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Phonemic awareness of schoolers test assessment (PASTA): A pseudoword blending task for Italian pupils

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Abstract

Phonemic awareness refers to the ability to reflect on and process the sounds of spoken language and to conduct mental operations on the units that represent them, that is, phonemes. This study intended to examine the descriptive and psychometric properties of the phonemic awareness of schoolers test assessment (PASTA), a new tool that assesses one dimension of phonological awareness, namely the ability to blend pseudowords. A sample of 627 Italian 3rd–5th graders, 314 females and 313 males (M_{age} = 9.3 years, SD = 10.2 months, age range = 7.8–11.4 years) took part in the study. Participants completed a battery of tests assessing verbal intelligence and working memory, reading, writing, word, and pseudoword-blending skills. A satisfactory internal consistency of PASTA (Kudar–Richardson 20 = 0.81) was documented. Moreover, a series of Pearson's correlations revealed adequate concurrent validity of the new test. In addition, an ANOVA showed the positive main effect of education in the PASTA condition ($F[2,621] = 11.083$, $p < .0001$, $\eta^2p = .03$). As expected, 3rd-grade pupils were outperformed by children attending the 4th- and 5th grades. In conclusion, the PASTA is a reliable and valid instrument for the assessment of phonological processing in Italian 3rd to 5th graders of primary school.

KEYWORDS
Italian, phoneme blending, phonological awareness, primary school, reading

1 | INTRODUCTION

1.1 | Phonological awareness: Defining the general construct

Phonological awareness refers to the metalinguistic ability to reflect on the speech flow and to manipulate the most basic units of sound (i.e., phonemes) and the larger phonological units (e.g., syllables, rhymes) that compose words (e.g., Tunmer & Rohl, 1991). The acquisition of phonological awareness depends on the development of metacognitive control over phonological processing, which, in turn, refers to the ability to use phonological information to process oral and written language (Hodson & Edwards, 1997). Moreover, as suggested by Tunmer and Rohl (1991) "phonological awareness refers to the ability to perform mental operations on the output of the speech-perception mechanism" (p. 3) when metalinguistic skills occur to control the linguistic information processing. Overall, these definitions are consistent with recent evidence showing that emerging inhibitory processes, that is, the earliest control processes in toddlerhood, contribute significantly to the development of phonological awareness 2–3 years later (Gandolfi et al., 2021).

From an applied viewpoint, phonological awareness is a multidimensional construct that might be evaluated through a wide range of tests, such as initial phoneme deletion (e.g., say "pen" without "p"), final phoneme deletion (e.g., if you remove the final sound of "team," what is the word? "tea"), phoneme blending (e.g., what is the word composed of the sounds "p-e-n"), phonemic segmentation (e.g., what is the sounds sequence encompassed in "pen"?), phoneme identification (e.g., what is the first sound in "pen"?), rhyme recognition (e.g., does "hat" rhyme with "cat"?), rhyme production (e.g., can you find a word rhyming with "cat"?), word categorization (e.g., "cat" and "can" belong to the same category, because their first syllable is "ca"), and spoonerism, that is, producing two new words by transposing the first consonant of a pair of words previously heard (e.g., given "doggy" and "fay," the new words are "foggy" and "day") tasks.

1.2 | The development of phonemic awareness in childhood

Embracing a developmental perspective, there is evidence that rudimentary phonological skills are already present in preschoolers, who gradually become receptive to different aspects of phonological sensitivity. Specifically, word rhyme recognition and rhyme production emerge at 3 years of age because they do not require any awareness of the phonological structure of speech (Troia et al., 1998). At the age of 4, children can identify syllables composing familiar words (e.g., "water"), and at the age of 5 approximately 90% of children can count syllables in words and approximately one in two preschoolers can count phonemes in spoken words (Goldsworthy, 2012). In this regard, it has been documented that the manipulation of syllables composing words is easier than the manipulation of single phonemes because syllables are more perceptually salient (Cossu et al., 1988; Troia et al., 1998). There is also evidence that alliteration, that is, the ability to recognize words starting with the same phoneme, emerges in preschoolers (Anthony and Lonigan, 2004), whereas phonemic segmentation and especially phonemic deletion of speech are more difficult to attain because they are very demanding in terms of working memory load; therefore they are developed in primary school (Troia et al., 1998). Research has also documented that the manipulation of sounds composing words is easier than performing the same tasks with pseudowords (e.g., Tunmer & Nesdale, 1982). Overall, according to Stanovich (2004), the acquisition of superficial phonological awareness, that is, rhyme recognition, is the basic metalinguistic skill that precedes the development of deep phonological awareness that implies phoneme discrimination, recognition, and processing. In this regard, research has established that children at the age of 6 can blend a maximum of three phonemes composing known words (e.g., "d-o-g"), and at 7 years of age children can blend sounds to form words (e.g., Goldsworthy, 2012). Furthermore, neuroimaging research has documented that the processing of pseudowords is more cognitively demanding than for regular words, as it engages mainly the neurological areas deputed to lexical access, which are not helpful in facilitating the recall of the verbal stimuli which are unfamiliar and invented (Raettig & Kotz, 2008). However, it must be noted that the ability to blend phonemes in pseudowords is supposed to be gradually achieved later, but to date, this has not been deeply examined in the literature.

