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HANDWRITING PERFORMANCE AMONG KINDERGARTEN CHILDREN IN HONG KONG

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Handwriting Performance among Kindergarten Children in Hong Kong

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A thesis submitted in partial fulfilment of the requirements for the degree of

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CERTIFICATE OF ORIGINALITY

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ABSTRACT

Introduction. Proficiency in writing of Chinese and English is essential for children in Hong Kong. However, some children encounter difficulties in learning how to write as early as in the kindergarten stage. Despite of the differences in English and Chinese characters, it is postulated that different types and levels of pre-requisite skills are required for legible Chinese and English handwriting.

Objectives. First, this study investigated the developmental characteristics of Chinese handwriting skills during the kindergarten stage using visuo-orthographic copying and name writing tasks. Second, it developed and validated a screening test (CHEST) for identifying the handwriting difficulties among K3 children in Hong Kong. Third, the study examined the underlying causes of the handwriting problems among these children.

Methods and results. In *Phase 1*, 316 children who were studying in the first to third year of kindergarten (K1-K3) were recruited in the validation study of visuo-orthographic copying task and Chinese name writing scale (CNWS). The results showed that the CNWS had good to excellent intra-rater and test-retest reliabilities. It also illustrated that K1 children were in scribbling stage; whereas there were a great improvement of handwriting skill once it is formally taught in K2. Finally, K3 children performed well in both tasks. In *Phase 2*, the CHEST test was developed for screening K3 children who had suspected handwriting difficulties. 128 typically-developing children and 26 children with handwriting difficulties

participated in this phase. Apart from test-retest and inter-rater reliabilities, there were significantly lower mean scores in Chinese and English handwriting among children with handwriting difficulties. But some children with Chinese handwriting difficulties did not have such problems in English handwriting. *Phase 3* examined the developmental skills needed to produce legible Chinese or/and English handwriting among K3 children. The handwriting and developmental skills of 20 children with Chinese handwriting difficulties (PC), 23 children with handwriting difficulties in both English and Chinese (PB), and 22 typically developing children (TD) were compared. With age and reading abilities controlled, children in PC and PB groups had significantly lower in some aspects of visual perception skills, in fine motor precision and integration, than the TD group. Finally, children in our sample, including those with handwriting difficulties, performed better in most perceptual-motor assessments than the U.S. norms obtained from test manuals.

Discussion. Direct copying plays a critical role in learning how to write among Chinese children. *Phase 1* illustrated the progression of Chinese handwriting among kindergarten children, from simple strokes, to radicals and complex characters; as well as the appropriate spatial organization of handwriting products. The CNWS test results provide additional information on the transition of copying to dictation via the writing of one's own name. The results showed that K3 is a suitable and reliable to screen out children who are potentially having difficulties in learning how to write Chinese. Summarizing the results of *phases 2 and 3*, it can be concluded that children are proficient in English handwriting before Chinese

handwriting. As Chinese characters are more complicated than English words, and more advanced developmental skills are required for Chinese handwriting. This is also explain why (1) children who had difficulties in writing both orthographies performed worse in developmental skills than children with Chinese handwriting difficulties; and (2) more children had handwriting difficulties in Chinese than that in English.

Conclusion. The findings of this study enhance our understandings on how Chinese handwriting skills are developed through visuo-orthographic copying as well as name writing; and the differences of developmental skills involved for legible Chinese and English handwriting. It helps educators and clinicians in designing programs on teaching kindergarten children how to write these two orthographies. It also highlights the needs in identifying children who exhibit handwriting difficulties in either Chinese, English or both, and their deficits in developmental skills that affecting their learning process during kindergarten stage.

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Chapter One: Introduction

1.1 Background

"Handwriting is essential to academic success" (Shah, Bialek, Clarke, & Jansson, 2016). The developmental of handwriting involves the maturation of cognitive, linguistics and perceptual-motor processes that include visual perception, motor planning and manual dexterity (Lifshitz & Har-Zvi, 2015). Despite the use of technological aids for writing, writing by hand is still a precursor to children's later literacy skills and school achievement (Wang, Yin, & McBride, 2015).

Both Chinese and English are the official languages of Hong Kong (Civil Service Bureau, 2016). Local education is expected to help children develop proficiency in Chinese-English biliteracy, as reading and writing on both languages are regarded as a norm in the local context. As early as kindergarten, Hong Kong children start to master both Chinese and English handwriting skills in preparation for full curriculum instruction in primary school. It is common that children learn to read both Chinese and English by the "look and say" method (McBride-Chang & Treiman, 2003). Teachers present the whole character, read out and introduce the morphemic and orthographic structure of the letters and words, such that children could build up the correlations between sound, form and meaning (Tse, Wong, Lee, & To-Chan, 2014; Wang, Yang, & Cheng, 2009). The learning of alphabetic and Chinese writing systems often depends on the use of combined use of orthography, phonology and

morphology. Children in both mainland China and Taiwan learn Pinyin (拼音) and Zhi-Yin-Fu-Hao (註音符號) respectively as the learning of oral and written Chinese reinforces each other. However, spoken Cantonese is not associated with written Chinese. It could be a greater challenge for Hong Kong children to learn orthographic Chinese characters than in mainland China or Taiwan.

Most children start to learn to write both English and Chinese at aged 3-4, i.e. when they start kindergarten education. Children do pre-writing tasks such as imitating horizontal and vertical strokes that prepare children to combine these strokes for writing in the later stage (Li & Rao, 2005; Schneck & Amundson, 2010). Since there are thousands of combination of semantics and phonetic radicals to form Chinese characters, formal instruction on writing rules, such as stroke sequence, together with handwriting practice (i.e. mainly by direct copying), would be beneficial to their learning in Chinese handwriting (Packard et al., 2006). A similar approach is used for learning to write English. Besides the help of phonetics in reading, teacher presents the English words in double-lined spacing to ensure the children understand the position and proportion within and between letters of a word. It facilitates children to write tidily on the designed space with adequate proportion and alignment.

This thesis proposes that the development of handwriting skills involves the complex interplay of visual-perceptual, visual-motor integration, and fine motor control. A range of developmental skills in these three areas could greatly increase the readiness for learning to

write. In the biliterate environment of Hong Kong, some developmental skills would contribute to acquisition of both English and Chinese handwriting, while some additional skills may be more important in learning of Chinese handwriting (Gottardo et al., 2001; McBride-Chang et al., 2013; Wang, Perfetti & Liu, 2005). However, because of the composition of Chinese characters, it is believed that the types and degree of involvement of developmental skills for writing would be partly different from English (Wang & Geva, 2003a).

This thesis also highlights the importance of "handwriting readiness", i.e. we should strengthen the pre-requisite developmental skills necessarily in the learning to write processes instead of direct drilling of handwriting skills. This is particularly important to children who face challenges in learning how to write. Recent studies have showed that identifying kindergarten children who have handwriting difficulties, followed by intervention on handwriting-related skills but not repetitive practice on handwriting, is effective to enhance their handwriting performance (Donica, Goins & Wagner, 2013; Lust & Donica, 2011; Maki et al.,2001; Ratzon, Efraim, & Bart, 2007). It also prevents further problems when the handwriting demands are increasing in the elementary school, resulting in academic underachievement, low self-esteem and even social rejection (Singer, 2005; Walker & Nabuzoka, 2007).

This study aimed to address the uniqueness of the language learning environment in Hong Kong, and attempt to fill up the current research gap in two aspects. First, although it

had been demonstrated that there was a close relationship of handwriting performance between kindergarten and elementary school student (Shatil, Share, & Levin, 2000), current studies focused more on the handwriting difficulties among students from elementary schools. This current study tried to address how early learning strategies in handwriting used in kindergarten and examine how children prepared to learn handwriting. Second, there was lack of information about the specific developmental skills require to write Chinese and English. This study would examine if the basic developmental skills would contribute differently in learning to write English and/or Chinese.

These goals were achieved by firstly examining the developmental characteristics of Chinese handwriting through the visuo-orthographic copying skills at different levels of the formation of Chinese character, namely strokes, radicals and characters, and the Chinese name writing skills across the three levels of kindergarten education (K1, K2 and K3). An evaluation tool of both Chinese and English handwriting was then developed to screen for handwriting difficulties among children at Kindergarten 3 (K3), which is the preparatory stage of primary education. The basic developmental skills would also be examined to guide the design of intervention strategies for children who exhibit difficulties in writing.

1.2 Aim and objectives of the study

In order to promote the early identification and intervention of Chinese-English biliterate children who have difficulties to learn to write since kindergarten stage in Hong Kong, this study aimed to find out the deficits in developmental skills among Chinese kindergarten children which might affect their abilities to write Chinese and English respectively.

In order to achieve the purposes, four primary objectives are targeted to be investigated:

1. To evaluate the reliability and validity of the visual-orthographic copying task and Chinese name writing scale (CNWS) for assessment of handwriting performance;
2. To explore the developmental characteristics of early Chinese handwriting products in kindergarten children;
3. To develop and validate Chinese and English Copying Screening Test for Kindergarten Children (CHEST) for K3 children, and examine its:
    a) Construct validity;
    b) Inter-rater reliability;
    c) Test-retest reliability;
4. To investigate the types of handwriting problems exhibited in K3 children who have handwriting difficulties;

5. To examine how developmental skills are related to different patterns of difficulties in Chinese and English handwriting among kindergarten children.

1.3 Organization of Chapters

The chapters of this thesis are organized according to the three phases of study. There are seven chapters in this thesis. Chapter One opens with an overview of the study. It introduces the current problems, aim and objectives, and the significance of this study. Chapter Two is the literature review on the approach on learning to write among Western children, the development of alphabetic writing skills, as well as the uniqueness of Chinese characters. This information provides justification on the needs to examine the how Chinese kindergarten children learn to write and the pre-requisite skills involved. The conceptual framework of this thesis is also formulated based on these literatures.

Chapter Three is Phase 1 of the study. Apart from the validation of visuo-orthographic copying and CNWS, the developmental characteristics of copying Chinese stroke, radical and character levels, as well as Chinese name writing across kindergarten stage is emphasized. It points out that the last year of kindergarten education (i.e. upper kindergarten, or K3) would be a suitable time to identify children who are having handwriting difficulties.

Chapter Four describes the research method and results of Phase 2 of the study. Kindergarten children have to learn to write both Chinese and English. Hence, this chapter

describe the development and validation of an evaluation tool (i.e. Chinese and English Copying Screening Test for Kindergarten Children, CHEST) that assessing both Chinese and English handwriting in K3 children. The handwriting performances between children with and without handwriting difficulties are also discussed. This tool would be used in Phase 3 in identifying the underlying problems of K3 children with different patterns of handwriting difficulties.

Chapter Five is the content of Phase 3. It describes the clinical manifestation of children with handwriting difficulties in Chinese, English or both orthographies. It also examines their developmental skills in perceptual-motor and linguistic aspects that affecting them to produce legible handwriting. The understandings of the underlying problems in these children could help clinicians in providing adequate remediation or strategies for helping them learn to write.

The thesis is further discussed in Chapter Six. It presents the research findings in relation to the existing knowledge and implications in helping kindergarten children learning to write Chinese characters and English words effectively. This thesis ended in Chapter Sever, followed by appendices and a reference list.

Chapter Two: Literature Review

This chapter will firstly review the development, evaluation method and criteria in studying the English handwriting performance. The review will follow by the composition of Chinese character, how Chinese children learn to write legibly as well as the existing method to evaluate the handwriting performance among kindergarten children. Finally, it will review the clinical manifestation of children with handwriting difficulties and the underlying causes of such problems. This review aims to point out the current research gap on Chinese handwriting development and the importance of pre-requisite skills for legible handwriting.

2.1 Development of English handwriting

There is a wealth of literature on the development of spelling or writing in English (Hildreth, 1936; Ferreiro & Teberosky, 1982; Ehri, 1991) (Figure 2.1).

Some studies stated the development of handwriting start from refusal to write. It was suggested that children refuse to write because they have some knowledge on handwriting, but they realized that they could not produce the written forms as good as adults (Ferreiro & Teberosky, 1982; Lieberman, 1985). However, it is difficult to assess this stage of refusal as there are no handwriting products for assessment (Ferreiro & Teberosky, 1982).

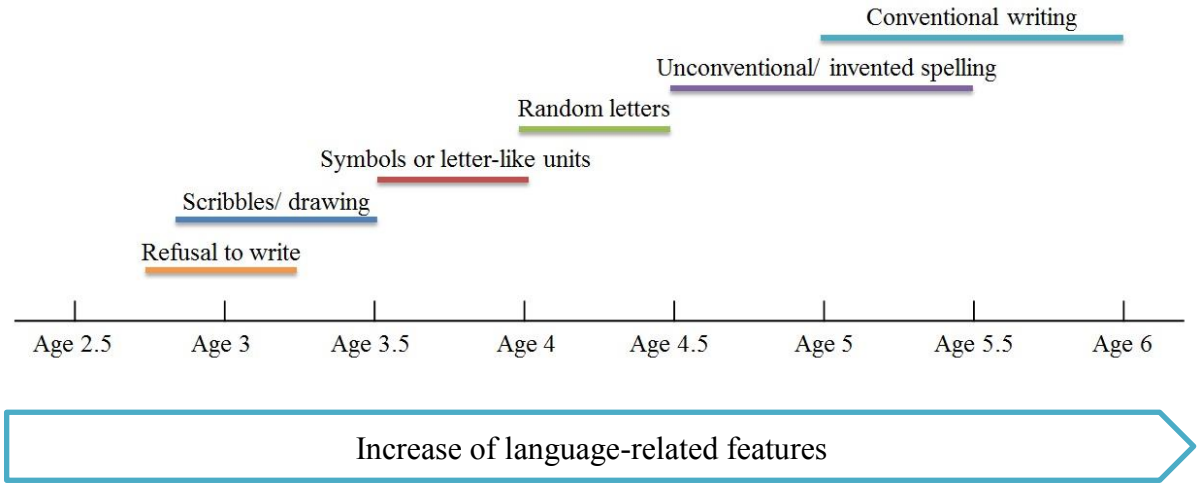


Figure 2.1. Characteristics of English handwriting development (In references to Hildreth, 1975; Ho, 2011)

Children start their writing journey from scribbling, an early form of drawing which is not random or meaningless (Puranik & Lonigan, 2011). Through drawing, children visualize what they want to express or communicate (Ho, 2011; Wu, 2009). Kellogg (1970) proposed 20 basic scribbles, at which Yang and Noel (2006) found that most 4- and 5-year-old children often use single vertical, horizontal, curved, and diagonal lines than any other types of scribbles. These lines could be used to compose letters. Children are purposefully imitating these lines which will prepare them to write letters at a later stage.

Handwriting skills would be enhanced when children begin to recognize the symbolic representation of language. Children try to use symbols, shapes, numbers and letter-like units as their handwriting, rather than drawing the object out directly (Ferreiro & Teberosky, 1982;

Lieberman, 1985). Letter-like units are advanced forms of symbols. Children then combine the symbols and letters observed to create their own letters. They also tend to write the letters that are frequently appeared or with simplest strokes. For instance, letters that make up of circles and simple straight line (e.g. I, H, O) are the most common letter-like units found in children's early handwriting.

Occasionally, children may try to invent their own spelling for the words that they do not know how to spell it. Such "invented" spelling could be based on their phonological knowledge as well as the orthographic patterns which they have been exposed (Niessen, Strattman & Scudder, 2011). In fact, when children began able to write the first letter of their name, and tend to use that letter to formulate the other words that they don't know, or substitute the letters that they are forgotten. This is an important step to proceed to the final stage of conventional spelling. Conventional writing means that children are able to acquire the skills resembles as adults, including the correct use of grammar and upper/ lower case in a sentence (Morrow, 2001).

2.2 Evaluation on English handwriting performance in kindergarten children

Two methods that are commonly used to evaluate the English handwriting performance are asking children to do alphabetic/letter writing (Molfese, Molnar & Vessels, 2006; Puranik & Lonigan, 2012) or writing their own names (Drouin & Harmon, 2009; Puranik, Lonigan &

Kim, 2011). This section will describe these two evaluation methods, as well as outlining the common criteria used to assess if the quality and legibility of English handwriting.

2.2.1 Alphabetic/ letter writing

The developmental characteristics of English handwriting are commonly examined by letter writing. It could carry out by asking children to write each letter in alphabetical order (Puranik & Apel, 2010; Puranik, Petscher, & Lonigan, 2013) or letters requested by examiners (Clark & Luze, 2014; Molfese, Molnar, & Vessels, 2006; Puranik & Lonigan, 2012). The ability to write letters uniquely affects spelling (Al Otaiba et al., 2010). Children's attempt at retrieving the visual shapes and names of letters is facilitated by their alphabetical knowledge (e.g., linking sound and form). Thus children with better letter-naming skills were able to combine letters using phonetic representations to create "words", and then they can write each letter one-by-one neatly to produce words.

2.2.2 Name writing

Alphabetic writing is a sub-lexical process that children analyze the words into letters and assemble each letters by phonics, while name writing is a lexical process. Children usually recognize their name as a whole and retrieve them based on sound and meaning as a

whole word (Both-de Vries & Bus, 2008). Name writing is considered as another task that effectively and accurately reflects the early stage of handwriting skills acquired by the presence of recognizable and correct letters in the name writing products (Hoorens & Todorova, 1988). The ability to write one's own name is a milestone on the symbolic use of language (Haney, 2002; Levin, Both-de Vries, Aram, & Bus, 2005). By calling from others and imitating the letters in children's name, it helps them to establish linkage among sound (phonology), structure (orthography) and meaning (morphology/ semantic) (Aram & Levin, 2004; Puranik, Schreiber, Estabrook, & O'Donnell, 2013).

Name writing is now widely used as an assessment item in standardized developmental tests of literacy or handwriting, such as the Phonological Awareness Literacy Screening for Preschool (PALS-PreK) (Invernizzi, Sullivan, Meier, & Swank, 2004) and the Development of the Writing Readiness Inventory Tool in Context (WRITIC) (Van Hartingsveldt, Cup, Groot, & Nijhuis-van der Sanden, 2014). Name writing test alone has been used to identify kindergarten children with handwriting deficits (Drouin & Harmon, 2009; Zakopoulou et al., 2011; Lifshitz & Har-Zvi, 2015).

2.2.3 Criteria for legible English handwriting

Apart from correctness, there are six criteria commonly used to justify the legibility of English handwriting. The first criterion is the letter formation, which is used as a criterion in

several tests, such the Scale of Children's Readiness In PrinTing (SCRIPT) (Weil & Amundson, 1994) and Test of Handwriting Skills-Revised (THS-R) (Milone, 2007). In the SCRIPT test, for instance, the bottom portion of the vertical line of the "t" must be longer than the top side (Weil & Amundson, 1994; Ziviani & Elkins, 1984).

The second criterion is the consistency of letter size, which means that letters need to be produced within a perimeter of certain height and width (Rosenblum, Weiss, & Parush, 2003). In learning to write, kindergarten children are often requested to write letters within given boundaries. The letters would be regarded as having improper size if they do not write within the given boundaries. The third criterion is the spacing between letters or words, which should not be too wide or overlapping with each other (Armitage & Ratzlaff, 1985). Spacing between letters or words will affect the readability of the words. The forth criterion is alignment. It often refers to the deviations of words from the horizontal alignment. Spacing and alignment could be measured by a transparent overlay with straight lines and ruler (Rosenblum, Weiss, & Parush, 2003).

The fifth criterion is the slant, or angles of rotation. This criterion assumes that beginning writers should write each letters in upright position (i.e., manuscript writing), but they allow some degrees of rotation in order to smoothen the transition from manuscript writing to cursive writing (Rosenblum, Dvorkin, & Weiss, 2006). The last criterion is the appropriate use of capital letters. It can be further defined by: (1) use of capital letter in the first letter of a word, and (2) mixture of upper and lowercase letters in the same word.

2.3 Characteristics of Chinese characters

2.3.1 Structure of Chinese characters

Chinese characters are constructed with a three-tier hierarchical model of orthographic structure: stroke, radical and character (Figure 2.2).

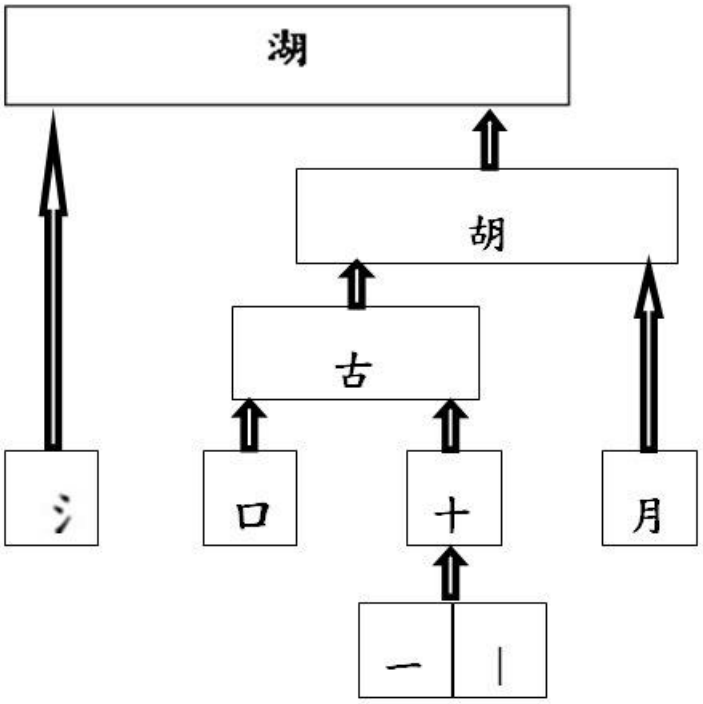


Figure 2.2. Example of building blocks of strokes and radicals into a character (cited from Matthews & Matthews, 2014)

In writing Chinese characters, strokes and radicals are placed in different configuration within the square structure occupied by the character (Tseng & Hsueh, 1997). Generally, the methods to assemble can be grouped into single (單一) or independent (獨體) (e.g. “山”

[hill] and “心” [heart]), and combined structures (合體). Independent characters also could be the radicals of other combined characters (e.g. “木” [wood] and “火” [fire]). In contrast, combined structures are further defined with different in proportions among the radicals.

Xu Shen (許慎) of the Eastern Han (東漢) period (25-220AD) categorized the Chinese characters into six categories based on their geometrics, phonetics and meaning, and phonetic-semantic compound characters (形聲字) is the largest category. It covers over 80%-90% of the modern Chinese characters (Kuo, Li, Sadoski, & Kim, 2014; Shu & Anderson, 1997). These characters compose of two radicals (or stroke-patterns): phonetic radical, often on the right side of a character to indicate the sound; and semantic radical on the left side to indicate its meaning. They provide cues to understanding the sound and meaning of the whole characters (Shu, 2003).

2.3.2 Forming Chinese Characters from Strokes and Radicals

Strokes. They are the basic units that are combined to formulate the smallest graphical and meaningful units called radicals. There are eight basic strokes, namely vertical (), horizontal ( ), angular (), slash (), saber (), hooked (), tick (), and dot ( ) in Chinese characters. These basic strokes have several variants, or combine to construct

compound strokes. Different resources had various description of number of stroke patterns, ranging from 6 to 32 (Fazziou, 1987).

Radical. Radicals are also called bujian (部件), is the smallest functional orthographical component of a Chinese character (Chen, Allport & Marshall, 1996). As they are made up of clusters of strokes, sometimes they are referred as stroke-patterns as in alphabetic writing system. They fall into two major types – either combine with one or more radicals to form a character, or act as a character alone. Radicals in a combined character generally followed certain positional regularities, which are located in the left and top positions with different proportion (Kuo, et al. 2014; Taft, Zhu & Peng, 1999). Usually the radicals would be distorted or abbreviated in order to fit into a square configuration (i.e. 手 [hand]→ 扌).

Characters. Chinese characters have homogenous shapes which are highly dependent on the formation of strokes and radicals into thousands of unique-structured characters. As there are visual similarities among Chinese characters but with different meaning, it requires higher sensitivity to the internal constituent components and better ability to ignore unimportant configured information for recognition (Ge, Wang, McCleery, & Lee, 2006).

2.3.3 Learning to write Chinese characters

As there are thousands of common radicals and combination that could form characters, intensive formal instruction on the writing rules and feedback on the performance are necessary to assist beginning writers to manage and write such amount of characters neatly.

It is important for children to recognize characters as they learn to write. Chinese character recognition is often taught using a "whole language approach". Each character is firstly presented as a whole with picture and teacher would read it aloud. It helps children to recognize the character with its sound and meaning. To expand the database of characters, formal instruction on the knowledge of orthographic structure of the largest category of Chinese characters – phonetic-semantic compounds, is also given. Orthographic knowledge in Chinese refers to the understanding of the positional constraint and the role of intra-character composition of the phonetic and semantic radicals and their integration, which are responsible to provide cues on pronunciation and meaning (Leong, Loh, Ki, & Tse, 2011). It also facilitates the development of handwriting skills by memorizing the characters in terms of meaningful parts, such as sharing of same radicals across characters. Packard et al (2006) found that raising children's awareness of orthographic structure and word morphology could promote the performance in both copying and writing Chinese characters from memory.

In the meantime, copying practice was found to be the best way to facilitate learning to write Chinese character (Wang, McBride-Chang, Zhou, Joshi, & Farver, 2017). Children start

to learn to write by imitating basic strokes, before combining them together in radical and character level. Practicing writing in the stroke level ensures children to be familiar with the legal strokes such that they could be correctly written and combined into a character.

With an emphasis on the precision of position in Chinese handwriting, concepts of strokes sequence are introduced (Lam & McBride-Chang, 2013). It helps children to manage and plan the order of analysis and motor execution. For example, horizontal stroke should be written before vertical stroke, from outside to inside components, and ended with enclosure. It provides visual cues on how and where they should be begin to write, such that good proportion of strokes and radicals, and thus overall alignment could be achieved. Concepts of stroke sequence are especially important for beginning writers, because skilled writers would develop their own writing habits on words formation (Kang, 2011).

Traditionally, these concepts are practiced together by rote learning, called “Lin Mo” (臨摹) in Chinese (Li & Rao, 2000; Liu & Hsiao, 2012; Wang et al., 2014). During writing, it encourages children to pay attention to the strokes sequences as well as the composition of strokes within a character. It helps them to associate the visual form with its sound and meaning, which further enhance their writing skills.

2.4 Evaluation on Chinese handwriting performance in kindergarten children

This section discusses the strength and limitations of using copying tasks or dictation to evaluate handwriting performance. The review highlighted that it is necessary to develop more detailed criteria in rating of Chinese handwriting performance.

2.4.1 Copying

Chinese children practice the orthographic knowledge and writing rules mainly by direct copying. It is an essential and functional skill that helps children to analyze and familiar with the visual-motor components between strokes, radicals and characters, which was found to develop slowly in children with weaker Chinese literacy skills (McBride-Chang, Cheung, Tong, 2011).

Usually, the ability to copy Chinese characters was an indicator to determine if a child has handwriting difficulties. Tseng's Handwriting Speed Test (Tseng & Hsueh, 1997) and Chinese Handwriting Analysis System (CHAS) (Li-Tsang et al., 2013) are currently available to assess Chinese handwriting performance of primary school children. These tests use copying speed, accuracy and legibility as assessment criteria. However, the criteria are too restrictive to kindergarten children. Currently, there is no screening tool specific for Chinese handwriting or copying for them. Handwriting is only a part of the fine motor (Siu, Lai, Chui,

& Yip, 2011) or developmental assessment (Lam et al., 2002) for kindergarten children. The results cannot clearly identify children with potential problems in learning to write.

Children who are able to copy neatly may not actually know the characters. But in a study conducted by Wang, McBride-Chang, & Chan (2014), children were first exposed the characters for a short period of time (e.g., 5 seconds) and then removed from view, followed by asking them to write down the character from memory as much as they could remember. Since the exposure of characters only provided a brief concept on how the characters are, children have to utilize their knowledge to analyze the internal structure of characters and reproduce them (Pak et al., 2005). It is suggested that children's orthographic awareness and memory capacity in integrating strokes into characters are important for Chinese handwriting.

2.4.2 Dictation and free writing

The second approach to evaluation of handwriting is through dictation. All the characters to be tested should be taught to ensure children have come across them. During the handwriting test, the assessor read aloud the character and children were asked to write the words down (Tong, McBride-Chang, Shu, & Wong, 2009; Wang et al., 2014). It required children to retrieve the visual forms from memory, and then reproduce it with movement. As dictation needed a great demand on cognition, it is used to assess school-age children who

might exhibit difficulties in reading and writing but not recommended to be used for kindergarten children (Ho, Law, & Ng, 2000).

In addition, free writing is commonly used in qualitative study on the developmental characteristics of Chinese handwriting in the longitudinal studies (Chan & Louie, 1992; Chan, Cheng, & Chan, 2008; Chan, 2013). It allows examination of changes in both universal and language specific graphic features. For instance, Chan, Cheng, & Chan (2008) had a case study on a girl when she was between 4 years 5 months and 5 years 6 months old. They reported that the size of each character becomes constricted and she used more characters to describe the situation. Another study by Chan (2013) stated the gradual change in the patterns of variability in using stroke, radical and character units by free writing. It showed that child's writing products become recognizable and likelihood to the targeted characters.

However, there are many disadvantages of using either dictation or free writing to evaluate the handwriting skills during the kindergarten stage. First, unlike alphabetic writing that words are string of letters, it is more complex to organize and maintain the legibility of handwriting. More advanced skills are required to embed such amount of strokes and radicals in a square-like form. It is not comparable when two children who are able to write the same number of characters but different in complexity. It cannot be used for screening those children who might be lagging behind in the learning process. Second, there are many confounding variables affecting the results. The learning and practicing effects at home and school could influence the amount and complexity of characters they can write.

2.4.3 Criteria for legible Chinese handwriting

Because of the spatial architecture of Chinese character, parameters in measuring the legibility of Chinese handwriting are slightly different from those in alphabetic writing systems. For instance, slant and the appropriate use of capital letter are not applicable.

Tseng Handwriting Problem Checklist (THPC) is commonly used to assess the legibility of Chinese handwriting product in terms of accuracy and construction of elementary school students (Tseng, 1993). Accuracy refers to stroke formation, including missing/superfluous and malformation of strokes (i.e. overshoot). In the meantime, construction is divided into (1) the appropriateness of alignment, spacing and position of strokes/radicals; and (2) the appropriateness of the proportion of strokes/radicals within a character.

