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BRIEF REPORT

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The relationship between emergent drawing, emergent writing, and visual-motor integration in preschool children

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Abstract

Drawing and writing are two major representational systems with many common aspects. Each also has its own system of rules, characterized by different degrees of visual realism and conventionality. The relationship between them at their emergence and the contribution of perceptual and motor skills to their development have been under-investigated, leading to discordant study results. This study investigated the emergence of the ability to draw and write and the association between these two processes in 3- to 5-year-old preschoolers, controlling for the role played by visual-motor integration ability. A total of 115 preschoolers were tested for drawing and writing tasks and visual-motor integration. Variance analysis, correlation analysis, and covariance analysis were performed. The results illustrated a stable association between drawing and writing in the age range considered, which can be traced to their common representational core. Moreover, the weight of visual-motor coordination is differentiated for the two notational systems.

KEYWORDS
drawing, literacies, preschool, visual-motor integration, writing

Highlights

- Drawing and writing skills share a core of representational and perceptual skills. Their relationship must be further explored, especially with respect to visual-motor skills.

- The results illustrate the correlation between these skills, as well as their autonomy in the visual-motor dimension.

1 | INTRODUCTION

Drawing and invented writing emerge in children between the ages of 2 and 5 years, and these representational systems have many aspects in common (e.g., both bring abstract concepts into a perceptual register, produce artificial marks that appear on a surface, and depict a two-dimensional, visible order in space), as well as specific systems of rules, characterized by different degrees of visual realism and conventionality. The relationship between these systems and the contribution of perceptual-motor skills to their efficiency have been under-investigated, with fragmentary study results. This study addresses the issue of whether emergent drawing and writing are autonomous processes or have a reciprocal effect, as well as whether and to what extent visual-motor integration supports their emergence.

The emergence of drawing and writing and their developmental trajectories in children have been studied primarily within separate lines of research. According to Thomas and Silk (1990), graphic development can be assimilated to the discovery of rules and regularities that underlie the construction of informative and recognizable representations shared by the 'visual' community to which the child belongs. Whenever a child is asked to draw, there is a tendency for the child to rely on canonical schemata for the representation of ordinary objects (e.g., human figures, animals, and buildings) shown from a typical view that best displays their important structural or invariant features. To realize such canonical representations, the drawer must develop a repertoire of simple written signs, the execution of which is suitable for his or her limited graphic abilities and, at the same time, is clearly recognizable to the viewer (Cox, 2005). As children develop, they learn to intentionally deviate from canonicality—to vary the shape, orientation, and articulation of their drawings, adapting them to the different demands to which the graphic representation must respond. This goal is achieved because of the joint contribution of the child's increased cognitive flexibility (Berti & Freeman, 1997) and the maturation of the ability to correctly execute and position on paper signs that are occasionally more articulated and complex (Barrett & Light, 1976), in an environment rich in iconographic models and favourable to the exercise of graphic activity (Burkitt, Jolley, & Rose, 2010).

The written symbol system is a cultural artefact that has evolved and differentiated throughout human history. In recent decades, scholars have paid particular attention to the emergence of time writing ability, labelling this process interchangeably as invented or emergent writing (Whitehurst & Lonigan, 1998) or as invented spelling (Read, 1971). In particular, these scholars document such an ability as one of the most powerful predictors of the subsequent mastery of reading and writing (Pinto, Bigozzi, Tarchi, & Camilloni, 2018; National Early Literacy Panel, 2008). Preschoolers have been proven to be capable of various emergent writing skills, such as writing letters of the alphabet (Clay, 1985), writing their names (Levin, Both-de Vries, Aram, & Bus, 2005), and spelling single words (Puranik, Lonigan, & Kim, 2011). Considering a broad set of preschool children's early writing skills, including their letter-writing, writing, and spelling skills, as well as their knowledge related to the conventions and functions of print, Puranik and Lonigan (2011) highlighted the substantial increase in all writing skills across children aged 3 to 5 years, including an increased number of correctly written letters, word spellings that progressed from the use of the initial letter of a word to invented and correct spellings of words, and increased complexity of descriptive writing (e.g., linearity, segmentation, and the use of letters to represent words).