1.3 | Phonological awareness and Reading skills: A Cross-cultural perspective

Several researchers have claimed that phonological awareness is one of the most important prerequisites for the subsequent development of reading skills in school-aged children (e.g., Hulme et al., 2015; Ziegler and Goswami, 2005). Indeed, as highlighted by Míguez-Álvarez et al. (2022), during reading acquisition, children must learn that the decoding of a written word implies that speech encompasses a stream of sounds—of which the smallest units are phonemes—that can be manipulated and arbitrarily matched with written units.

In line with this, it has been documented that in alphabetic orthographies in which grapheme–phoneme correspondence rules are applied, phonological awareness (e.g., assessed in terms of initial phoneme deletion, final phoneme deletion, phonemes counted in spoken words, and word–blending skills) is the best predictor of reading accuracy in reading beginners (e.g., Leather & Henry, 1994; Nation & Hulme, 1997). However, other researchers argue in favor of a mutual dependence between the development of phonological awareness and the acquisition of reading fluency in school-aged children (e.g., Duncan et al., 2013; Perfetti et al., 1987; Stanovich, 2009; Wagner et al., 1994), whereas according to Ehri (1989), the development of reading and spelling skills facilitates the development of phonological awareness.

There is also evidence that the acquisition of written-word spelling knowledge (i.e., orthography) through reading learning correlates positively with phonological awareness in 5th-grade and young adult readers (Castles et al., 2003). Consistent with this, it has been demonstrated that spelling knowledge accounts for 76% of the variance in the factor measuring phonological awareness at the end of kindergarten (Clemens et al., 2014). However, additional evidence suggests an opposite trend, that is, that phonological awareness would favor the creation of orthographic representations of a speech stream (e.g., Dixon et al., 2002; Ehri & Wilce, 1985), especially in transparent orthographic representation systems such as Spanish and Italian, where there is a direct and consistent correspondence between phonological units and the letters (Rack et al., 1994). In this regard, it has been documented that thanks to the high consistency between the letters and sounds, children who learn to read in a phonologically transparent orthography do so more quickly than reading beginners who learn to decode text in an opaque orthography such as those of French or English (Seymour et al., 2003), in which the mapping between phonemes and written letters is less regular (Perfetti & Harris, 2013). Despite this evidence, it has also been argued that the relationship between phonological awareness and reading skills might not be universal and linear (Pugh & Verhoeven, 2018), since in opaque orthographies the former is less predictive of the efficiency of the decoding skills (Ziegler et al., 2010).

Since the study that will be presented has been conducted with Italian children, a more extensive analysis of the literature on the development of phonological awareness in Italian native speakers and its relationship with that transparent orthography will be illustrated below.

1.4 | Phonological awareness in typically developing Italian children

Relative to studies conducted in a transparent writing system such as Italian, which is the focus of the present work, it has been documented that the development of phonological segmentation of spoken words (i.e., the ability to identify the sound units that form a linguistic flow) improves with age, such that while Italian preschoolers can manipulate syllables as segmental cues, only pupils attending the 1st and 2nd grades of primary school can perform phonemic segmentation tasks more accurately, because reading novices gradually become more aware of the correspondence between single graphemes composing words and their phonemes (Cossu et al., 1988).

A very relevant facet of phonological awareness is phonemic awareness, which has been defined as a subset of phonological awareness encompassing the awareness of, sensitivity to, and control over the phonemes structuring the speech stream (Yopp & Yopp, 2000). In the clinical setting, phonemic awareness is evaluated using tasks that require manipulating sounds composing real words or pseudowords (i.e., verbal stimuli composed of phonemes that are assembled in conformance with the orthographic rules of a language, but lacking in meaning). The sounds manipulation often occurs through (a) the identification of the phonemes composing the spoken verbal stimulus (i.e., segmentation, such as the word "dog" being composed of "d," "o," "g"); and (b) putting together (i.e., blending) a stream of phonemes to utter a verbal stimulus (e.g., "d," "o," "g" together make the word "dog"). Therefore, word- and pseudoword-blending tasks must not be confounded with word- and pseudoword-reading tasks. In the former condition, phonemic segments are spoken, that is, streams of sounds are orally presented and the individual must combine them into the whole. In contrast, in word- and pseudoword-reading tasks, verbal stimuli are written and must be decoded.

In the Italian context there is evidence that phoneme segmentation assessed through the presentation of spoken words improves with age, that is, according to Cossu et al. (1988), if the proportion of errors is 72.6% at the age of 4, the proportion drops to 5.8% in 2nd graders (i.e., the age of 7). Moreover, Tobia and Marzocchi (2014) found that phonemic awareness of Italian 3rd to 5th graders (assessed through two phoneme- and syllable-blending tasks based on the use of words) was positively associated with vocabulary, reading speed, and immediate verbal serial recall. These findings are consistent with those of a study conducted with typically developing Finnish adolescents, in which it was documented that the ability to blend syllables to form pseudowords contributed to predicting reading speed and reading accuracy of a text, words, and pseudowords (Kairaluoma et al., 2013). In addition, the outcomes by Tobia and Marzocchi (2014) extend previous evidence showing that during 1st-grade attendance, Italian children use both phonological encoding (i.e., conversion of single graphemes in phonemes) and lexical strategies (i.e., recognition of whole words) to read (Pagliuca et al., 2008), whereas older and more proficient readers rely mainly on their lexical knowledge (Zoccolotti et al., 2009). These findings are consistent with a body of studies conducted with reading beginners in other transparent languages that showed that thanks to the development of phonemic awareness, at approximately 6 years of age children are very proficient in decoding words and nonwords in Finnish (Torppa et al., 2010), Spanish (Denton et al., 2000), and Turkish (Güldno˘glu, 2016).