In addition to writing along the lines, it is necessary to write each Chinese character within a discrete, imagery square (Kao, 2000). This concept should be developed before a child could write character-like forms (Chan, 2013). Hence, the alignment and position of strokes/radicals in Chinese handwriting refers to the ability in maintaining both horizontal and vertical alignment among the strokes and radicals. Second, instead of uniform size between letters, strokes and radicals are in proper proportion according to different types of combination of Chinese characters. One part could be slightly larger or smaller within the

square-like shape. Overall, the ability to write within grid should also be assessed as one of the Chinese handwriting problem as well (Tseng, 1994; Ho, Chan, Tsang, & Lee, 2000).

2.5 Visual-orthographic-motor processing of handwriting

Regardless of the writing systems, handwriting is a process that combining the visual-orthographic processing of word recognition (Seymour & Evans, 1994) and the transfer of orthographic information into written form (Ellis and Yung, 1988) (Figure 2.3). Problems in any one of the steps would disturb the whole process of handwriting.

Handwriting starts with a visual acquisition process begins by an early (low level) visual-perceptual processing (Seymour & Evans, 1994). It includes those basic visual functions that are required for registering all incoming printed information. Another name of this skill is called visual efficiency, which the pattern of eye movement, such as where and how long they fixate into a target. It affects the types and amount of information to be perceived, and thus the reading performance as a whole (Chen & Ko, 2011).

Information captured is then transferred to higher-level visual processing, which includes visual-perceptual processing and orthographic processing (Seymour & Evans, 1994). Visual-perceptual (VP) processing is the person's analysis of the visual form in relation to the environment. It is differed from visual-orthographic processing by the absence of linguistic components (Berninger, Cartwright, Yates, Swanson, & Abbott, 1994). Chinese character

acquisition involves the use of five VP skills (Zhou, McBride-Chang and Wong, 2014). The first one is visual form constancy. The person needs to identify that it is the same Chinese character when radicals appear smaller, larger or distorted. The second one is spatial relationship. The person identifies Chinese characters by breaking them down into component radicals and maintaining good proportion during writing. The last one is visual memory, which the children use to memorize the rules of stroke sequences for Chinese handwriting, and how different radical parts are located within a character. Other study by McBride-Chang, Chow, Zhong, Burgess, & Hayward (2005) suggested that visual discrimination and visual closure are also associated to the Chinese character acquisition. For instance, it is crucial to detect subtle line differences across similar characters (e.g., "大" [big] and "太" [too]). Chinese character acquisition also required the skill to predict to target complete form with incomplete line drawing (i.e., visual closure) (Chen & Kao, 2002).

Visual-orthographic processing is the utilization of past experience to interpret the visual form (characters) into meaningful "words". There are two stages in the orthographic processing for writing: allograph stage and graphic motor pattern (Ellis and Young, 1988; Ellis & Young, 2013). In the allograph stage, it assigns the visual shape with grapheme, or a meaningful unit. It saves up energy for further analysis and provides cues for graphic motor pattern to execute movement. For Chinese, it is called the "sub-lexical" stage (Taft, 1994; Taft & Zhu, 1997), at which the character is extracted into radicals and strokes. If it is impaired, it affects the accuracy of the retrieving process and causes additional errors such as

confusing of similar forms (e.g., “目” [eye] and “日” [sun]). In addition to the understandings of functional units, orthographic processing also involved the knowledge about the writing rules: the specific patterns to organize the words (e.g., filv vs.filk) (Wang, Park & Lee, 2006).

The information extracted in allograph stage facilitates the selection of graphic motor patterns for writing. Such pattern guides the movement of pencil in creating stroke. Impairment in selecting or executing graphic motor patterns results in incorrect, incomplete or overlapping of forms, or difficulties to maintain proper alignment and spacing between characters (Wong, 2005).

Further to the visual-motor and graph motor processes, the child need to exercise fine motor control to produce the characters. Fine-motor control refers to the development and coordination of intrinsic muscles that are needed to perform daily tasks, including handwriting (Ho, 2011). For example, adequate hand grip pattern and strength helps children to hold and operate writing tools smoothly. Delay in fine motor skills acquisition often is the main reason for school children’s handwriting difficulties (Berninger, 2000; Berninger et al., 2006). Their writing product become oversize in relation to the box/line provided (Chang & Yu, 2005; Tseng, 1993).

Finally, the ability to integrate visual image of letters with appropriate motor response is called visual motor integration (VMI) skill (Sovik, 1975). It is an integral part of handwriting development, and explains why the maturation of analyzing perceived information and motor control are the pre-requisite of VMI.

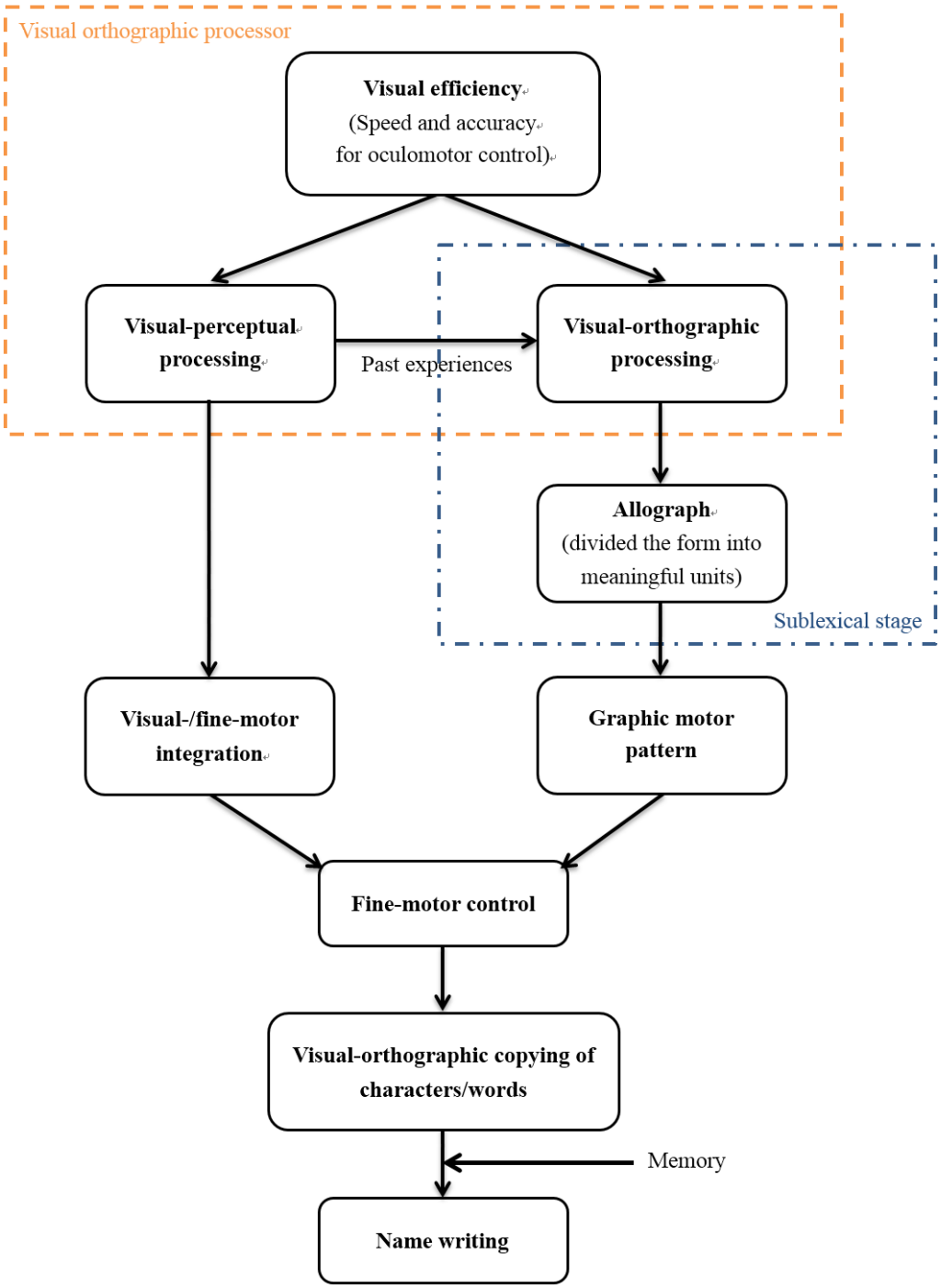


Figure 2.3. Visual-orthographic-motor processing for learning to write in Chinese communities

2.6 Challenges to learn both Chinese and English handwriting in kindergartens

Children in Hong Kong started to learn to write in both English and Chinese handwriting in kindergarten. While there are common approaches and strategies in learning to write the two languages, the learning process of Chinese handwriting is more challenging than English handwriting. It is unlikely the skills acquired in writing English could be fully applicable to Chinese handwriting.

2.6.1 Differences between Chinese and English handwriting

Chinese and English are two distinct writing systems in terms of phonology, orthography and semantics. Chinese is classified as logographic writing while English is morphophonemic writing (Shen & Bear, 2000). Since there is no radical/component level in English, their differences would be explained in the use between stroke and word/character. Basically, English letters are combined with at most two strokes that are mainly horizontal, vertical and (semi-)circular. Writing of letters is simply adding of strokes without overlapping. In comparison, there are eight basic strokes in Chinese, and about 30 variants of combined strokes which maybe consisted of more than two basic strokes (Guan et al., 2012). These strokes are only the foundation of radicals, in which would be further combined into characters. On the other hand, semi-circles or circles are not common in modern Chinese

(Taylor & Taylor, 2014). Apart from horizontal and vertical strokes, turning angles and with a hook are common in Chinese characters.

At the character level, English has only 26 upper- and 26 lower-case letters with a linear, left-to-right arrangement. The letters have discrete shapes that can be easily discriminate with each other, and words are formed by assembling of letters. The orthographic variations of English words are determined by the letter sequence or position of consonant doublets that able to produce sounds. For example, it is more common to have final doublets (e.g., baff) than beginning doublets (e.g., bbaf) (Wang, Park, & Lee, 2006). On the other hand, a Chinese character consists of interwoven strokes and radicals that are configured by different approaches in a square-shape form (Shen & Bear, 2000). Children need to learn the positional constraint and regularities of radicals to obtain information on its sound or meaning in different portion of a Chinese character. The assembling process is more complicated and people could be confused with characters that are visually similar. And there is lack of phonological components to assist in writing. Therefore, it is generally believed that it is more demanding to read and write Chinese characters than English words (Ho & Bryant, 1999).

2.6.2 Reading-writing connections in English and Chinese

In language development, listening, speaking, reading, and writing are key leaning methods, and these methods interact and reinforce with each other in the developmental process (Chan, Ho, Tsang, Lee, & Chung, 2006). Over the years, there are many studies which examined the impact of reading practice on writing, or vice versa. According to Fitzgerald & Shanahan (2000), there were three connections between reading and writing: rhetorical relations, procedural connections and shared knowledge. It hypothesizes that reading and writing are connected by identical or similar developmental skills.

In English language, the reading-writing relationship is reinforced by the presence of letter-sound correspondence. Children would associate letter shapes and sounds during writing, such that they could map sounds to phonetically appropriate letters to spell the words (Pollo, Kessler, & Treiman, 2009). This is called phonological awareness, the processing of written and oral language with the use of phonological information (Shu, Peng & McBride-Chang, 2008). Over the past decades, empirical research has demonstrated the importance of phonological processing skills influencing both reading and writing abilities across languages. Alloway et al (2005) demonstrated the phonological awareness uniquely associated with English reading skills and it could significantly predict English writing scores after controlling age and ethnicity in Singaporean kindergartners (Dixon, 2011).

However, children learn logographic Chinese characters based on meaning rather than sound (phonology). Although phonological deficits were found in Chinese children with reading problems (Ho, Law & Ng, 2000; McBride-Chang et al., 2012; So & Siegel, 1997), there was limited information on the impact of phonological awareness for writing. It is because phonetic radicals only provide cues for the sound of the word, it should further combine with the semantic radicals or the sound of another character in a word phrase. For instance, 娘 [mother] (*Cantonese: noeng4*) and 狼 [wolf] (*Cantonese: long4)* have the same phonetic radical 良 [good] (*Cantonese: loeng4*) but with different semantic radical on the left side. Thus, the bonding between phonological awareness and reading is much reduced.

On the other hand, reading and writing development were complemented. As children understand of the conventions used in the writing system of their language, they also become more aware of the links among visual symbols, phonology, and semantics in sub-lexical level (Tan et al., 2005). In learning of Chinese handwriting, children need to understand orthographic rules, such as fixed position of radicals in a Chinese character (Qian et al., 2015). In addition, morphological awareness, the sensitivity of radical perception by knowledge (Shu & Anderson, 1997; Su & Kim, 2014), could help learners to decompose and extract useful information to analyze the characters (Li, Shu, McBride-Chang, Liu, & Peng, 2012; Su & Kim, 2014). It would facilitate the acquisition of writing skills in terms of speed and accuracy by using this knowledge in selecting appropriate motor program in writing (Hsiao, Shillcock & Lavidor, 2007; (Packard et al., 2006; Shen & Ke, 2007).

2.6.3 Learning English and Chinese handwriting in Hong Kong

Consistency of learning methods could help children to acquire both orthographies easier by allowing them to transfer and generalize the strategies. However, Chinese kindergarten children in Hong Kong speak the Cantonese dialect, which do not use phonological units and consonant clusters like in Mandarin/ Putonghua. Thus, children cannot make use of Pinyin (拼音) or Zhi-Yin-Fu-Hao (注音符號) as children in mainland China or Taiwan to correlate the sound with the visual form of a character. Teachers in Hong Kong prefer to use holistic, logographic approach in teaching Chinese children to read and write Chinese characters and English words (Dixon, Zhao, & Joshi, 2010; McBride-Chang & Treiman, 2003). Without the systematic phonetic notation training, Hong Kong children have more difficulties in developing phonemic awareness than English-speaking children as well as children from mainland China (McBride-Chang, Bialystok, Chong, & Li, 2004).

Instead of phonetic writing, Chinese children rely heavily on graphic information and visual processing skills as a compensatory strategy in learning to read and write English words although it is visually distinct from Chinese writing systems (Wang & Geva, 2003a; Leong, Tan, Cheng, & Hau, 2005). It showed that although Chinese children performed poorly on spelling pseudowords which are largely depended on letter-sound correspondence, they are better to differentiate orthographically legitimate and illegitimate letter strings than English-speaking children systems (Wang & Geva, 2003b). Leong et al (2008) explained that

the massive amount of repetitive practice in associating orthography, phonology and semantics from Chinese character in reading and writing would affect the use of same strategy in learning the English language.

However, some studies showed that Chinese children would develop sense of the relationship between the visual form and sound of letters in English (i.e., letter-sound correspondence) after they exposed to English language (Ho & Bryant, 1997; Holm & Dodd, 1999). But the role of this knowledge is not as important as in English-speaking children in reading and writing.

2.7 Home and School factors affecting handwriting development in Hong Kong

This section proposes that it is important to consider how parental attitude and kindergarten curriculum in Hong Kong may shape handwriting development. It is necessary to include these two factors in the studying handwriting development and difficulties in the main study of this thesis.

2.7.1 School education and curriculum

Under the Education Ordinance, kindergartens in Hong Kong can be categorized into non-profit making kindergartens and private independent kindergartens (Education Bureau,

2016). Both types of kindergarten provide three-year pre-primary education service for children from three to six years old, namely nursery (K1), lower kindergarten (K2) and upper kindergarten (K3) classes. It aims to nurture children to attain all-round development and prepare them for life-long learning.

Over 84% are non-profit making kindergartens are subsidized under the Pre-primary Voucher Scheme (學前教育學券計劃). It allows all children aged 3-6 years to receive the kindergarten education in Hong Kong. On the other hand, kindergartens which under this subsidies should follow the guideline of the "Guide to the Pre-primary Curriculum" (Curriculum Development Council, 2006) in designing their own curriculum, teaching approaches and school administration. In the language domain, they have to learn to read and write Chinese and English with similar content across kindergartens.

2.7.2 Parents' attitudes and involvement

In recent year, a slogan "The wise win before the fight" (贏在起跑線)" is used to describe how parents help their children to get a head start by providing excessive training beyond their developmental level. Besides formal kindergarten education, Hong Kong parents taught their two to six years old children to read (70%) and write (50%) at home respectively. Parents usually assist their children to finish the home assignment from the kindergarten (Lin et al., 2009; 2012). They would usually teach their children how to

visualize the characters by component segmentation, point out the internal structures of a character and explain the functions of radicals by using daily-life examples (Lin et al., 2009; McBride-Chang et al., 2013). Lin et al (2012) has proved that maternal verbal cueing that through the process of writing (e.g. “make this stroke longer.”) was associated with word writing skills of K3 children in Hong Kong.

2.8 Kindergarten children with handwriting difficulties

2.8.1 Clinical manifestation

Handwriting difficulties (usually known as dysgraphia) are defined by DSM-5 as specific learning disorder in written expression (APA, 2013). Apart from the comorbidity with developmental coordination disorders (DCD) (Bo et al., 2014; Cheng et al., 2011; Smits-Engelsman et al., 2003) and language delays (Adi-Japha, Strulovich-Schwartz & Julius, 2011; Aram, Bazelet & Goldman, 2010; Puranik & Lonigan, 2012; Sices et al., 2007), children with family history of the above problems are also prone to have handwriting problems (McBride-Chang et al., 2008a; Pennala et al., 2013).

The prevalence rate of handwriting difficulties in Hong Kong is between 9.7 and 12.6% in primary school students (Chan, Ho, Tsang, Lee, & Chung, 2007; Lam, Shum, Chan, & Li-Tsang, 2008). Very often, children with handwriting difficulties face challenges in participating in active learning and meet the demands of schoolwork (Tseng & Chow, 2000).

They were sometimes labeled as noncompliant, lazy, or lack motivation (Feder & Majnemer, 2007). Although handwriting difficulties in children are usually identified when they start primary school, they usually exhibited similar problems during kindergarten stage (McBride-Chang et al., 2008). Early identification and intervention are essential to prevent worsen of this situation. Thus there is a need to examine handwriting issues in kindergarten children.

Children often learn to write by repetitive copying practices and those children with handwriting difficulties may find it hard to keep up with their classmates. They may be slower in writing or/ and their writing products are less legible. They may need to pay extra effort with unreasonable longer period of time to complete writing assignments. They may have poor letter formation, such as poor spatial orientation as well as spacing and alignment when completing the tasks (Lifshitz &Har-Zvi, 2015). It affects children's abilities to memorize the words with appropriate structures or slow down the process. Hence, when the handwriting demand greatly increased in primary school, their problems become more obvious.

2.8.2 Handwriting Difficulties and developmental skills

This section discusses a number of perceptual-motor and linguistics skills that are known to affect handwriting performance. It is necessary to evaluate these skills in the main study, and further specify how these skills may affect handwriting performance.

Perceptual-motor Skills. Difficulty in handwriting is a multi-dimensional problem involving visual-orthographic-motor processing. There are very few studies examining the relationship between oculomotor control and handwriting problems. Previous studies reported that children with dyslexia performed significantly poorer in a number of oculomotor control tasks (Edens, Stein, & Wood, 1994; Hyönä & Olson, 1995; De Luca et al., 1999). They cannot perform smooth pursuit from left to right, and fixation instability at the end of saccades (Edens et al., 1994). This deficit is not due to the linguistic factors such as visual complexity and word frequency (Liversedge et al., 2014).

Despite the importance of various visual perceptual skills in Chinese character acquisition (Meng et al., 2011), weaknesses were found in children with handwriting difficulties (Chen et al., 2013). First, visual memory is the major problem among these children. While Tseng and Chow (2000) reported the poorer performance of visual memory in slow handwriters and visual sequential memory is the predictor on their handwriting speed, Bavin, Wilson, Maruff and Sleeman (2005) stated the visual-spatial memory problem in children with dyslexia, affecting their abilities to build up the paired association of visual form of a character with its sound (Li Shu, McBride-Chang, Liu, & Xue, 2009; McBride-Chang & Ho, 2000). Second, the importance of spatial relationship in Chinese handwriting is well-documented. Children with handwriting difficulties are weak in identifying radicals in different direction (i.e., left-right reversal) (Huang & Hanley, 1994; Wong, 2005). For

example, they confuse between 陪 [accompany] and 部 [part] (McBride-Chang et al., 2005). However, these studies did not point out how the deficits affect how children write.

Third, delay in fine motor skills acquisition also lead to handwriting difficulties (Adi-Japha, Strulovich-Schwart & Julius, 2011; Berninger, 2000; Berninger et al., 2006; Clark & Luze 2014; Kaiser, Albaret, & Doudin, 2009). The fine motor skill involved may include poor finger dexterity, which prevents them from the effective pencil control (Clark & Luze 2014; Tseng & Murray, 1994; Volman, van Schendel, & Jongmans, 2006). Handwriting difficulties often come hand in hand among children with developmental coordination disorder (DCD). These children do not have problems in reading but temporal variability with longer pausing in handwriting process (Chang & Yu, 2009; Cheng et al., 2011).

Finally, visual motor integration (VMI), the ability to integrate visual image of letters with the appropriate motor response, is an integral component in handwriting development (Daly, Kelley, & Krauss, 2003). Since there is a positive relationship between the quality of handwriting and VMI skill (Kaiser, Albaret, & Doudin, 2009; Klein et al., 2011; Weil & Amundson, 1994), VMI task is usually used to find out young children who are at risk of handwriting difficulties (Marr, Windsor, & Cermak, 2001). Previous studies has showed improvement of both VMI and handwriting legibility after intervention program (Howe, Roston, Sheu, & Hinojosa, 2013). It is also a significant predictor of children with handwriting difficulties (Clark & Luze, 2014; Marr & Cermak, 2002; Naidoo, Engelbrecht,

Lewis, & Kekana, 2009; Tseng & Chow, 2000; Volman, van Schendel, & Jongmans, 2006; Weintraub & Graham, 2000).

Linguistic aspects. As a whole, rapid automatized naming (RAN) is examining the automaticity of the processing without much attention and awareness on the task as it should be over-trained (Conrad & Levy, 2011). In the task, it requires the person to read out the stimuli as fast as possible and the time taken is recorded. The nature of the stimuli could be divided into graphological (i.e., digits and phonetic notation) and non-graphological (i.e., color). Liao, Georgiou and Parrila (2008) suggested that RAN with graphological stimuli assimilate the automaticity situation of orthographic processing by associating homophones in the word recognition. It was found that deficit in RAN was dominant in Chinese dyslexic children when age effect was controlled (Ho et al., 2002; Kalindi et al., 2015).

The ability of reading and writing is the interaction between orthographic, morphological and phonological knowledge. Studies showed that Chinese children with reading difficulties would performed significantly worse in both orthographic and morphological awareness tasks (Ho, Leung, & Cheung, 2011; McBride-Chang et al., 2012). It prevents them from building up strategies for speedy decoding and retrieval of information necessarily for motor execution, especially for characters they are unfamiliar with (Tong, McBride-Chang, Shu, & Wong, 2009). In addition, although phonological deficits were found in children with reading disabilities (Siok, Spinks, Jin, & Tan, 2009; McBride-Chang et al., 2012), there is very few evidence to support its effect on handwriting. Ho, Law and Ng's

(2000) study showed that children with dyslexia of both reading and writing disabilities had poorer performance in phonological tasks than those children with reading disabilities alone. But they did not give any explanation on this observation.

2.9 Conceptual framework for studying handwriting difficulties in kindergarten children

Based on the literature reviewed above, a conceptual model is built up looking into the handwriting performance of kindergarten children. This model is also developed based on the developmental approaches of handwriting proposed by Berninger et al (1992) and Abbott & Berninger (1993). The model proposed a sequential process of how developmental skills are linked to writing-related skills. As these two models are developed for English handwriting skills, it is necessary to consider the similarities and differences in learning Chinese and English handwriting.

A two-stage interactive model of how developmental skills contribute to biliterate handwriting difficulties was therefore proposed (Figure 2.5). In the first stage (the lower part of the figure), the model listed skills in perceptual-motor and linguistics skills that explained the clinical manifestation of higher-level handwriting difficulties in English or Chinese handwriting. Three perceptual-motor skills were proved to be related to handwriting difficulties: (1) visual efficiency; (2) visual perception (VP); and (3) fine motor (FM) control

(Tseng & Murray, 1994). Visual efficiency refers to speed and accuracy for controlling eye movement, namely saccades and pursuits, or oculomotor control in general. Liversedge et al (2014) pointed out that the duration and efficacy of fixations allow the person to only obtain necessary information. Furthermore, Martin (2006) defined VP with seven components: (1) visual discrimination; (2) visual memory; (3) spatial relations; (4) form constancy; (5) visual sequential memory; (6) figure ground; and (7) visual closure. This study aimed to examine how each of the VP skills influence the handwriting performance in Chinese and English respectively, as well as the general profile of VP skills in children with different pattern of handwriting difficulties.

As previously discussed, fine motor control includes the mature pencil grip (Schneck & Henderson, 1990; Schwellnus et al., 2012), fine motor coordination (Clark & Luze, 2014; De Vries et al., 2015) and in-hand manipulation (Breslin & Exner, 1999). It is considered as one of the predictors for children's handwriting performance (Clark & Luze, 2014; De Vries et al., 2015). They believed that immature FM skills would affect the efficiency of controlling the writing tool in producing legible strokes.

In Berninger et al's (1992) model, visual motor integration (VMI) was considered at the important as other perceptual-motor skills. VMI is a transitional process that requires children to integrate VP and FM skills in reproducing the visual forms without much cognitive-related thinking process (Carlson, Rowe, & Curby, 2013). It is the pre-requisites which allow children to learn a particular orthography through copying (Maldarelli, Kahrs, Hunt, &

Lockman, 2015). The inability to integrate the skills would interrupt their handwriting performance by making errors or reduced fluency.

The right boxes are the linguistic skills. As discussed, there is much evidence on the associations between visual form, sound and meaning that promotes the decoding skills and in turnthe efficiency of perceptual-motor skills in handwriting performance. At the beginning, children do not have knowledge towards orthographies, such that they treat the letters as same as other visual representation. However, when orthographic knowledge was introduced and practice, children are more aware of the differences between language-related orthographies and non-language visual form. They would apply the writing rules for managing and facilitating their handwriting process. According to Luo et al (2011), Chinese children would memorize the characters in terms of radicals rather than a combination of meaningless strokes. If they failed to understand the orthographic rules, they would have difficulties in decoding the orthography systematically or need extra effort to achieve the same result as their peers.

The upper part of the model is the clinical manifestation of handwriting difficulties. When the children are not acquired sufficient developmental skills, their handwriting performance would be affected. Although there is some overlapping of skills, at which learning of one language would have beneficial effect to other languages (Wang, Park, & Lee, 2006), the types and degree of developmental skills required would be varied because of the differences between English and Chinese orthographies. In Figure 2.5, the color and

thickness of the arrows represent the types and amount of developmental skills for the Chinese and English writing system. The red lines are for the relationships between developmental skills and Chinese handwriting difficulties, while the blue lines are those related to English handwriting difficulties. For example, English is a phonetic writing that depends on sounds to produce word, while understanding the construction of a character would help to write Chinese. There are also some common skills required for Chinese and English handwriting, which are illustrated in red/blue line.

Based on the hierarchical model from lower-level developmental skills to higher-level writing-related skills, this study proposed that the pre-requisite on the types and levels of developmental skills depend on the language to be learned to write. For instance, the advanced spatial relationship and visual memory skills, should be accomplished among Chinese children in order to meet the demand on the visual complexity of Chinese characters (Ho et al., 2015; Lai & Leung, 2012).

Gender differences in developmental skills as well as handwriting performance maybe existed. Regardless of age and culture, boys tend to have greater risk of dyslexia than girls (Berninger & Fuller, 1992; Berninger et al., 2008; Chan et al., 2007; Wong et al., 2012). They explained that boys were more impaired in handwriting and spelling, which may be due to the lower scores on various literacy and cognitive skills. Therefore, gender difference would also be examined.

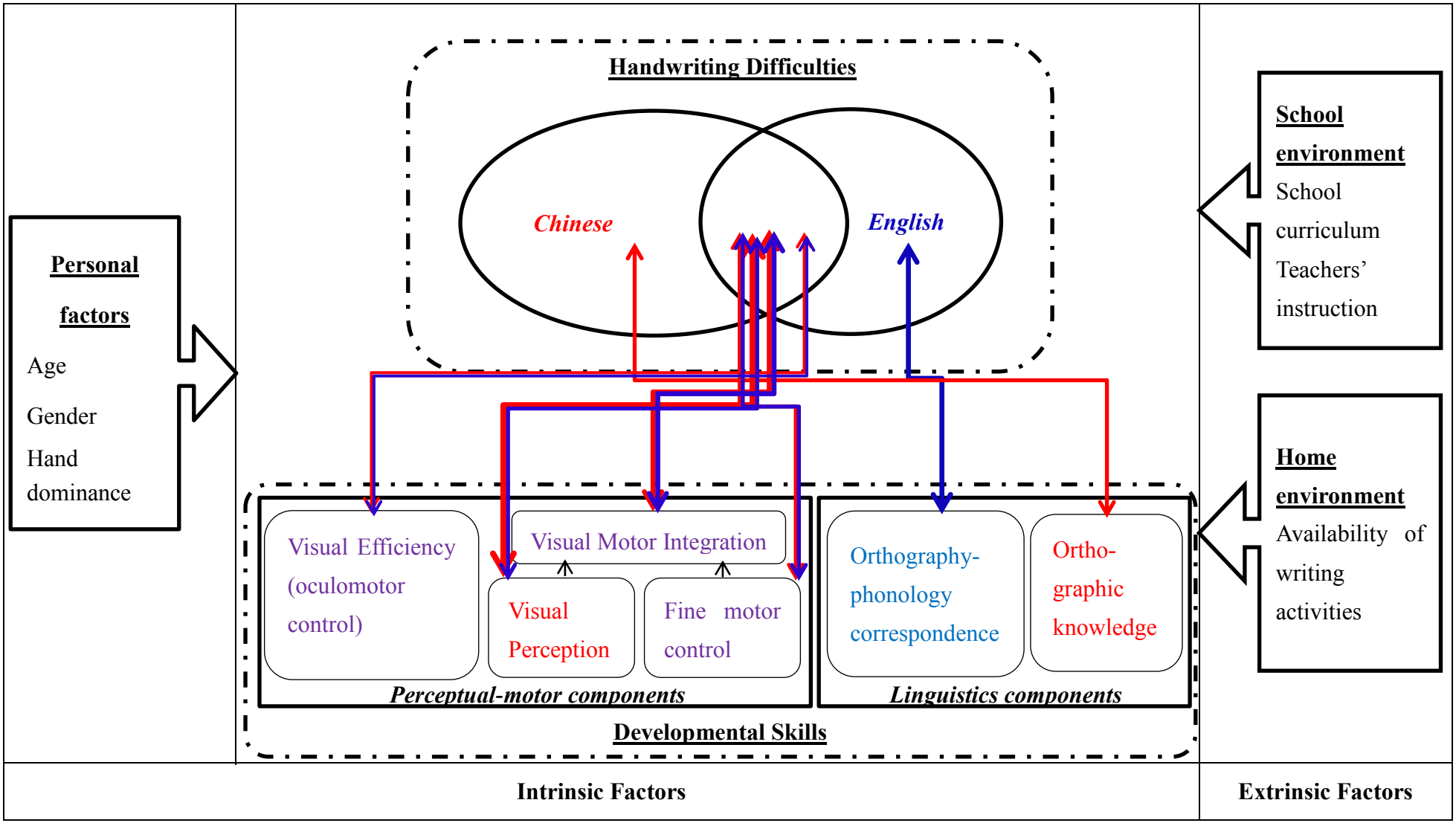


Figure 2.4. The influences of developmental skills of children with different patterns on handwriting difficulties

As discussed, the development of handwriting skill might be influenced by school, home and parental training. It is hard to examine these social factors without a large sample of parents and schools representing different influences. The researcher would like to control these variables. Participants of this study should be come from local kindergartens that subsidized by Education Bureau. It ensures the school curriculum follow the guidelines of Education Bureau. And the teaching content and the amount of writing time would be recorded to examine if there is between school effects. In the meantime, the content and amount of writing exercise additionally provided by parents would also be recorded. The data would be discarded if the parents showed exaggerated training on writing.