Studies attempting to overcome this fragmentation have investigated the relationship between the emergence of pictorial ability and the emergence of writing efforts, composing a mixed pattern.

One line of research has provided empirical evidence for the assumption that drawing and writing systems stem from a common core and are closely intertwined, revealing that scribbling was long used as a form of writing before being followed by invented spelling (Coates & Coates, 2006; Goodnow, 1978; Levin et al., 2005; Stetsenko, 1995; Sulzby, Barnhart, & Hieshima, 1988). Furthermore, comparative analyses of scribbles, drawing patterns, and invented writing have revealed a significant relationship between writing and drawing performance in both preschoolers (Yang, & Noel, 2006;

Steffani & Selvester, 2009) and older children (Wu, 2009), suggesting that a writing-specific route does not emerge earlier than 6 years of age and may be a result of practice in formalized writing (Adi-Japha & Freeman, 2001).

Other authors have argued that the differentiation between drawing and writing occurs much earlier in life, or even that the emergence of these abilities is supported by independent cognitive and executive processes. Children as young as 3 years old make different cognitive choices when asked to write versus to draw (Lavine, 1977) and are aware of their different constraints, specifically the constraints that writing is segmentable into a limited number of discrete elements to constitute a closed system, while drawing is a relatively open referential system (Tolchinsky-Landsmann & Karmiloff-Smith, 1992) and requires a separate set of abilities from writing (Treiman & Yin, 2011). In the field of neuroscience, several authors have focused on the role of neuronal maturation and the existence of executive and cognitive differences between writing and drawing. According to Brenneman, Massey, Machado, and Gelman (1996), preschoolers have an 'implicit knowledge of the distinctive features of each notational system as a domain of knowledge' (p. 412) and approach writing and drawing with different plans of action, while Anderson, Damasio, and Damasio (1990) documented the involvement of distinct brain areas for the two abilities. In a recent EEG study, van der Meer and van der Weel (2017) found that drawing by hand activates larger networks in the brain compared to writing.

These divergent pieces of empirical evidence concerning the unique or distinct nature of the processes underlying drawing and writing and their relationship could be clarified by considering the weight that the combination and coordination of both visual perceptual skills and motor skills, known as *visual-motor integration*, may respectively have on the drawing and writing processes.

However, current research on this topic has predominantly focused on the impact of visual-motor coordination on the notational abilities of adults or schoolchildren with neuropsychological problems. Specific information on the role of visuospatial processes in the drawing of typical children is generally derived from observations relating to the accuracy and the order in which single elements are drawn (Ingram & Butterworth, 1989) and from children's ability to generate drawing motions that capture the visual characteristics of shapes (Freyd, 1983). The role of visuospatial representational abilities in drawing competence has also been emphasized in neuropsychological research. Bo, Contreras-Vidal, Kagererm, and Clark (2006) investigated the salience for preschoolers to directly access the visual-motor mapping between the visual signals and motor signals they use to draw, suggesting that the visual-motor internal representation is not yet fully developed in children as young as 4 years old. Meanwhile, Mon-Williams, Waterman, Culmer, and Hill (2015) stress the role drawing plays in one's ability to remember visual shapes and the use of such representations to generate motor activity.

With regard to writing, a few longitudinal studies have highlighted the role of visual-motor skills at preschool age as a predictor of the mechanism of writing (Mäki, Voeten, Vauras, & Poskiparta, 2001; Weil & Cunningham Amundson, 1994). These skills contribute to phonological-orthographic connectivity (Pinto, Bigozzi, Gammannosi & Vezzani, 2012; Read & Treiman, 2013), the perception and production of letter-like forms (James & Atwood, 2009), and handwriting legibility in children attending kindergarten (Daly, Kelley, & Krauss, 2003). However, other studies have questioned the weight of visual-motor skills in predicting handwriting quality (Marr & Cermak, 2002), demonstrating that teaching these skills does not always have a productive effect on handwriting acquisition (Cornhill & Case-Smith, 1996) and that good and poor writers do not differ in their perceptual-motor skills prior to formal writing instruction (Karlsdottir & Stefansson, 2002).