Moreover, the correlation between phonemic awareness and verbal working memory is not surprising, since to identify speech sounds during the execution of phonological awareness tasks, individuals must rely on a temporary memory system in which strings of acoustic units must be briefly maintained and processed (Siegel & Linder, 1984).

1.5 | Phonological awareness in Italian children with dyslexia

Embracing an atypical development perspective, further studies on phonological awareness skills have been conducted with Italian individuals exhibiting a developmental deficit in the core competence of reading (i.e., dyslexia). Overall, Italian individuals with dyslexia are less fluent but relatively accurate in reading (Zoccolotti et al., 1999), and their impairment is generalized to word and pseudoword reading (Judica et al., 2002). Concerning phonological awareness in this clinical population, the evidence is controversial. Indeed, Brizzolara et al. (2006) found that, apart from very poor word and pseudoword reading and verbal working memory skills, only Italian children with dyslexia and with a history of language delay displayed phonological awareness (i.e., spoonerism) impairment. Consistently, very mild impairment (Angelelli et al., 2004) or no differences (Bigozzi et al., 2016) between children with dyslexia and typically developing peers have been documented in distinct phonological awareness skills (e.g., rhyme detection, phoneme identification, phonemic blending into words). In contrast, more recently, Vender and Melloni (2021) showed that both monolingual and bilingual Italian children with dyslexia displayed poorer phonological awareness (i.e., rhyme detection and spoonerism when words were presented) than did monolingual and bilingual typically developing peers.

To our knowledge, to date, no studies have examined phonemic-blending skills in typically developing Italian pupils attending primary school through the presentation of pseudowords, since a validated tool covering the 3rd to 5th grade (i.e., when, according to Italian law, the diagnosis of specific learning disabilities could be done) is missing. In this regard, only one study has documented that typically developing 3rd to 5th graders outperformed peers with dyslexia when they were asked to blend a series of sounds forming pseudowords (Fastame et al., 2018) but in that study no normative data were provided.

1.6 | The study

This study aimed to develop and validate the phonemic awareness of schoolers test assessment (PASTA), a new test for the assessment of pseudoword-blending skills, that is, phonemic awareness. In our opinion, the need to develop a tool to assess the phonemic blending of spoken pseudowords is crucial, for at least three reasons. First, as pointed out by Daffern and Ramful (2020), one limit of using real words in phonemic awareness tests is that the performance may be the result of word-based knowledge rather than reflecting knowledge of how phonemes can be manipulated to compose words. Therefore, the PASTA is designed to overcome this issue in the Italian context, since it is focused on letter–sound correspondence. That is, unlike other tools used with Italian pupils (e.g., Marotta et al., 2004), the novelty of the PASTA is that it requires the manipulation of the sounds composing pseudowords. In short, pseudowords have been developed to avoid the activation, from long-term memory, of mental representations of those Italian words that sound partially like the stimuli to be blended. That is, the pseudowords of the PASTA are designed to avoid lexical anticipation and recall facilitation (e.g., presentation of the sound sequence "t-e-l-e" promotes lexical access to the word "television"). Second, there is evidence that pupils who were trained to manipulate the sounds of both words and pseudowords through phonemic blending activities implicating the use of manipulative letters improved their phonological awareness and decoding of pseudowords and words (Pullen & Lane, 2014). Three, Marotta et al. (2004) provided normative data to evaluate word-blending skills until the 3rd grade of primary school, perhaps because as reported in the literature, the ability to blend words emerges in the 1st grade and is well established in the 2nd grade (Goldsworthy, 2012). Fourth, the ability to blend pseudowords has not been sufficiently examined in school-aged children, and it is only supposed (but not confirmed) to develop after the 2nd grade, when the ability to blend word stimuli is consolidated. Therefore, from an applied perspective, providing a tool for the assessment of phonemic blending of pseudowords in Italian pupils attending grades 3–5 might be useful, especially when the diagnosis of specific learning disabilities can be carried out.

2 | METHOD

2.1 | Participants

A final sample of 627 children (M_{age} = 9.3 years, *SD* = 10.2 months, age range = 7.8–11.4 years), 314 females and 313 males was recruited in several Italian primary schools located in Sardinia and northern Italy. This sample included only typically developing children, as 33 pupils who had been certified for the occurrence of dyslexia (with or without additional specific learning disabilities or language delay) were excluded. Moreover, six typically developing children (who attended the 4th and 5th grades) were excluded because their performance on the PASTA was significantly lower (i.e., outliers) than that of their peers. Participants were recruited among children attending the 3rd-, 4th-, and 5th grades because according to Italian law on the diagnosis of specific learning disabilities (law

TABLE 1 Socio-demographic characteristics of the school-aged children enrolled in the study.

