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Developing drawing skill: Exploring the role of parental support and cultural learning☆

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A B S T R A C T

Learning to draw is an important developmental milestone that most children achieve during their preschool years. Primary caregivers play a significant role in supporting this process, which may affect the pace of acquisition and subsequent unfolding of drawing ability. In this study, we aimed to investigate parental support in the context of children's drawing activity, complemented by quantifying the effects of four individual factor constructs of parental support for drawing. Our sample comprised 68 parent-child dyads with children aged 3.0–6.9 years. Parents completed an online survey about actions related to promoting the drawing abilities of their child, while children's drawing skill was measured with the Beery-Buktenica Test of Visual-Motor Integration. Contrary to our initial prediction, we found that parental support as a construct had no significant effect on children's drawing skill. However, the component Scaffolding was positively associated with enhanced drawing skill. These results have important theoretical implications for understanding skill development within a cultural learning framework, and open up practical applications for art education and developmental studies.

1. Introduction

Is the early development of drawing skill influenced by the social environment? If so, how? The current literature suggests that parental attitudes are one factor that affects the acquisition and quality of drawing in young children. Yet, the types and effectiveness of the strategies used by parents to elicit children's drawing behavior have remained relatively overlooked by researchers, especially among preschool-aged samples. Our study is the first to directly quantify parental support for drawing in early childhood (3–7 years of age), rendering our findings relevant to theoretical, methodological, and educational discussions surrounding the ontogeny of

☆ All relevant data will be made available via the Dutch repository https://dataverse.nl/

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drawing.

Drawing, or the ability to purposefully create discernible marks on a surface (de Groot et al., 2023; Martinet et al., 2021), is one of the most unique human behaviors. Like language, drawing is a mode of communication and a cognitive tool that from an early age allows us to interact with others, to think, to learn, to remember, and to solve problems (Brooks, 2009; Callaghan, 2020; Fan, 2015). But unlike language, drawing typically incorporates extrasomatic materials, i.e., a support and a drawing implement, like paper and pencil. For that reason, in addition to cognitive capacities, drawing recruits specific technical and motor abilities such as manual dexterity and precise tool use (Lin et al., 2015).

The material aspect of drawing means that its products may be preserved and shared over time, ranging from a few minutes to millennia. The earliest archaeological evidence of drawing behavior in our species comes from objects bearing incised and painted geometric patterns dating as far back as 77,000 years (Henshilwood et al., 2018). By 44–35,000 years ago, people were drawing realistic renditions of animals that today offer us a window into the minds and environments of the remote past (Aubert et al., 2014, 2019; Clottes & Arnold, 2003). What is more, recent archaeological evidence suggests that also pre-modern hominins such as *Homo erectus* (Joordens et al., 2015) and Neanderthals (Hoffmann et al., 2018; Rodríguez-Vidal et al., 2014) might have engaged in drawing behavior.

Comparative psychology research also has shown that, initially incentivized by humans, captive monkeys and great apes can and will voluntarily make non-representational drawings (Martinet & Pelé, 2021). Specially, chimpanzee drawings have been found to display some intentionality and direction, on a par with those of young human children (Martinet et al., 2021, 2023; Saito et al., 2014). Nevertheless, intentional mark-making does not seem to develop naturally in wild populations of non-human primates (or has not yet been observed). Furthermore, despite the repeated attempts of trainers, captive great apes seem unable to make representational drawings, suggesting that iconicity might require uniquely human motor and cognitive capacities (Callaghan, 2005; Saito et al., 2014; Seghers, 2014). In brief, even if certain aspects of drawing are likely shared with great apes and perhaps other primates, some traits required for its production appear to be unique to the human lineage. Tentatively, the latter may entail visuomotor coordination abilities related to precise tool grasping and manipulation, as well as social cognitive abilities such as joint intentionality and perspective-taking (Rakoczy et al., 2005; Saito et al., 2014; Westphal-Fitch & Fitch, 2015). The summary above seems to imply that the foundational capacities for drawing have a deep phylogenetic history in our genus, and have served as the basis of all modern forms of visual art practices and graphic communication (Cohn, 2012; Dissanayake et al., 2016; Fan et al., 2023; Salagnon et al., 2022).

Nowadays, drawing is one of the most common activities that young children undertake in many communities around the world (Cameron et al., 2020). Learning to draw usually starts between the second and third years of life (Callaghan, 2020; Restoy et al., 2022). As the main facilitators of drawing activities during the preschool years, the role of parents is fundamental to the early development of drawing (Burkitt et al., 2010). For that reason, it is crucial to gain a better understanding of the circumstances that determine how and to what extent parents invest in helping children foster drawing abilities.