Overall, the picture of the relationship between preschool children's drawing and writing and the influence of visual-motor skills on emergent drawing and writing remains far from definitive. Most evidence on the matter thus far derives from research on older children or children with developmental disorders; the impact of visual-motor coordination on normal developmental presentational processes in preschoolers has been less investigated (Brock, Kim, & Grissmer, 2018).

1.1 | The current study

This study aimed to investigate, in preschoolers, (a) the pattern of relationships between emergent drawing and emergent writing and (b) the role visual-motor integration exerts within this framework.

We expected that between the ages of 3 and 5 years, the skills of drawing and invented writing, as well as eye–motor coordination skills, taken in isolation, would progress significantly. We also expected that emerging writing and drawing would be steadily associated with each other because of their common underlying symbolic core. In addition, we hypothesized that visual-motor coordination may have varying weights on the ability to draw and produce invented writing, given the different measures of development underlying the two tasks.

2 | METHODS

2.1 | Participants

The sample comprised 115 participants ($\text{mean}_{\text{age}} = 4.55 \pm .85$; 56 males and 59 females) from a kindergarten (preschool) in central Italy, divided into three age groups: 30 3-year-olds (from 3 years to 3 years and 11 months), 40 4-year-olds (from 4 years to 4 years and 11 months), and 45 5-year-olds (from 5 years to 5 years and 11 months). The recruited subjects were middle class and homogenous with regard to demographic aspects. Both parents of each participant signed an informed consent form allowing their children to participate in the research activities.

2.2 | Procedure

The children were individually tested in a quiet room within the school building, and the task order was randomized among the participants. The children sat next to the experimenter at a table. The experimenter provided the children with white sheets of paper, pencils, and coloured pencils, then explained the modalities of the tasks by giving them instructions for each task. Six coloured felt tip pens were placed on the table, and the children freely selected the pen(s) with which they would draw or write. The experiment employed drawing- and writing-related production tasks from Levin and Bus (2003) and Yamagata (2007). The children's production was coded by two independent judges.

All examiners were psychologists with training in research and methodology in educational psychology; they received specific training on how to administer the tests included in this study.

All tests were conducted in school during school hours. The principal and teachers agreed with the aims and procedures of the study prior to its commencement. The measures were administered at a time agreed upon with the school and with due adherence to the requirements of privacy and informed consent dictated by Italian law (Law Decree no. 196/2003). Regarding the ethical standards for research, we referred to the latest version of the Declaration of Helsinki (World Medical Association [WMA], 2013).

2.3 | Measures

2.3.1 | Drawing task

Levin and Bus's (2003) drawing task was adopted in this study. First, the children engaged in free drawing to familiarize themselves with the task. The children were then asked to draw eight drawing referents: grass, a sun, a mother, a baby, a flower, three flowers, a father, and a bird. In the free-drawing task, the children were asked to draw anything they wanted. Free drawing was used because children were expected to feel more at ease if they were less restricted. For the referent-drawing task, children were told to 'draw x'. For scoring, we used Levin and Bus's scale, which reflects the number and completeness of elements drawn by a child. The maximum score on this scale was the number of features represented in the drawing. When the referent had a characteristic colour (e.g., yellow for *sun*), position (e.g., the upper part of the page for *sun*), or number (2–3 for *three flowers*), these were also included in a list of relevant features. The minimum obtainable score was 0. The maximum scores for *grass*, *sun*, *flower*, *three flowers*, *mother*, *baby*, *father*, and *bird* were 7, 5, 8, 10, 14, 12, 13, and 10, respectively. The combined scores across stimuli were based on the *z* scores.

Coding was carried out by two independent judges, whose degree of agreement varied from 80 to 100% for the different drawing referents considered. Conflicts were resolved by a third independent judge.