2.10 Significance of the study

There are lots of researches studying handwriting development across alphabetic writing systems, but there appear very few studies addressing the unique context in Hong Kong where children have to learn both Chinese and English handwriting in their early years. In particular, research on Chinese handwriting is scarce. Although there are some local studies on early Chinese handwriting development, they are either case studies (Chan, Cheng, & Chan, 2008; Chan, 2013) or conducted a long time ago (Chan & Louie, 1992; Curriculum Development Council, 1996; Opper, 1996). This study would explore the learning process in

terms of the composition of Chinese characters by strokes and radicals, as well as the Chinese name writing skills across the kindergarten stage.

Many previous studies on Chinese handwriting performance focus on primary and secondary students rather than in kindergarten children. This study focuses on studying how kindergarten children begin to learn Chinese and English handwriting. The developmental progression of these skills would also be explored. The findings on the developmental characteristics and comparison between children with and without handwriting difficulties would provide evidence on the timing of intervention for children who exhibit difficulties in learning how to write.

With the fact that Chinese children in Hong Kong have to learn to read and write both Chinese and English since kindergarten stage, it was a good opportunity to investigate the Chinese and English handwriting performance with the same group of children, especially those with handwriting difficulties. According to McBride-Chang et al (2012), they stated that local children with dyslexia were having different profiles in reading problems in Chinese, English or both. It draws out the attention that similar problems would be occurred in handwriting. The present study would address this issue by examining Chinese and English handwriting performance among K3 children respectively.

This study also aims to examine how developmental skills in perceptual motor, fine motor, and linguistic aspects may contribute to handwriting development and difficulties. While many of these skills are hypothesized or found to be linked to handwriting

development, few studies were comprehensive to study all three types of skills under an organized framework as in this research. This research gap would be filled up by the present study in examining the children with different patterns of handwriting performance and their performance on these developmental skills, and thus their deficits that resulting barriers on children's handwriting development. It also assist clinicians and educators on how to prepare children to be ready for receiving formal instruction on handwriting, and the underlying problems among those children who exhibits difficulties in the learning process.

In summary, there are two main objectives of this study. First, a Chinese visuo-orthographic copying task and Chinese name writing scale was validated to find out the developmental progression of Chinese handwriting skills in the kindergarten stage. Second, I would like to examine how in developmental skills may contribute to development of Chinese and English handwriting in specific manners. These results could help to establish a cultural-specific screening protocol to identify kindergarten children who may need extra support on learning to write Chinese and English neatly. The ultimate goal is to promote the public awareness on the importance of early identification and remediation of handwriting difficulties from kindergarten stage such that these children would have better preparation for learning to write in future.

2.11 Research Questions and Hypotheses

2.11.1 Research questions

Phase 1 – Validation of visuo-orthographic copying tasks and Chinese Name Writing Scales and the developmental characteristics of Chinese handwriting skills among kindergarten children in Hong Kong

1. Are the visuo-orthographic copying task and Chinese name writing scale reliable and valid instruments for assessing handwriting skills?
2. What are the stages of development in Chinese handwriting skills among kindergarten children in Hong Kong?

Phase 2 – Evaluation of Chinese and English handwriting performance among K3 children with and without handwriting difficulties

1. How could we identify children who are at-risk in handwriting difficulties during kindergarten stage?
2. What are the characteristics of kindergarten children with handwriting difficulties, as illustrated in their handwriting products?

Phase 3 – Comparisons of the developmental skills among K3 children with handwriting difficulties in Chinese or/and English

1. Do children with handwriting difficulties in Chinese or/and English have poorer developmental skills, when compared with the controls?

2. What are the types and levels of developmental skills required for legible Chinese and English handwriting respectively?

2.11.2 Research hypotheses

It hypothesized that,

~ The development of Chinese handwriting skills follows the stages of becoming proficient in writing strokes, radicals and then characters.

~ The development of Chinese name writing follows a continuum from scribbling to conventional writing.

~ When compared with typically developing children, children with handwriting difficulties have poorer performance in visuo-orthographic copying tasks of Chinese characters/ English words and name writing tasks.

~ Chinese handwriting places greater demands on developmental skills of children than English handwriting.

~ Deficits in developmental skills, particularly visual-perceptual, fine motor and linguistic skills, lead to difficulties in learning how to write Chinese or/and English.

Chapter Three: Phase 1 – Validation of visuo-orthographic copying tasks and Chinese Name Writing Scales and the developmental characteristics of Chinese handwriting skills among kindergarten children in Hong Kong

3.1 Introduction

The first phase of this study was to explore the developmental characteristics of Chinese handwriting skills among kindergarten children. Given the unique formation of traditional Chinese characters and the way in which Chinese children learn to write, a visuo-orthographic copying task was developed based on the composition of Chinese characters, namely stroke, radical and character.

Since name writing was a developmental indicator of early writing in alphabetic writing systems, a Chinese name writing scale (CNWS) was also established and assessed. The discriminant validity, test-retest and interrater reliabilities were examined before the establishment of the developmental characteristics of Chinese handwriting skills in terms of visuo-orthographic copying and name writing. In addition, the home and school factors would be recorded and evaluated on whether these two factors would influence the handwriting performance of kindergarten children.

3.2 Objectives of the study

1. To develop and validate the visuo-orthographic copying task and Chinese name writing scale for kindergarten children;
2. To develop and validate a Chinese Name Writing Scale (CNWS);
3. To investigate the developmental characteristics of Chinese handwriting skills via visuo-orthographic copying and name writing tasks among Chinese kindergarten children enrolled in Hong Kong.

3.3 Methodology

This phase of study was divided into three stages. It was carried out from November 2014 to April 2015. All children attended kindergarten for at least half of the year and had some experience with pencil control or writing.

3.3.1 Stage 1: Establishment of the assessment content and scoring criteria on Chinese handwriting skills

3.3.1.1 Development of visuo-orthographic copying task

A list of common Chinese strokes, radicals and characters was formulated. Five of the eight basic strokes were selected along with ten compound strokes that consisted of two basic

strokes. The selection of these strokes was based on the frequency they were appeared in the characters learnt by kindergarten children in Hong Kong. In addition, several criteria were applied in the selection of radicals from a list of 80 common radicals by Ma (2006): (1) appeared in the characters that are commonly learnt in kindergarten curriculum; (2) semantic radicals that comprised meaning for a character; and (3) deviated from original form to avoid confusion between radicals and characters. For example, distorted from 亻 (人 [man]) instead of 牜 (牛 [ox]) were chosen.

Finally, characters were selected by reviewing curricula from nine kindergartens based on the Guide to the Pre-primary Curriculum (Curriculum Development Council, 2006), with the opinions from pediatric occupational therapists (OTs) and kindergarten teachers of Hong Kong Christian Service on the mistakes that kindergarten children usually made. It showed children's ability to arrange strokes and radicals into a character with correct proportion and spatial relationships.

3.3.1.2 Development of the Chinese name writing scale (CNWS)

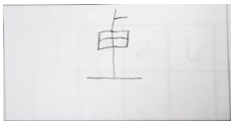
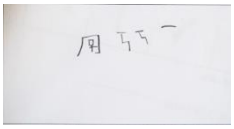
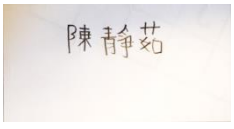
Two OTs who are experienced in handwriting assessment and training designed the name writing scale (Chinese version; CNWS). They began by conducting a thorough review of literature pm the assessment of name writing skills in English writing systems used since 2006, and identified eight sets of assessment protocols or criteria (Appendix A). To prepare for the development of a Chinese name writing scale, the formation of Chinese characters and

names was reviewed, as were the ways in which Chinese handwriting is taught in kindergarten.

Three stages of development in name writing were identified from the review and applied to the Chinese Name Writing Scale. In the first, or graphic, phase, name writing could range from no response, to scribbling in lines and curves, to drawing strokes to form separate or more complex units. However, the words are not properly or correctly written. In the second, or character-like writing phase, children intentionally write separate word units by merging strokes with different patterns. Language-specific features start to appear, such as square-like word forms in Chinese characters. However, these units may resemble the characters in the child's name but still are not correctly written. In the third, or symbolic, phase, children write at least one letter in their names. They try to use phonetic representation to assist them in writing letters until they can write all letters correctly (Gerde et al., 2012; Levin et al., 2005). In previous studies, Chinese children usually start to write their names beginning with its simplest character; scores are therefore given for any correct characters within the name. Three rating criteria (in order of difficulty) were developed for each of the three stages, and a 9-point scale with which to evaluate the developmental changes of name writing was finalized (Table 3.1).

Table 3.1

Stages of development and rating criteria of the Chinese Name Writing Scale (CNWS)

Stage	Points	Rating criteria	Example
Graphic	0	No response or aimless scribble.	-
	1	Straight and curved lines with turning angle.	
	2	Contains separate and complex units that are combined with strokes.	
	3	Contains parts of a character (i.e., a defined stroke pattern) (e.g., 卓) that is demonstrated by a square configuration.	
Character-like writing	4	Contains character-like parts of more than one character that is illustrated from left to right (e.g., 周巧兒).	
	5	One character is correctly written (e.g., 杏), while unable to write other characters or other characters are represented by simple stroke patterns (e.g., 胡杏遙).	
	6	At least one character is correctly written (e.g., 子希), while others are partly written or use characters with similar sounds/shapes (e.g., 嚴).	
Symbolic	7	All characters are generally written (e.g., 王國維), with mistakes on stroke formation, disproportion of radicals or poor alignment (e.g., wrong stroke formation in the character 國).	
	8	All characters are correctly written, with good alignment and proportion (e.g., 陳靜茹).	

After that, some descriptions were added to meet the requirement for Chinese name writing. For instance, writing the whole name (i.e., usually with three Chinese characters) was required instead of the first name in alphabetic writing systems. Then, a forward translation from English to Chinese was done by a final-year student who was majoring in English for Communication. By comparing the English and Chinese versions, the appropriateness of the scale to illustrate Chinese name writing development was developed. It also minimized the language barrier so that the results could be explained to educators and parents.

3.3.1.3 Expert panel review

An expert panel of three occupational therapists (OTs), three kindergarten teachers (QKTs) and five parents of children of kindergarten stage was formed. All QKTs and OTs had more than five years' experience working with kindergarten children, and all of the parents had received at least tertiary education. They were responsible for selection of the assessment content and to determine the scoring criteria.

They then completed a questionnaire to determine the suitability of the content of visuo-orthographic copying template and CNWS by rating the levels of appropriateness and difficulties in using particular items to assess their handwriting skills in each grade using a 5-point Likert scale (1 = very poor, 2 = poor, 3 = neutral, 4 = good and 5 = very good). They

were also asked to recommend the number of items of strokes, radicals and characters and the grid size to be used in each grade (Appendix B).

They suggested dividing the scale into two parts, to examine the skills required for visuo-orthographic copying. Part 1 included the simplest characters with the fewest strokes. These characters should be learned in kindergarten. It was used to identify children whose writing was illegible or who took a long time to write, despite direct practice. Part 2 consisted of characters which are more complex that children knew how to read but might not have been familiar with. As a result, legibility was used to assess how well the children arrange radicals within square configuration and writing rules were applied to unfamiliar characters.

To accommodate students with different levels of writing ability across grades, templates were formulated with a variety of items in strokes, radicals and characters suggested by expert panel for K1, K2 and K3 children. There were ten strokes, five simple radicals and ten independent characters from Part 1 for K1 children. For K2 children, in addition to ten strokes and ten radicals, there were 15 characters from Part 1 and eight from Part 2. Finally, five combined strokes, ten radicals, together with 25 characters from Part 1 and 12 from Part 2 were included for K3 children.

Only correctness of the writing products was suggested to be assessed to show the changes in handwriting. Nine criteria were selected by occupational therapists and kindergarten teachers in the expert panel: (1) out of grid, (2) wrong words, (3) improper proportion among strokes/radicals, (4) inverted stroke or radicals, (5) disproportion of

strokes/radicals, (6) superfluous stroke, (7) missing strokes, (8) overshooting strokes, and (9) strokes are too short. Each item was scored in different scales based on its complexity. Dichotomous scores (0 or 1) were used to assess in the stroke level. 3-point Likert scale were used to assess in the radical level, where 2 points for all correct, 1 point if there was one mistake, and no points when there were two or more mistakes. In character level, 5-point Likert scale (0-4) was used: 4 points meant all correct, 3 points for one mistake, 2 points for two mistakes, or when characters were incompletely written (i.e., among radicals), 1 point for three mistakes or for combinations of strokes within a square configuration. The maximum points for each category of strokes, radicals and characters are shown in Table 3.2.

Table 3.2

The maximum scores for each category of strokes, radicals and characters by grade

	Stroke (@1mark)	**Radical (@2marks)**	**Character (Part 1) (@4 marks)**	**Character (Part 2) (@4marks)**
K1	10	10	40	-
K2	5	20	60	32
K3	-	20	100	48

The grid size was chosen based on the expert panel's suggestions. Figure 3.1 shows the distribution of their choice in each grade. After discussion, 4cm, 2.5cm and 2cm were selected for K1, K2 and K3, respectively.

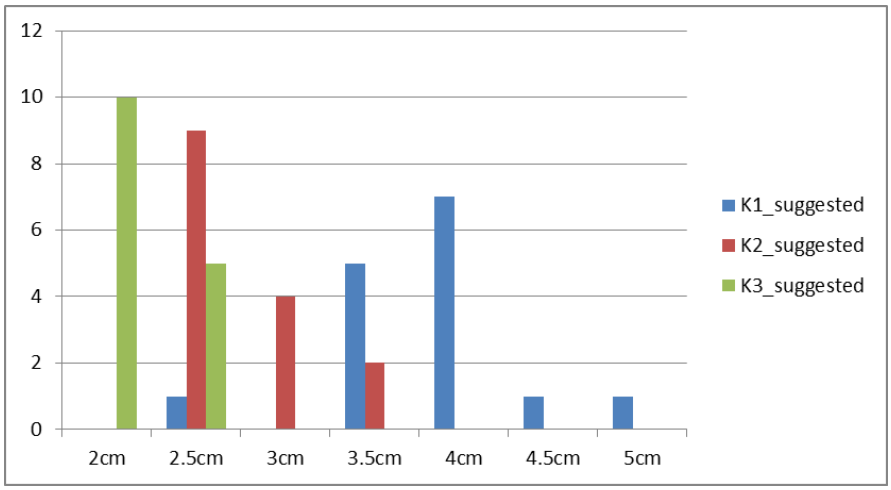


Figure 3.1. The grid size suggested by expert panel across grades

For the CNWS, all panel members gave scores of at least 4 out of 5 on each item. The mean score for the whole scale was 4.27 (*SD* = 0.46), ranging from 4.13 to 4.73 (*M* = 4.74, *SD* = 0.18) for each point. One panel member expressed a need to clarify the description of rating in the middle part of the scale (such as Point 4), which indicates children can only write part of each character in their names. In response to this comment, more detailed descriptions of scoring criteria, such as the presence of radicals and correct proportions, along with photos of each point were added to increase the reliability of the rating.

3.3.2 Stage 2: A pilot trial on the appropriateness of the assessment content and scoring criteria

A pilot study was conducted to examine the suitability of the assessment content and the scoring criteria, standardize the assessment procedures and scoring among researchers, and identify potential problems in the administrative procedures.

3.3.2.1 Participants

One hundred and forty-one K1 to K3 children were recruited from one kindergarten in Kowloon by convenience sampling. The inclusion criteria were those studying at the corresponding grade according to their year of birth (i.e., all K1 were born in 2011). They had attended the local kindergarten since nursery class and were learning to use Cantonese and traditional Chinese as for oral and written communication. Students from non-Chinese families or with documented developmental physical, visual, hearing and emotional/behavioral disabilities were excluded. The demographic information of the children is shown in Table 3.3.

Table 3.3

Demographic information of children in the pilot study

Grade	No. of children	Gender		Mean Age (*SD*) (months)
		Boys	Girls	
K1	50	35	15	42.54 (3.50)
K2	36	16	20	54.00 (2.77)
K3	55	25	30	66.31 (3.37)
Total	141	76	65	

3.3.2.2 Revision of the assessment protocol

Further revision of the content of visuo-orthographic copying task was done to increase its sensitivity to differences in Chinese handwriting ability among kindergarten children in the same and in different grades.

All children could complete all items in less than 20 minutes. This is acceptable to accommodate the attention span for kindergarten children is about 15 minutes. Some ceiling effects were observed in the copying of strokes. K2 children could correctly copy most of the strokes while all K3 children performed well. Therefore, only five combined strokes were retained in K2 and all were deleted for K3 children. In contrast, although most children could copy radicals, the items were retained. It would be worthwhile to examine if the problems of copying characters started at the radical level (e.g., missing strokes or poor stroke formation) or originated purely in a poor spatial relationship between radicals in compound characters.

The grid size for K1 children was reduced from 4cm to 3.5cm because it was too large for some children.

Because some K1 and K2 were lacked concept about their whole name and how it looked like, two prerequisite skills were assessed: (1) the ability to say their name on request; and (2) pick their name from a list of five. These criteria ensured that the children could recognize their name, but only access their ability in retrieving that information from memory to formulate the motor program in writing.

3.3.3 Stage 3: Validation of visuo-orthographic copying task and CNWS and the study of developmental characteristics of Chinese visuo-orthographic copying and name writing skills across age and grades

The purposes of this study are to examine the psychometric properties of visuo-orthographic copying template and Chinese name writing scale and to identify the developmental characteristics of Chinese handwriting in terms of visuo-orthographic copying and Chinese name writing.

3.3.3.1 Sampling method

According to the Population Census of Hong Kong (2011), there were around 150,000 children between 3 years 0 months to 5 years 11 months (i.e., kindergarten age; Census and

Statistics Department, 2011). By using a 5% margin of error and 95% confidence level, a sample size of 384 was estimated for the main study.

Stratified sampling of kindergartens and convenience sampling of children's age and grade were used. Assuming that 60 to 80 children in each kindergarten would participate in our study, two kindergartens from Hong Kong Island, two from Kowloon and two from the New Territories were recruited. To increase the variability of children's socioeconomic status and the generalizability of the findings, no two kindergartens were selected from the same district. All children in these kindergartens were invited to participate if they: 1) were enrolled at the corresponding grade according to his or her year of birth; 2) had learned to use Cantonese and traditional Chinese as the primary source of oral and written communication since K1; and 3) did not have any diagnosis on physical (including visual and hearing) and emotional/ behavioral problems or were on a wait list at the Child Assessment Center. In addition, teachers had to identify children with poor handwriting, together with those diagnosed with developmental/motor delay to form a contrast group for construct validity.

Children who met these criteria from one additional kindergarten were randomly recruited to assess twice with a two-week interval to establish the test-retest reliability.

3.3.3.2 Participants

Three hundred and sixteen children from nursery (K1) to upper kindergarten (K3) classes were recruited from six kindergartens in different districts in Hong Kong. The demographic data of these children are illustrated in Table 3.4.

Forty-two children (21 boys and 21 girls) from another kindergarten were assessed twice, with a two-week interval between assessments to establish the test-retest reliability. Seventeen children were from K1, 14 from K2 and 12 from K3.

Table 3.4

Demographic information of children for the validation study

Grade	**No. of children**	**Gender**		**Handedness**		**Mean Age (*SD*) (months)**
		Boys	**Girls**	**Right**	**Left**	
K1	93	44	49	89	4	45.82 (3.78)
K2	121	63	58	116	5	57.43 (3.60)
K3	102	52	50	97	5	69.74 (4.27)
Total	316	159	157	302	14	

In addition, for the study of discriminant validity, we identified children with handwriting difficulties by using the kindergarten version of the Tseng Handwriting Problem Checklist (THPC; Tseng, 1993; Yang, 2000). The description and scoring method was modified from Tseng's (1993; for primary school students), making it more appropriate to

assess handwriting in kindergarten stage. A child was regarded as having handwriting difficulty if he or she showed problems at least 50% of the time in at least six of 15 criteria in the THPC. The children with handwriting difficulties (n = 42) were matched on the gender and age variables with typically developing children from the same class (n = 42; Table 3.5).

Table 3.5

Demographic information of children with handwriting difficulties and typically developing children

	Children with handwriting difficulties			**Typically developing children**	
	Formal diagnosis	**Classified by teachers**	**Mean Age (*SD*) (months)**	**Number of children**	**Mean Age (*SD*) (months)**
K1	3	13	43.21 (3.87)	16	44.63 (3.30)
K2	5	10	56.00 (2.73)	15	56.13 (2.59)
K3	5	6	69.73 (4.22)	11	70.09 (3.99)
Overall	13	29		42	

3.3.3.3 Instruments

3.3.3.3.1 Visuo-orthographic copying task

The numbers of items in stroke, radical and character levels were finalized specific to K1, K2 and K3 children (Table 3.6). Children were requested to write each item in the grid as quickly and legibly as they could.

Table 3.6

The assessment content of the visuo-orthographic copying task in K1 to K3 Children

	Stroke	**Radical**	**Character (Part 1)**	**Character (Part 2)**
K1	10	5	10	-
K2	5	10	15	8
K3	-	10	25	12

3.3.3.3.2 Name writing task

The procedure was adopted from the standardized assessment tools such as Phonological Awareness Literacy Screening (Prekindergarten version; PALS-PreK; Invernizzi et al., 2004). Children were first asked their name and to find on a class list of five. If they could not, they would not be asked to write their names. A sheet of unlined 12cm x 6cm paper was given to each child, with the request to write his or her name from memory (Blair & Savage, 2006; Bloodgood, 1999; Drouin & Harmon, 2009). They were only prompted "to write as many features of the characters in your name as you can" (Gerde et al., 2012).

3.3.3.4 Procedures

All the tasks were administered in the corresponding kindergarten in groups of 10 to 12 children, where were furnished with children's tables and chairs. They used the stationary

provided by schools. Every two children completed the tasks that supervised by a university student who received training on the administrative procedure and the whole session was overseen by me.

The tasks started by asking the children to speak out their names and find them on the class list, to ensure they could recognize their names and acknowledge their names' function before beginning the name writing task. If they could not say or recognize their name, it would be marked and their name writing performance would not be assessed. Students who could complete these tasks were encouraged to write as many features of the characters from their name as possible. They then performed the Chinese visuo-orthographic sequence of strokes, radicals and characters. They were encouraged to copy the figure as closely to the template as they could.

Children from the kindergarten for test-retest reliability were assessed twice with two-week interval and all environmental factors were kept constant. Four raters (two occupational therapists and two undergraduate psychology students) scored the Chinese name writing skills. They used the samples from the pilot study for the consensus of rating.

3.3.3.5 Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics 21.0; all tests were applied two-tailed and the significance level was set at $p < 0.05$. To begin, mean scores and the standard deviations of each measurement items through K1 to K3 children were also

computed. Then, the construct validity, inter-rater and test-retest reliabilities in terms of grade were also calculated. According to Portney and Watkins (2009), ICC of 0.75 to 0.90 was considered good reliability; an ICC above 0.90 was considered excellent.

All typically developing children from the six kindergartens involved in the validation study participated to demonstrate developmental trends and characteristics of visuo-orthographic copying skills regarding strokes, radicals and characters, as well as the increasing character-like features in Chinese name writing. Their performance in each measurement item was analyzed and compared in terms of age group of every three months in reference to most of the developmental milestones.

3.4 Results

3.4.1 Descriptive statistics of visuo-orthographic copying task

As shown in Table 3.7, K1 children could copy only some simple strokes and combine two of them to form radicals and characters. K2 children were better at copying strokes and radicals. They wrote simple characters correctly but had difficulties in copying compound characters. K3 children were expected to be able to do this.

Table 3.7

Means and standard deviations on the performance in visuo-orthographic copying of Chinese characters across grades

Variables	Mean (*SD*)		
	K1	**K2**	**K3**
Strokes	4.72 (2.13)	9.57 (0.58)	-
Radicals	4.28 (2.31)	17.23 (2.10)	18.79 (1.12)
Character (Part 1)	18.09 (9.23)	54.38 (4.20)	96.56 (2.40)
Characters (Part 2)	-	24.49 (5.32)	44.95 (1.96)

3.4.2 Descriptive statistics of Chinese name writing task

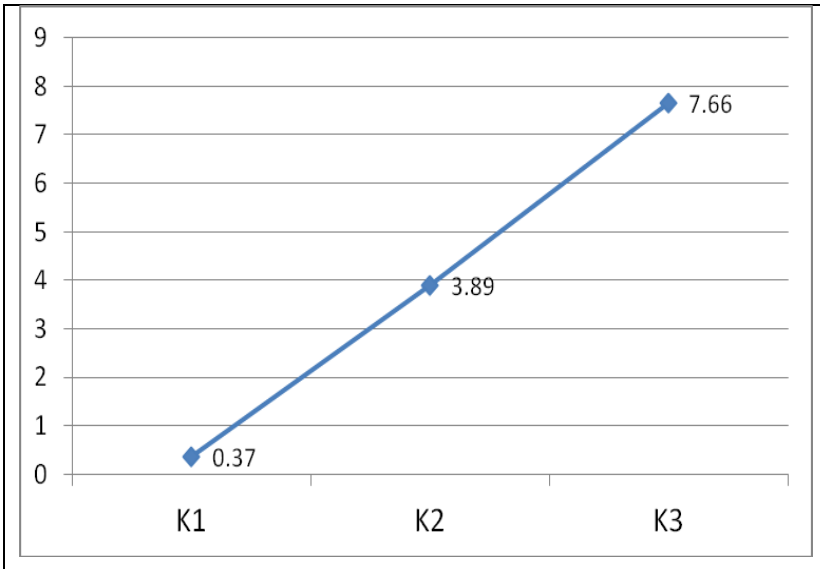
There were three levels to examine children's understanding of their Chinese name. They were first asked to tell the researcher their names. They were then asked to pick out their name from a list of their classmates. It ensured they knew the meanings and functions of their own name before they were asked to write (Table 3.8).

Table 3.8

Frequency of using one's own name in representing the sense of self

Grade	Variables	No. of children who are able to tell their own name (%)	No. of children who are able to recognize from the list (%)
K1 (n = 93)		90 (96.7%)	78 (83.9%)
K2 (n = 121)		121 (100%)	120 (99.2%)
K3 (n = 102)		102 (100%)	102 (100%)

Their handwriting was analyzed only when the children could tell the researcher their name and recognize it on a list. Figure 3.2 shows that name writing products in K1 children were dominated by scribbling and/or simple lines but in K2 children more figures resembled characters. Nearly all K3 children could write their full name, with minor mistakes or poor proportion of radicals.



	Mean (SD)	Range
K.1	0.37 (1.05)	0-6.25
K.2	3.89 (2.91)	0-8
K.3	7.66 (0.37)	6-8

Figure 3.2. Chinese name writing across grades (*n* = 300).

3.4.3 Inter-rater reliability of CNWS

Intra-class correlation coefficients (ICCs) were used to test the inter-rater reliability of the CNWS scores. There was good inter-rater reliability for K3 children and excellent reliability in K1 and K2 children and as a whole (Table 3.9).

Table 3.9

Intraclass correlation coefficients (ICC) of CNWS scores across grades

	ICC (2,1)	**Mean (*SD*)**			
		Rater 1	**Rater 2**	**Rater 3**	**Rater 4**
K1	0.76	0.49 (1.12)	0.36 (1.06)	0.32 (1.10)	0.32 (1.04)
K2	0.99	4.04 (2.86)	3.95 (2.85)	4.09 (3.00)	4.05 (2.97)
K3	0.99	7.74 (0.51)	7.74 (0.49)	7.66 (0.52)	7.43 (0.57)
Overall	0.99				

3.4.4 Test-retest reliability

The ICC of the visuo-orthographic copying tasks among children from different grades is shown in Table 3.10. Except for poor test-retest reliability of the copying of strokes in K.2 children, good to excellent test-retest reliabilities were yielded in the copying of strokes, radicals and characters across grades.

The Chinese Name Writing Scale showed moderate to excellent test-retest reliability for kindergarten children (Table 3.11). Although only moderate test-retest reliability was shown in K1 children (ICC = 0.53), excellent reliabilities were found in K2 (ICC = 0.98) and K3 children (ICC = 0.97).

Table 3.10

Intra-class correlation coefficients (ICC) of visuo-orthographic copying tasks of children across grades in the test-retest

Variables	**Grades**	**ICC (3,1)**	**Mean Score (*SD*)**		**95% CI**	
			Test	**Retest**	**Lower**	**Upper**
Strokes	K1	0.90	3.00 (1.32)	3.43 (1.90)	0.73	0.97
	K2	0.27	4.50 (0.65)	4.79 (0.43)	-1.41	0.72
Radicals	K1	0.81	2.44 (2.13)	2.50 (2.16)	0.44	0.93
	K2	0.78	16.71 (2.09)	17.64 (1.86)	0.31	0.93
	K3	0.89	19.17 (0.94)	19.33 (0.89)	0.61	0.97
Characters (Part 1)	K1	0.91	8.13 (6.54)	10.44 (9.48)	0.74	0.97
	K2	0.88	51.86 (4.93)	52.93 (3.63)	0.63	0.96
	K3	0.97	97.58 (1.31)	97.50 (1.62)	0.89	0.99
Characters (Part 2)	K2	0.82	21.07 (6.53)	23.93 (4.51)	0.42	0.94
	K3	0.98	45.67(1.44)	45.83 (1.40)	0.93	0.99

Table 3.11

Intra-class correlation coefficients (ICC) of the Chinese Name Writing Scale during the test-retest

Grade	ICC (3,1)	Mean Score (*SD*)		95% CI	
		Test	Retest	Lower	Upper
K1	0.53	0.34 (0.47)	0.36 (0.90)	-0.76	0.88
K2	0.98	4.46 (2.07)	4.54 (1.99)	0.94	0.99
K3	0.97	7.62 (0.61)	7.54 (0.66)	0.90	0.99
Overall	0.99			0.99	0.99

3.4.5 Discriminant validity

3.4.5.1 Differences in performance in visuo-orthographic copying task

The differences in performances were compared by grade (Table 3.12). Except for insignificant differences in copying strokes in K1 children (t = 1.75, p = 0.950), typically developing children had higher mean scores in all items of visuo-orthographic copying task than children who were at risk of handwriting difficulties.