Grade			
	3	4	5
n	225	266	136
Gender			
Males	112	134	67
Females	113	132	69
Age (months)	*M* = 103.5 (*SD* = 4.4)	*M* = 111.6 (*SD* = 7.8)	*M* = 124.9 (*SD* = 5)
Age range (months)	96–118	92–136	115–135

Note: SD denotes standard deviation scores. Data are distinguished by educational (i.e., grade) level.

n°170, October 8, 2010), a certification of dyslexia can be provided from the end of the 2nd grade and during the 3rd grade. A further reason is that phoneme-blending skills for pseudowords should emerge after that the ability to blend words has been developed, and this usually occurs in the 2nd grade (Goldsworthy, 2012).

Gender was counterbalanced across participants ($\chi^2 = 0.002$, $df = 1$, $p = 0.968$) and across the grade levels ($\chi^2 = 0.047$, $df = 2$, $p = 0.977$) (Table 1).

2.2 | Materials

The battery encompassed the following tests that are usually administered to screen verbal abilities in the clinical setting and Italian primary school:

The primary mental abilities (PMA) verbal meaning subtest by Thurstone and Thurstone (1981) was used to assess lexical knowledge. This test comprises two tasks: the first consists of matching 30 pictures to the corresponding nouns that were selected from four alternatives; whereas the second task requires matching 30 words to their synonyms that were presented among a series of other nouns. A score was given for each correct answer (maximum total score = 60). The internal consistency of this instrument, as measured by Spearman and Brown's procedure, is 0.93.

The DDE-2 sentence writing test (Sartori et al., 2007) is a measure of orthographic knowledge. This task was administered to assess the accuracy in writing 12 sentences that include a set of homophonic (i.e., with the same phonology) but not homographic (i.e., with a different spelling) Italian words (e.g., letto/l'etto). One point was assigned to each misspelled target word (maximum total score = 19). The test–retest coefficient was used as a measure of internal consistency. The test–retest coefficient ranges from 0.19 (i.e., for 2nd graders) to 0.68 (i.e., for 6th graders) (Sartori et al., 2007).

The MT Reading test (Cornoldi & Colpo, 1998) was administered to assess the ability to read a narrative passage. Each pupil was invited to read aloud a text within 4 min. Accuracy (i.e., the total number of errors made while reading the text aloud) and speed (i.e., the number of syllables read correctly per second) were computed. According to Cornoldi and Colpo (1998), the internal consistency of this test, calculated in terms of test–retest coefficient, is very good (i.e., $r = .86$ for accuracy, and $r = 0.97$ for speed).

The DDE-2 Word Reading test (Sartori et al., 2007) was administered to evaluate the ability to decode 112 written words. Each pupil was invited to read aloud four sets of nouns, whose level of imaginability (i.e., high vs. low) and frequency of occurrence (i.e., high vs. low) in the Italian language were manipulated. Accuracy (i.e., the number of words read aloud incorrectly) and speed (i.e., the total time spent reading the lists aloud) were calculated for each participant. According to Sartori et al. (2007), the test–retest reliability coefficients are 0.77 for speed and 0.56 for word reading accuracy.

The DDE-2 Pseudoword Reading test (Sartori et al., 2007) was administered to assess the ability to read 48 written verbal stimuli that sound like Italian words but that do not belong to the Italian vocabulary (i.e., pseudowords). Specifically, each pupil had to read aloud three lists of stimuli as quickly and correctly as possible. The accuracy and reading speed of the pseudowords were computed using the same procedure as for the DDE-2 Word Reading test. Sartori et al. (2007) reported test-retest reliability *r* coefficients of .77 for speed and .56 for accuracy.

The Word Blending test (Marotta et al., 2004) was administered as a measure of validated phonological awareness in the Italian school-aged population. Each pupil was acoustically presented with 15 sequences of sound units and he/she was invited to blend each series to pronounce aloud 15 disyllabic and trisyllabic Italian words (e.g., S-O-L-E, the corresponding word is "SOLE" that means "sun"). One point was awarded for each correct word (maximum total score = 15). The reliability of this tool is expressed by Spearman's ρ of 0.97.

The Forward Digit Span test of the Wechsler Intelligence Scale for Children 4th edition (WISC-4, Wechsler, 2003; Italian validation, Orsini et al., 2012) was used to test the efficiency of the passive verbal component of working memory. After the presentation of a sequence of digits, each participant had to retain and immediately recall those stimuli in the same order of presentation. Participants were initially presented with two series consisting of two numbers (e.g., 5–9), and if their recall was correct, other progressively longer sequences were used (maximum sequence length = 9 numbers). One score was assigned to each sequence recovered correctly (maximum total score = 16). The administration of this task was interrupted when the child failed to immediately recall two sequences of the same length. According to Orsini et al. (2012), the internal consistency of this test ranges from 0.70 to 0.86.

The WISC-4 Backward Digit Span test (Wechsler, 2003; Italian validation, Orsini et al., 2012) was administered to assess the efficiency of the active component of verbal working memory. After the acoustic presentation of the digit-number sequence, the participant had to immediately recall those verbal stimuli in reverse order, that is, first the last presented number had to be retrieved, then the penultimate one, and so on. The same administration and scoring procedures used for the Forward Digit Span test were applied (maximum total score = 16). The internal consistency of this test ranges from 0.65 to 0.79 (Orsini et al., 2012).