1.1. *Defining parental support for drawing*

Exploring parental support has become part of recent efforts to learn about the influence of the social context on the acquisition of drawing skill (Restoy et al., 2022). By parental support for drawing, we refer to the attitudes and actions adopted by parents to promote their child's drawing engagement and performance (de Groot et al., 2023).

The effects of parental support have been thoroughly investigated in several developmental domains such as children's academic performance (Boonk et al., 2018; Jaiswal & Choudhuri, 2017) and sports activities (Bremer, 2012), but few studies on this topic have targeted drawing behavior in particular. Those that have, suggest that adult participation increases children's drawing frequency and quality (Anning, 2002; Burkitt et al., 2010; Huntsinger et al., 2011), and that parents tend to encourage drawing in their children through different actions such as providing drawing supplies, drawing together, and offering instruction and praise (Cameron et al., 2020; Rose et al., 2006). Other than these reports, strategies of parental support for drawing have been under-researched.

The absence of studies on social support for drawing among children of preschool age is particularly striking, since this stage corresponds to a critical period that includes the onset of several drawing-related milestones (Niklas et al., 2016). Between 2 and 4 years of age, children learn to manipulate tools and to direct and sustain attention to the production of marks (scribble-to-drawing transition). From the fourth year up to the start of formal schooling (primary or elementary school equivalent), generally around ages 6–7 (Suggate, 2009), children develop their understanding and use of symbolism in the pictorial domain, reflected on the transition from intellectual to visual realism (Callaghan et al., 2012; Fang et al., 2017; Kirkham et al., 2013; Restoy et al., 2022; Simpson et al., 2019). Thus, to better outline the ontogeny of drawing, more attention should be paid to preschool-aged children (ages 2–7) as once kids start primary education, drawing skill usually becomes standardized, thereby minimizing inter-subject differences (Anning, 1999; Happé & Vital, 2009; Restoy et al., 2022).

1.2. *The present study*

Our study aimed to quantify strategies of parental support for drawing in children up to 7 years, which is the age at which they usually start primary school in the Netherlands, where the research took place (for an explanation of the Dutch school enrollment system, see: Oosterbeek et al., 2021). We defined drawing skill as the extent to which one is able to produce an intended mark (de Groot et al., 2023; Martinet et al., 2021). This differs from traditional studies in which drawing ability is measured according to the degree of visual realism of finished drawings (e.g., Simpson et al., 2019). Recently, the primacy given to Western-style realism as the ultimate goal of learning to draw has been challenged by researchers pointing out that proficiency in drawing rather aligns with mastering the representational conventions inherent to one's particular culture, which may or may not include realism (Cohn, 2012; Drake & Winner, 2010; Fan et al., 2023; Restoy et al., 2022). We therefore focused on the *skill* to create an intended drawing and subsequently, on whether and how parental actions affect that skill.

Given that we deemed representational realism as an inadequate indicator of drawing skill, we looked for an alternative measure. It is well established that drawing ability improves as hand-eye coordination develops throughout childhood (Cohn, 2012; Simpson et al., 2019). Children between 2 and 3 years of age normally produce only haphazard marks best known as scribbles (Jolley & Rose, 2008; Restoy et al., 2022). As they learn to control and synchronize their gaze and hand movements, and become more accomplished tool users, children also get better at expressing content intentionally in drawings (Lin et al., 2015; Simpson et al., 2019; Toomela, 2002). The efficient coordination of the visual and motor systems involved in manual dexterity constitutes a fundamental component of drawing ability (Beery & Beery, 2010; Riggs et al., 2013). Consequently, visuomotor integration, or "the degree to which visual perception and finger-hand movements are well coordinated" (Beery & Beery, 2010, p.13), presented an appropriate measure of drawing skill, which was assessed with the Beery-Buktenica Developmental Test of Visual-Motor Integration, also known as 'Beery VMI' (Beery & Beery, 2010).

To investigate whether and how parental involvement related to developing children's drawing skill, we employed the Parental Support for Drawing Questionnaire, or PSDQ (de Groot et al., 2023), which comprises four scales: Resource Support, Joint Drawing, Scaffolding, and Praise. This questionnaire is designed to measure general parental support for drawing, as well as its four individual components, which are described in more detail in the methods section (for a comprehensive explanation of the PSDQ, see: de Groot et al., 2023).

To control for the general home learning situation, we also applied the Home Learning Environment Questionnaire, or HLE (Niklas, 2015). This entails all aspects of the home environment which support children's overall development and learning. The HLE has been shown to be a significant predictor for early competencies, including literacy and numeracy (Melhuish et al., 2008; Niklas & Schneider, 2017).