Table 3.12

Means and standard deviations of visuo-orthographic copying tasks with a comparison between children with handwriting difficulties and typically developing children

Variables	Grade	Children with handwriting difficulties		Typically developing children		*t*
		Mean	***SD***	**Mean**	***SD***	
Strokes	K1	3.85	1.92	2.56	1.42	1.75
	K2	9.50	0.65	8.75	0.87	2.52*
Radicals	K1	4.06	2.21	1.00	1.21	4.87**
	K2	17.80	1.08	13.20	2.70	6.12**
	K3	19.00	0.77	17.18	1.47	3.63**
Characters (Part 1)	K1	14.69	8.16	4.06	5.05	4.42**
	K2	55.60	2.72	39.60	13.75	4.42**
	K3	97.27	1.01	90.82	3.46	5.94**
Characters (Part 2)	K2	26.60	3.25	13.33	5.86	7.67**
	K3	44.55	1.86	40.82	2.32	4.16**

** $p < 0.01$. * $p < 0.05$.

3.4.5.2 Differences in performance in Chinese name writing

The comparison of Chinese name writing skill was carried out by grade even though the same scale was used (Table 3.13). The results showed significant differences in performance between K2 ($t = 2.95$, $p = 0.006$) and K3 children ($t = 4.53$, $p < 0.001$), but not in K1 children ($t = 1.13$, $p = 0.267$).

Table 3.13

Means and standard deviations of the name writing task with a comparison of children with handwriting difficulties and typically developing children

	Children with handwriting difficulties		**Typically developing children**		***t***
	Mean	***SD***	**Mean**	***SD***	
K1	0.30	0.75	0.08	0.18	1.13
K2	3.65	3.04	0.93	1.87	2.95**
K3	7.86	0.23	7.09	0.52	4.53**

** $p < 0.01$. * $p < 0.05$.

3.4.6 Developmental characteristics of visuo-orthographic copying skills

Children's ability to copy strokes, radicals and characters of different levels of complexity across age ranges and grades is shown in Table 3.14.

For better illustrations of the changes, the progression of mean scores in copying of strokes, radicals and characters is shown in Figure 3.3. The progression of copying changes with age and grade. Most K1 children were able to copy mainly strokes. The ability to copy radicals improved from K1 and reached a plateau in K2. Although K1 children could only copy part of a character, the skill sharply improved from K1 to K2, and then again in K3. Nearly all K3 children could copy both types of characters neatly.

Table 3.14

*Means and standard deviations on visuo-orthographic copying skills across age ranges and grades (*n = *316)*

Grade	Age range	Number of children	Mean (*SD*)			
			Strokes	**Radicals**	**Characters (Part 1)**	**Characters (Part 2)**
K1	3;3-3;5	11	3.13 (1.36)	2.73 (1.49)	11.00 (6.54)	-
	3;6;3;8	20	3.70 (1.78)	3.26 (1.63)	12.95 (7.59)	-
	3;9-3;11	27	4.56 (1.92)	4.56 (2.15)	16.67 (7.91)	-
	4;0-4;2	28	5.92 (2.23)	5.61 (2.88)	24.10 (9.74)	-
K2	4;3-4;5	21	8.32 (2.14)	13.25 (5.13)	46.71 (11.52)	20.07 (4.51)
	4;6-4;8	35	9.24 (1.28)	15.59 (4.37)	51.62 (8.97)	22.61 (6.18)
	4;9-4;11	33	9.59 (0.50)	17.59 (1.81)	54.88 (3.15)	25.66 (3.96)
	5;0-5;2	28	9.64 (0.56)	17.71 (1.90)	55.18 (5.31)	25.57 (5.19)
K3	5;3-5;5	34	9.85 (0.50)	18.65 (1.23)	83.76 (8.91)	38.61 (9.60)
	5;6-5;8	23	-	18.74 (1.05)	95.00 (7.92)	44.23 (3.22)
	5;9-5;11	17	-	19.00 (0.87)	96.59 (2.58)	45.06 (1.85)
	>6;0	39	-	18.83 (1.19)	97.05 (2.47)	45.28 (2.09)

At the same time, there were variations in performance between children of different ages in the same grade. Older children were slightly better at copying than younger children in the same grade, but the difference diminished in K3.

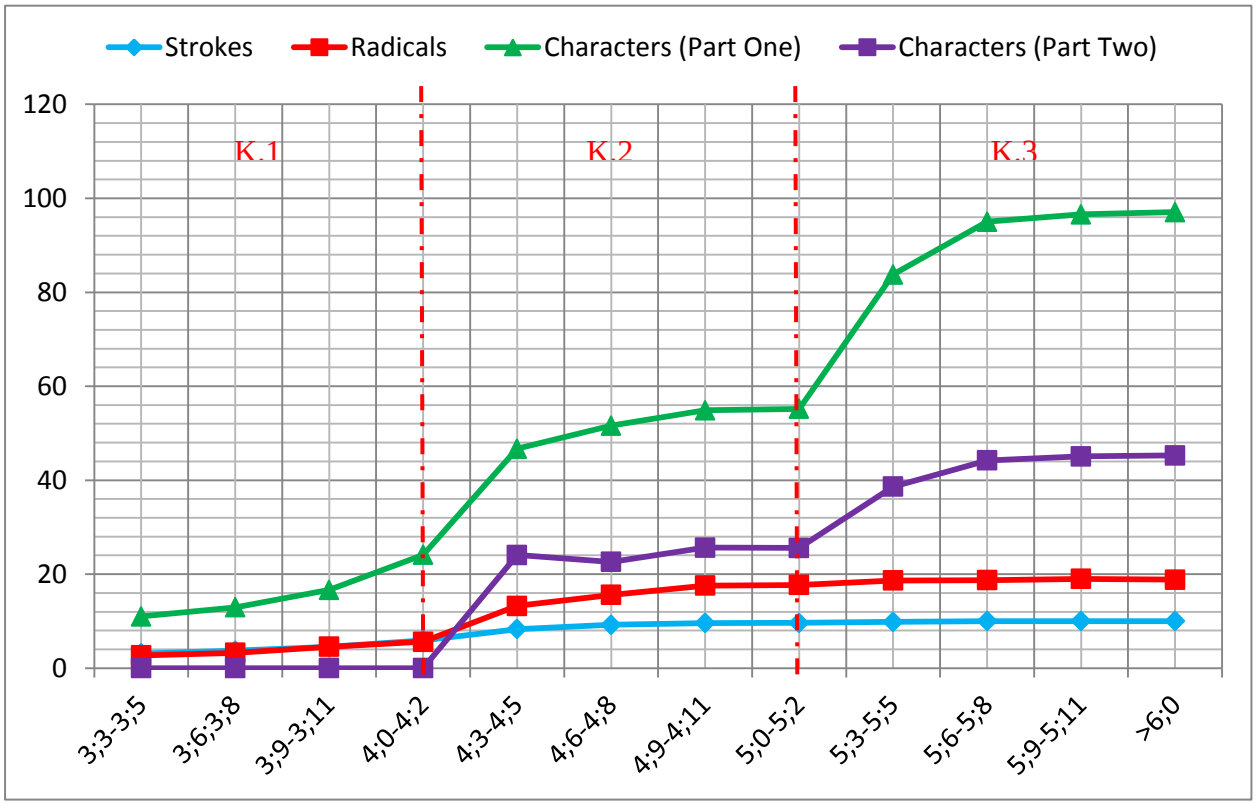


Figure 3.3. Progression of mean scores in visuo-orthographic copying of Chinese strokes, radicals and characters

3.4.7 Developmental characteristics of Chinese name writing skills

This study highlighted the characteristics in the development of Chinese name writing skills, and its difference from those in alphabetic writing systems.

Thirty-four children in K1 (n = 78) and 21 in K2 (n = 120) refused to write when prompted. According to Ho (2011), K1 children might refuse to write when they do not know what language and writing are. However, K2 children who were in between scribbling and character-like writing stage might refuse to write because they aware of their limited literacy

skills. As a result, those K2 children who refused to write their name were excluded. The progression of mean scores in Chinese name writing scale in terms of age and grade is shown in Figure 3.4.

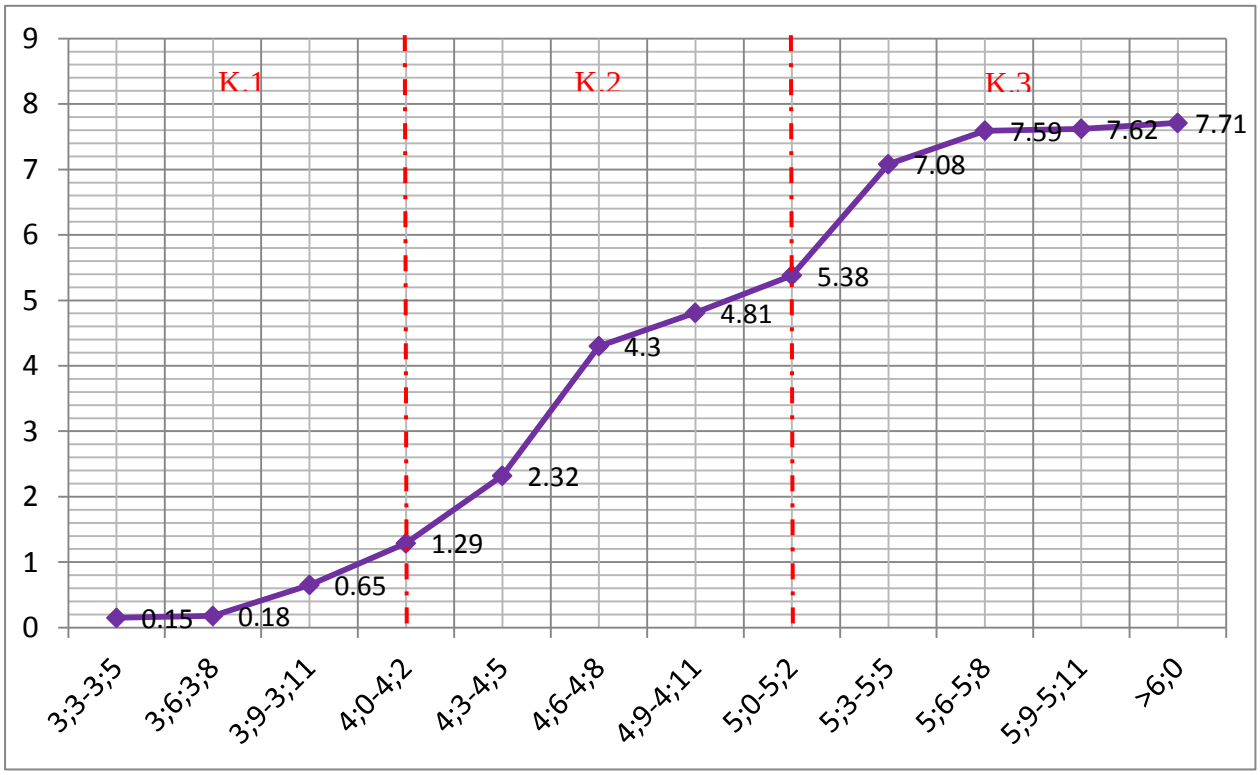


Figure 3.4. Developmental characteristics of Chinese name writing skills (n = 245)

3.4.8 School effects on the Chinese handwriting development

One-way ANCOVAs were used to investigate if there were discrepancies among the recruited kindergartens (Table 3.15). Afte r controlling age as the covariate, only the copying of compound characters was found significant. Thus, post-hoc tests showed that only two kindergartens showed significant differences in performance (t = -2.05, p = 0.012).

Table 3.15

One-way ANCOVAs for the effects of the school curriculum on Chinese handwriting development with the controlling of ages across grades

Variables	K1		K2		K3	
	F	***p***	***F***	***p***	***F***	***p***
Strokes	1.17	0.331	0.69	0.630	-	-
Radicals	1.33	0.259	1.47	0.203	1.08	0.375
Characters (Part 1)	0.58	0.719	1.92	0.097	1.17	0.328
Characters (Part 2)	-	-	1.77	0.124	3.47**	0.006
Name writing	0.56	0.734	1.86	0.108	0.67	0.646

** $p < 0.01$. * $p < 0.05$.

Since formal instruction on Chinese handwriting is done in K2 and K3, the amount of time involved in handwriting task was examined. Thirty female teachers who teach in one of the six kindergartens were recruited as volunteers. Three of these teachers had been teaching for less than three years, four had been teaching for 3-5 years and two had 6-10 years. Most teachers (n = 21) had more than 10 years of experience. Sixteen teachers were from K2 and 14 were from K3.

Eight teachers from K2 and six from K3 indicated that they spend less than 20% of their teaching time on teaching children the writing skills. The same number of teachers spent 21-40% of their time in it. Two teachers from K3 said that they spent 41-60% of their classroom time on handwriting.

3.4.9 Parent involvement on the Chinese handwriting development

Two-way ANCOVA was used to investigate the influence of additional home writing activities on Chinese handwriting development by controlling the age in each grade. The results showed insignificant effect on both amount and content of home writing activities in any of the variables in the visuo-orthographic copying task (Table 3.16).

Table 3.16

Effects of content and amount of home writing activities on visuo-orthographic copying across grades

Home activities	**Amount of writing activities**		**Content on Chinese handwriting**		**Interacting effect of amount and content**	
Variables	***F***	***p***	***F***	***P***	***F***	***p***
K1						
Strokes	1.80	0.178	1.89	0.177	1.43	0.239
Radicals	0.97	0.388	0.95	0.334	0.28	0.597
Characters (Part One)	2.32	0.111	1.15	0.290	0.05	0.820
K2						
Strokes	0.94	0.443	2.80	0.066	0.18	0.951
Radicals	0.50	0.734	2.82	0.065	1.00	0.411
Characters (Part One)	0.31	0.871	0.38	0.689	0.60	0.663
Characters (Part Two)	0.41	0.801	0.19	0.829	0.54	0.708
K3						
Radicals	1.20	0.316	0.81	0.450	0.35	0.882
Characters (Part One)	0.71	0.589	1.50	0.229	0.66	0.652
Characters (Part Two)	2.43	0.054	2.74	0.070	1.13	0.349

One-way ANCOVA was conducted to examine the effect of learning to write one's name and the frequency of writing activities at home on the name writing performance by controlling age and grade (n = 245). It demonstrated that parents who teach their children to write their name had significant effects on the CNWS score (F = 17.59, p < 0.001), but neither learning to write other characters (F = 2.84, p = 0.093) nor the number of writing activities (F = 1.88, p = 0.651) had a significant effects on the development of name writing. Thus, further analysis was conducted to illustrate its effect in terms of grade. It showed an insignificant effect of home exercise on Chinese name writing among K1 (t = 0.50, p = 0.621) and K3 (t = -0.11, p = 0.910) children but not on K2 (t = 3.81, p < 0.001) after controlling for age.

3.5 Discussion

The purpose of this phase was to examine the developmental characteristics of Chinese handwriting skills via visuo-orthographic copying and name writing tasks among kindergarten children in Hong Kong.

3.5.1 Validity of the two tasks

According to the expert panel of kindergarten teachers recruited in this study, formal instruction of handwriting begins in the first term of K2. K1 children were recruited to obtain the baseline in examining the developmental characteristics (i.e., what is happening before formal training). Therefore, it is not a surprise to find that there was no significant difference between children who were clumsy in manipulating writing tools in class and typical developing children. However, when K2 and K3 typical developing children compared with children with suspected handwriting difficulties, the latter had significantly lower scores in copying and name writing. This result supported that once the handwriting strategies were introduced, the visuo-orthographic copying and name writing tasks could be used to identify children who had difficulties in learning to write.

3.5.2 Reliability of the two tasks

The interrater reliability of the CNWS appeared to be very satisfactory in assessing children in K1 and K2, but is less reliable in assessing children in K3. We found that a large proportion of children ages five and six (K2 and K3) can write their names correctly. However, in this symbolic stage of name writing, K3 children are often required to master more sophisticated skills, such as alignment and the appropriate proportion of characters. Due to the increasing emphasis on the quality of handwriting, the test examiners tended to rate the

name writing products with criteria reflecting quality. This may contribute to a high variability in scoring of the writing products by the test examiners.

It was noted that both the copying task and CNWS had good to excellent test-retest reliabilities, indicating that stable results could be obtained in test and retest. There was slightly lower test-retest reliability in copying strokes among K2 children, as it appeared that there was substantial improvement of these skills to form characters over two weeks. The test-retest reliability of CNWS was excellent in K2 and K3 children, but was fair in testing in K1 students. We observed that the writing of K1 children was not too stable; and many students were still scribbling. K1 children may start to realize the importance of writing and were eager to learn, but clearly struggled to communicate in writing (Qian, Song, Zhao & Bi, 2015). This may contribute to a larger variation in performance between test and retest reliability.

3.5.3 Development of Chinese handwriting skills

The development of Chinese handwriting skills was assessed by visuo-orthographic copying and name writing tasks. Visual-orthographic copying skills, where the children must analyze the characters with the writing rules, should be stressed in this stage to facilitate self-initiated learning on handwriting. Conversely, learning Chinese name writing is kindergarten

children's introduction to orthography, phonology and meaning when they write characters from memory.

3.5.3.1 Developmental characteristics of visuo-orthographic copying skills

This is a pioneer study on the development of visuo-orthographic copying skills in compositing strokes, radicals and characters. The purpose of dividing the skills into the three levels provides a framework for examining the changes in children's performance due to the increasing demands on visual perception and spatial relationship in the learning of Chinese handwriting.

As children increase in age and progress to higher grades, they developed better Chinese visuo-orthographic copying skills. The ability to copy strokes emerges in K1, and children are expected to combine these strokes into radicals and simple characters as they move on to K2. By K2, children are ready to form characters by combining strokes and radicals in the proper proportion. As a whole, the ability to copy independent and compound characters improves steadily from K1 to K2, and there is a big jump in skills from K2 to K3. In K1, the ability to copy strokes but not radicals is insufficient. So their ability to write character remains in the bottom level. But in K2, with the formal instruction on orthographic rules, children can combine their knowledge to form more complex Chinese characters. These skills steadily improve in K3 but at a slower pace. K3 children should copy familiar characters neatly, it is also essential to introduce characters with different structures and

formations so they can analyze and write new characters independently when they enter primary school.

3.5.3.2 Developmental characteristics of Chinese name writing skills

The CNWS was used to examine the developmental characteristics of Chinese name writing skills. Similar to studies on English writing system, the knowledge of writing systems are reflected in their progression along a continuum from scribbling to writing their names legibly (Puranik & Lonigan, 2011; Table 3.17). It also showed that children begin learning to write before formal instruction. Starting from K1, most of the children understood the concept of "name" and it is the symbolic representation of self. Because of their limited understanding of language systems and their inability to manage writing implements, they scribble more than they produce defined lines.

By K2, most children receive formal instruction in writing Chinese characters, but are not competent in writing their names. The results showed that more character-like features appeared in the name writing products. They tried to apply what they had learned to writing their names. Finally, once they were taught to write their names in the second term of K2, their skills greatly improved and most children were able to write their name by K3.

Table 3.17

Name writing developments by age range

<table>
<tr><th>Age range</th><th>Mean scores</th><th>Description</th><th>Hildreth (1936)</th><th>Yin & Treiman (2013)</th><th>Ho (2011)</th></tr>
<tr><td>3;0-3;2</td><td>-</td><td rowspan="2">Aimless scribbles</td><td rowspan="2">Horizontal scribble</td><td rowspan="4">Character-like form</td><td rowspan="4">Scribbling to character-like forms</td></tr>
<tr><td>3;3-3;5</td><td>0.15</td></tr>
<tr><td>3;6;3;8</td><td>0.18</td><td rowspan="3">Wavy scribble</td></tr>
<tr><td>3;9-3;11</td><td>0.65</td><td rowspan="2">Simple straight or/and curved lines</td></tr>
<tr><td>4;0-4;2</td><td>1.29</td><td rowspan="3">Symbol/ letter-like units</td><td rowspan="4">Write by using required strokes, correctly position</td><td rowspan="4">Wrote with required strokes in the correct position</td></tr>
<tr><td>4;3-4;5</td><td>2.32</td><td>Separate units combined with strokes</td></tr>
<tr><td>4;6-4;8</td><td>4.30</td><td>Character-like compound</td><td rowspan="2">Random letters</td></tr>
<tr><td>4;9-4;11</td><td>4.81</td><td rowspan="2">At least one characters correct but not the others</td></tr>
<tr><td>5;0-5;2</td><td>5.38</td><td rowspan="3">Almost correct, with incorrect or revered letters</td><td rowspan="4">Correctly</td><td rowspan="4">Correctly written</td></tr>
<tr><td>5;3-5;5</td><td>7.08</td><td rowspan="2">All characters are generally written, with minor mistakes</td></tr>
<tr><td>5;6-5;8</td><td>7.59</td><td rowspan="2">Mostly correct</td></tr>
<tr><td>5;9-5;11</td><td>7.62</td><td rowspan="2">Correctly written</td></tr>
<tr><td>>6;0</td><td>7.71</td><td>-</td><td>-</td><td>-</td></tr>
</table>

3.5.3.3 Differences in name writing skills between children from different writing systems

The results showed that most 6-year-olds could write their names, there was more formal instruction on writing Chinese name than in English. According to Both-de Vries and Bus (2008), children who can write their own (English) name are demonstrating phonetic writing. They learned their name, spelled it based on its sound, and then applied this

knowledge to other words. But phonetic knowledge in name writing was not quite applicable in writing other Chinese characters, because of the wide variety of Chinese characters (Yin & Treiman, 2013). Hence, children required external cues to write their name correctly and to learn each Chinese character.

Chinese children usually had their name with three characters (i.e., from two to four) and they had to write them in full. Some people may argue that it may not be fair to use Chinese name writing in test of handwriting, as the Chinese characters in names of children could have a great variation in visual complexity, different number of strokes, and may require more mature skills to write. To address these concerns, this study examined if Chinese name writing could be used for testing handwriting skills effectively. There were 10 children with two-character names; the names of the other children consisted of three characters (n = 245). The mean number of strokes of the three characters were 7.96 (SD = 2.67), 10.36 (SD = 2.90) and 14.22 (SD = 3.22), and 32.29 (SD = 7.28). MANCOVA was carried out and the result illustrated no significant effect of stroke numbers of each character on CNWS scores controlling for age (F = 0.94, p = 0.511).

3.5.3.4 The phenomenon on refusal to write

During the name writing task, some K1 and K2 children refused to write their names but could copy the characters of their names. The refusal to write is an important developmental characteristic so we should not automatically assign the lowest possible rating

to these children (Ferriro & Teberosky, 1982; Ho, 2011; Lieberman, 1985). When children develop their writing skills to a point in between the scribbling and writing, it appears that they are likely to refuse to write when they realize they cannot produce the exact written forms like adults do. However, these children could copy their name when instructed to do so. They demonstrated they have some orthographic knowledge, but perhaps it is not yet adequate to write their whole name correctly. When examiners come across examinees who refuse to write, they could instruct the examinees to try copying their names, instead of trying to write their names independently. This works during the study.

3.5.4 Effects of school environment on the Chinese handwriting development

The kindergartens were selected from different districts to maximize the variety of schools and family backgrounds. Under the guideline on pre-primary school curriculum, the teaching contents included all common skills that kindergarten children should possess to write legibly. During K1, there is pre-writing training, such as connecting dotted lines and coloring. By K2 the curriculum will include simple to complex characters, the basic rules of Chinese writing systems, and the relationships among orthography, phonology and meaning. Children were asked to copy some common characters to internalize the knowledge. Thus, children should be able to apply this knowledge when they encounter new characters in K3.

3.5.5 Effects of parental involvement on the Chinese handwriting development

No parents in our study provided intensive training in handwriting at home. Most of said that they merely assisted their children to complete their writing assignments. More than 50% of parents said that they asked children to write fewer than 20 words at home per week, usually as a part of games. As parents in this sample tend not to train their children in handwriting, the study found that parent involvement had no significant effects on visuo-orthographic copying tasks. All kindergartens will begin to teach children how to write their names in Chinese and English name at the end of the second term of K2 (i.e., June). Teachers would assume that their students have acquired sufficient knowledge of handwriting and to use their name as the basis of learning how to write more complex characters. The limited knowledge in K2 could explain the significant effect of learning to write children's own name at home, in which direct practice of name writing would have positive influence on children's name writing performance. But once the formal training and practice is introduced at school, the effect from home environment is diminished.

The insignificant effects of school and the home environment confirmed that although children may come from schools and families of different socioeconomic status, it did not affect their handwriting development. This finding enhances the generalizability of the conclusions in this and upcoming phases.

3.6 Clinical implications

This study identified the developmental progress of Chinese visuo-orthographic copying and Chinese name writing among kindergarten children. It promotes the current understanding of how Chinese children develop their handwriting skills in response to teachers' instruction and writing practice. Because of the specific features of Chinese writing systems, the results of this study help teachers to design suitable activities to instill handwriting skills.

Apart from grades, children develop name writing more quickly than copying skills as they grow older. The study results imply under similar amount of instruction and practice received among children in the same grade, the maturation of pre-requisite skills is more instrumental to the development of handwriting skills. This also suggested that children of the same grade may have different *handwriting readiness*, the capacity of the children to acquire these skills and profit from formal instruction in writing (Van Hartingsveldt et al., 2014).

The study results showed that most children possess certain handwriting skills before leaving kindergarten, and some children have started to experienced handwriting difficulties as early as kindergarten. There is a need to conduct more in-depth studies on children who have handwriting difficulties during kindergarten, and search for the origin of these problems.

3.7 Limitations of the study

An overall score was used to illustrate the developmental characteristics of handwriting across kindergarten stage, and could document on how much a child has fallen behind his or her peers. However, it could not show the types of deficits among children with handwriting difficulties. Therefore, besides overall scores, subscale scores on each criterion of legible handwriting should be addressed to specify children's handwriting problems, and helped to design for targeted interventions.

Although the Chinese-English biliteracy of Hong Kong children, the English handwriting performance as a second language did not address. It is interesting to investigate the handwriting profile across orthographies and challenges faced by children with respect to different orthographies. Moreover, there was a gap in the research on the types and degree of basic developmental skills that should be required for legible handwriting in Chinese and English. It was believed that these skills should be well-prepared in beginning writers before they learnt to write (Berninger et al., 1992). Although some studies have been done in alphabetic writing systems (Clark & Luze, 2014; de Vries et al., 2015; Klein et al., 2011), there is little information on or comparison of Chinese handwriting and English handwriting as a second language. These issues will be addressed in the next phases to provide empirical support for the evaluation and intervention.

3.8 Conclusion

The abilities to copy Chinese characters and to write one's name are crucial to adaptation in primary education (Chan, 2010). This is one of the first studies to examine the development of Chinese handwriting skills among kindergarten children. Handwriting skills were assessed using visuo-orthographic copying of traditional Chinese characters and the writing of Chinese names. Results of this study showed the developmental progression of a child from K1, K2 to K3, in learning Chinese handwriting.

This study also showed that most kindergarten children at K3 stage have already acquired basic level of skills in handwriting to meet the demands of primary education.Given that children in Hong Kong have to begin learning Chinese and English in kindergarten, further analysis should examine both the Chinese and English handwriting of K3 children. It is important to identify children with handwriting difficulties in one or both orthographies, and their underlying deficits. This information is important for providing holistic support for Chinese kindergarten children who are struggling to learn how to write.

Chapter Four: Phase 2 – Evaluation of Chinese and English handwriting performance among K3 children with and without handwriting difficulties

4.1 Introduction

The findings from Phase 1 of the study further verified the developmental characteristics of children's handwriting skills while attending kindergartens.

They were shown to progress from writing strokes, radicals, whereas K3 children should be able to write legibly, even unfamiliar characters. However, there were some children who might have difficulties learning to write Chinese during the kindergarten education. Some children would face more challenges if they have to learn both Chinese and English at the same time. Hence, this phase firstly develops a standardized Chinese and English handwriting test to screen out K3 children with handwriting difficulties, then to examine their profiles of handwriting difficulties across two orthographies.

4.2 Objectives of the study

The main objectives of this phase of study are:

1. To develop the Chinese and English Handwriting Screening Tool for Chinese kindergarten children (CHEST);

2. To establish the test-retest and interrater reliabilities, and discriminant validity of the CHEST;
3. To examine the types and severity of handwriting problems exhibit in children who are at risk of handwriting difficulties in Chinese and English respectively.

4.3 Methodology

This phase was divided into two parts between October and December 2015. Part 1 of the study was to develop and validate a Chinese and English handwriting screening tool (CHEST). Part 2 of the study was to identify children who were having difficulty learning to write either Chinese or English, or both.

4.3.1 Part 1: Development of the Chinese and English Handwriting Screening Tool (CHEST)

4.3.1.1 Selection of assessment content

Another expert panel which consisted of three kindergarten teachers (QKTs), five occupational therapists (OTs) and five parents of kindergarten children who were responsible for evaluating the assessment content and scoring criteria. They also helped to choose the scale for the English name writing task. None of them were involved in Phase 1. As same as

in Phase 1, all QKTs and OTs had more than five years' experience working with kindergarten children, and all the parents received at least a tertiary education.

CHEST is consisted of Chinese and English visuo-orthographic copying tasks. Based on the results from Phase 1, visuo-orthographic copying could be used to reflect the handwriting performance as well as difficulties among K3 children. It is expected that Chinese character is more complex to master than English words due to its visual complexity, and the difficulties in learning to write Chinese than English could be two separate issues. Hence, the English part of the test was added, while all panel members agreed that the Chinese part could be adopted from the two tasks adapted in Phase 1, but with amendment on its scoring system after phase I of the study.