The PASTA was designed to assess the ability to blend sequences of phonological stimuli (i.e., phonemes) presented acoustically to pronounce pseudowords that sound like Italian words. Therefore, this tool was designed to be used as a screening test to evaluate the efficiency of a specific dimension of phonemic awareness in primary school, only through phonological access. A larger pool of stimuli was originally developed respecting the following criteria: (1) pseudowords had to sound like Italian words, therefore, our stimuli had to start with a consonant, and they had to end with a vowel; (2) uncommon consonant groups that are not used in Italian were forbidden (e.g., "ZK"); (3) pseudowords did not have to remind any Italian words, to avoid a facilitating effect of lexical completion (e.g., "S-A-P-O,…" reminds "SAPONE" that means "soap") during the blending of the acoustically presented sound; (4) consonant groups had to be presented in the median position. In a pilot study, a set of pseudowords was presented to a small sample of school-aged children, who tried to blend each stimulus. Based on this study, we excluded monosyllabic stimuli and some pseudowords for which participants tended to anticipate the response during the sound presentation. Overall, the current version of the PASTA encompasses 16 phoneme sequences forming 16 pseudowords (i.e., 4 disyllabic stimuli comprising two consonant-vowel syllables, 4 disyllabic stimuli presenting a consonantal cluster, 6 trisyllabics, and 2 quadrisyllabic verbal stimuli). The pseudowords were designed to sound like Italian words (e.g., being composed of consonant-vowel syllables such as "TA-DI") and could also include consonantal groups widely used in Italian (e.g., "MB") but they were not reminiscent of Italian nouns. Moreover, the phoneme sequences were presented through a recorded auditory track for two reasons: (1) to avoid the facilitation effect of pseudowords identification due to the examiner's lip-reading; (2) and to uniform the presentation rate of the stimuli (i.e., approximately 1 phonemic unit per second) among the participants. To perform this task, once the sequence of sounds (e.g., D-U-R-T-A) was acoustically presented, children had to temporarily store the phonemic units in the correct order of presentation in their working memory, then they had to blend those sounds, and finally, he/she had to speak the corresponding pseudoword (i.e., DURTA) aloud. There was no time limit to perform the task. The test ended when the children tried to blend the sounds forming the last pseudoword.

Following Marotta et al. (2004), performance was assessed in terms of the total number of pseudowords correctly blended, that is, 1 point was assigned to each correct response (total maximum score = 16). The psychometric information of the PASTA will be presented in the Results section, whereas the entire test is provided in the Appendix A.

2.3 | Procedure

The study was conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its subsequent amendments. When the heads of the schools approved the procedure for the collection of our data, to be enrolled in the study, parents of potential participants had to provide written informed consent before participating in the study.

The PMA Verbal Meaning Subtest and Sentence Writing task were presented collectively, whereas the other tasks were administered individually in a quiet room of the school. During the collective session, pupils belonging to the same class were tested concurrently in their classrooms. Except for the PMA Verbal Meaning Subtest and MT Reading test, no time limits were set to perform the additional tasks. Following the Latin square procedure, the presentation order of the tasks was counterbalanced among the participants. When requested or when participants appeared tired, a short break was taken between the presentation of two consecutive tests to avoid the fatigue effect. Each collective session lasted approximately 30 min, whereas the individual session lasted approximately 50 min.

3 | RESULTS

The statistical analyses reported in this section were conducted on the final sample of 627 school-aged children which was illustrated in Section 2.1.

3.1 | Preliminary analyses

First, response distributions were inspected to detect outliers and missing data in the original sample. No missing data were detected. Moreover, as was already pointed out in the Participants section, six outliers were excluded from the analyses. Descriptive statistical analyses were conducted to examine the participants' performance in each cognitive test. Table 2 summarizes the findings relative to the cognitive measures for the whole sample.

3.2 | Reliability

The Kuder–Richardson Formula 20 (Kuder & Richardson, 1937) was applied for reliability estimation, and a Kudar–Richardson 20 coefficient of 0.81 was found, which is higher than the critical value of 0.60 (Wasserman and Bracken, 2003). Furthermore, the test–retest reliability procedure was applied in a subsample of 129 pupils (61 males, 68 females) to data collected approximately 1 month after the initial testing. A test–retest reliability coefficient r of .81 ($p < .0001$) was found. Overall, following Nunnally (1978), these coefficient values are satisfactory, suggesting good internal consistency of the PASTA.

TABLE 2 Mean raw scores of the participants in PASTA, Words Blending test (i.e., Word Blending), MT Reading test (i.e., MT-accuracy and MT-speed), DDE-2 Words Reading test (i.e., DDE2-Word-Accuracy and DDE2-Word-Speed), DDE-2 Pseudoword Reading test (i.e., DDE2-Pseudoword Accuracy and DDE2-Pseudoword-speed), DDE-2 Sentence Writing Test (i.e., DDE2-Writing), Forward Digit Span test (i.e., Digit-Span-Forward), Backward Span test (i.e., Digit-Span-Backward), and PMA Verbal Meaning Subtest (i.e., PMA-verbal) conditions.