According to Levin and Bus's psychometric properties, the Cronbach's alpha values for drawing ranged from .70 to .94.

2.3.2 | Writing task

Levin and Bus's (2003) writing task was adopted in this study. The task included name writing and the same eight referents used for the drawing task. Children were told to 'write x'. Writing commenced with the children writing their names, as they were most familiar with name writing. According to Levin and Bus (2003), in the writing scale, each written product is assigned a score within a general scheme. We used Levin and Bus's three sequential general schemes: graphic, writing-like, and symbolic. After sorting according to scheme, the written product was scored according to the subscale. The steps within the graphic scheme, scored 0–2, reflect the development of graphic control and range from scribbles to good form. The steps within the writing-like scheme, scored 3–8, reflect the number of writing-like features. The steps of symbolic writing, scored 9–13, range from using numbers or random letters to conventional spelling. The minimum obtainable score was zero for each stimulus. The maximum score was 11 for *babies*, *birds*, and *flowers*; 12 for *three flowers*, *sun*, and *grass*; and 13 for *name*, *father*, and *mother*.

Coding was carried out by two independent judges, whose degree of agreement varied from 80 to 100% for the different writing referents considered. Conflicts were resolved by a third independent judge.

According to Levin and Bus's psychometric properties, the Cronbach's alpha values for writing ranged from .83 to .91.

2.3.3 | Visual-motor integration task

This task utilized the 18 items of the Beery Developmental Test of Visual-Motor Integration (VMI; Beery & Buktenica, 2000) assessment tool. The Beery VMI test involves respondents being presented with a developmental sequence of geometric forms to be copied using paper and pencil. The test was designed to assess the extent to which individuals could integrate their visual and motor abilities (eye–hand coordination). The task was explained to the children in the following manner: 'Now children, try to copy the figures. These figures become increasingly difficult, but do not worry if you do not succeed well; try it all the same'. To code the test, we followed the instructions in the test manual (Beery & Buktenica, 2000). One point was awarded for each correct item.

2.4 | Data analyses

Descriptive statistics (mean, *SD*, minimum and maximum scores, skewness, and kurtosis coefficients) for the total sample and for each class of age (i.e., 3 years old vs. 4 years old vs. 5 years old) were calculated, and the normality of the probability distributions of all of the metric variables (i.e., drawing, writing, and VMI) was checked. When some variables were not normally distributed, that is, when the skewness and kurtosis coefficients were not within the range $-1/+1$, monotonic transformations increased (Thompson, 2004).

Following this, three one-way analyses of variance (ANOVAs) were performed, one for each dependent variable, to explore the presence of significant mean differences between the three age subgroups. For each ANOVA, the eta-squared coefficient was used to estimate the effect size.

Then, correlational analyses were carried out on all metric measures using the Bravais–Pearson linear bivariate correlation coefficient, both for the global sample and for each age subgroup, and Bravais–Pearson linear partial correlation analyses were conducted using VMI as the covariate.

Finally, several analyses of covariance (ANCOVA) were carried out, with writing and drawing as dependent variables, age as an independent categorical factor, and VMI as a covariate. For each ANCOVA, the partial eta-squared coefficient was used to estimate the effect size.

3 | RESULTS

The main descriptive statistics for all of the study's quantitative variables (i.e., drawing, writing, and VMI) are presented in Tables 1 and 2. All metric variables had skewness and kurtosis coefficients between −1 and +1, meaning all of these variables were normally distributed (Table 1).

Regarding the first aim of this study, even with great caution, it is possible to say that the means were sufficiently centred between the minimum and maximum empirical values, and the values of all of the dependent variables seemed to increase with an increase in age (Table 2).

The one-way ANOVAs all had statistically significant results (Table 2). The estimate of the effect size, obtained from the eta-squared coefficient, revealed that the proportion of deviance explained 68% of the total deviance for writing, 53% for drawing, and 67% for VMI. Bonferroni post-hoc tests showed significant differences in all pairwise comparisons between the three age classes (3 years old <4 years old <5 years old) for all three dependent variables.