Although handwriting skills in kindergarten children were commonly assessed by letter writing and spelling in Western countries, it may not be suitable for Chinese children as they learned to write English through rote memorization in copying, without the emphasize of the knowledge in monosyllabic writing. Since there was no suitable copying template for English handwriting, it started up by summarizing a list with 100 English words from five kindergartens in Hong Kong. These kindergartens indicated that K3 children had to copy around 20 words in their home assignment every day, thus a 20-item word list is proposed. Each panel members were asked to choose 20 words that children copied incorrectly and five additional words that could identify children who have handwriting difficulties. Words that

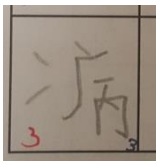
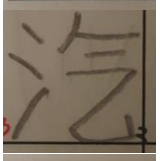
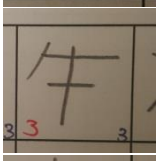
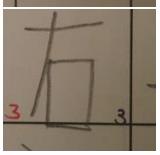
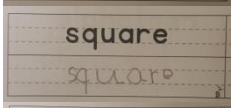
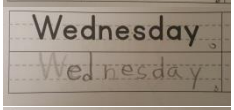
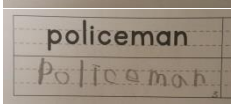
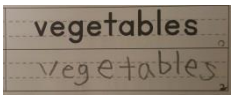
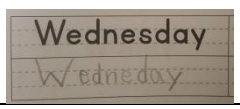
were chosen by at least six of 13 panel members were selected. Finally, a list of 20 four- to ten-letter English words was compiled.

4.3.1.2 Selection of measurement items

As stated in Section 2.8.1, children who diagnosed with handwriting difficulties were usually exhibited similar problems during kindergarten stage. The scoring criteria for the CHEST should be adjusted to target on the handwriting problems faced by kindergarten children. The scoring criteria in Phase 1 were not deep enough to specific handwriting problems. The handwriting of K3 children is expected to have both neat and correct. This test was developed based on the Tseng Handwriting Problem Checklist (THPC; Tseng, 1993a). It was a 24-item checklist that covered six factors of handwriting: construction, sequencing, behavior, accuracy, motor, and directionality. Each item was scored according to the percentage of error on a 4-point Likert scale, ranging from 1 = always to 4 = seldom. Because the checklist was designed for elementary school students, it was modified to suit the needs of kindergarten children. It was summarized into four criteria as the construct for measuring "legibility": (1) appropriate alignment, spacing and position (i.e., "alignment"); (2) proper stroke formation (i.e., "stroke formation"), including missing/additional and malformation of strokes; (3) appropriate proportion of stroke/component (i.e., "proportion"); and (4) ability to write within grid (i.e., "out of grid") (Table 4.1). Each character was scored on a 5-point

Table 4.1

Description of the scoring criteria of Chinese and English visuo-orthographic copying

Criteria	Example	Descriptions
Chinese		
- Alignment and spacing		Appropriate position of radicals within a grid
- Stroke formation		Missing/ additional and malformation of strokes (e.g. overshooting, wrong direction)
- Proportion between strokes/radicals		Appropriate proportion of stroke/radicals according to the writing rules (e.g. radical on the left side should be smaller than that on the right side)
- Out of grid		Ability to write with no more than 2mm of a character outside a grid
English		
- Alignment		Ability to write along the lines
- Spacing		Letters should not be too close or far away from each other
- Uniformity of letter size		Appropriate proportion between and within letters
- Capitalization		Ability to copy capital/ small letters as stated in the template (e.g. Tuesday)
- Letter formation		Modified from Scale of Children's Readiness In PrinTing (SCRIPT) (Weil & Amundson, 1994), e.g. the bottom portion of the vertical line of the "t" must be at least 2mm longer than the top side
- Correctness		Additional/ missing letters in a word

Likert scale (range: 0–4), and maximum two points (range: 0–2) for each criterion (i.e., subscale score). Hence, the maximum scores for overall performance were 100 for 25 characters in Part 1 and 48 for 12 characters in Part 2, while the subscale scores were 50 in Part 1 and 24 in Part 2. It allowed an initial screening by overall score, while subscale scores were used to identify the problems exhibited by a child.

For the English part, five criteria were adopted from the characteristics of legibility summarized by Tseng (1993a) for assessing English handwriting: alignment, spacing, size, letter formation and (appropriate) use of capital letters. An additional criterion -- correctness -- was suggested by the expert panel (i.e., additional/ missing letters) for a total of six criteria (Table 4.1). The item "slunt" was discarded, as Chinese children were taught to write block letters. Like Chinese handwriting, two scores resulted: for the overall performance of each word, a maximum of five points would be given (range: 0–5); and subscale scores of a maximum of two points (range: 0–2) for each criterion. Thus, the maximum overall score for English handwriting was 80, and subscale scores were 40 for each criterion.

4.3.2 Part 2: Evaluation of the psychometric properties of CHEST and identification of the problems in children with handwriting difficulties

4.3.2.1 Sampling method

Convenience sampling was adopted for subject recruitment. Invitation letters were sent to all non-profit kindergartens in Hong Kong, and followed up with a phone call. Only kindergartens whose curriculum followed the Guide to the Pre-Primary Curriculum (Curriculum Development Council, 2006) were invited. This curriculum covered over 90% of kindergarten in Hong Kong. To ensure representativeness of the selected sampled subjects, only one kindergarten was selected in one district of the city or from the same kindergarten groups. All Chinese children from these kindergartens were invited to participate if they were enrolled in K3 according to their year of birth; learned to use Cantonese and traditional Chinese as the major source for oral and written communication since K1; and did not have any developmental physical, sensory and emotional/ behavioral disabilities.

At the same time, children with handwriting difficulties but no other developmental disabilities were identified, along with the same number of gender- and age-matched children with average handwriting, by class teachers based on their observations in class and home assignments. These children also had to submit two assignments for a QKT in our research group to demonstrate their handwriting. One kindergarten was randomly chosen to assist twice with two weeks intervals to obtain the test-retest reliability.

4.3.2.2 Participants

One hundred and twenty-eight children (63 boys and 65 girls) who were enrolled in the final year of kindergarten (i.e., upper kindergarten, or K3) were recruited from six kindergartens located in six of 18 districts in Hong Kong. Their mean age was 64.49 months (*SD* = 3.99 months). Twenty-three children (15 boys and eight girls) with handwriting difficulties (Mean age = 63.41 months, *SD* = 4.06 months) and the same number of gender- and age-matched children with average handwriting performance (Mean age = 63.87 months, *SD* = 3.27 months) were identified by class teachers based on their observations in class and on their home assignments.

Finally, 25 children (13 boys and 12 girls; Mean age = 65.24 months, *SD* = 3.93 months) from one of the six kindergartens were randomly invited to assess twice at two-week intervals to test for test-retest reliability. Post-hoc power analysis was done by G*Power using α = 0.05, a power of 0.80, a medium effect size (d = 0.5), and two tails. The result showed that the power was 66.9%.

4.3.2.3 Instrument: Chinese and English handwriting screening test for kindergarten children (CHEST)

CHEST was a test for screening out Chinese kindergarten children with difficulties in copying Chinese and/or English words. There were two parts for Chinese and one part for English which evaluated different visuo-orthographic skills of copying. And two scores were

given in each part: total scores represented the performance of a child in copying Chinese or English, and the subscale scores were used to examine the types of handwriting difficulties that the child had. Detailed instruction for administration and scoring was designed by an expert panel.

4.3.2.4 Procedures

All the tasks were administered in schools to groups of 10 to 12 children. A pair of children was supervised by a university student majoring in language or health sciences, who had been trained on the administrative procedure. The class teacher and I were responsible for overseeing the whole session.

Children began by writing of their name in a sheet of unlined 12cm x 6cm. Then, grid and doubled-line paper that were the kind that kindergarten children used to learn to write was provided. They were asked to read the Chinese characters in the template as well as they could before copying the characters, even if they had never seen them before. The same procedures were used to copy English letters. They were told to do what they did in the classroom lessons. A stopwatch kept time for Part 1 of Chinese and English handwriting. The purpose was to screen out those who wrote very slowly. The pencil grip pattern used for writing was recorded according to the description of Edwards, Buckland, and McCoy-Powlen (2002), and to identify those who held the pencil awkwardly. The assessments took approximately 20 minutes.

To determine test-retest reliability, children from one kindergarten were assessed twice within two weeks, and all environmental factors were kept constant between the sessions. Class teachers and one QKT from our research team identified children with and without handwriting difficulties based on their schoolwork, such that the known-groups method was used to show that the test could differentiate children with difficulties from those without. For the establishment of inter-rater reliability, two OTs were responsible for rating. Prior to the scoring, they discussed 20 samples to reach consensus.

4.3.2.5 Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics 22.0, all tests were applied two-tailed and the significance level was set at $p < 0.05$.

Besides the descriptive statistics, the relationships between Chinese and English handwriting, and reading and writing (i.e., speed and legibility), would be examined. Lastly, an independent t-test was used to calculate the differences in Chinese and English handwriting between children with handwriting difficulties and their peers.

4.4 Results

4.4.1 Descriptive statistics

The visuo-orthographic copying performance in Chinese and English among typically developing children is presented in Table 4.2.

Table 4.2

*Descriptive statistics of CHEST among typically developing children (*n = *128)*

	Mean	***SD***	**Range**
Chinese (Part One)	92.89	3.72	80-100
- Alignment	49.42	1.02	44-50
- Stroke formation	45.57	2.57	36-50
- Proportion	48.46	1.46	43-50
- Out of Grid	48.40	1.82	41-50
Chinese (Part Two)	42.72	3.27	29-48
- Alignment	23.20	1.10	19-24
- Stroke formation	20.47	2.21	13-24
- Proportion	22.97	1.29	19-24
- Out of Grid	23.32	1.19	18-24
English	72.76	5.50	55-80
- Alignment	38.77	1.81	32-40
- Spacing	38.61	1.69	33-40
- Size between letters	37.74	2.48	27-40
- Use of capital letter	39.55	0.77	37-40
- Letter formation	38.59	1.67	31-40
- Correctness	39.30	1.03	35-40

4.4.2 Reliabilities of CHEST

The overall score indicated excellent interrater reliability between the scores according to two occupational therapists in both Chinese (Part 1: ICC (2,1) = 0.97, 95% CI = 0.95-0.98; Part 2: ICC (2,1) = 0.98, 95% CI = 0.98-0.99) and English (ICC (2,1) = 0.91, 95% CI = 0.81-0.95). There was moderate to excellent reliability under each criterion (Table 4.3).

Then, it showed good to excellent test-retest reliability in examining overall Chinese handwriting (Part 1: ICC (3,1) = 0.86; Part 2: ICC (3,1) = 0.95) and excellent in English handwriting (ICC (3,1) = 0.97). It showed only moderate to excellent reliability in some of the subscales of Chinese and English visuo-orthographic copying (Table 4.4).

Table 4.3

Intraclass correlation coefficients between two raters among typically developing children (n = 128)

Criteria		**ICC (2,1)**	**Mean (SD)**	
			Rater 1	**Rater 2**
Chinese (Part 1): ICC (2,1) = 0.97	Alignment/ spacing	0.41	49.08 (1.46)	49.76 (0.62)
	Stroke formation	0.74	44.53 (4.68)	45.21 (2.98)
	Proportion	0.77	48.09 (1.86)	48.46 (1.51)
	Out of grid	0.84	48.15 (1.93)	48.85 (1.50)
Chinese (Part 2): ICC (2,1) = 0.98	Alignment/ spacing	0.48	23.13 (1.12)	23.73 (0.58)
	Stroke formation	0.91	19.88 (2.81)	20.12 (2.72)
	Proportion	0.69	22.80 (1.43)	22.95 (0.95)
	Out of grid	0.91	23.14 (1.46)	23.22 (1.24)
English: ICC (2,1) = 0.91	Alignment	0.81	37.86 (3.82)	36.05 (4.81)
	Spacing	0.52	38.47 (1.80)	36.04 (3.52)
	Size of letters	0.87	36.58 (4.23)	35.25 (4.73)
	Letter formation	0.90	39.40 (0.97)	39.31 (1.03)
	Use of capital letter	0.97	37.85 (2.99)	37.16 (3.00)
	Correctness	0.95	39.07 (1.35)	39.10 (1.32)

Table 4.4

*Intraclass correlation coefficient for Chinese and English visuo-orthographic copying performance in the test-retest (*n = *25)*

Criteria		**ICC (3,1)**	**Mean (*SD*)**	
			Test	**Retest**
Chinese (Part 1): ICC (3,1) = 0.86	Alignment/ spacing	0.80	48.60 (2.20)	48.88 (1.69)
	Stroke formation	0.95	44.56 (3.76)	44.80 (3.30)
	Proportion	0.63	48.28 (1.88)	48.96 (1.46)
	Out of grid	0.85	48.48 (2.04)	48.32 (2.73)
Chinese (Part 2): ICC (3,1) = 0.95	Alignment/ spacing	0.63	23.64 (0.81)	23.04 (1.20)
	Stroke formation	0.73	20.72 (2.35)	20.48 (2.24)
	Proportion	0.37	23.16 (0.94)	23.12 (1.39)
	Out of grid	0.88	23.28 (1.46)	22.76 (2.35)
English: ICC (3,1) = 0.97	Alignment	0.92	36.72 (3.88)	37.48 (3.20)
	Spacing	0.72	37.68 (2.19)	38.68 (1.46)
	Size of letters	0.85	37.56 (2.93)	38.48 (2.14)
	Letter formation	0.95	36.08 (5.53)	37.32 (5.27)
	Use of capital letter	0.74	39.24 (1.45)	39.56 (0.71)
	Correctness	0.51	39.32 (1.10)	39.36 (1.44)

4.4.3 Handwriting problems of children with handwriting difficulties

Significant differences in handwriting legibility appeared between two groups of children in both Chinese (Part 1: $t = 8.49$, $p < 0.001$; Part 2: $t = 5.91$, $p < 0.001$) and English visuo-orthographic tasks ($t = 4.33$, $p < 0.001$; Table 4.5). Except the subscale score in spacing and the appropriate use of capital letter in English handwriting, children with handwriting difficulties scored significantly lower in all criteria of Chinese and English visuo-orthographic copying than typically developing children. However, when look at the distribution of overall scores between the two groups of children, some children seemed to have difficulties writing Chinese but not English (Figures 4.1-4.3).

Table 4.5

Means and standard deviations with comparison between typically developing children and children with handwriting difficulties

	Typically developing children		Children with handwriting difficulties		*t*	Mean difference
	Mean	***SD***	**Mean**	***SD***		
Chinese (Part 1)	95.48	2.25	84.43	4.30	10.90**	11.05
- Alignment	49.57	0.79	47.22	2.13	4.96**	2.35
- Stroke formation	46.91	2.09	41.13	2.82	7.91**	5.78
- Proportion	49.48	0.85	46.39	2.15	6.41**	3.09
- Out of Grid	48.83	1.56	46.35	2.17	4.46**	2.48
Chinese (Part 2)	43.87	2.96	36.13	6.14	5.44**	7.74
- Alignment	23.61	0.78	22.74	1.29	2.77**	0.87
- Stroke formation	21.04	1.82	17.48	3.64	4.20**	3.56
- Proportion	23.26	0.92	21.74	1.81	3.59**	1.52
- Out of Grid	23.74	0.54	21.70	2.24	4.24**	2.04
English	71.52	6.40	57.22	13.13	4.64**	14.30
- Alignment	38.52	1.78	33.65	6.55	3.14**	4.87
- Spacing	38.48	1.27	38.09	2.11	0.77	0.39
- Size between letters	37.00	2.73	32.17	5.33	3.42**	4.83
- Use of capital letter	39.43	0.90	38.83	1.38	1.73	0.60
- Letter formation	38.39	2.02	34.52	5.24	3.24**	3.87
- Correctness	39.30	0.97	37.87	1.94	3.24**	1.43

** $p < 0.01$. * $p < 0.05$.

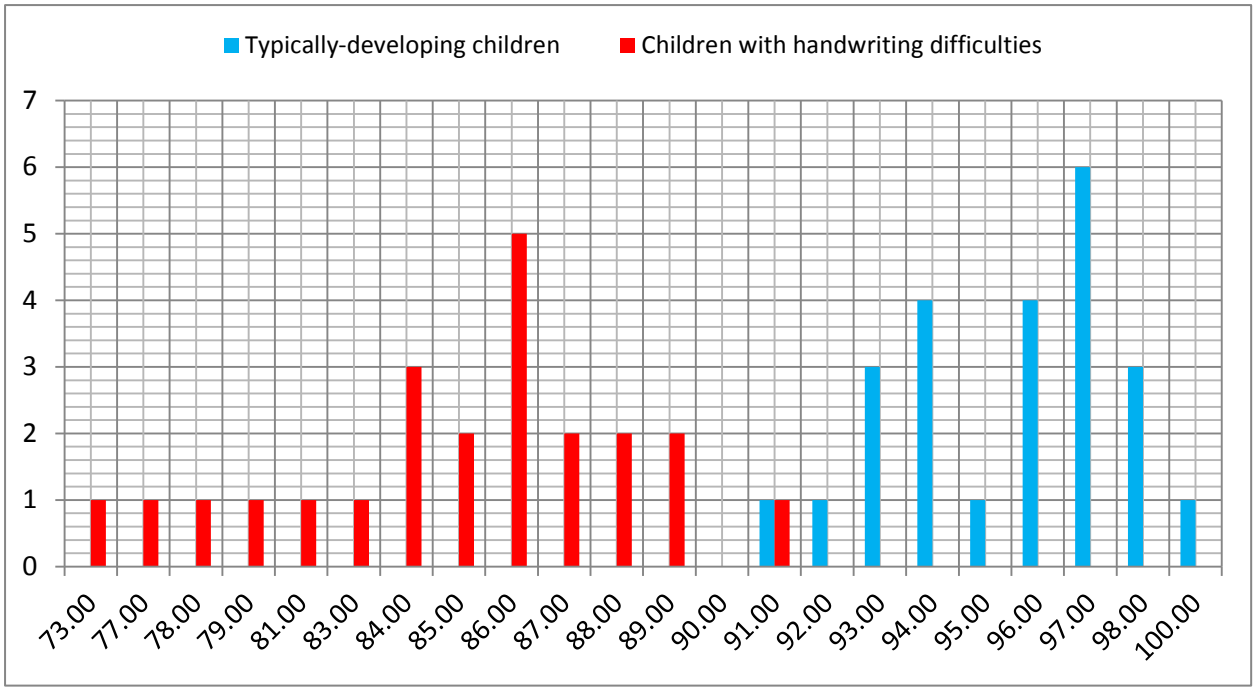


Figure 4.1. Distribution of Chinese visuo-orthographic copying (Part 1) performance between children with and without handwriting difficulties

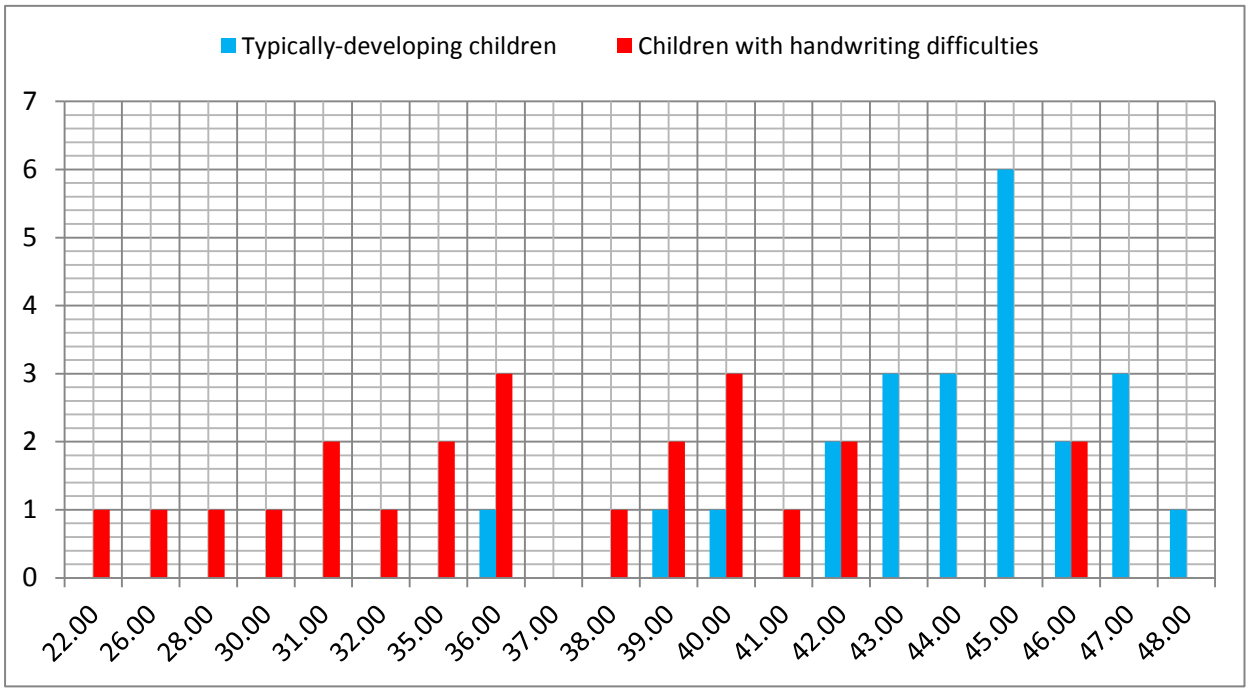


Figure 4.2. Distribution of Chinese visuo-orthographic copying (Part 2) performance between children with and without handwriting difficulties

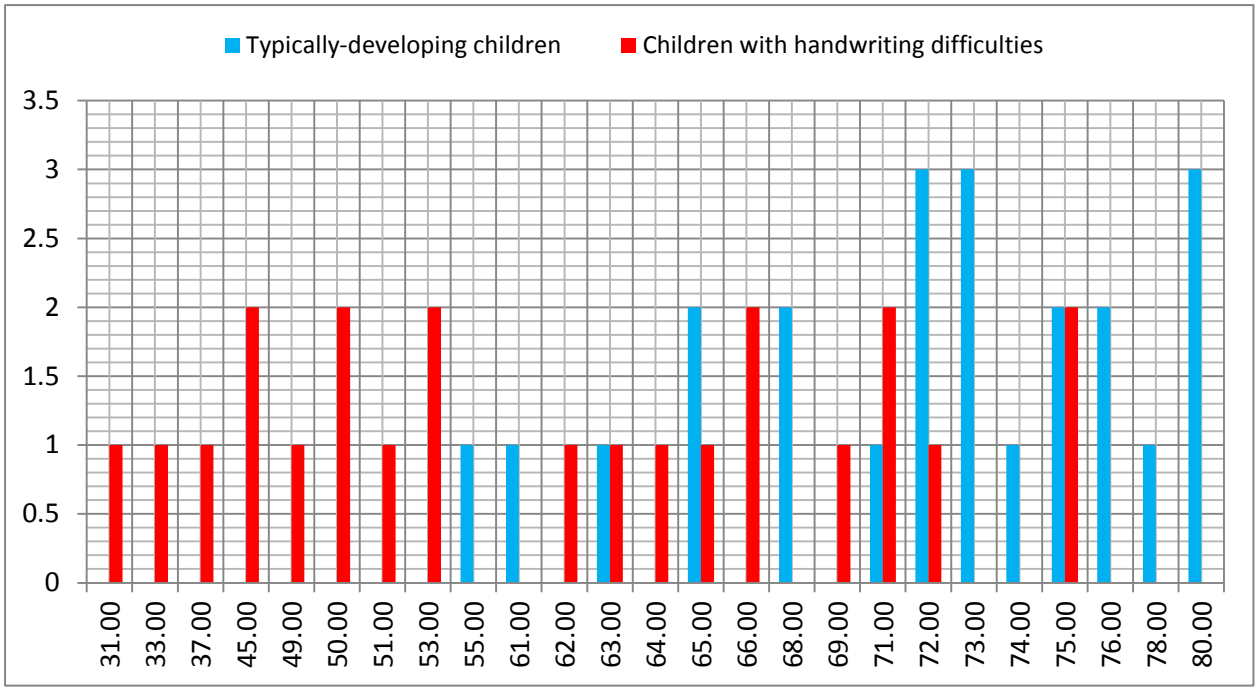


Figure 4.3. Distribution of English visuo-orthographic copying performance between children with and without handwriting difficulties

4.4.4 Relationship between Chinese and English handwriting performances

As Chinese and English were two distinct orthographies, Spearman's rank correlation coefficient was used to examine the relationship between the quality of Chinese and English handwriting. The result showed a moderate relationship between Chinese and English handwriting performances (Part 1: $r = 0.62$, $p < 0.001$; Part 2: $r = 0.56$, $p < 0.001$).

4.4.5 Relationship between reading and handwriting abilities

As reading and writing was an interactive process that enables children to understand the associations between orthography, phonology and semantics of a language, the

relationships between reading and copying abilities were examined. The result showed fairly significant relationships between reading and copying of Chinese characters (Part 1: $r = 0.37$, $p < 0.001$; Part 2: $r = 0.32$, $p < 0.001$). Reading and writing skills, however, were not significantly related in English ($r = 0.007$, $p = 0.934$).

4.4.6 Other factors affecting handwriting performance

Despite the inconsistent result in gender differences from previous studies, an independent t-test was performed. It yielded insignificant differences in boys' and girls' handwriting in Chinese (Part 1: $t = -1.83$, $p = 0.069$; Part 2: $t = -0.06$, $p = 0.956$) and English ($t = -1.80$, $p = 0.074$).

Because of the importance of pencil grip patterns in handwriting performance among beginning writers, the relationship between these two factors were also examined (Koziatek & Powell, 2003; Schwellnus et al., 2012; Shah et al., 2016). Most children used a static tripod grip to write ($n = 50$), followed by cross-thumb grasp ($n = 25$) and four-finger grasp ($n = 31$). Different pencil grip patterns had insignificant effects on Chinese (Part 1: $F = 0.21$, $p = 0.960$; Part 2: $F = 0.70$, $p = 0.628$) and English ($F = 1.30$, $p = 0.269$) handwriting.

Finally, for the hand dominance, six children were left-handed and the remaining ($n = 122$) were right-handed. It also yielded insignificant differences of handedness in Chinese

(Part 1: t = -0.03, p = 0.980; Part 2: t = -0.80, p = 0.425) and English (t = -1.39, p = 0.167) handwriting.

4.5 Discussion

4.5.1 Children with and without handwriting difficulties

From the findings in Phase 1, although local curriculum followed the Guide of Pre-primary Curriculum (Curriculum Development Council, 1996) and there would be slight differences in teaching media, it did not influence the handwriting abilities of the children. In this phase, kindergartens from different regions of the province were selected to maximize the representativeness of the samples.

Unlike the result in Phase 1, some children in this study exhibited difficulties in handwriting but they were not any diagnosed with any developmental disabilities. Even though the comorbidity of developmental disabilities, such as ADHD and DCD, and handwriting difficulties is well-recognized (Racine et al., 2008; Shen, Lee & Chen, 2012), past studies did not pay much attention to children who exhibit difficulties in handwriting but no medical diagnosis. The findings of this study reveal that these children showed early symptoms on handwriting difficulties which could be detected by observation and standardized assessments before they are admitted to primary schools.

4.5.2 Appropriateness of the assessment tool to identify children with handwriting difficulties

CHEST was designed for early identification of handwriting difficulties in Chinese and/or English for the final-year kindergarten children. CHEST appeared to be a more objective method to screen children with handwriting difficulties (based on set criteria).

Teachers, clinicians and parents usually would identify children having troubles inlearning to write. However, most of them rely on their subjective experiences without an objective measurement to confirm their concerns. This screening tool appears to serve identifying kindergarten children with problems of copying Chinese and English words. From the results, the scores of typically developing children clustered at the higher end showing that most children could perform the copying tasks in Chinese and English (Rao et al., 2013). These children could generalize their experiences to copy similar characters and words (e.g., characters with same radicals but different combination), and applied writing rules (e.g., stroke sequences) to facilitate their writing process. It may also indicate that they are better prepared to write other new characters and words in primary school. However, if a child scored much lower than the norms (e.g., below -2SD), it is obvious that the child required additional support.

CHEST could be easily administered in a reasonable amount of time. The average writing time for Chinese and English in typically developing children were about six minutes

(*M* = 364.76 seconds, *SD* = 123.82 seconds) and nine minutes (*M* = 528.52 seconds, *SD* = 182.24 seconds) respectively, while most children could complete all the tasks in less than 20 minutes. The assessment content did not require prior preparation for children since it resembled regular classroom activities. However, when a child needed extra time to complete the tasks, further investigation is required.

In addition, CHEST also evaluated the abilities to copy both Chinese characters and English words separately. Since the Chinese characters and English words are orthographically different, it is expected that a child may have different scores on Chinese and English handwriting. This showed the influence of orthography on the learning how to write. It is essential to evaluate handwriting competence in each orthographic system separately.

From a psychometric viewpoint, excellent inter-rater reliability indicates that a consistent result could be obtained by different professionals who worked closely with kindergarten children. It could be used as a reference to describe the handwriting performance of a child. Besides that, good to excellent test-retest reliability allows the CHEST to be used as a screening tool to identify children who are at risk of handwriting difficulties, and to evaluate the effectiveness of treatment.

For educators and clinicians, no intensive training was required for administration and scoring. An hour-long briefing session was offered to ensure they understand the procedures and to try out the scoring. It was not difficult for them to conduct CHEST as it simulates the

usual practice in evaluating children's ability to copy characters and words. In this study, the raters took an average of 20 minutes for scoring the CHEST of one child. The description and sample in Table 1 covered the major problems observed in the handwriting.

4.5.3 Handwriting performances between children with and without handwriting difficulties

The results showed that some children had handwriting difficulties in Chinese but not in English. It is hypothesized that learning to write Chinese is more difficult than learning to write English due to the visual complexity of Chinese. Unlike alphabetical letters that consist of straight lines and curves, Chinese characters have several basic strokes. It is believed that more advanced skills are needed to decompose the character into its components for copying (Li-Tsang et al., 2012). Therefore, a child might be able to analyze English words but not Chinese characters. It also explained that children who had difficulties in writing English only would be less obvious to identify by class teachers.

Apart from the overall score, four subscale scores in Chinese handwriting and six subscale scores in English handwriting provided additional information about the types and severity of challenges that children might face. Instead of correctness, children seemed to have more problems with legibility. With the same overall scores, the subscale scores specified the difficulties of a child had. It was suspected that the specific problems in

handwriting products were originated from developmental perceptual-motor and linguistic skills, for instance, the difficulties to produce precise movement within grid (i.e., subscale score in out of grid) or spatial organization of components (i.e., subscale score in proportion). It was presumed that these deficits that cannot be overcome simply by handwriting repetition and practice.