Our study was guided by two research questions, examining: a) the extent to which the construct of parental support contributed to children's drawing skill. We expected to find a positive correlation between parental support, as measured by the PSDQ, and children's age-appropriate visuomotor integration, as measured by the Beery VMI scores, even after controlling for the overall home learning environment, as measured by the HLE (Hypothesis 1). And, b) the extent to which each of the four components of parental support for drawing (Resource Support, Joint Drawing, Scaffolding, Praise) made a unique contribution to children's VMI score. Because this second question was exploratory, no specific hypotheses were put forward given the lack of literature regarding the role of the individual components of parental support in children's drawing skill. This study was not preregistered. All relevant data concerning this study is available via the online repository Dataverse.nl.

Table 1
Primary Demographic Information.

Variables	Mean (SD)	Frequency	Percentage
Educational institution			
School 1 (DS)		34	50.0%
School 2 (DS)		15	22.1%
School 3 (IS)		19	27.9%
Children			
Age (months)	64.9 (9.2)		
36-47		4	5.9%
48-59		16	23.5%
60-71		31	45.6%
72-83		17	25.0%
Gender			
Female		35	51.5%
Male		33	48.5%
Parents			
Age (years)			
30-35		20	29.4%
36-40		31	45.6%
41-45		16	23.5%
46-50		1	1.5%
Gender			
Female		49	72.1%
Male		19	27.9%

Note. This table depicts the demographic information of the children (n = 68) and parents (n = 68). DS = Dutch School; IS = International School.

2. Methods

2.1. Participants

Participation was voluntary and anonymized. Prior to data collection, the study received the approval of the Ethics Committee of Leiden University.

2.1.1. Children

A total of 73 children of preschool age were recruited for the study. The number of participants was estimated through a power analysis (G*power 3.1), according to which a projected sample size of $N = 74$ was required for an effect size of $f2 = .15$, with a power = .95 and an $\alpha = .05$ (Faul et al., 2009). All participants were enlisted by their parents through their kindergarten or preschool. Inclusion criteria were listed as (i) being 2 to 7 years old; (ii) being pre-literate; and (iii) having parental consent to participate. Exclusion criteria were stated as (i) attending the equivalent to first grade of primary school, and (ii) with visual, developmental, or physical disabilities, in compliance with the Beery VMI administration protocol. A total of five participants were excluded due to (a) absence on the testing day (=3); (b) unidentified child (=1); and (c) exhibiting visual difficulties (=1). Thus, the final sample consisted of 68 children (35 girls, 33 boys) aged 3.0 to 6.9 years (M= 5.41, SD=.77) (see Table 1).

2.1.2. Parents

74 parents completed the survey, which comprised informed consent, two questionnaires (PSDQ and HLE), and supplementary demographic information (see Table 1a). Parents were required to meet the following criteria: (i) being the parent or primary caretaker of a participating child, and (ii) being 16 years of age, or older. Because our populations represented a dependent sample, only the responses from the parents of the 68 participating children (49 female, 19 male) were included in the data analysis (see Table 1). Accordingly, a total of six respondents were excluded due to: (a) the exclusion of their child from the study for the reasons specified above (=5); and (b) both parents completing one survey form (=1).

2.2. Measures

2.2.1. Drawing Skill

To assess children's drawing skill we administered the short form of the Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI 6th edition, Beery & Beery, 2010). This short version of the test can be completed within ten minutes and is suitable for ages 2 through 7 (Beery & Beery, 2010). The assessment requires participants to copy 21 geometric shapes of ascending difficulty, starting with a single line and ending with an arrangement of figures, using a pencil and paper. In line with the testing protocol, the first three test items (vertical line, horizontal line, circle) are demonstrated by the evaluator. Children under 5 years get started by imitating the examiner's drawings, while older children start directly with the copying task. Next, the child copies the printed test items on their own. The test ends in the event of three consecutive errors or at completion. The evaluator grants one point

Table 1a
Secondary Demographic Information.

Variables	Frequency	Percentage
Children		
Nationality		
Dutch	49	72.1%
Indian	17	25.0%
Other	2	2.9%
Education		
Nursery	4	5.9%
Kindergarten	64	64.1%
Parents		
Nationality		
Dutch	48	70.6%
Indian	17	25.0%
Other	3	4.4%
Highest level of education		
High school	2	2.9%
Technical education	3	4.4%
University bachelor	33	48.5%
University Master/Doctorate	29	42.7%
Other	1	1.5%
Occupation		
Full-time	30	44.2%
Part-time	36	52.9%
Other	2	2.9%

Note. This table depicts additional demographic information of the children (n = 68) and the parents (n = 68).

for each item copied correctly (i.e., raw score). According to the official instruction manual, the total raw score is obtained by adding the number of correctly drawn items, with a higher score reflecting better performance. The raw score is then translated into a standardized norm score which is adjusted for age, following the table provided in the manual (Beery & Beery, 2010). The standard score places the subject on a scale above, below, or within the average that corresponds to their chronological age, disclosing the child's current level of development (Crotty & Baron, 2011). The Beery VMI has been standardized and normalized several times over the years, with the stability of outcomes by age group showing good psychometric properties (Coallier et al., 2014).