The Bravais–Pearson bivariate correlation coefficients illustrate the pattern of relationships between emergent drawing, emergent writing, and visual-motor integration for both the global sample and each age level (3 vs. 4 vs. 5 years). The results of the bivariate correlational analyses revealed that, for the total sample, all variables were positively and significantly correlated with each other. Writing was correlated with drawing ($r = .80$, $p < .001$) and VMI ($r = .76$, $p < .001$). Drawing was correlated with VMI ($r = .77$, $p < .001$). For the 3-year-old subjects, writing with drawing ($r = .50$, $p = .003$), drawing with VMI ($r = .47$, $p = .005$), and writing with VMI ($r = .40$, $p = .008$) were positively correlated. For the 4-year-olds, writing was significantly correlated with drawing ($r = .59$, $p < .001$) and VMI ($r = .43$, $p = .006$), and drawing and VMI resulted in mutual correlation ($r = .47$, $p = .005$). Finally, at the age of 5 years, writing was correlated with drawing ($r = .56$, $p < .001$) but not with VMI ($r = .13$, $p = .157$), and drawing was correlated with VMI ($r = .56$, $p < .001$). As in previous research, these results demonstrate that correlational analyses are sensitive to sample size. The coefficients show higher scores in samples with a high number of participants and lower scores in smaller samples (Bonett & Wright, 2000; Faul, Erdfelder, Buchner, & Lang, 2009).

In addition, Table 3 reports a partial correlation, considering VMI as the control variable. For the total sample and the three different sub-samples, the results were the same as those obtained for the bivariate correlations: The correlation between writing and drawing was significant, with coefficients between .45 and .55.

Moreover, the results obtained in the ANCOVA models with regard to the interaction between age and VMI were mainly the same: Age was a significant predictor of writing, $F\ (2, 109) = 4.00$, $p = .043$, $\eta^2 = .068$, and drawing, $F\ (2, 109) = 3.09$, $p = .032$, $\eta^2 = .054$. Meanwhile, VMI was identified as a significant covariate of writing, $F\ (1, 109) = 7.73$, $p = .003$, $\eta^2 = .066$, and drawing, $F(1, 109) = 26.21$, $p < .001$, $\eta^2 = .194$. However, there was no

TABLE 1 Descriptive statistics of all metric variables (drawing, writing, and VMI) for the total sample: mean, *SD*, minimum and maximum scores, skewness, and kurtosis coefficients

Variable	M	*SD*	Min	Max	Skewness	Kurtosis
Drawing	0	1	−2.27	1.82	−.579	−.491
Writing	8.81	3.57	0	13	−.973	−.234
VMI	10.63	4.10	0	18	−.340	−.605

Abbreviation: VMI, visual-motor integration.

TABLE 2 Descriptive statistics of all metric variables (drawing, writing, and VMI) for each age class: number of participants (*N*), mean, *SD*, minimum and maximum scores, F score, and effect-size coefficient eta-squared

Variable	$Age_{(years)}$	N	M	SD	Min	Max	$F_{2,112}$	η^2
Writing	3	30	4.04	2.81	0	9.67	120.82***	
	4	40	9.56	1.86	2.56	12.78		.683
	5	45	11.34	1.47	5.11	13		
Drawing	3	30	−1.11	.87	−2.27	.67	63.30***	
	4	40	.02	.61	−1.90	.93		.531
	5	45	.72	.62	−1.43	1.82		
33VMI	3	30	5.4733	2.33	0	11	113.05***	
	4	40	10.83	2.30	6	17		.669
	5	45	13.89	2.48	6	18		

***$p < .001$.

TABLE 3 Correlational analyses between all metric variables (writing and drawing) for the total sample and each sub-sample, controlling for the covariate *VMI*: Bravais–Pearson linear partial correlation coefficients

Sample/sub-sample	Variable	Drawing
Total sample	Writing	.53***
3 y/o	Writing	.50**
4 y/o	Writing	.55***
5 y/o	Writing	.45**