Several studies illustrated that children who have handwriting difficulties also tend to have problems with visual recognition (Mesrahi & Sedighi, 2013; Richmond & Taylor, 2014) as well as fine motor acquisition. For instance, significant differences in fine motor skills were demonstrated in children with good and poor handwriting (Klein et al., 2011; Tseng & Chow, 2000; Volman, van Schendel & Jongmans, 2006). Poor fine motor skills might inhibit children from producing precise strokes, in turn, the handwriting products tended to be larger than the designed space (i.e., out of grid). Visual-motor integration (VMI) is another significant predictor of handwriting difficulties (Clark & Luze, 2014; Marr & Cermak, 2002; Tseng & Chow, 2000; Volman, van Schendel & Jongmans, 2006). If the children did not equip certain VMI skills, they were unable to analyze and then reproduce the written forms of a language correctly.

4.5.4 Relationship between Chinese and English handwriting proficiency

Even though studies have demonstrated the similarities and transfer of skills in reading two languages, this phase confirms the possibility of similar skills when children with handwriting difficulties write in Chinese and English.

When linguistic components were removed, writing of different orthographies was a visual-motor integration process that requires similar skills. For example, visual-spatial skill was equally to identify the direction of strokes in both radicals (i.e., "扌") and letters (i.e., "b" and "d"). Precise control of fingers was needed to produce legible words. In contrast, even though Chinese and English are distinct writing systems, exposure to the one language would hinder the acquisition of the other (Buckwalter & Lo, 2002). Children attempt to extract as much phonological and semantic information as possible to read and understand a second language from the knowledge of their first (Cheung, Chan & Chong, 2007; Gottardo et al., 2006; Sun-Alperin & Wang, 2011).

However, due to the complexity of orthographic structures and its relationships to sounds and meaning, the importance of each perceptual-motor and linguistic skill would change. Chinese characters are complex visual-spatial structures of strokes in square configuration within characters and a left-to-right orientation between characters. It is likely that learning to write Chinese characters requires advanced visual-related skills (Ho & Bryant, 1999). In contrast, English letters have a word by letter-sound correspondence. Therefore,

phonological cues are available to assist the handwriting process. It is also possible that children who have difficulties in writing Chinese do not have similar problems in English, but not vice versa.

This hypothesis arises from neurophysiological studies on reading. Similar language processing pathways but different degrees of activation were found between Chinese and English reading (Booth et al., 2006; Stowe & Sabourin, 2005), which depended on the age of acquisition on both languages and on the amount of processing involved (e.g., lexical-semantic or phonological; Chou et al., 2006). Some studies have claimed that bilateral activation was observed in reading English but mainly on the left hemisphere in Chinese (Tham et al., 2005). Although no study was found on Chinese and English handwriting, it is hypothesized that Chinese (first) and English (second) handwriting were similar in terms of neurological processing of basic skills (Pu et al., 2001).

Since no previous studies have examined handwriting proficiency in Chinese and English with the same group of children, especially those with handwriting difficulties, and the origin of the difficulties, these will be addressed in the next phase.

4.5.5 Relationships between reading and handwriting abilities

In language development, listening, speaking, reading and writing, are interactive and mutually reinforcing (Chan et al., 2006). English writing, emphasize grapheme-to-phoneme

correspondence at the letter level. There are significant relationships between letter reading and writing among kindergarten children (Molfese et al., 2006). They were able write letters of a word based correctly on their sounds without knowing the meaning (Levin et al., 2005). Although there was no similar study in Chinese, it is proposed that children who could recognize more characters would have better handwriting.

Surprisingly, significant relationships between the ability in reading and handwriting legibility were found in Chinese but not English. These differences might due to the nature and learning methods between two orthographies. Chinese has an orthography-to-phonology correspondence, where an integrated circuit that links orthography, meaning, and pronunciation is formed at the character level. According to Tan et al. (2005), reading depends on writing. Through writing, children learn to analyze the internal structure of Chinese characters (orthographic awareness). Consequently, when the children read a character, they use their orthographic knowledge to decode and reconstruct the character in writing.

In contrast, Western children's early experiences with letters emphasize on phonetics. Their ability to link letters and phonemes is important in learning reading and spelling. Knowledge on letter helps a child to pronounce a word by the combination of the pronunciation even the word was not existed. Instead of using phonetics, Chinese children learn to read and write English logographically (McBride-Chang & Treiman, 2003). The consistency of these learning methods across two orthographies helps Hong Kong children to

acquire both languages more easily. And this relies on rote memorization. Children might not know how to generate the sounds of new words based on their existing knowledge; each word is learned separately, in conjunction with other words to form meaning. Hence, in our study, all children could read individual letters but not whole words in English.

4.5.6 Other factors affecting handwriting performance

This phase showed insignificant differences in handwriting between gender, hand dominance and pencil grip pattern. Since more boys than girls were diagnosed with dyslexia (Chan et al., 2007), it is expected that more boys may need the services on handwriting screening and remediation. The result also suggested that the CHEST cutoff could be applied to both boys and girls. On the other hand, although there is no evidence that hand dominance affects handwriting, assessor should be aware of hand dominance in writing (Mishra & Mohan, 2016).

Poor handwriting resulted from holding pencils incorrectly was one of the most frequent reasons for referring children to occupational therapy (Hammerschmidt & Sudsawad, 2004). It was believed that mature grip patterns, including dynamic tripod/quadripod grips, were necessary for legible handwriting. Most of the pencil grips used by our samples were transitional grasp patterns (Edwards, Buckland, & McCoy-Powlen, 2002). It was acceptable for 5-year-olds, who would develop more mature grips when they started to coordinate finer

intrinsic muscles. Tseng's (1998) study found that Chinese children used the tripod grasp more than American children of the same age.

According to Ziviani and Elkins (1986) and Schwellnus et al. (2012), the way children held their pencils while writing did not influence the speed or legibility of their writing, even in poor handwriters. But the variations of pencil grip might place undue stress on hand muscles, or in other words, some positions might make handwriting easier (Tseng, 1998; Tseng & Cermak, 1993). Given that variations in pencil grip patterns were often seen in children with poor handwriting, these variations should be considered during the evaluation (Tseng & Cermak, 1993).

4.6 Clinical implications of the findings

CHEST is a user-friendly screening tool and easy to use in the classroom. Children do not require any prior preparation or additional training. Copying with paper and pencil is similar to what children do in class every day. And the similar amount and content of assignments could accurately reveal the difficulties they might have. CHEST is superior to daily practice by providing an objective measure for identifying children who are having certain kinds of difficulties in learning to write Chinese and/or English, especially children who are prone to these problems because of family history or comorbid with other developmental disabilities. The higher-end scores of CHEST among typically developing

children demonstrates that they are confident to master the skills and do not have extra pressure to perform CHEST. It also avoids the need of excessive copying tasks for kindergarten children. However, if a child largely deviated from his or her peers (e.g., below -1.5 to 2SD), the underlying causes should be sought.

For educators or clinicians, no intensive training was required for administration and scoring. An hour-long briefing session was enough. It was not difficult to administer CHEST as it simulates children's copying of characters and words. In this study, the raters took an average of 20 minutes to score one CHEST. The description and sample in Table 4.1 covered the major problems in handwriting.

4.7 Limitations of the study

Due to the time constraints and limited resources, this study could only be carried out by convenience sampling in a cross-sectional design. Ideally, stratified samplings with more kindergartens but the same number of children from each kindergarten would increase the representativeness of the data.

Moreover, due to administrative difficulties, teachers had to distinguish children with handwriting difficulties from those without to make comparisons. Although a teacher from my research team was responsible for confirming their handwriting problems, borderline cases or those with English handwriting difficulties only may not be picked up by teachers

and referred to us. It recommended that handwriting should be evaluated by CHEST and by daily assignments.

4.8 Conclusion

Since Chinese children must learn both Chinese and English handwriting from the kindergarten stage, a cultural-specific screening tool should be available for early and effective identification of children with handwriting difficulties. The key achievement of this phase was to develop and validate CHEST for evaluating the handwriting performance among K3 children in the local context. The reasonable and satisfactory results in inter-rater and test-retest reliabilities supported CHEST could be used in differentiating children who exhibited difficulties in learning to write Chinese or/and English. Children seemed to exhibit difficulties in the writing of both languages, but more in Chinese.

Another goal achieved was to find out the main problems in their handwriting products. Since these problems cannot be simply solved by repetitive practice, opened a window for the upcoming phase to examine the origin of this phenomenon from the deficits of developmental skills in perceptual-motor and linguistic aspects.

Chapter Five: Phase Three – Comparisons of the developmental skills among K3 children with handwriting difficulties in Chinese or/and English

5.1 Introduction

Learning to write legibly in Chinese and English words is important for children in Hong Kong. The findings from Phase 2 showed that children with handwriting difficulties encountered different problems in Chinese and English handwriting. Instead of correctness (i.e., additional or missing strokes), children commonly write with different forms which were incorrect.

Handwriting is a complex task that integrates perceptual-motor and linguistic developmental skills. Although numerous studies support the deficits in perceptual-motor and linguistic processing in children with handwriting difficulties, very few studies attempt to find out how developmental skills affect the learning of Chinese and English handwriting separately. Understanding developmental shortcomings could help clinicians and educators to identify the special needs of children, and through training of these skills, their abilities to write in Chinese and English could be improved.

5.2 Objectives of the study

The main objectives of this phase are:

1. To examine the Chinese and English handwriting performance of K3 typically developing children and children with handwriting difficulties in Chinese and/or English;

2. To investigate the deficits in developmental skills among children with handwriting difficulties in Chinese or/and English, with the controls;

3. To explore the types and degrees of developmental skills required for legible Chinese and English handwriting.

5.3 Methodology

This phase was carried out between May and July, 2016. It was near the end of school term and children should equip sufficient handwriting skills such that to prevent further problems in their primary education.

5.3.1 Calculation of sample size

Since there was no similar study, the sample size was calculated by using G*Power at which Cohen's d (effect size) = 0.8, type I error of 5% and power of 80%. It showed that this phase required a minimum of 21 children in each category of children with and without handwriting difficulties. This provided a reference point on the number of children to be recruited.

5.3.2 Sampling method

Convenience sampling was employed. Chinese children were recruited if they fulfilled the following criteria: 1) studied in upper kindergarten (i.e., K3/N4) at the local kindergartens and born in the Year of 2010; 2) used Cantonese and traditional Chinese as the major source for oral and written communication since K1; 3) did not have any developmental disabilities, including physical, sensory and emotional/ behavioral problems, but children who were waiting/received assessment in Child Assessment Center (CAC) related to handwriting, or difficulties in learning to write as reported by teachers were also recruited.

5.3.3 Participants

Initially, 81 children were recruited randomly when they fulfilled the inclusion and exclusion criteria. Their performances on handwriting and developmental skills were assessed. They were classified as having handwriting difficulties if they scored below -1.3 SD from the mean scores obtained in Phase 2 in either Chinese (Part 1 or two) and/or English tasks from CHEST. -1.3 SD was chosen as the cutoff line because it was acceptable to include children who were marginally at risk of handwriting difficulties for remediation (Hannay & Lezak, 2004). Children who scored above -0.5 SD in both Chinese and English visuo-orthographic copying tasks and did not have any formal diagnosis received from CAC were classified as the typically developing children (TD). The group allocation was

confirmed by their daily handwriting performance justified by a kindergarten teacher from our research team.

Sixty-five children met the selection criteria on handwriting difficulties or controls. However, one child showed difficulties only in English handwriting. His performance would not be included for statistical analyses and presented individually. The demographic information of the participants was presented in Table 5.1.

Table 5.1

*Demographic information of children across three groups (*n = *65)*

	No. of children	**Gender**		**Mean age (SD)**
		Boys	**Girls**	
Handwriting difficulties in Chinese only (PC)	20	10	10	70.55 (4.43)
Handwriting difficulties in English only (PE)	1	1	-	74.00 (-)
Handwriting difficulties in both orthographies (PB)	23	17	6	69.73 (3.24)
Typically developing children (TD)	21	10	11	72.52 (3.54)

5.3.4 Instruments

As discussed in Section 2.8.2, a number of developmental skills were reported to be related to the handwriting difficulties. The instruments selected in this study were targeted on

these developmental skills. They were also standardized assessments with (local) norms, at which were commonly used by local clinicians and educators to evaluate the performance of specific skills among kindergarten children. It was not only to increase the reliability of the study results, but also the repetition of this study in identifying the underlying causes of handwriting difficulties among Chinese kindergarten children in the future.

5.3.4.1 Test of Developmental Eye Movement (2nd Ed.) (DEM-2)

Test of Developmental Eye Movement (2nd Ed.; DEM-2) was an objective measure on a child's eye movements and oculomotor ability. The first version (DEM) was normed for children ages 6-13 in countries such as Portugal and Hong Kong (Baptista et al., 2011; Pang, Lam & Woo, 2011) and DEM-2 was the latest version. It consisted of a pre-test with 10 single digits, two vertical tests (Test A and B) with 80 digits arranged equally in two rows, and a horizontal test (Test C) composed of the same 80 digits but arranged in 16 rows of five numbers each and random spacing between digits. Children were asked to read the number as quickly and accurately as they could. Total time of each test and errors would be calculated.

Since DEM-2 was designed to measure the oculomotor control of children above 6 years old, a pilot study was carried out in five K3 children to examine if they could perform the tasks. It illustrated that they needed extra guidance on Test C.

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5.3.4.2 Test of Visual Perceptual Skills-3 (TVPS-3)

Test of Visual Perceptual Skills-3 (TVPS-3) was a standardized assessment for children from 4-0 to 18-11 on seven domains of visual perception skills, namely visual discrimination (DIS), visual memory (MEM), spatial relations (SPA), form constancy (CON), sequential memory (SEQ), figure-ground (FGR) and visual closure (CLO). There were 16 items in each subtest arranged by level of difficulty. Children had to choose correct answer, starting from the beginning and until a ceiling was reached after three consecutive wrong answers. The Cronbach's alphas ranged from 0.75 to 0.88 for subtests and 0.96 for the whole, and split-half coefficients ranged from 0.76 to 0.88 for subtests and 0.96 for the whole test. The test-retest reliability was reported as $r = 0.97$ (Martin, 2006).

5.3.4.3 Fine motor subscales of Bruininks-Osteretsky Test of Motor Proficiency, Second Edition (BOT-2)

Fine-motor skills were assessed by Bruininks-Osteretsky Test of Motor Proficiency, Second Edition (BOT-2; Bruininks, 2005), a standardized, norm-referenced measure of fine and gross motor skills of children and youth, 4 through 21 years of age. There were eight subscales in BOT-2 and only four fine motor subscales were evaluated in this phase: (1) fine motor precision (FMP; Subscale 1); (2) fine motor integration (FMI; Subscale 2); (3) manual dexterity (MD; Subscale 3); and (4) upper-limb coordination (ULC; Subscale 7). According to Deitz, Kartin and Kopp (2007), the results for the complete form showed good inter-rater

reliability and internal consistency ($r > 0.90$), and acceptable test-retest reliability ($r > 0.80$). It also showed a moderate to strong correlation with Peabody Developmental Motor Scales, Second Edition (PDMS-2; Folio & Fewell, 2000; PDMS-2 Total Motor Quotient and BOT-2 Total Motor Composite, adjusted $r = 0.73$; PDMS-2 Fine Motor Quotient and BOT-2 Fine Manual Coordination, adjusted $r = 0.51$).

5.3.4.4 The Hong Kong Reading Ability Screening Test for Preschool Children (RAST-K)

The Hong Kong Reading Ability Screening Test for Preschool Children (RAST-K; Ho et al., 2011) was designed to identify K2 and K3 children who have reading problems. It composed of "Chinese word reading," "rapid digit naming," and "lexical decision" subtests. It illustrated good internal consistency (Cronbach's alpha: 0.83 – 0.97) and convergent validity with teachers' comments ($r = 0.47$, $p < 0.001$). Receiver operating characteristic curve also showed that it has 85% sensitivity and 77% specificity to predict children with poor reading and writing abilities in Primary One.

In this phase, only Chinese word reading and lexical decision subtests were chosen. The Chinese word reading subtest was used to investigate whether there was comorbidity of reading and writing difficulties among our sample. It required children to read 30 single Chinese characters and 25 two-character words aloud. The children were given one point for each correct item, and the maximum score was 55.

Lexical decision subtest examined children's understanding toward the composition of Chinese character and the radical position (Ho et al., 2002). It was based on the concept of orthographic rules. For instance, the possible combination of letters may produce sounds (i.e., filk versus filv; Adi-Japha, Strulovich-Schwartz & Julius, 2011). In Chinese, it was related to positional regularity of semantic and phonetic radicals. There were two types of characters: rare characters might have looked unfamiliar to the children, but they were real Chinese characters that conformed to the legal character structure, while non-characters were those in illegal position or included two semantic/ phonetic radicals. Children were asked to indicate whether the character was similar to what they learn or not. One point would be given for the correct choice and the maximum score was 64.

5.3.4.5 Chinese and English Handwriting Screening Test for Kindergarten Children (CHEST)

CHEST developed and validated in Phase 2 is used in this phase to identify Chinese kindergarten children with difficulties in writing Chinese and/or English words. Visuo-orthographic copying tasks were divided into two parts for Chinese and one for English, which evaluate different aspects of copying skills.

5.3.4.6 Name writing tasks

Name writing tasks assessed children's ability to write from memory. They were asked to write the letters/ characters in their name as much as possible onto a unlined 6cm x 12cm

Table 5.2

English Name Writing Scale adapted from Puranik and Lonigan (2011, 2012)

Scores	Description
0	No response or a scribble produced by scratching generally distributed over the page
1	A scribble which is linear, i.e., organized in a horizontal or vertical line
2	Writing contains distinguishable/separate units (e.g., circles, dots, or lines that are separated)
3	Writing contains simple characters—units are simple forms including dots, circles, square and triangle like forms, short lines and symbols- that are separated
4	Writing contains simple characters and is written demonstrating left-to-right orientation
5	Writing contains first letter of name and other letters may be represented by simple characters
6	Writing contains first letter of name and other letters may be represented by complex characters—the units are not simple, but include pseudo and real letters
7	Writes name using correct first letter and represents other letters in name with random letters
8	Writes more than half of the letters contained in their first name
9	Correctly spells first name using conventional spelling

paper. Their name writing products were assessed by the name writing scale: CNWS from Phase 1 for Chinese name writing while their English name writing would be assessed by a 9-point scale by Puranik and Lonigan (2011; 2012) (Table 5.2). The internal consistency for the English name writing task was 0.92.

5.3.5 Procedures

All assessment tasks were administrated individually in the Hong Kong Polytechnic University or children's kindergarten after obtaining the signed consent from parents.

At the beginning, children were asked to complete the CHEST and name writing tasks before the Chinese reading subtest of RAST-K. It minimized the potential effects on attention that affecting the reading and writing performance. Then, other assessments (i.e. BOT-2, VMI-6 etc.) were randomly administrated. It approximately took 2.5 hours, which was divided into 3 sessions with 15 minutes rest in between sessions.

In addition, three samples (i.e. two for English and one for Chinese) from their daily handwriting were submitted to our research team, at which the consistency of handwriting performance were further reviewed by a kindergarten teacher from our team who did not know the children or involve in the assessment separately.

5.3.6 Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics 22.0, all tests were applied two-tailed and the significance level was set at $p < 0.05$.

Descriptive statistics were used to describe the mean and standard deviation of the handwriting parameters and development skills among different groups. One-way ANOVAs and MANOVAs were done to examine and compare the significant differences of performance between children with handwriting difficulties in either or both orthographies and their TD peers, followed by post-hoc tests for the significant group differences.

Spearman's rank correlation coefficient was computed for the relationships between developmental skills and handwriting performance. For the correlation studies, a coefficient valued between 0.50 and 0.75 was considered as having moderate to good relationship, and higher than 0.75 was considered as good to excellent relationship (Portney & Watkins, 2009). The alpha value 0.05 was remained as it would like to increase the factors that were positively related to handwriting performance. Multiple regression analysis was also used to examine the predictability of developmental skills onto the legibility of Chinese and English handwriting. *R*-square (R^2) represents the degree to which handwriting proficiency could be explained by developmental skills.

Finally, the comparisons of perceptual-motor performance between Chinese children in our samples and U.S. norms from the instruction manual were made to investigate the

differences in developmental skills to be required for learning to write between Chinese and Western children, and the barriers resulting from problems with writing Chinese and English.

5.4 Results

5.4.1 Handwriting performance of children with and without handwriting difficulties

5.4.1.1 Visuo-orthographic copying of Chinese characters

Significant differences in the subscale scores of visuo-orthographic copying of Chinese characters performance were found among the three groups of children (Part 1: Wilks' λ = 0.384, $F_{2,63}$ = 8.73, $p < 0.001$, partial eta squared = 0.380; Part 2: Wilks' λ = 0.648, $F_{2,63}$ = 3.46, p = 0.001, partial eta squared = 0.195). Both groups of children with handwriting difficulties had significantly lower scores than their typically developing peers, but children with difficulties in writing both orthographies had poorer performance than those with handwriting difficulties in Chinese only (Figures 5.1 and 5.2).

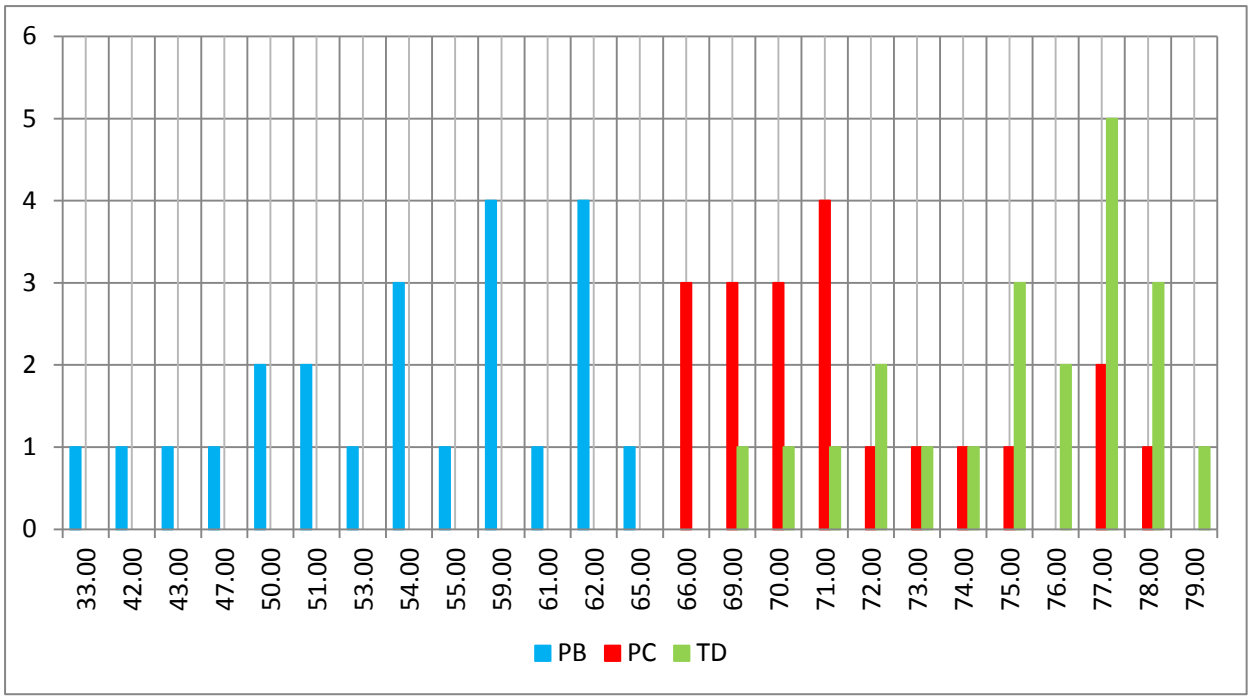


Figure 5.1. Comparison of overall score of CHEST visuo-orthographic copying of Chinese characters (Part 1) performance between three groups

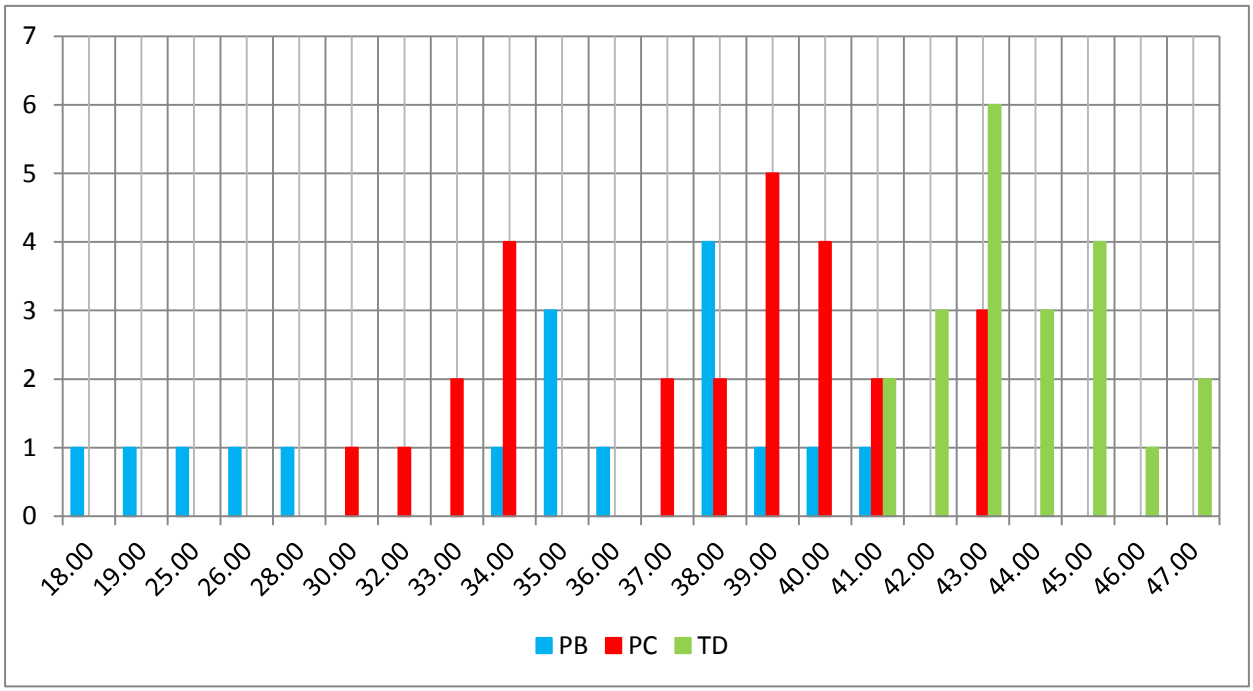


Figure 5.2. Comparison of overall score of CHEST visuo-orthographic copying of Chinese characters (Part 2) performance between three groups

Table 5.3

Comparison of subscale scores of CHEST visuo-orthographic copying of Chinese characters (Part 1) between children with and without handwriting difficulties

	M	***SD***	***F***	***p***
Alignment				
Typically developing children (TD)	49.25	0.72	4.17	0.020
Handwriting difficulties in Chinese only (PC)	48.20	2.12		
Handwriting difficulties in both orthographies (PB)	47.65	2.19		
Stroke Formation				
Typically developing children	46.80	1.82	30.41	< 0.001
Handwriting difficulties in Chinese only	39.70	3.63		
Handwriting difficulties in both orthographies	36.57	6.13		
Proportion				
Typically developing children	48.60	1.23	15.19	< 0.001
Handwriting difficulties in Chinese only	46.70	1.72		
Handwriting difficulties in both orthographies	45.17	2.64		
Out of Grid				
Typically developing children	49.70	0.57	13.37	< 0.001
Handwriting difficulties in Chinese only	49.15	1.39		
Handwriting difficulties in both orthographies	47.13	2.49		

Table 5.4

Comparison of subscale scores of CHEST visuo-orthographic copying of Chinese characters (Part 2) between children with and without handwriting difficulties

	M	*SD*	*F*	*p*
Alignment				
Typically developing children (TD)	23.90	0.31	0.65	0.526
Handwriting difficulties in Chinese only (PC)	22.75	1.02		
Handwriting difficulties in both orthographies (PB)	23.35	5.18		
Stroke Formation				
Typically developing children	20.70	1.95	5.23	0.008
Handwriting difficulties in Chinese only	17.75	2.43		
Handwriting difficulties in both orthographies	15.61	8.00		
Proportion				
Typically developing children	23.15	0.88	0.66	0.521
Handwriting difficulties in Chinese only	21.85	2.56		
Handwriting difficulties in both orthographies	21.96	6.13		
Out of Grid				
Typically developing children	23.60	0.68	0.07	0.929
Handwriting difficulties in Chinese only	23.30	0.80		
Handwriting difficulties in both orthographies	23.17	6.03		

Given the significance of the overall test, the univariate main effects were examined. Significant univariate main effects were obtained from all subscale scores in Part 1 (Table 5.3), but only score on stroke formation subscale in Part 2 ($F_{2,63}$ = 5.23, p = 0.008; Table 5.4). Post-hoc analysis showed that children with handwriting difficulties in Chinese and both orthographies had significant lower scores in stroke formation (PC & PB: $p < 0.001$) and proportion (PC: p = 0.011; PB: $p < 0.001$) in Part 1. PB also performed significantly lower score in alignment (p = 0.017) than TD, and poorer in out of grid than both PC (p = 0.001) and TD (< 0.001; Table 5.3). However, the differences in score on stroke formation in Part 2 were only derived between PB and TD (p = 0.006).

5.4.1.2 Visuo-orthographic copying of English words

Figure 5.3 showed some children who only faced challenges in learning to write Chinese, their performance in writing English words was mildly affected.