	PASTA	Word blending	MT-accuracy	MT-speed	DDE2-word-accuracy	DDE2-word-speed	DDE2-pseudoword-Accuracy	DDE2-pseudoword-Speed	DDE2-writing	Digit-span-forward	Digit-span backward	PMA-verbal
Mean	10.8	11.4	3.55	3.16	4.68	114	6.14	83.7	3.98	7.63	6.30	49.0
SD	3.65	3.02	3.43	0.900	4.52	44.6	4.78	29.6	3.07	1.68	1.57	9.41

Abbreviations: PASTA, phonemic awareness of schoolers test assessment; PMA, primary mental abilities; SD refers to standard deviation.

3.3 | Construct validity: Convergent validity

Convergent validity was examined by computing Pearson's correlation coefficients between the PASTA total score and several measures of vocabulary (i.e., verbal meaning subtest of the PMA battery), reading (i.e., the MT Reading, DDE-2 Word, and Pseudoword Reading tests), writing (i.e., the DDE-2 sentence writing test), phonological awareness (i.e., Word Blending Test), and verbal working memory (i.e., Forward and Backward Digit Span tests), respectively. Table 3 illustrates the significant associations found between the PASTA total score and the above-mentioned measures.

Following Cohen (1988), the effect size of the correlations was found to range from low (i.e., $r = .10–.30$) to medium (i.e., $r = >0.30–0.50$) values.

3.4 | Construct validity: Discriminant validity

Fastame et al. (2018) conducted a previous investigation with a sample of 54 Italian 3rd to 5th graders, with and without a diagnosis of dyslexia, who completed a battery of tests including the PASTA. The authors documented that the PASTA could detect differences in terms of pseudoword-blending skills exhibited by typically developing pupils and peers with dyslexia. That is, the study showed that typically developing pupils outperformed the group with a diagnosis of dyslexia in the PASTA condition.

In addition, in the current study, the discriminant validity of the PASTA was determined by examining the effect of gender and age-related factor (evaluated as grade level) on the new phonemic awareness measure. Specifically, an ANOVA was performed to investigate the impact of gender (i.e., males vs. females) and grade level (i.e., 3rd, 4th, and 5th grades) on the PASTA total score. The main effect of grade level was significant [$F(2,621) = 11.083$, $p < .0001$, $\eta^2_p = 0.03$], whereas the effect of gender [$F(1,621) = 0.006$, $p = .983$] and the interaction between grade level and gender [$F(2,621) = 0.784$, $p = 0.457$] were not significant. Bonferroni's post hoc tests revealed that the pseudoword–blending skills of the 3rd graders ($M = 9.955$, $SD = 3.793$) were significantly poorer than those of the

TABLE 3 Pearson's correlations between PASTA total score (i.e., PASTA), phonological awareness (i.e., word blending), reading (i.e., MT-accuracy, MT-speed, DDE2-Word-Accuracy, DDE2-Word-Speed, DDE2-pseudoword-accuracy, DDE2-pseudoword-speed), writing (i.e., DDE2-writing), verbal working memory (i.e., digit-span-forward and digit-span-backward), and verbal intelligence (i.e., PMA-verbal) measures, respectively.

	PASTA	p
Words blending	0.500	<.0001
MT-accuracy	−0.301	<.0001
MT-speed	0.430	<.0001
DDE2-word-accuracy	−0.210	<.0001
DDE2-word-speed	−0.351	<.0001
DDE2-pseudoword-accuracy	−0.218	<.0001
DDE2-pseudoword-speed	−0.288	<.0001
DDE2-writing	−0.352	<.0001
Digit-span-forward	0.313	<.0001
Digit-span-backward	0.354	<.0001
PMA-verbal	0.420	<.0001

Abbreviation: PASTA, phonemic awareness of schoolers test assessment.

4th ($M = 10.947$, $SD = 3.692$, $p = .007$) and 5th graders ($M = 11.748$, $SD = 3.02$, $p < .0001$), whereas no statistical differences were found between the 4th graders and those attending the 5th grade ($p = .104$). These results were replicated when an additional ANOVA was conducted to examine the impact of gender and grade on the Word Blending score. The main effect of grade was significant ($F(2,621) = 7.836$, $p < .0001$, $\eta^2_p = .025$), whereas the main effect of gender [$F(1,621) = 0.278$, $p = .598$] and the interaction grade and gender [$F(2,621) = 0.510$, $p = .601$] were not significant. Bonferroni's post hoc tests documented that compared to the 4th graders ($M = 11.47$, $SD = 2.95$, $p = .047$) and the 5th graders ($M = 12.07$, $SD = 2.36$, $p < .0001$), the 3rd-grade group ($M = 10.81$, SD = 3.35) displayed the poorest word-blending skills. Finally, no significant differences were found between pupils attending the 4th and 5th grades ($p = .164$).

3.5 | Predictive validity

Predictive validity was assessed by calculating Pearson's correlation coefficient between PASTA and age. A r score = .20, $p < .0001$ was found.