**$p < .01$; ***$p < .001$.

TABLE 4 Summary of analysis of covariance with writing as the dependent variable, age as the independent categorical factor, and VMI and the interaction between age and VMI as covariates: sum of squares (SS), degree of freedom (*df*), mean of squares (MS), Fisher's *F*, *p*-value, and partial η-squared

Source	SS	df	MS	F	p	Partial η^2
Intercept	203.82	1	203.82	52.23	<.001	.324
Age	31.22	2	15.61	4.00	.021	.068
VMI	30.16	1	30.16	7.73	.006	.066
Age*VMI	1.37	2	.69	.18	.224	.003
Error	425.30	109	3.90	—	—	—

Note: R^2 – adjusted = .69, $p < .001$.

interaction between age and VMI when the dependent variable was drawing or writing. The total variance explained by the models was 69% for writing and 61% for the covariance model of drawing (Tables 4 and 5).

In particular, regarding the ANCOVA reported in Table 5, the absence of a significant interaction between age and VMI suggests that the predictive impact of VMI on drawing is statistically the same among the different age groups. The effect size of the principal effect of VMI for drawing ($\eta^2 = .194$) was significantly higher than that for writing ($\eta^2 = .066$), F (1, 109) = 18.48, $p = .234$.

Controlling for the VMI score, the Bonferroni post-hoc analyses showed that, for writing, the mean differences were between 3 and 4 (3 < 4; $p < .001$) and between 3 and 5 (3 < 5; $p < .001$) years old, whereas there were no differences in drawing.

TABLE 5 Summary of analysis of covariance with drawing as the dependent variable, age as the independent categorical factor, and VMI and the interaction between age and VMI as covariates: sum of squares (SS), degree of freedom (*df*), mean of squares (MS), Fisher's *F*, *p*-value, and partial η-squared

Source	SS	*df*	MS	*F*	*p*	Partial η^2
Intercept	10.60	1	10.60	27.35	<.001	.201
Age	2.40	2	1.20	3.09	.049	.054
VMI	10.16	1	10.16	26.21	<.001	.194
Age*VMI	1.04	2	.52	1.34	.101	.024
Error	42.24	109	.39	—	—	—

Note: R^2 – adjusted = .61, $p < .001$.

4 | DISCUSSION

This study investigated the association between drawing and writing in 3- to 5-year-old preschoolers, considering the role of visual-motor coordination.

At first glance, the results confirmed the expectation, based on the literature, that 5-year-olds would draw and attempt to write significantly better than 4-year-olds, who in turn would perform better than 3-year-olds, and that a similar progression would occur with regard to their visual-motor skills. The marks left by a 3-year-old child on paper are essentially scribbles. In the drawings of 4-year-olds, well-defined forms begin to appear, organized according to appropriate spatial relationships, and are considered to be clear. When the child is 5 years old, drawings become richer in detail and have more refined strokes, with depicted objects assuming their canonical features. In regard to writing, from the scribbles of 3-year-olds, peculiar wavy lines or linear sequences of undifferentiated vertical strokes emerge; 4-year-olds begin to present letter-shaped forms, confined in number, segmentation, and linearity; and at age 5, an awareness emerges that signs should vary in number and pseudo-shape with the length and type of sounds into which the word can be spelled. A considerable improvement was also observed in the ability to trace geometric shapes that are increasingly better configured, complete, well-proportioned, and accurately placed in relation to each other (Best & Miller, 2010).

Concerning the first aim of the research, the results revealed a significant relationship between drawing and writing in all age groups considered, highlighting the commonalities and interdependencies between these symbolization processes. Drawing and writing share several characteristics: They leave visible marks, unlike what occurs with speaking, and they are both symbolic systems—that is, systems in which significance stands in place of meaning. Meanwhile, these symbolic systems differ in several other aspects, primarily in the specific graphic 'vocabulary' applicable to each and in the grammar that links the various graphic equivalents together—in other words, in their degree of arbitrariness and conventionality. As a child practice each of these systems, he or she learns what they have in common and what makes them different: which sign fits for a drawing, which one is appropriate for writing, in what order the elements of a drawing should be, and how letters should be arranged in space. This learning by comparison, grasping similarities and differences, is fundamental to abstract thought. It allows one to make analogies and apply inferences between superficially unlike domains and underlies appreciation of invariances (Goswami, 2001), suggesting that domain-general components of the cognitive system support the developmental interplay of drawing and writing.