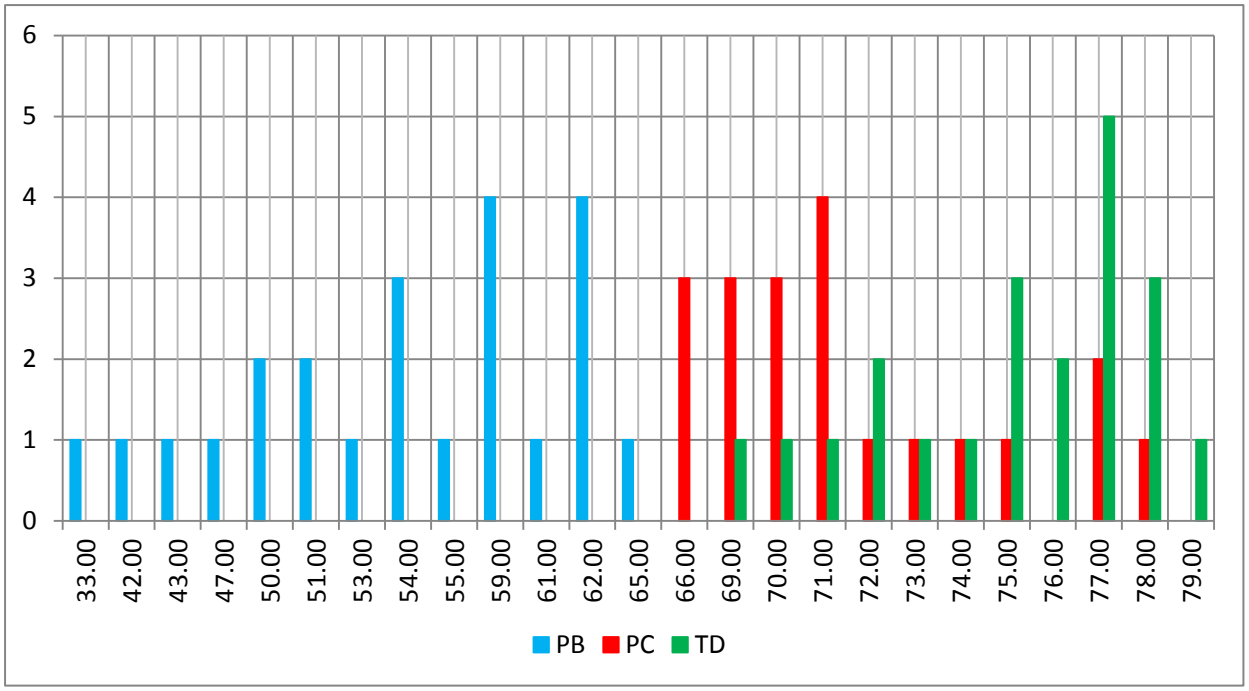


Figure 5.3. Comparison of overall score of CHEST visuo-orthographic copying of English word performance between three groups

Table 5.5

Comparison of subscale scores of CHEST visuo-orthographic copying of English words between children with and without handwriting difficulties

	M	***SD***	***F***	***p***
Alignment				
Typically developing children	39.10	1.33	14.09	< 0.001
Handwriting difficulties in Chinese only	39.15	1.35		
Handwriting difficulties in both orthographies	34.35	5.40		
Spacing				
Typically developing children	38.55	1.88	13.36	<0.001
Handwriting difficulties in Chinese only	38.10	1.86		
Handwriting difficulties in both orthographies	35.57	2.35		
Regularity of Size between Letters				
Typically developing children	38.40	1.70	31.73	< 0.001
Handwriting difficulties in Chinese only	37.80	1.96		
Handwriting difficulties in both orthographies	31.04	5.06		
Appropriate Use of Capital Letter				
Typically developing children	39.90	0.31	5.27	0.008
Handwriting difficulties in Chinese only	39.50	0.69		
Handwriting difficulties in both orthographies	39.17	0.98		

	M	*SD*	*F*	*p*
Letter Formation				
Typically developing children	39.15	1.04	20.63	< 0.001
Handwriting difficulties in Chinese only	37.65	3.01		
Handwriting difficulties in both orthographies	32.95	4.62		
Correctness				
Typically developing children	39.70	0.47	4.59	0.014
Handwriting difficulties in Chinese only	39.50	2.46		
Handwriting difficulties in both orthographies	38.00	2.41		

One-way MANOVA showed the significant difference in overall subscale scores of visuo-orthographic copying of English words among three groups of children (Wilks' λ = 0.270, $F_{2,63}$ = 8.46, $p < 0.001$, partial eta squared = 0.480). Significant univariate main effects were obtained from all subscale scores (Table 5.5), at which PB had significantly lower scores in all subscales than TD ($p < 0.001$ to $p = 0.024$) as well as lower scores in alignment, spacing, regular size and letter formation than PC in the post hoc tests ($p < 0.001$).

5.4.1.3 Chinese and English name writing

Similar to copying skills, TD had the highest name writing scores in both Chinese and English, while PB had the lowest (Table 5.6).

Table 5.6

Comparison of name writing scores between children with and without handwriting difficulties

	M	***SD***	***F***	***p***
Chinese name writing (Total score = 8)				
Typically-developing children (TD)	7.65	0.49	49.65	< 0.001
Handwriting difficulties in Chinese only (PC)	6.90	0.55		
Handwriting difficulties in both orthographies (PB)	6.13	0.46		
English name writing (Total score = 9)				
Typically-developing children	8.70	0.47	6.63	0.003
Handwriting difficulties in Chinese only	7.50	1.96		
Handwriting difficulties in both orthographies	6.48	2.71		

In Chinese name writing, the significant differences were found among three groups of children ($F_{2,62}$ = 49.65, $p < 0.001$). When the post-hoc analysis was done, the significant

differences were found between TD and PC ($p < 0.001$) and PB ($p < 0.001$), as well as between PC and PB ($p < 0.001$).

Although significant differences in English name writing scores were found among three groups of children ($F_{2,62} = 6.63$, $p = 0.003$), there was significant difference between typically developing children and children with poor handwriting in both orthographies ($p = 0.002$).

5.4.2 Developmental skills' performance of children with and without handwriting difficulties

5.4.2.1 Oculomotor control

One-way MANOVA showed no significant difference in the speed and accuracy of digit naming tasks (Wilks' $\lambda = 0.827$, $F_{2,63} = 1.44$, $p = 0.185$, partial eta squared = 0.091). But children with handwriting difficulties (i.e., PC and PB) were slower and making more errors than TD, but the differences were not significant (Table 5.7).

Table 5.7

Comparison of performance in DEM-2 among three groups of children

	M	***SD***	***F***	***p***
Vertical Adjusted Time (sec)				
Typically developing children	77.52	25.44	0.60	0.550
Handwriting difficulties in Chinese only (PC)	81.45	29.53		
Handwriting difficulties in both orthographies (PB)	86.39	25.58		
Horizontal Adjusted Time (sec)				
Typically developing children	120.71	40.55	2.52	0.089
Handwriting difficulties in Chinese only	159.20	76.13		
Handwriting difficulties in both orthographies	152.32	56.29		
Number of Errors in Horizontal Task				
Typically developing children	4.14	7.27	2.07	0.135
Handwriting difficulties in Chinese only	8.95	14.61		
Handwriting difficulties in both orthographies	12.56	17.06		
H/V Ratio				
Typically developing children	1.58	0.37	1.33	0.270
Handwriting difficulties in Chinese only	1.88	0.70		
Handwriting difficulties in both orthographies	1.78	0.68		

5.4.2.2 Visual perception

Although there was no significant difference in TVPS-3 overall score among three groups of children ($F_{2,63}$ = 2.62, p = 0.113), the profile of the subtest scores could differentiate children with and without handwriting difficulties (Wilks' λ = 0.564, $F_{2,63}$ = 2.60, p = 0.003, partial eta squared = 0.249) (Figure 5.4). However, the significant differences were found only in the subtests of visual discrimination (DIS) ($F_{2,63}$ = 5.08, p = 0.009), spatial relations (SPA) ($F_{2,63}$ = 8.03, p = 0.001), sequential memory (SEQ) ($F_{2,63}$ = 5.16, p = 0.008). There were marginally insignificant results of visual memory (MEM) ($F_{2,63}$ = 3.01, p = 0.057) and figure-ground (FGR) ($F_{2,63}$ = 3.00, p = 0.057) (Table 5.8).

In post hoc analysis, PB had poorer performance in visual discrimination and spatial relations than PC (DIS: p = 0.025, SPA: p = 0.011) and TD (DIS: p = 0.024, SPA: p = 0.001). Surprisingly, there was significant difference in the performance on sequential memory between TD and PC (p = 0.006) but not PB (p = 0.329).

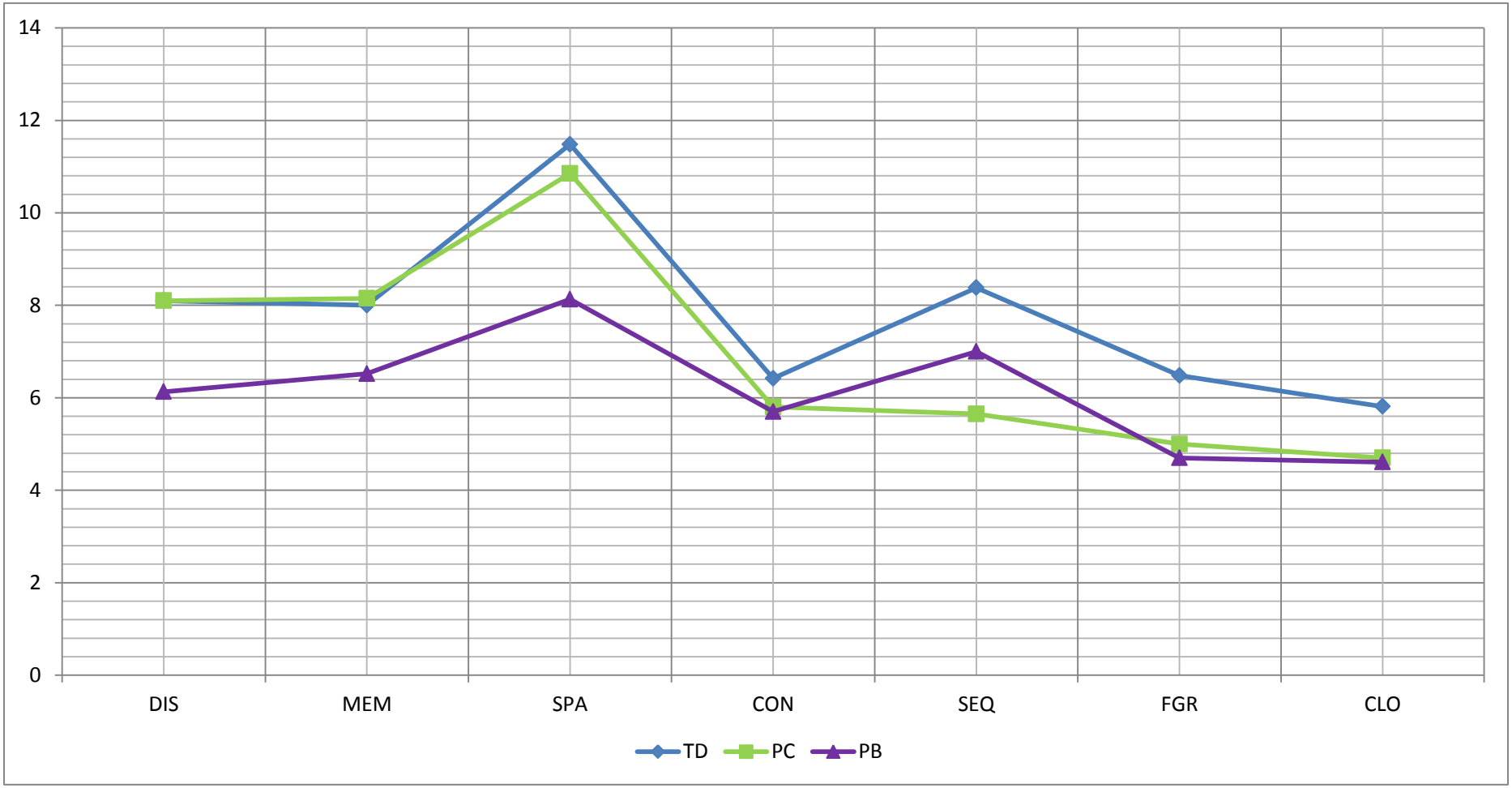


Figure 5.4. Distribution on the mean raw scores of TVPS-3 subtests among children with and without handwriting difficulties

Table 5.8

Comparison of subtests of TVPS-3 among three groups of children

	M	*SD*	*F*	*p*
Visual Discrimination (DIS)				
Typically developing children (TD)	8.10	1.92	5.08	0.009
Handwriting difficulties in Chinese only (PC)	8.10	2.36		
Handwriting difficulties in both orthographies (PB)	6.13	2.72		
Visual Memory (MEM)				
Typically developing children	8.00	1.96	3.01	0.057
Handwriting difficulties in Chinese only	8.15	2.29		
Handwriting difficulties in both orthographies	6.52	2.74		
Spatial Relations (SPA)				
Typically developing children	11.48	2.42	8.03	0.001
Handwriting difficulties in Chinese only	10.85	3.34		
Handwriting difficulties in both orthographies	8.13	3.03		
Form Constancy (CON)				
Typically developing children	6.42	1.75	0.86	0.429
Handwriting difficulties in Chinese only	5.80	1.99		
Handwriting difficulties in both orthographies	5.70	2.16		
Sequential Memory (SEQ)				
Typically developing children	8.38	2.44	5.16	0.008
Handwriting difficulties in Chinese only	5.65	3.18		
Handwriting difficulties in both orthographies	7.00	2.53		

	M	*SD*	*F*	*p*
Figure Ground (FGR)				
Typically developing children	6.48	2.48	3.00	0.057
Handwriting difficulties in Chinese only	5.00	2.70		
Handwriting difficulties in both orthographies	4.70	2.48		
Visual closure (CLO)				
Typically developing children	5.81	3.23	1.07	0.350
Handwriting difficulties in Chinese only	4.70	3.11		
Handwriting difficulties in orthographies	4.61	2.61		

5.4.2.3 Fine motor control

Figure 5.5 illustrated the distribution of mean scores of fine motor subtests of BOT-2 among three groups of children.

It showed significant differences in the mean scores of FMP ($F_{2,63} = 17.19$, $p < 0.001$) and FMI ($F_{2,63} = 13.89$, $p < 0.001$). PB performed significant poorer than TD and PC in FMP (PB and TD: $p < 0.001$, PB and PC: $p < 0.001$) and FMI (PB and TD: $p < 0.001$, PB and PC: $p = 0.005$). In contrast, there were no significant differences in the mean scores of MD ($F_{2,63} = 0.97$, $p = 0.387$) and ULC ($F_{2,60} = 0.66$, $p = 0.521$) (Table 5.8).

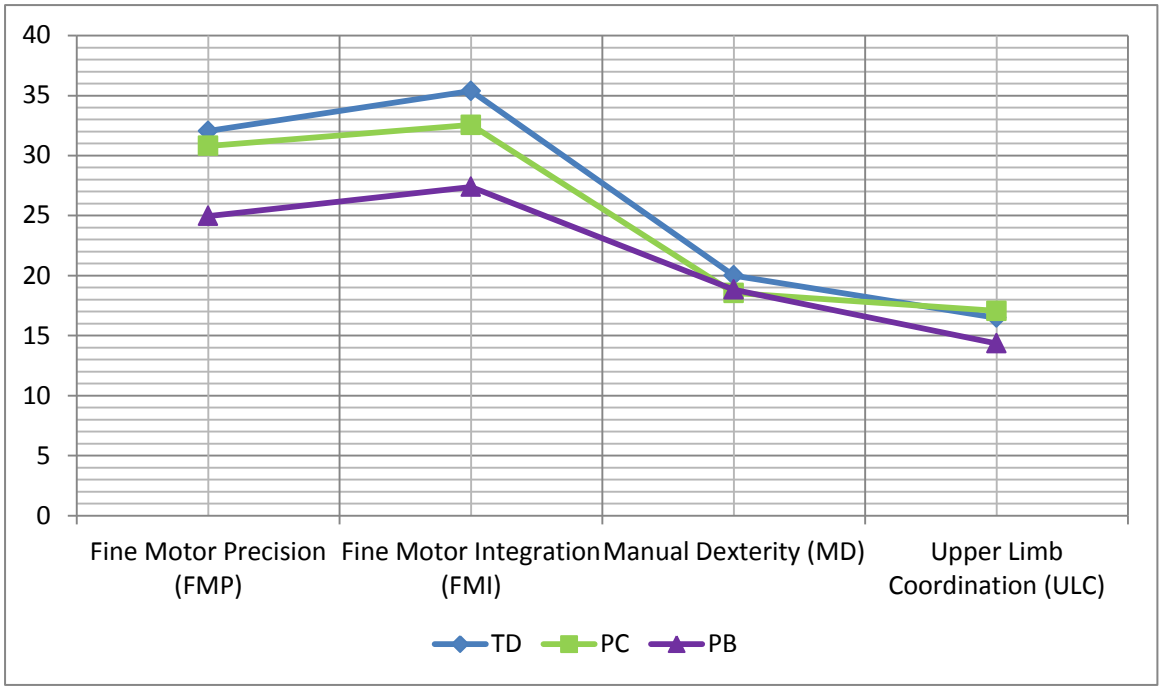


Figure 5.5. Comparison on the mean scores of fine motor subtests of BOT-2 between three groups of children

Table 5.9

Comparison of fine motor subtests of BOT-2 among three groups of children

	M	***SD***	***F***	***p***
Fine Motor Precision (FMP)				
Typically developing children (TD)	32.05	4.59	17.19	< 0.001
Handwriting difficulties in Chinese only (PC)	30.80	4.06		
Handwriting difficulties in both orthographies (PB)	24.96	4.23		
Fine Motor Integration (FMI)				
Typically developing children	35.38	4.15	13.89	< 0.001
Handwriting difficulties in Chinese only	32.55	5.69		
Handwriting difficulties in both orthographies	27.39	5.37		
Manual Dexterity (MD)				
Typically developing children	20.00	3.42	0.97	0.387
Handwriting difficulties in Chinese only	18.55	3.92		
Handwriting difficulties in both orthographies	18.83	3.45		
Upper Limb Coordination (ULC)				
Typically developing children	16.48	9.18	0.66	0.521
Handwriting difficulties in Chinese only	17.05	7.58		
Handwriting difficulties in both orthographies	14.35	7.77		

5.4.2.4 Visual motor integration

One-way ANOVA illustrated the significant differences in the mean raw score of VMI-6 among children with handwriting difficulties and typically developing children ($F_{2, 63}$ = 3.67, p < 0.001). Post-hoc analysis revealed that the mean scores in TD (M = 20.14, SD = 2.15) was similar to PC (M = 19.10, SD = 1.55) (p = 0.217), but both significantly higher than PB (M = 17.30, SD = 1.72) (TD: p < 0.001; PC: p = 0.006).

5.4.2.5 RAST-K Chinese word reading

There was no significant difference in Chinese word reading abilities among three groups of children ($F_{2,62}$ = 2.20, p = 0.122), even though PC (Mean score = 31.85, SD = 15.07) and PB (M = 35.61, SD = 15.02) had lower mean scores in Chinese word reading than TD (M = 41.05, SD = 11.33).

5.4.2.6 RAST-K Lexical decision

TD had higher scores in the lexical decision task (*M* = 48.05, *SD* = 6.24) than PC (*M* = 43.35, *SD* = 8.96) and PB (*M* = 43.31, *SD* = 9.12), but these differences were insignificant ($F_{2,62}$ = 2.19, *p* = 0.120).

5.4.3 Relationships between handwriting and developmental skills performance

5.4.3.1 Visuo-orthographic copying of Chinese characters

First, overall scores were (marginally) fair and negative correlated with the number of errors in DEM-2 horizontal task (Part 1: r = -0.24, p = 0.051; Part 2: r = -0.33, p = 0.007), but positively correlated to visual perceptual skills such as SPA (Part 1: r = 0.36, p = 0.003; Part 2: r = 0.45, p < 0.001) and FGR (Part 1: r = 0.25, p = 0.046; Part 2: r = 0.32, p = 0.009). Although there were moderate correlations between overall scores with FMI (Part 1: r = 0.58, p < 0.001; Part 2: r = 0.60, p < 0.001) and VMI-6 (Part 1: r = 0.55, p < 0.001; Part 22: r = 0.50, p < 0.001), there was fair correlation with FMP (Part 1: r = 0.45, p < 0.001; Part 2: r = 0.43, p < 0.001; Tables 5.10-5.11).

Although scores in stroke formation were correlated with SPA (Part 1: r = 0.25, p = 0.050; Part 2: r = 0.35, p = 0.004) and FRG (Part 1: r = 0.26, p = 0.040; Part 2: r = 0.30, p = 0.016) in both parts, the correlations with DIS (r = 0.29, p = 0.023), MEM (r = 0.28, p = 0.028) and SEQ (r = 0.26, p = 0.036) were occurred only in Part 2. Besides, there was fair correlation between SEQ and proportion in Part 1 (r = 0.34, p = 0.007), while CON was fairly and negative correlated with out of grid in both parts (Part 1: r = -0.29, p = 0.022; Part 2: r = -0.33, p = 0.009).

Table 5.10

*Correlations between Chinese handwriting (Part 1) and developmental skills (*n = *66)*

	Overall	**Alignment**	**Stroke formation**	**Proportion**	**Out of grid**
Perceptual-motor aspects					
DEM vertical adj. time	-0.08	-0.13	-0.10	-0.04	-0.05
DEM horizontal adj. time	-0.11	-0.02	-0.16	-0.14	0.03
DEM horizontal error	*-0.24*	-0.04	**-0.30***	-0.22	-0.21
DEM ratio	-0.06	0.06	-0.11	-0.13	0.14
TVPS-3 DIS	0.22	0.06	-0.11	-0.13	0.14
TVPS-3 MEM	0.22	0.22	0.12	0.12	0.17
TVPS-3 SPA	**0.36****	0.13	**0.25***	**0.37****	0.24
TVPS-3 CON	0.08	0.00	0.05	0.07	**-0.29***
TVPS-3 SEQ	0.20	0.10	0.11	**0.34****	0.09
TVPS-3 FGR	**0.25***	0.04	**0.26***	0.20	0.11
TVPS-3 CLO	0.17	0.19	0.15	0.19	-0.06
BOT-2 FMP	**0.45****	0.18	**0.39****	**0.41****	**0.29***
BOT-2 FMI	**0.58****	**0.41****	**0.52****	**0.52****	**0.46****
BOT-2 MD	0.12	-0.08	0.05	0.15	0.11
BOT-2 ULC	0.10	0.12	0.10	-0.01	0.11
VMI-6	**0.55****	**0.27***	**0.55****	**0.41****	**0.38****
Linguistic aspects					
RAST-K Chinese word reading	0.18	0.13	0.17	0.15	-0.06
RAST-K Lexical decision	**0.27***	**0.32***	0.25	**0.28***	0.08

** $p < 0.01$. * $p < 0.05$.

Table 5.11

*Correlations between Chinese handwriting (Part 2) and developmental skills (*n = *66)*

	Overall	**Alignment**	**Stroke formation**	**Proportion**	**Out of grid**
Perceptual-motor aspects					
DEM vertical adj. time	-0.15	-0.10	-0.12	0.05	0.04
DEM horizontal adj. time	-0.19	-0.16	-0.14	-0.02	0.07
DEM horizontal error	**-0.33****	-0.08	**-0.33****	-0.23	-0.09
DEM ratio	-0.09	-0.08	-0.07	-0.05	0.07
TVPS-3 DIS	**0.30***	0.15	**0.29***	0.18	0.02
TVPS-3 MEM	**0.30***	0.03	**0.28***	0.05	0.00
TVPS-3 SPA	**0.45****	0.16	**0.35****	0.23	0.15
TVPS-3 CON	0.08	0.16	0.09	-0.11	**-0.33****
TVPS-3 SEQ	**0.29***	0.22	**0.26***	0.18	0.20
TVPS-3 FGR	**0.32****	0.19	**0.30***	0.12	0.16
TVPS-3 CLO	0.14	0.07	0.12	-0.02	-0.05
BOT-2 FMP	**0.43****	**0.25***	**0.35****	0.21	0.20
BOT-2 FMI	**0.60****	**0.50****	**0.49****	**0.27****	**0.32****
BOT-2 MD	0.04	-0.01	0.01	-0.13	0.00
BOT-2 ULC	0.13	0.01	0.16	0.10	0.14
VMI-6	**0.50****	**0.32****	**0.47****	*0.24*	0.23
Linguistic aspects					
RAST-K Chinese word reading	0.14	0.23	0.07	-0.10	0.03
RAST-K Lexical decision	**0.38****	**0.39****	0.23	*0.27*	-0.05

** $p < 0.01$. * $p < 0.05$.

Furthermore, FMI and VMI-6 were fairly to moderately correlated with all subscales scores in Part 1. The *r* values were ranging from 0.27 to 0.52 (p value < 0.001 to 0.028). In Part 2, although FMI were correlated with all subscales scores, VMI-6 only correlated with alignment ($r = 0.32$, $p = 0.020$) and stroke formation ($r = 0.28$, $p = 0.038$). In contrast, there were fair correlations between FMP and subscale scores in stroke formation ($r = 0.39$, $p = 0.002$), proportion ($r = 0.41$, $p = 0.001$) and out of grid ($r = 0.29$, $p = 0.021$) in Part 1, while alignment ($r = 0.25$, $p = 0.049$) and stroke formation ($r = 0.35$, $p = 0.005$) in Part 2.

Despite insignificant correlations between reading and writing of Chinese characters, orthographic knowledge was correlated with the overall score (Part 1: $r = 0.28$, $p = 0.045$; Part 2: $r = 0.38$, $p = 0.004$) as well as the subscale scores in alignment (Part 1: $r = 0.32$, $p = 0.020$; Part 2: $r = 0.39$, $p = 0.004$) and proportion (Part 1: $r = 0.28$, $p = 0.038$; Part 2: $r = 0.27$, $p = 0.053$).

5.4.3.2 Visuo-orthographic copying of English words

The speed and accuracy of DEM yielded negative and fair correlations with the overall score of English handwriting, and its subscale scores in spacing, use of capital letters, letter formation and correctness. A significant correlation was reported between DEM vertical adjusted time and spacing ($r = -0.38$, $p = 0.002$). DEM horizontal adjusted time was correlated with overall score ($r = -0.26$, $p = 0.037$) and subscales score in spacing ($r = -0.38$, $p = 0.002$). And the number of errors in DEM horizontal task was correlated with the

subscale scores in spacing (r = -0.38, p = 0.002), use of capital letter (r = -0.27, p = 0.034), letter formation (r = -0.26, p = 0.035), correctness (r = -0.25, p = 0.043) and to overall score (r = -0.33, p = 0.007).

In addition, overall score was also fairly correlated with the TVPS-3 subtest scores on DIS, MEM, and SPA (r = 0.25-0.42, p < 0.001-=0.015). TVPS-3 subtest scores on DIS was also fairly correlated with spacing (r = 0.31, p = 0.014), while form constancy was fairly correlated with regular size between letters (r = 0.34, p = 0.008). In addition, there were fair correlations between visual memory with spacing (r = 0.28, p = 0.024) and regular size between letters (r = 0.38, p = 0.002). Finally, SPA were fairly correlated to spacing (r = 0.41, p = 0.001), regular size between letters (r = 0.33, p = 0.008) and letter formation (r = 0.31, p = 0.013).

Except the insignificant correlations between BOT-2 FMP and FMI with the appropriate use of capital letter, as well as BOT-2 FMI and correctness, there were significant fair correlations between the subscale scores of FMP and FMI with the rest of the subscales in English handwriting. There were significant correlations between VMI-6 and the overall (r = 0.56, p < 0.001) and all subscale scores of English handwriting (r ranged from 0.27 to 0.55, p value ranged from < 0.001 to 0.040).

Table 5.12

Correlations between English Handwriting and Developmental Skills (n = 66)

	Overall	**Alignment**	**Spacing**	**Regular size**	**Capital used**	**Letter formation**	**Correctness**
Perceptual-motor aspects							
DEM vertical adj. time	-0.22	-0.08	**-0.38****	-0.07	-0.05	-0.19	-0.17
DEM horizontal adj. time	**-0.26***	-0.06	**-0.38***	-0.16	-0.14	-0.18	-0.08
DEM horizontal error	**-0.33***	-0.21	**-0.38***	-0.22	**-0.27***	**-0.26***	**-0.25***
DEM ratio	-0.13	-0.06	-0.05	-0.25	-0.15	0.05	0.05
TVPS-3 DIS	**0.31***	0.16	**0.31***	0.19	0.16	0.18	0.24
TVPS-3 MEM	**0.30***	0.02	**0.28***	**0.38****	0.12	0.16	0.01
TVPS-3 SPA	**0.48****	-0.01	**0.41****	**0.33****	0.04	**0.31***	-0.08
TVPS-3 CON	0.18	0.03	0.08	**0.25***	-0.03	0.01	0.03
TVPS-3 SEQ	0.10	-0.04	0.18	-0.06	-0.07	0.07	0.02
TVPS-3 FGR	0.23	-0.11	0.18	0.13	0.07	**0.31***	0.06
TVPS-3 CLO	0.16	0.00	0.05	0.23	0.21	0.11	-0.02
BOT-2 FMP	**0.52****	**0.46****	**0.29***	**0.53****	0.20	**0.37***	**0.35****

	Overall	Alignment	Spacing	Regular size	Capital used	Letter formation	Correctness
BOT-2 FMI	**0.60****	**0.45****	**0.44****	**0.48****	0.19	**0.43****	0.22
BOT-2 MD	0.07	0.03	0.08	0.04	-0.08	0.13	0.02
BOT-2 ULC	0.11	0.12	0.12	0.13	-0.15	0.10	0.02
VMI-6	**0.56****	**0.36****	**0.33****	**0.55****	**0.27***	**0.40****	**0.28***
Linguistic aspects							
RAST-K Chinese word reading	0.15	0.01	0.06	0.11	0.07	0.18	-0.02
RAST-K Lexical decision	**0.32***	0.09	**0.32***	0.24	0.21	0.09	0.19

** $p < 0.01$. * $p < 0.05$.

Surprisingly, the lexical knowledge toward Chinese character was fairly correlated with the overall score of copying English words (r = 0.32, p = 0.018) and its subscale on spacing (r = 0.32, p = 0.018; Table 5.12).

5.4.3.3 Name writing

The strength of correlations between Chinese and English name writing and developmental skills was similar. As shown in Table 5.13, there were fair and negative correlations between name writing scores and DEM vertical (Chinese: r = -0.26, p = 0.038; English: r = 0.29, p = 0.019) and horizontal adjusted time (Chinese: r = -0.31, p = 0.031; English: r = 0.29, p = 0.019). Name writing scores were also correlated with the number of errors in DEM horizontal task (Chinese: r = -0.27, p = 0.032; English: r = 0.36, p = 0.003).

Fair correlations were yielded in Chinese and English name writing scores with the TVPS-3 subtests on DIS, MEM, SPA, FGR and CON. The r values ranged from 0.25 to 0.42, and p value varying from 0.001 to 0.046. There was moderate correlation between Chinese name writing score and BOT-2 FMI subtest score (r = 0.55, p < 0.001), but only fair correlations occurred in English name writing (r = 0.36, p = 0.004). The correlations between BOT-2 FMP were fair between Chinese (r = 0.45, p < 0.001) and English name writing (r = 0.40, p = 0.001). In addition, there were moderate correlations between both Chinese (r = 0.59, p < 0.001) and English (r = 0.50, p < 0.001) name writing and VMI-6.