The Beery VMI presents several advantages over other tests. For one, it is cross-culturally applicable (Pereira et al., 2011). Second, it focuses on the motor and perceptual skills involved in drawing rather than on content or meaning, unlike tests based on iconic stimuli such as the 'Draw-A-Person test' (Huntsinger et al., 2011). Moreover, previous research has indicated that during childhood, copying tasks involve similar cognitive skills, working memory, visuo-spatial perception, and mental representation abilities as free drawing (Senese et al., 2015). Third, the simple shape-copying task of the Beery VMI means that it can be implemented from the age of 2, making it suitable for testing drawing skill in children of preschool age. This allowed us to measure individual differences prior to the influences of formal schooling, which in the Netherlands begins in the '3rd grade', usually by age 7 (Oosterbeek et al., 2021), and the irreversible impact of literacy on visuomotor integration (Dehaene et al., 2010). Finally, because the Beery VMI measures the same ability across age groups, it made it possible to test preschoolers of various ages as a cohort, irrespective of their developmental stage (Beery & Beery, 2010; Coallier et al., 2014; Crotty & Baron, 2011; Ng et al., 2015).

2.2.2. Parental support for drawing

To investigate how different types of parental support relate to visual-motor integration, we implemented the Parental Support for Drawing Questionnaire (PSDQ; de Groot et al., 2023). This questionnaire consists of 14 items that predominantly assess four types of parental support: Resource Support, Joint Drawing, Scaffolding, and Praise. The Resource Support scale (items 1–4) refers to the provision of the drawing utensils, time, and space needed for the child's drawing activities. The literature suggests that greater availability of, and access to these resources increases children's drawing opportunities (Huntsinger et al., 2011; Ring, 2006). The Joint Drawing scale (items 5–8) concerns activities where parent and child engage in drawing together, or where the parent is present during the child's drawing activity. Several studies show that drawing with a parent enhances children's interest, enjoyment, and exploration (Anning, 2002; Burkitt et al., 2010; Kindler, 1995). The Scaffolding scale (items 9–11) examines parental behaviors aimed at improving the child's drawing skills, including parental demonstration (item 10) and verbal instruction (item 11). Modeling and guiding drawing behavior are consistently reported as a strategy of parental support for drawing, which increases drawing frequency and children's understanding of drawing as a communication tool (Anning, 2002; Callaghan, 2005; Kindler, 1995). Lastly, the Praise scale (items 12–14) relates to giving praise during or after the drawing activity. Verbal or implicit praise by the parents (e.g., displaying the child's drawings) can build up children's drawing confidence and encourage creativity (Burkitt et al., 2010; Huntsinger et al., 2011). The survey answer options are presented on a seven-point Likert scale ranging from 'never' (0) to 'all the time' (6). This instrument thus, not only captures overall parental support in the context of drawing, it also brings to light the specific contributions of each individual support strategy (de Groot et al., 2023).

2.2.3. Demographic information and home environment

To control for the specific circumstances of each parent-child dyad that could potentially influence how children developed drawing skill (Burkitt et al., 2010; Harkness et al., 2011; Huntsinger et al., 2011; Lim et al., 2015), we collected information from parents regarding their age, nationality, gender, socioeconomic status (i.e., occupation, income, education level), and perceived drawing ability; as well as their child's age and gender (Table 1 & Table 1a).

The general situation of the home was assessed through the short form of the Home Learning Environment Questionnaire (HLE; Niklas et al., 2016). This instrument consists of 12 items covering all aspects of home life that facilitate children's learning, including formal and informal learning frequencies. The HLE survey requires parents to quantify the times per week that they engage with their kids in joint activities, e.g., reading, drawing, and playing. The raw score is obtained by adding up the total number of days per item, with a greater number of days indicating higher learning frequencies and thus a higher-quality HLE (Niklas et al., 2016). By adding the HLE as a covariate (control variable), we were able to determine whether the Parental Support for Drawing Questionnaire scale was a better predictor of VMI score than the more general Home Learning Environment.

2.3. Procedure

Data collection was carried out in collaboration with three educational institutions recruited by the research team, two Dutch schools and one international school. The study consisted of two stages. The first stage was completed online and involved recruiting the participants, obtaining consent, and filling out the parental survey. The second stage involved the in-person administration of the Beery VMI test to the participating children.

2.3.1. Stage 1

Parents were recruited through an online invitation from the school, which contained information regarding the study and a Qualtrics link. If interested, the parents could access the survey by clicking on the link. First, candidates were required to provide informed consent for themselves and the child under their guardianship, followed by confirmation of the inclusion criteria. If the parent did not provide informed consent or did not meet the inclusion criteria, the form closed automatically. Otherwise, they were asked to provide their name and email address to validate their identity before being forwarded to the questionnaires. The survey was split into two parts, consisting of the PSDQ and the HLE respectively. Finally, parents provided demographic information, received a debriefing, and a thank you notice for their participation. They also had the option to leave feedback.