Regarding our second aim, the expectation that visual-motor integration would have a relevant but different predictive power for drawing and writing as a child age was also confirmed: Visual-motor coordination proved to be crucially associated with drawing for 3-, 4-, and 5-year-old children (Toomela, 2002). In the executive process of drawing, both younger and older children portray better, accurate, and realistic products the more they master the pictorial equivalents of the represented concepts. This is done in a continuous interplay between the skills of conceiving and planning the drawing and the skills of executing it in an adherent way to the project.

In the case of invented writing, the contribution of graphical-motor skills is evident, especially in the early stages, when the child is around the age of 3 or 4 years; at 5 years old, this association declines. The different weights of eye–motor coordination for drawing and writing can be traced back to the different characteristics of the two systems and, in particular, to their different degrees of conventionality and arbitrariness. Indeed, while drawing is largely guided by the principle of maximum similarity and recognizability between the signifier and the signified, between the figure outlined on paper and its real appearance, this is not the case for writing. Writing has no resemblance to the object it represents. The signs from which it is composed are, in fact, arbitrary and conventional, reduced in number (particularly in the alphabetic system), and must recur, with forms as similar as possible in the flow of writing. Improving writing inventing does not mean writing pseudo-letters in beautiful handwriting but rather grasping the correspondence between the sounds of which the oral words are composed and the quantity and quality of the signs to be traced on paper.

If, on the one hand, writing and drawing have in common the fact that their execution cannot be separated from the execution of precise motor schemes, visual-motor coordination is put at the service of different needs and results in each of the two activities. To progress in his or her pictorial ability, a child must be able to create graphic signs or pictorial equivalents that are increasingly complex and finely articulated; in drawing the mouth, for example, the child should progress from creating it with a simple line or circle to endowing it with increasingly realistic and specific details (e.g., the lips, teeth, and curvature to express different emotions). To do so, he or she needs increasingly greater graphical-motor abilities (Cannoni, Pinto, Bombi, 2021). On the other hand, progress in invented writing consists of the elaboration of forms closer to the norms that conventionally link orality to writing, and not of the execution of letters better drawn from a figurative perspective. Particularly in alphabetic languages, writing is based on a biunivocal correspondence sound sign. Therefore, the child, to reach increasing levels of competence, will need to control the number of signs he or she draws, their linear arrangement, and the spacing between groups of signs. Thus, the pseudo-letters that the child executes need not be particularly well drawn, nor is the refinement of the stroke or the appropriateness of the dimensions important.

Altogether, these findings (which are to be taken with caution, as a true developmental perspective would benefit from a longitudinal research design) suggest that drawing and writing abilities need both representational and perceptual competencies to develop properly, mainly at their first appearance. As maturation and experience progress, the effort required to understand how alphabetic writing works is primarily cognitive. What needs to be refined is the understanding of the specific correspondence mechanism that links the composition of written words with the properties of their oral formulation: recursiveness of sounds, length, and so on. These are highly conventional and arbitrary rules of transcription, for which the availability of particularly accurate or differentiated graphic traits is of minor importance, while the contribution of educational experiences and opportunities comes to the fore.

4.1 | Limitations

As previously mentioned, the results should be taken with caution, as a true developmental perspective would benefit from a longitudinal research design; however, the age between 3 and 5 years is confirmed here as a scenario of great interest for research on symbolic and notational skills.

Given the relationship between gender differences and motor development, as suggested by Singh, Dhanda, and Shanwal (2010), future research may also consider gender as a covariate.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Giuliana Pinto: Conceptualization; funding acquisition; methodology; project administration; supervision; writing – original draft. **Oriana Incognito:** Conceptualization; data curation; methodology; writing – original draft.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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