3.6 | A further analysis

Based on the above-mentioned correlational analysis and the results shown in Table 2, a hierarchical multiple regression analysis was performed to examine whether age, blending, and reading skills of pseudowords predicted performance in the PASTA condition. Age was entered in Step 1, the Word Blending score was entered in Step 2, and the speed and accuracy indices of the DDE-2 Pseudoword Reading test were inserted in Step 3, whereas the PASTA total score was the dependent variable.

Preliminary analyses were carried out to ensure no violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity (tolerance value < 0.10, or a VIF value > 10). After the entry of the predictors in Step 3, the total variance explained by the model as a whole was approximately 30% [$F(4,614) = 66.965$, $p < .0001$]. Table 4 illustrates these results.

3.7 | Normative data

Table 5 reports normative data of Italian pupils attending the 3rd, 4th, and 5th grades on the PASTA.

Based on these normative data and those provided by Marotta et al. (2004), the percentage of concordance in detecting very proficient pupils and those exhibiting the poorest performance (i.e., ≤ 5° percentile) among children attending the 3rd grade was computed. This analysis was limited to 3rd graders because Marotta et al. (2004) did not provide normative data for older children. Overall, a 90.9% concordance between the two assessments was found; that is, 30 out of 33 3rd graders were identified as exhibiting the poorest ($n = 15$) and best ($n = 15$) phoneme blending performance in both tests (i.e., PASTA and Word Blending test). Moreover, the PASTA identified a further three highly proficient pupils (i.e., children showing a performance ≥ 95° percentile in the PASTA condition) who showed average performance according to the normative data provided by Marotta et al. (2004).

4 | DISCUSSION

The aim of this study was to present the psychometric properties of the PASTA in a sample of Italian 3rd-to-5th graders. Overall, several conclusions can be highlighted.

TABLE 4 Summary of the hierarchical regression analysis for pseudowords blending skills assessed through PASTA.

Variable	B	95% CI for B LL	UL	SE B	β	R^2	ΔR^2
Step 1						.04	.04***
Constant	2.596	−0.488	5.679	1.570			
Age	0.073***	0.046	0.101	0.014	.206***		
Step 2						.26	.22***
Constant	−1.012	−3.769	1.746	1.404			
Age	0.047***	0.023	0.072	0.012	.133***		
Word blending	0.573***	0.490	0.655	0.42	.475***		
Step 3						.30	.04***
Constant	3.100*	0.065	6.135	1.545			
Age	0.033**	0.008	0.057	0.012	.092**		
Word blending	0.534***	0.452	0.615	0.042	.443***		
DDE2-pseudoword-accuracy	−0.072*	− 0.126	−0.017	0.028	− .094*		
DDE2-pseudoword-speed	−0.019***	− 0.028	−0.010	0.005	−.156***		

Abbreviations: CI, confidence interval; LL, lower limit; UL, upper limit.
*p < .05; **p < .01; ***p < .0001.

TABLE 5 PASTA normative data differentiated by educational (i.e., grade) level.

	Grade 3	Grade 4	Grade 5
n	225	266	136
Mean score	9.955	10.947	11.748
SD	3.793	3.692	3.02
Median	10	12	13
Skewness	−0.562	−0.767	−0.919
Kurtosis	−0.361	−0.214	o.555
5th percentile	3	4	6
50th percentile	10	12	13
95th percentile	15	15	16

Abbreviation: PASTA, phonemic awareness of schoolers test assessment.

First, both the Kudar-Richardson 20 and test–retest reliability indices demonstrated good internal consistency (i.e., reliability and stability) of the PASTA. In addition, Pearson's correlational analyses documenting significant associations between the PASTA and scores on word blending, vocabulary, verbal working memory, reading, and writing tests, showed the convergent validity of the new phonemic awareness test. Indeed, as expected, the PASTA and a word-blending test developed by Marotta et al. (2004) were correlated with each other, because they both evaluate similar facets of phonological awareness (i.e., the ability to blend phoneme sequences). Moreover, consistent with previous studies (e.g., Duncan et al., 2013; Wagner et al., 1994), significant mutual associations were found between the PASTA measure and some indices of reading skills. Specifically, following Cohen (1988), the magnitude of the relationship between the PASTA index and accuracy and speed in reading a text was found to be medium, whereas the associations between PASTA and further word and pseudoword reading scores were found to be small, that is, *r* was smaller than .30. In this regard, it must be noted that when accuracy in reading was evaluated in terms of errors, the associations were negative, that is, the more mistakes children made in reading a text or a list of words and pseudowords, and the less efficient was their ability to blend phonemes to produce pseudowords. Similarly, the negative associations between the PASTA index and word and pseudoword reading speed scores imply that children who were slower in reading those stimuli also exhibited poorer phonemic awareness.

Therefore, it can be argued that better pseudoword-blending skills of our participants were exhibited by pupils who displayed better accuracy and speed in the phoneme–grapheme correspondence underlying word, pseudoword, and text reading. In addition, proficient reading skills, in turn, shape the ability to reflect on the sounds of the language. In this regard, it must be noted that the current results replicated findings by Kairaluoma et al. (2013) showing small associations between a pseudoword-blending index and some speed and accuracy reading measures in a sample of Finnish adolescents.