2.3.2. Stage 2

The second stage of the data collection required two researchers to visit the partnered educational institutions to administer the paper-based Beery VMI to the children in person. The testing sessions took place in an empty classroom which was set up following a pre-approved research protocol. As the data was collected during the Covid-19 pandemic, special hygiene measures were implemented to guarantee the safety of the children, school staff, and researchers. In accordance with the Covid-19 regulations by Leiden University, these measures included regular disinfecting of surfaces and materials, room ventilation, keeping a safe distance, and wearing a face masks (for the adults).

Each child was individually picked up from their classroom by the researcher and guided to the testing location. Once in place, participants were told they would play a drawing game. They were instructed to sit centered with respect to the table and to hold the testing manual with one hand. When ready, the Beery VMI was carried out in accordance with the administration protocol (Beery & Beery, 2010). Testing generally took between 5 to 10 min per participant. The test came to an end if the child exhibited three consecutive errors, or when they finished copying all items. Upon completion, the child was rewarded with a multicolor pencil and a small novelty eraser before being escorted back to their classroom. Immediately after, the evaluator scored each form following the official Beery VMI 6th edition manual (Beery & Beery, 2010).

2.3.3. Statistical analyses

The separate data sets from stage 1 and stage 2 were merged into one file, which was then imported to IBM SPSS 27, where the statistical analyses were ran.

First, a series of correlation analyses were conducted to examine the relations between the dependent variable (i.e., VMI score) and the demographic variables (i.e., children's age and gender; parents' age, gender, socioeconomic status, and drawing ability). Because the VMI measures a developmental ability, the test results were expected to relate to chronological age and the scores would tend to increase with age (Ng et al., 2015). Our preliminary analyses showed that children's age ($r = -.24$, $p = .050$) and gender ($r = -.34$, $p = .005$) were correlated with the VMI scores. Therefore, the children's age and gender were added to the subsequent regression analysis as a control variable, together with the HLE.

Second, to answer the research question, a hierarchical multiple regression analysis was conducted. In this analysis, children's VMI score was the dependent variable, while the independent variables were added step by step to the model, based on a priori criteria to examine the relative explanatory power of the variables. Hence, in the first model, the control variables, i.e., children's age, gender and HLE, were entered. In the second model, the four types of parental support for drawing, i.e., Resource Support, Joint Drawing, Scaffolding, and Praise, were further added to model 1, to examine the extent to which parental support could explain children's VMI on top of the control variables. When the R square value significantly increased in model 2 compared to model 1 according to F tests, parental support was considered to have a significant contribution.

Prior to the statistical analyses, normality, multicollinearity, homoscedasticity, linearity, and outliers in the data were checked, to examine if the assumptions for regression analyses were met. The dependent variable (i.e., VMI score) was shown to be normally distributed as the Shapiro-Wilk test was non-significant, $W(68) = .98$, $p = .335$. The absence of multicollinearity between the predictors (i.e., children's gender, HLE, and the four types of parental support) was established, as none of the correlations had a r coefficient $> .9$ (Mason & Perreault, 1991) and tolerance values of $< .10$ (O'brien, 2007). By inspecting the scatterplot of standardized residuals, the assumptions for linearity, homoscedasticity, and the absence of outliers were confirmed to be met as well, as an approximately rectangular shape was observed (Osborne & Waters, 2002) with absolute values < 3 (Tabachnick & Fidell, 2013). Thus,

Table 2
The regression model for examining the contribution of parental support to children's visuo-motor integration (VMI).

	VMI scores		
	b	*t*	*p*
Step 1	*$R^2 = .14$, $F(3, 64) = 3.58$, $p = .019$*		
Intercept	119.57	14.52	< .001
Children's age	-.18	-1.49	.142
Children's gender	-5.50	-2.54	.014 *
Home learning environment	.01	.11	.911
Step 2	*$\Delta R^2 = .08$, $F(4, 60) = 1.52$, $p = .207$*		
Intercept	117.96	11.67	< .001
Children's age	-.14	-1.18	.242
Children's gender	-5.42	-2.44	.018 *
Home learning environment	-.04	-.50	.620
PSDQ Resource support	-.17	-.51	.613
PSDQ Joint drawing	-.33	-.96	.340
PSDQ Scaffolding	1.02	2.36	.022 *
PSDQ Praise	.10	.26	.794

Note: PSDQ = Parental Support for Drawing Questionnaire.
* $p < .05$. * * $p < .01$.

the data was deemed suitable for conducting regression analyses.

