017/s0305000907008240

Fleischhauer, E., & **Clahsen, H.** (2012). Generating inflected word forms in real time: evaluating the role of age, frequency, and working memory. In *Proceedings of the 36th annual Boston University Conference on Language Development*. Cascadilla Press, Somerville, MA (pp. 164–176).

Gandolfi, E., & **Viterbori, P.** (2020). Inhibitory control skills and language acquisition in toddlers and preschool children. *Language Learning*, **70**, 604–642. https://doi.org/10.1111/lang.12388

Gandolfi, E., **Viterbori, P.**, **Traverso, L.**, & **Usai, M. C.** (2014). Inhibitory processes in toddlers: a latent-variable approach. *Frontiers in Psychology*, **5**, 381. https://doi.org/10.3389/fpsyg.2014.00381

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin*, **134**, 31–60. https://doi.org/10.1037/0033-2909.134.1.31

Guasti, M. T. (2017). *Language acquisition: The growth of grammar*. MIT press.

Ibbotson, P. (2020). *What it takes to talk: Exploring developmental cognitive linguistics* (Vol. 64). DeGruyter Mouton. https://doi.org/10.1515/9783110647914

Ibbotson, P., & Kearvell-White, J. (2015). Inhibitory control predicts grammatical ability. *PLoS One*, **10**(12), e0145030. https://doi.org/10.1371/journal.pone.0145030

Kaushanskaya, M., Park, J. S., Gangopadhyay, I., Davidson, M. M., & Weismer, S. E. (2017). The relationship between executive functions and language abilities in children: A latent variables approach. *Journal of Speech, Language, and Hearing Research*, **60**, 912–923. https://doi.org/10.1044/2016_JSLHR-L-15-0310

Korkman, M., Kirk, U., & Kemp, S. (2011). *NEPSY–II. Italian Adaptation*. Firenze: Giunti O.S. Organizzazioni Speciali.

Lee, K., Bull, R., & Ho, R. M. (2013). Developmental changes in executive functioning. *Child Development*, **84**, 1933–1953. https://doi.org/10.1111/cdev.12096

Leonard, L. B., Caselli, M. C., & Devescovi, A. (2002). Italian children's use of verb and noun morphology during the preschool years. *First Language*, **22**, 287–304. https://doi.org/10.1177/02F014272370202206604

Marchman, V. A., & Fernald, A. (2008). Speed of word recognition and vocabulary knowledge in infancy predict cognitive and language outcomes in later childhood. *Developmental Science*, **11**, F9–F16. https://doi.org/10.1111/j.1467-7687.2008.00671.x

Marini, A., Marotta, L., Bulgheroni, S., & Fabbro, F. (2015). *Batteria per la Valutazione del Linguaggio in Bambini dai 4 ai 12 anni*. Firenze: Giunti OS.

Marzi, C., Ferro, M., & Pirrelli, V. (2019). A processing-oriented investigation of inflectional complexity. *Frontiers in Communication*, **4**, 48. https://doi.org/10.3389/fcomm.2019.00048

Miller, D. C. (2010). *How to report and interpret the NEPSY-II scores within a school neuropsychological framework*. Denton, TX: Texas Woman's University. Retrieved from http://www.schoolneuropsych.com/document.php?file=NEPSY2InterpretGuide.pdf

Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science*, **21**, 8–14. https://doi.org/10.1177%2F0963721411429458

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, **41**, 49–100. https://doi.org/10.1006/cogp.1999.0734

Raven, J. C. (1947). *Progressive matrices, Set A, Ab, B, Board and book form*. London, H.K. Lewis: trad. it. Progressive matrici colorate, Firenze, Organizzazioni Speciali, 1954.

Stella, G., Pizzoli, C., & Tressoldi, P. (2000). *Peabody picture vocabulary test. Italian adaptation*. Torino: Omega Edizioni.

Traverso, L., Fontana, M., Usai, M. C., & Passolunghi, M. C. (2018). Response inhibition and interference suppression in individuals with Down Syndrome compared to typically developing children. *Frontiers in Psychology*, **9**, 660. doi: 10.3389/fpsyg.2018.00660

Traverso, L., Viterbori, P., Malagoli, C., & Usai, M. C. (2020). Distinct inhibition dimensions differentially account for working memory performance in 5-year-old children. *Cognitive Development*, **55**, 100909. https://doi.org/10.1016/j.cogdev.2020.100909

Usai, M. C., Viterbori, P., Gandolfi, E., & Zanobini, M. (2020). The relationship between temperamental dimensions and inhibitory control in early childhood: Implications for language acquisition. *Infant Behavior and Development*, **61**, 101495. https://doi.org/10.1016/j.infbeh.2020.101495

van Hout, A., & Hollebrandse, B. (2001). On the acquisition of the aspects in Italian. In J.-Y. Kim and A. Werle (eds.), *The proceedings of SULA, The semantics of under-represented Languages in the Americas. UMOP* 25, 111–120. GLSA, Amsterdam.

Verhagen, J., & Leseman, P. (2016). How do verbal short-term memory and working memory relate to the acquisition of vocabulary and grammar? A comparison between first and second language learners. *Journal of Experimental Child Psychology*, **141**, 65–82. https://doi.org/10.1016/j.jecp.2015.06.015

Woodard, K., **Pozzan, L.**, & **Trueswell, J. C.** (2016). Taking your own path: Individual differences in executive function and language processing skills in child learners. *Journal of Experimental Child Psychology*, **141**, 187–209. https://doi.org/10.1016/j.jecp.2015.08.005

Yuile, A. R., & **Sabbagh, M.** (2020). Inhibitory control and preschoolers' use of irregular past tense verbs. *Journal of Child Language*, **18**, 1–19. https://doi.org/10.1017/s0305000920000355