In addition, the significant moderate association between the new phonological awareness measure and writing skills shows that participants who were more accurate in producing the correct orthographic representations of homophonic stimuli were also more phonemically aware (Castles et al., 2003). Furthermore, the positive associations between vocabulary knowledge and phonemic awareness scores are explained by the fact that to manipulate sounds during the blending task, one needs to transfer and maintain the sequences of phonemes in the correct order for a short time in the temporary memory system while processing auditory traces to produce output (Siegel & Linder, 1984; Wagner & Torgesen, 1987). Moreover, in line with Tobia and Marzocchi (2014), the PASTA score was positively associated with vocabulary knowledge, perhaps because when children manipulate phonemic units to blend them and speak pseudowords aloud, they try to use their semantic knowledge to perform the task.

Furthermore, the current findings have also documented the discriminant validity of the PASTA, showing that the new test can detect the developmental trend of the phonemic awareness underpinning the blending of pseudowords from the 3rd to the 5th grade. That is, younger pupils showed the worst performance, whereas no statistically significant differences were found between the 4th and 5th graders, perhaps because the development of phonemic awareness is already well developed and consolidated by the age of 9. Overall, the current results extend those reported by Fastame et al. (2018), according to which the PASTA can detect significant differences in terms of pseudowords-blending skills of typically developing pupils and peers with dyslexia attending Italian elementary schools.

Moreover, the outcomes in this study have also documented the predictive validity of the PASTA, as a significant relationship was found between age and the PASTA score.

Finally, the study also documented that age, word-blending skills, and accuracy and speed in reading pseudowords accounted for approximately 30% of the variance related to the new measure of phonemic awareness. Thus, it can be concluded that the PASTA is a reliable and valid tool to evaluate pseudoword-blending skills in Italian pupils. In addition, the PASTA is easy to administer, and its scoring method is fast; therefore, this new tool may be used both in clinical and research settings.

However, some limitations need to be discussed. To date, the reliability and validity of the PASTA have been documented only in typically developing children and in a small sample of Italian pupils with dyslexia (Fastame et al., 2018) attending 3rd to 5th grade. Moreover, no longitudinal evidence has been provided about the predictive validity of the PASTA in identifying 1st and 2nd graders who were later diagnosed as dyslexic. Similarly, following Vender and Melloni (2021), studies conducted to investigate whether the PASTA can discriminate between typically developing monolingual and bilingual pupils and children with dyslexia are lacking. In addition, no studies have been conducted to examine whether the PASTA can be successfully administered to students attending secondary school.

Therefore, future studies should provide evidence for the adequate psychometric properties of the PASTA test as a valuable measure of phonemic awareness of children attending the 1st and 2nd grades. Moreover, future cross-sectional and longitudinal research using the PASTA is needed to examine the developmental trends of school-aged children and to evaluate the predictive validity of the new phonemic awareness test to detect pupils at risk for dyslexia who are attending both primary and secondary schools. Therefore, a related future goal is to provide some normative data to detect poor phonemic awareness skills evaluated through the PASTA measure in children diagnosed as dyslexic. In addition, it would be desirable to replicate the current study with both monolingual and bilingual children, to examine the discriminant validity of the PASTA in those participants. Finally, considering the nature of the stimuli used to evaluate phonemic awareness through our new tool, that is, pseudowords, it would also be desirable for future investigations to examine the usability of the PASTA in other transparent languages, such as Spanish or Finnish. This would favor the usability of this open-source tool for the screening of pseudoword-blending skills in different linguistic contexts.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Research data are not shared. The data that support the findings of this study are not publicly available due to privacy or ethical restrictions.

ETHICS STATEMENT

This study was conducted in conformity with the provisions of the Declaration of Helsinki and its later amendments. The heads of the schools approved the procedure for the data collection and written informed consent was given by the parents of the children enrolled before participation in the study.

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APPENDIX A

PASTA

Pseudoword Blending Test

Instructions

"*Ora ti dirò delle parole che non hanno nessun significato, ma non te le dirò tutte intere, te le presenterò un pezzetto alla volta, suono per suono. Tu dovrai mettere insieme questi suoni nella tua mente e indovinare che parola formano. Dovrai stare molto attento, perché queste parole strane diventeranno sempre più lunghe e io te le posso dire una volta sola. Hai capito cosa devi fare? Sei pronto?*" ["Now I am going to tell you some words that have no meaning, but I am not going to utter them as a whole, I am going to present them bit by bit, sound by sound. You will have to put these sounds together in your mind and guess what word they form. You will have to be very careful because these strange words will become longer and longer and I can only tell them to you once. Do you understand what you have to do? Are you ready?"]

	Item	Notes/response*
Trial	VAB	
Trial	GOC	
		Score 0–1
(1)	RILO	
(2)	TADI	
(3)	MUNA	
(4)	VIFE	
(5)	LARPO	
(6)	DURTA	
(7)	SORZA	

	Item	Notes/response*
(8)	TAMBO	
(9)	TEBACE	
(10)	GORACO	
(11)	NEMISA	
(12)	VORUFE	
(13)	GENOCI	
(14)	BONIPO	
(15)	FIBEVINE	
(16)	BENATORA	
Total score	/16	

*This space can be used for a qualitative assessment (e.g., type of errors made in blending the acoustic units) of the performance.