3. Results

The hierarchical multiple regression analysis, with the VMI scores as the dependent variable, was conducted with two models. In model 1 only the control variables, i.e., children's age, gender and HLE, were entered. In model 2 the four types of parental support, i.e., Resource Support, Joint Drawing, Scaffolding, and Praise, were further added alongside the control variables. Results showed that adding the four parental support types in model 2 did not explain more variances of children's VMI scores than model 1, $\Delta R^2 = .08$, $F(4, 60) = 1.52$, $p = .207$ (see Table 2). This suggested that parental support as a whole did not significantly contribute to children's VMI scores, rejecting Hypothesis 1. Further, by inspecting the regression coefficients, we found significant effects from children's gender, $b = -5.42$, $p = .018$, and from Scaffolding, $b = 1.02$, $p = .022$. No other effects were noted. These findings showed that boys had an overall lower VMI score than girls, and that parents' scaffolding behaviors for drawing had a unique contribution to children's VMI scores.

An additional inspection on the four types of parental support showed that when supporting their child's drawing skills, parents used these strategies with significantly different frequencies, $F(2.71, 181.31) = 116.80$, $p < .001$. Praise was used more than Resource Support, which was used more than Joint Drawing, and Scaffolding was the least frequently used (all adjusted $ps < .001$; see Table 3).

4. Discussion

Parental support has been identified as a highly relevant factor in the development of children's cognitive, academic, and motor abilities (Boonk et al., 2018). Our study was the first to aim at gaining a better understanding of the relation between parental support and the development of drawing skill during early childhood, by testing dyads of parents and children of preschool age (3–7 years). We expected to find a general positive correlation between parental support and children's drawing skill, but our results did not support that hypothesis. Our second research question intended to explore how much each of the individual components of parental support for drawing contributed to children's drawing skill. Here, Scaffolding emerged as a significant and unique predictor of children's VMI score. In this section, we discuss various implications of this outcome.

Previous research has suggested that learning to draw is a skill that requires intensive social guidance and practice (Callaghan, 2020; Cameron et al., 2020; Cohn, 2014; Rakoczy et al., 2005). In line with those studies, our results confirm that parental scaffolding has an overall positive correlation with children's drawing skill. It is worth noting that the mean scores of the individual items showed that the most recurrent types of parental support for drawing stated in the PSDQ survey involved praising the child during and after the drawing activity, as well as providing a wide variety of drawing utensils. Nevertheless, neither the Praise nor Resource Support scales affected our drawing skill measure. In contrast, the parents reported only occasionally engaging in scaffolding behaviors such as providing verbal instruction and demonstration, whereas its enriching effects on drawing skill were consistent even after controlling for home environment variables.

We also found that girls scored higher than boys on the Beery VMI test. Similar gender differences in VMI score have been observed in other studies (Coallier et al., 2014; Fang et al., 2017; Visser & Nel, 2018) and agree with literature suggesting that during early childhood girls tend to outperform boys in visuomotor and manual dexterity tasks (Vlachos et al., 2014), including handwriting quality, which recruits similar skills as drawing (Barnett et al., 2018; Duiser et al., 2014; Skar et al., 2022; van Hartingsveldt et al., 2015).

4.1. Implications

The finding that Scaffolding emerged as the unique predictor of enhanced children's drawing skill is of theoretical, methodological, and practical relevance for research on the ontogeny of drawing and motor skills. Particularly within the framework of cultural learning theory, which highlights the importance of appropriate social support and opportunities to learn from experienced individuals in the acquisition of skills (Rakoczy et al., 2005; Tomasello et al., 1993).

In developmental psychology, scaffolding refers to the support that a caregiver or instructor provides to enhance a learner's skill and knowledge (Wood et al., 1976). Scaffolding behaviors may include for instance, simplifying the task, guiding the learner's attention to important task components, manipulating the environment or the learner's actions to allow task completion, or carefully demonstrating the task either verbally or physically (Tomasello, 2016; Ugur et al., 2015). Crucially, all such interventions allow the

Table 3
Mean scores and standard deviations (SD) of the study variables.

	Cronbach's alpha	Range	Mean	SD
Visual-motor integration	-	80-130	105.78	9.21
PSDQ Resource support	.31	2-6	3.87	0.89
PSDQ Joint drawing	.71	0-5	3.10	0.96
PSDQ Scaffolding	.85	0-5	2.11	1.06
PSDQ Praise	.72	1-6	4.66	1.10
Home learning environment	-	10-78	37.21	14.18

learner to achieve goals that without instruction would be beyond their ability (Vygotsky, 1978; Wood et al., 1976).

Apart from its pedagogical applications, scaffolding has been characterized in cognitive evolution research as a fundamental mechanism in human learning and the general development of skills (Sterelny, 2012), and parental scaffolding has been associated with enhanced cognitive abilities and academic performance throughout childhood (Mermelshtine, 2017). Also, scaffolding has been identified by other researchers as essential to the development of children's pictorial and visuo-symbolic competence (Callaghan, 2020; Cameron et al., 2020; Cohn, 2012; Rakoczy et al., 2005). The outcome of our study is in keeping with this literature.

Our results are especially compatible with a cultural learning account of drawing, according to which the development of drawing skill in early childhood occurs through 'cultural imitative learning, supported by adult scaffolding' (Rakoczy et al., 2005, p. 78). Consequently, parental guidance and instruction should not only improve drawing-related visuomotor skills but also increase children's opportunities to learn from expert models. Interestingly, a closer examination of the contribution of the individual PSDQ items pointed to scaffolding through verbal instruction as having the biggest effect on drawing skill, despite not reaching statistical significance. Although further research would be needed to confirm this finding, the relevance of verbal instruction to drawing skill has been hinted at by previous studies which highlight the key role of communication and language mediation in the development of visual symbolic cognition (Cohn, 2012; Kirkham et al., 2013; Toomela, 2002).

Alternative to cultural learning, motor accounts describe the development of drawing skill as mainly depending on the maturation of motor control and the inhibitory system (Riggs et al., 2013; Simpson et al., 2019). If such were the case, age would suffice to explain variance in drawing skill, and no component of social support should influence the VMI score significantly. Opposite to this, our results showed that age did not explain differences in VMI score, while parental support through scaffolding partially did, which is more consistent with cultural learning theory (Rakoczy et al., 2005). That is not to say that motor control is not of primary importance towards the development of drawing. In fact, inhibitory control, the capacity to suppress impulsive thoughts or actions (Lyons & Zelazo, 2011), is a strong predictor of early drawing skill (Panesi & Morra, 2022; Simpson et al., 2019), and both VMI and inhibitory control strongly predict early academic success (Cameron et al., 2015). Rather, our claim is that visuomotor integration is not only a natural maturation process, but the result of actively learning meaningful actions which are largely promoted by the social environment (Reed & Bril, 1996).

Methodologically, our approach suggests that it might be advantageous for developmental research to go beyond the construct of parental support as a single factor and look more carefully to its discrete components, as proposed by Boonk and colleagues (2018). We have demonstrated that such a shift of focus allows to better quantify the effects of different types of parental support in the context of drawing. Hence, studying the role of parental support in other domains, and of scaffolding in the acquisition of various skill sets, would contribute to improving understanding of individual and cross-cultural variance throughout children's development (Cohn, 2014; Mermelshtine, 2017; Reed & Bril, 1996; Tomasello et al., 2005).

For example, a recent review paper indicated that children across cultures generally show an adult-bias when learning motor skills and instrumental domains, whereas they favor peer learning for affective and normative behaviors (Lew-Levy et al., 2023). Drawing skill may well illustrate these two types of social learning biases in childhood, since children seem to acquire representational conventions from peers (Happé & Vital, 2009) but, as implied by our study, the motor skills that underlie drawing largely develop under adult guidance. Children's adult-biased motor learning may in turn be motivated by a caregiver's tendency to modulate their actions when demonstrating the use of objects and tools to infants, for instance by performing large and slow movements (Ugur et al., 2015; van Schaik et al., 2020). Parent-child interactions during drawing instruction might therefore provide an excellent focus for developmental research on the pedagogy of motor skills.

Our study also has practical implications for art education. The insight that adult scaffolding is positively correlated with children's drawing skill is valuable for a much-needed improvement to teaching art at home and in school (Anning, 2002; Cohn, 2014; Rose et al., 2006). Our survey revealed that while most parents are eager to offer support for drawing, they most commonly do it by providing their child with utensils and praise. While this is valuable, previous research (Kindler, 1995) and our own analyses showed that giving materials and encouragement are not sufficient to engage children in drawing activities, and in the end have no significant impact on drawing skill. Informing parents about the importance of giving feedback and instruction to the child, starting at the preschool stage, would be a simple way of allowing them to better support and enhance children's drawing performance. Encouraging parents to invest in generally improving children's drawing skill may also help close the observed gender gap in VMI score, as parents may inadvertently promote drawing and handicrafts more in girls than in boys hence generating a gender difference in fine visuomotor skills from an early age (Dinkel & Snyder, 2020; Matarma et al., 2020).

In a school setting, Burkitt et al. (2010) reported that even though teachers generally appreciate the benefits of drawing, they struggle with finding ways to properly foster and enrich children's drawing ability. Perhaps for that reason, drawing activities in the classroom are often carried out as playtime or 'time-fillers' (Anning, 1999; Cameron et al., 2020). The results of our study suggest that in addition to allocating time and materials to drawing, teachers could easily improve pupils' drawing skill through active guidance and demonstration.

The overall advantages of cultivating drawing skill at home and in the classroom may lead to improving children's cognitive and emotional development. Drawing ability is positively correlated with academic skills, namely reading, writing and math (Kulp, 1999; Rouleau et al., 2014; Sortor & Kulp, 2003). Drawing also improves young people's mental health (Zarobe & Bungay, 2017), self-awareness (Franklin, 2012; Straffon et al., 2022), academic comprehension and learning (Fan, 2015; Tyler & Likova, 2012), and memory (Roberts & Wammes, 2021). Therefore, parental and educator support for drawing through scaffolding actions may be a small investment that can have short and long-term positive effects on children's lives. Furthermore, the effects of scaffolding interventions towards boosting VMI score are likely to positively affect early learning and behavioral abilities in general (Cameron et al., 2015).

In sum, learning to draw is an important milestone in children's development that can have far-reaching benefits on different aspects of cognition and affect (Tyler & Likova, 2012). But we have reasons to believe that the rewards of parental and social support explored here likely extend beyond drawing and apply to diverse learning contexts, particularly to instrumental and academic competences (Cameron et al., 2015; Lew-Levy et al., 2023; van Schaik et al., 2020). For these reasons, gaining a better understanding of how different types of parental support relate to skill development across domains should receive more attention in early childhood research.

4.2. Limitations and future directions

In spite of our interesting results, this study has some limitations related to our methods, sample, and approach. First, we worked with a cross-sectional dataset including children aged 3.0 to 6.9 years. It would be advisable to replicate this study with a longitudinal design to exclude possible cohort effects and establish a cause-effect relationship between variables (Solem, 2015). It may also be the case that parents adapt their support strategies according to the child's age. So, it would be worth examining the levels and types of parental support for drawing across age categories, as well as before and after the start of children's formal schooling.

Second, although our finding that Resource Support had no significant impact on drawing skill is consistent with previous research (Kindler, 1995), this scale had a very low item-score reliability, i.e., the inter-relatedness between the items in this scale was relatively low. This could be attributed to the fact that most of the parents in this sample responded that they provided their kids with drawing utensils and spaces for drawing "(almost) all the time", resulting in a near-ceiling effect for many of the items in this scale. Due to its low internal consistency, we ran the analysis without this scale with no effect on our results, and Scaffolding remained the only variable that had a unique contribution. Even if our conclusion was not affected, future studies should consider a wider range of socioeconomic backgrounds when investigating the effect of resource provision in promoting children's drawing skill.

Finally, our study focused exclusively on the production aspects of drawing, not on its comprehension. However, there is evidence that the benefits of scaffolding are also found in the development of drawing as a symbolic communicative operation (Callaghan, 2020; Cohn, 2014; Kirkham et al., 2013; Rakoczy et al., 2005; Ring, 2006; Toomela, 2002). Follow-up studies might want to integrate both aspects of production and symbolic comprehension, to fully understand the influence of scaffolding in the development of drawing skill. Moreover, we would suggest further exploring different components of parental scaffolding for drawing (e.g., verbal and physical instruction, feedback, cognitive and emotional support, etc.) and how scaffolding strategies vary across cultures, households, child gender, and developmental stages (Cameron et al., 2020; Mermelshtine, 2017).

4.3. Constraints on generality

The generalizability of the results should be taken with caution. On the one hand, the majority of the participant children (72%) were of Dutch nationality and, on the other hand, those of a different background were recruited at an international school with a dedicated art curriculum, which may already prescribe better-than-average drawing skill. Similarly, most of our parent participants had a high level of education (91%). The low cultural and demographic diversity of our sample is also seen as a limitation, since cultural and socioeconomic differences in parenting style and parental support may have distinct effects on skill development during childhood (Brown & Iyengar, 2014; Huntsinger et al., 2011; Lim et al., 2015). Additionally, the full extent of the influence of culture on VMI score variance is yet to be thoroughly explored (Cameron et al., 2015; Lai & Leung, 2012; Lim et al., 2015). For those reasons, we would recommend replicating this study with a more heterogeneous sample.

Also, our parent participants included mothers as a majority. It is possible that our factor construct will not apply equally to fathers. One more caveat is that our parental survey dealt with self-report questionnaires, which may suffer from the so-called social desirability effect, according to which respondents complete a survey based on socially acceptable responses (Bertrand & Mullainathan, 2001). Future studies might benefit from complementing questionnaires with ethnographic methods (e.g., direct observation, video recordings, diary keeping) or face-to-face interviews (e.g., Cameron et al., 2020).

CRediT authorship contribution statement

Naike Gorr: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yung-Ting Tsou:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Larissa Mendoza Straffon:** Writing – review & editing, Writing – original draft, Supervision, Resources, Investigation, Funding acquisition, Conceptualization. **Brenda de Groot:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mariska Kret:** Writing – review & editing, Supervision, Resources, Project administration, Methodology.

Declaration of Competing Interest

none.

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