Finally, it was interesting to note that RAST-K Chinese word reading and lexical decision were not only correlated to Chinese name writing score (r = 0.27-0.29, p = 0.030-0.035), but also the English name writing score (r = 0.27-0.33, p = 0.007-0.030).

5.4.4 Predictors of Chinese and English handwriting performances

Multiple regression analyses were carried out to examine the potential predictors for visuo-orthographic copying and name writing of Chinese and English (Table 5.14). For copying of Chinese characters, BOT-2 FMI (β = 0.71, p < 0.001) and VMI-6 (β = 1.13, p = 0.025) accounted for 43.9% variability in Part 1 (R^2 = 0.44, F = 23.85, p < 0.001), while BOT-2 FMI subscale (β = 0.53, p < 0.001) and TVPS-3 SPA subscale (β = 0.49, p < 0.001) accounted for 45.4% variability in Part 2 (R^2 = 0.45, F = 25.36, p < 0.001). In contrast, three predictors explained 39.7% in English word copying task (R^2 = 0.40, F = 13.18, p < 0.001). VMI-6 (β = 0.53, p < 0.001) and TVPS-3 SPA subscale (β = 0.79, p = 0.029) are the most significant predictors, followed by BOT-2 FMI (β = 0.49, p = 0.010).

For name writing, VMI-6 (β = 1.24, p = 0.009), BOT-2 FMI (β = 0.04, p = 0.008) and TVPS-3 DIS (β = 0.08, p = 0.022) explained a total of 44.2% variability of Chinese name writing performance (R^2 = 0.44, F = 15.53, p < 0.001), while 28.2% of the variability in English name writing (R^2 = 0.28, F = 11.76, p < 0.001) was explained by VMI-6 (β = 0.46, p < 0.001) and DEM vertical adjusted time (β = -0.02, p = 0.029).

Table 5.13

Correlations between name writing and perceptual-motor skills (n = 66)

	Chinese name writing	**English name writing**
Perceptual-motor aspects		
DEM vertical adj. time	**-0.26***	**-0.29***
DEM horizontal adj. time	**-0.31***	**-0.29***
DEM horizontal error	**-0.27***	**-0.36****
DEM ratio	-0.14	-0.07
TVPS-3 DIS	**0.32***	**0.25***
TVPS-3 MEM	**0.31***	**0.30***
TVPS-3 SPA	**0.36***	**0.34****
TVPS-3 CON	0.18	0.11
TVPS-3 SEQ	0.14	0.14
TVPS-3 FGR	**0.35****	**0.42****
TVPS-3 CLO	**0.27***	**0.33****
BOT-2 FMP	**0.45****	**0.40****
BOT-2 FMI	**0.55****	**0.36****
BOT-2 MD	0.11	0.00
BOT-2 ULC	0.04	0.06
VMI-6	**0.59****	**0.50****
Linguistic aspects		
RAST-K Chinese word reading	**0.27***	**0.33****
RAST-K Lexical decision	**0.29***	**0.35****

Table 5.14

Predictors of Chinese and English handwriting performance among Chinese kindergarten children

	Copying of Chinese characters (Part 1)		**Copying of Chinese characters (Part 2)**		**Chinese name writing**		**Copying of English words**		**English name writing**	
	β	*t*	*β*	*t*	*β*	*t*	*β*	*t*	*β*	*t*
VMI-6	1.13	2.29			0.12	2.72	1.45	2.38	0.45	4.13
BOT-2 FMI	0.71	4.06	0.53	5.28	0.04	2.72	0.48	2.18		
TVPS-3 SPA			0.49	2.65			0.79	2.23		
TVPS-3 DIS					0.08	2.36				
DEM-2 vertical adj. time									-0.02	-2.23
R^2	0.44		0.45		0.44		0.40		0.28	
F	23.85		25.36		15.53		13.18		11.76	

5.4.5 Performance on handwriting and developmental skills in a child with English handwriting difficulties only

Since the participants were recruited by random sampling, it found that only one child (PE) showed poor handwriting in English but not Chinese. He was referred to Child Assessment Center because of his difficulties in reading and writing at school, and pediatrician's comments as the early sign of specific learning difficulties as no other impairments that affecting his handwriting performance was observed.

Most of his difficulties in English handwriting were on maintaining proper alignment, letter formation and correctness. From Figure 5.6, the child had the problems to write along the line. For example, the flowing letter "u" in the word "Thursday." There was poor formation of letter "a" and missing letter "c" in the word "policeman." But he performed similarly in overall and subscale scores in Chinese handwriting as the TD group.

For developmental skills, the child with poor English handwriting underperformed other groups of children with handwriting difficulties in vertical digit naming task of DEM-2 (Figure 5.7). Although he performed similarly to other children in the horizontal task, he made more errors. At the same time, PE had similar or even superior performance in most of visual-perception and motor skills with TD group, especially the skills that were significantly correlated to Chinese and English handwriting performance (e.g., DIS). The scores of PE (raw score = 20) in VMI-6 were also comparable to those of the TD group. In the meantime,

PE scored lower on the Chinese word reading task than all other three groups of children, but he performed similar to TD children on the lexical decision task. The profiles on oculomotor control (i.e., DEM-2), visual perception (i.e., TVPS-3) and fine motor control (i.e., BOT-2) between the PE (Red) and other groups of children are shown in Figures 5.7-5.9.

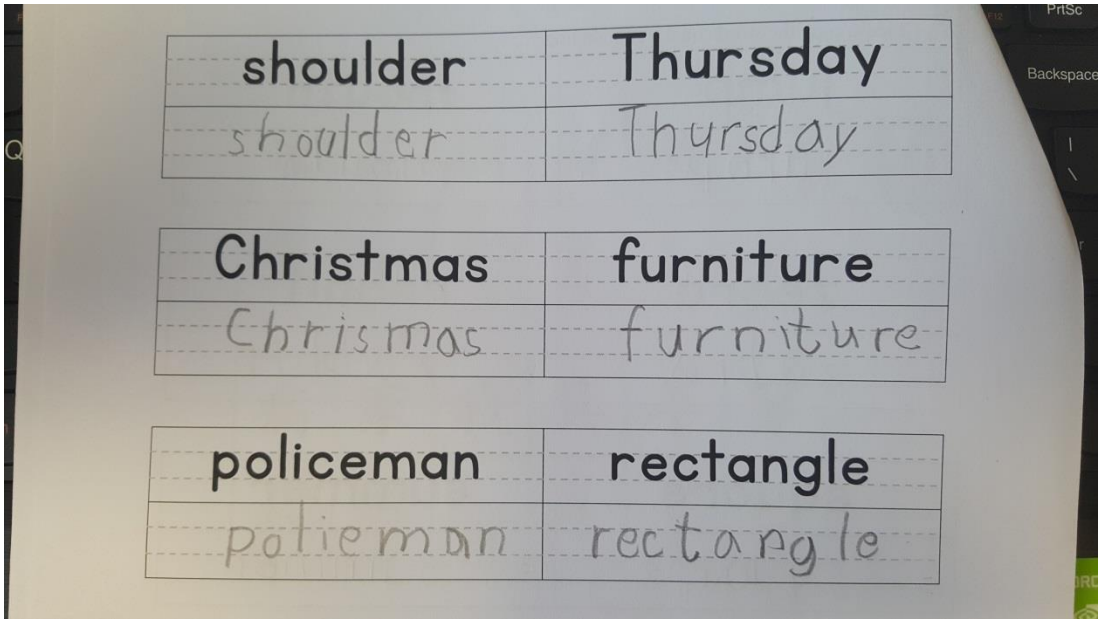


Figure 5.6. Handwriting samples from the child with English handwriting difficulties.

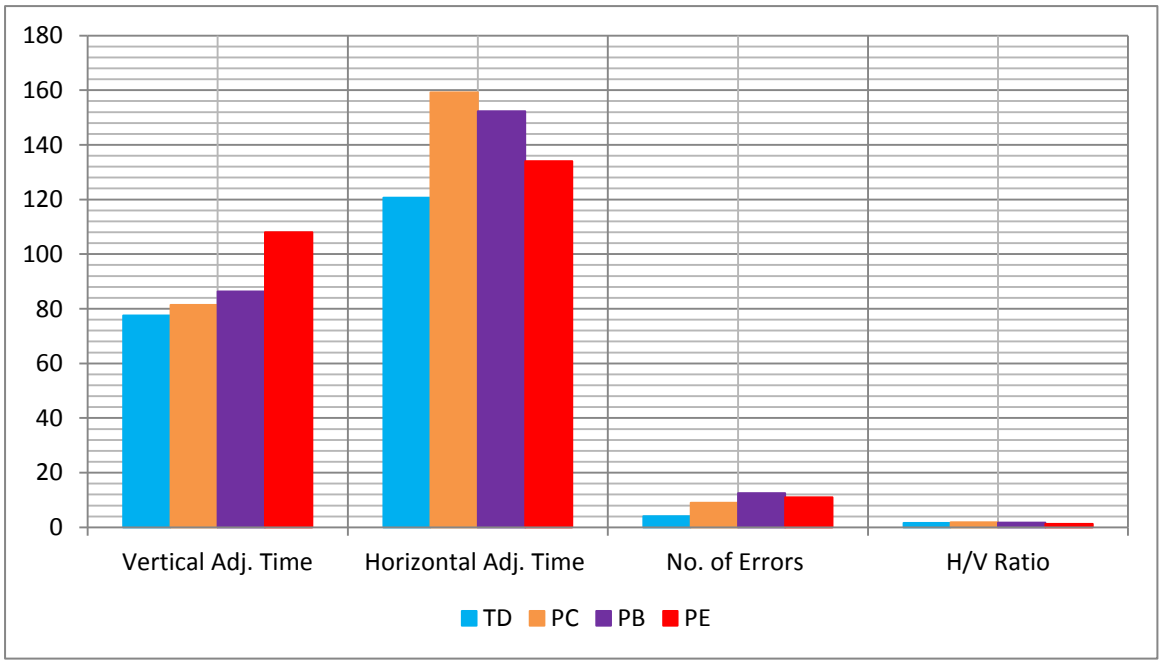


Figure 5.7. Distribution on the speed and accuracy of oculomotor control among different groups of children

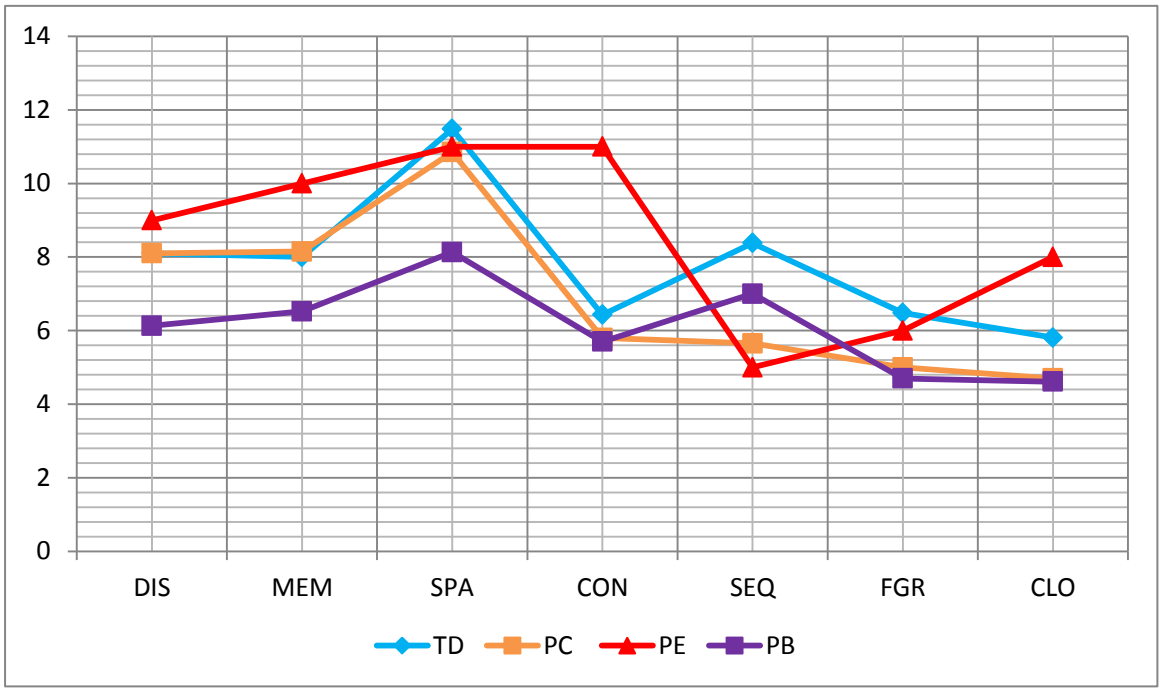


Figure 5.8. Distribution on the mean raw scores of TVPS-3 subtests among children with different patterns of handwriting difficulties and the controls

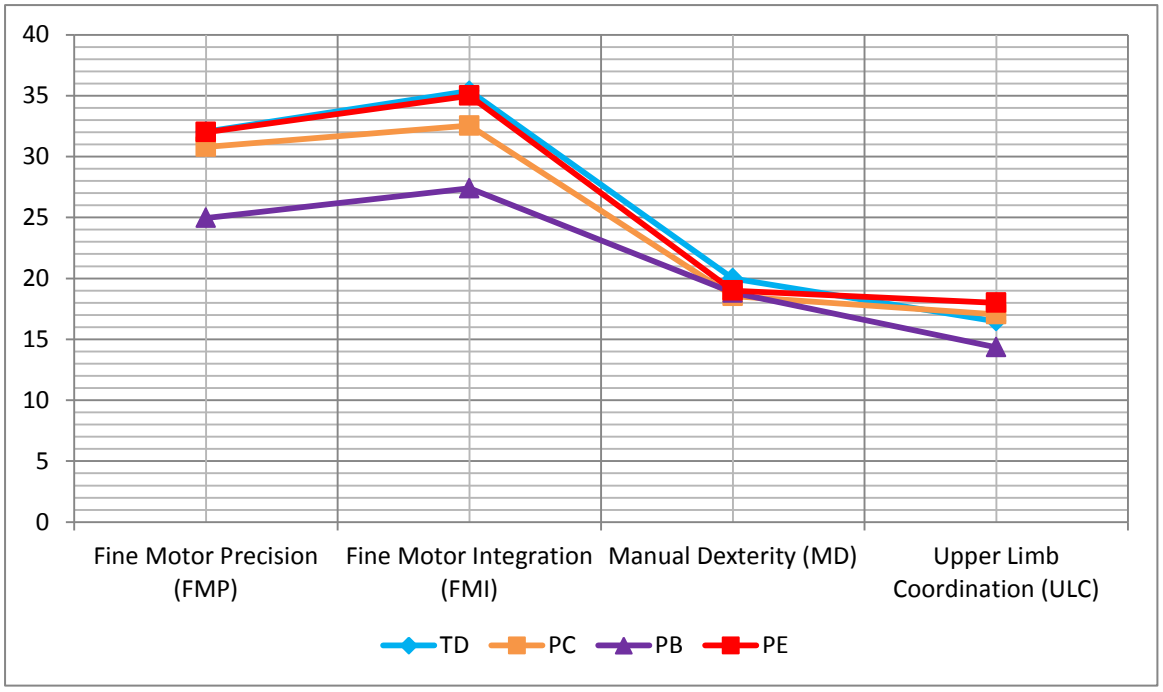


Figure 5.9. Distribution on the mean raw scores of BOT-2 subtests among children with handwriting difficulties in Chinese or English with the controls

Table 5.15

Comparison of linguistic skills (RAST-K) among children with different patterns of handwriting

	Mean (SD)	
	Chinese word reading (Total score: 55)	**Lexical decision (Total score: 64)**
Typically developing children	41.05 (11.33)	48.05 (6.24)
Handwriting difficulties in Chinese only	31.85 (15.07)	43.35 (8.96)
Handwriting difficulties in English only	20.00 (N.A.)	46.00 (N.A.)
Handwriting difficulties in both orthographies	35.61 (15.02)	43.31 (9.13)

5.4.6 Comparison on perceptual-motor performance between Chinese children and U.S. norms

Assessments on oculomotor control, visual perceptual and fine motor aspects, namely DEM-2, TVPS-3, BOT-2 and VMI-6, are commonly used by clinicians and educators to explore the problems of children with poor handwriting. Since these assessment tools were developed in the U.S., we would like to investigate if there are cultural differences in performance between two populations.

Table 5.16

Performance in DEM-2 between Chinese children and U.S. Norms

		Mean (*SD*)	
		Chinese children (n = 64)	**U.S. norm (n = 52)**
Vertical adjusted time (sec)	TD	77.52 (25.44)	63.11 (16.59)
	PC	81.45 (29.53)	
	PB	86.39 (25.58)	
Horizontal adjusted time (sec)	TD	120.71 (40.55)	98.26 (32.61)
	PC	159.20 (76.13)	
	PB	152.32 (56.29)	
Number of errors in horizontal task	TD	4.14 (7.27)	15.22 (11.49)
	PC	8.95 (14.61)	
	PB	12.57 (17.06)	
Ratio	TD	1.58 (0.37)	1.58 (0.45)
	PC	1.88 (0.70)	
	PB	1.78 (0.68)	

When compared with the norm aged 6.0-6.11, children in our sample performed vertical and horizontal tasks more slowly, but fewer errors were made in the horizontal task (Table 5.16).

The overall scores in Chinese children (*M* = 111.62, *SD* = 6.33), even those with handwriting difficulties (PC group: *M* = 106.55, *SD* = 11.52; PB group: *M* = 101.65, *SD* = 8.99), were higher than the standard mean of 100 (*SD* =15). When we looked at the subscale score, only children with handwriting difficulties in both orthographies scored near or below the mean of 10 (*SD* = 3) in five out of seven subtests (Figure 5.10). Generally, TD children in Chinese population performed significantly better than the U.S. norms in all of the subtests.

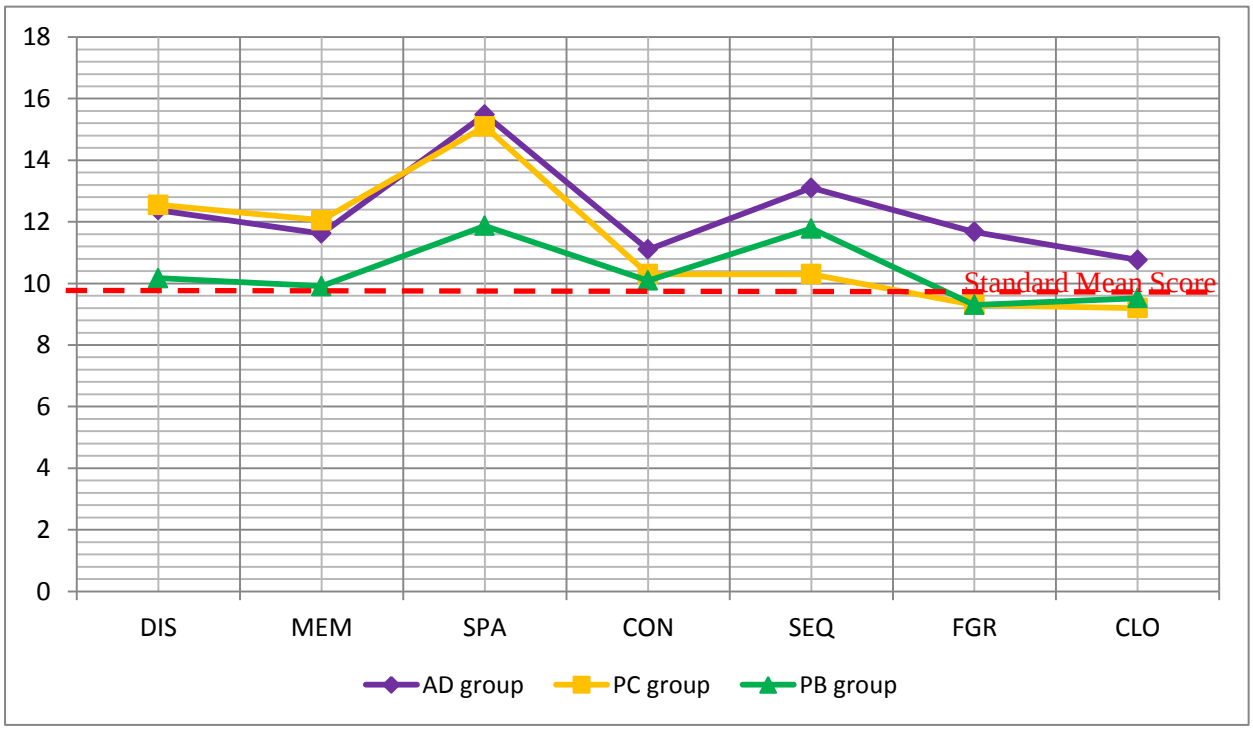


Figure 5.10. Distribution of TVPS-3 subtest scaled scores among three groups of Chinese children

Figure 5.11 showed that TD children in Chinese communities had higher scores when compared with their Western counterparts (the red line), while only children with handwriting difficulties in both orthographies scored slightly below the mean of 15 (SD = 5) in FMP and ULC.

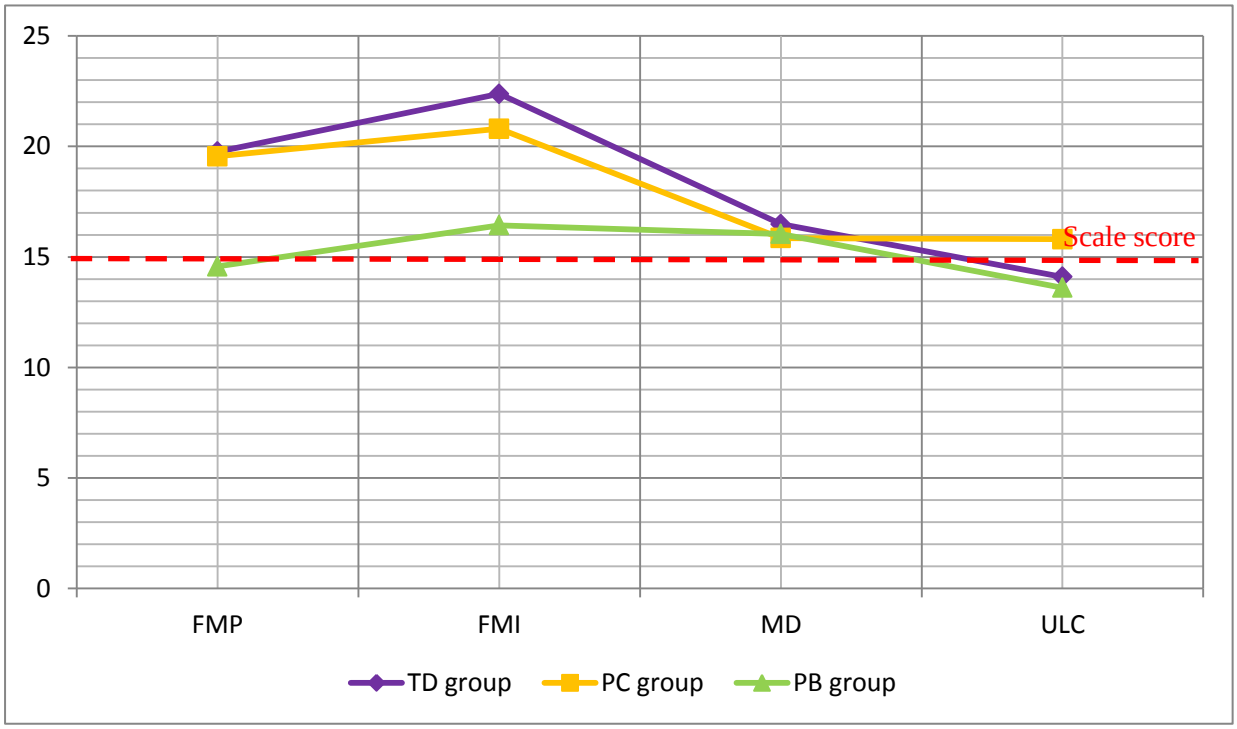


Figure 5.11. Distribution of BOT-2 subtest scale scores between Chinese children and U.S. norms

Simultaneously, all TD (*M* = 114.48, *SD* = 9.20), PC (*M* = 112.40, *SD* = 6.38) and PB groups (*M* = 105.83, *SD* = 6.92) in our sample were higher than the standard mean of 100 (*SD* = 15) in VMI-6.

5.5 Discussion

5.5.1 The quality of Chinese and English handwriting between children with and without handwriting difficulties

Using CHEST as a screening tool, we found that Chinese handwriting difficulties are quite common among K3 children. Only one child (1.5%) had difficulty in English handwriting, 20 (30.7%) had difficulty in Chinese handwriting only, while 23 (35.4%) had difficulty in both Chinese and English. This showed that Chinese handwriting difficulties appeared to be more difficult than writing English for the kindergarten children in Hong Kong. At the same time, children who exhibit difficulties in writing both orthographies had lower score in Chinese handwriting than children who have Chinese handwriting difficulties alone. The findings might be associated with the deficits in some of the developmental skills among these two groups of children.

Among these children with Chinese handwriting difficulties, we would like to investigate their difference in performance under two different situations: direct profit from writing practice (Part 1) and generalization of writing rules (Part 2). The characters in Part 1 were those should be learned in kindergartens. The PC group scored significantly lower in stroke formation and proportion subscales than TD group, while the PB group performed worse in all the subscales than the TD group. This result is consistent with expectations, and it demonstrated the discriminant power of Part 1 of the test. Children with Chinese

handwriting difficulties showed weakness in all features of legible handwriting. It could also be explained by the result of unproductive writing practice that was only based on repetition.

However, Part 2 of the test appeared to be less effective than Part 1 in differentiating children with and without Chinese handwriting difficulties. There were significant differences between children with and without handwriting difficulties in only one (stroke formation) of the four subscales. Since the characters in this part were less familiar to the children, they have to apply skills in advanced stroke formation and orthographic rules which could be harder for those in the TD group, and thus the content may not be sensitive enough to detect the differences. In fact, it may be used in scenarios for identifying kindergarten children those with average and very good handwriting.

From the finding from both Parts 1 and 2, the ability in producing proper strokes had been regarded as an essential component in the learning to write Chinese characters (Law, Ki, Chung, Ko & Lam, 1998). It could be explained by the larger numbers and forms of strokes required in writing Chinese characters. Traditionally, explicit instruction on stroke formation was emphasized when children learned to write Chinese characters (Lin et al., 2009; Lin, McBride-Chang, Aram & Levin, 2011; Packard et al., 2006). It was also widely believed that stroke formation could affect the overall alignment, proportion, and ability to write required strokes within a square. This effect would be more obvious when the visual complexity of a character increased.

Only one child was identified as having English handwriting difficulty, thus we could only examine the evidence of how far the English visuo-orthographic copying task differentiate children with typical development (TD group) and with handwriting difficulties in Chinese (PC group) or both Chinese and English (PB group). The PB group had significantly lower subscale scores than PC and TD groups in all four subscales, but not in the appropriate use of capital letters and correctness. It appeared that both children with and without handwriting difficulties did not differ in copying all the letters and understood the use of capital letters in English words, thus there is no clear difference between groups. In contrast, the ability to maintain proper alignment, spacing and proportion within or between letters is essential to legible English handwriting, so this is what English handwriting practice tends to focus on. The significant differences in all these subscale scores may also imply that handwriting difficulties in English were caused by developmental shortcomings.

5.5.2 Performance on developmental skills and its relationships with handwriting performance among children with handwriting difficulties in Chinese (and English)

5.5.2.1 Perceptual-motor aspects

As this study hypothesized that handwriting difficulties were originated from deficits in developmental skills, these skills between children with and without handwriting difficulties are compared. Oculomotor control, one of the developmental skills, is important for a child

to perceive the information of words through visual input. There were no significant difference in the speed and accuracy of oculomotor control among the three groups of children. The vertical task tests examined the automaticity and the horizontal task was combined with automaticity and ocular motor control. Those children who had poor performance in writing Chinese showed poorer performance on the horizontal time. It might be related to how a child reads the Chinese words. The only child who had poor English handwriting showed problems in vertical time. When horizontal/vertical ratio is calculated, it represents purely on the oculomotor efficiency. The insignificance proves that the poor handwriting was not due to the problem in automaticity. It could be related to cognitive deficit which was found in Chinese children with reading problems (Chow, McBride-Chang & Burgess, 2005; Ho & Lai, 1999; Shu, McBride-Chang, Wu & Liu, 2006). The oculomotor efficiency may also refer to the accuracy, at which the number of errors made was fairly correlated with both Chinese and English handwriting. However, in figure 5.7, there was difference in scores among the same groups of children, particularly on the error rate. Children with handwriting difficulties in both orthographies underperformed the other two groups. This result was inconsistent with the expectation that the accuracy of oculomotor control significantly contributes to legible handwriting (Francuz & Borkowska, 2013).

Most Chinese characters consist of intricate strokes, and require accurate visual information to write correctly. In comparison, English letters have more distinct features, and demand less oculomotor control. The better efficiency of oculomotor control may also

smooth visual tracking and feedback, and thus a better quality of spatial organization and lighter pressure in handwriting could be resulted with faster speed (Cheung, 2007; Pang, 2004).

There were also significant differences in some visual perceptual skills, including visual discrimination (DIS), spatial relationships (SPA) and sequential memory (SEQ), in children with and without handwriting difficulties; while differences in visual memory (MEM) & figure-ground (FGR) between children with and without handwriting difficulties was marginally insignificant.

DIS was essential for differentiating symbols, such as “b” and “d,” before relating it with sounds in reading (Woodrome & Johnson, 2009). It was well-recognized that DIS is used to detect subtle line differences across characters for Chinese reading, but this significant result seemed to be more related to writing from memory (ka, 1997). It was because copying relies more on visual perceptual skills in analyzing the letters or strokes of a word or character (Liu, Chung, McBride-Chang, & Tong, 2010). Deficits in DIS could be compensated by following stroke sequences to guide the movement, for those children who could compensate by memorizing the stroke sequence guidelines. But when writing from memory or familiar words, the image perceived and memorized should be totally correct, and the role of visual discrimination may be more important while writing Chinese. This assumption was proved by the significant prediction of DIS in Chinese name writing but not in visuo-orthographic copying. Chinese name writing needed to write from memory. There

was no visual cue when the children were unable to memorize the characters correctly. On the other hand, the children were allowed to copy stroke-by-stroke, even not to follow the stroke sequence, if they had poor DIS skill.

SPA was another significant predictor of visuo-orthographic copying of both Chinese characters and English words. Besides correctness, legible handwriting emphasizes the spatial relationships of within and between radicals/letters. SPA was crucial to the decoding of a Chinese character into integral and functional parts for further analysis of its sound and meaning (Chen, 1996). It also helped the child to identify the starting point of each stroke, so that a proper proportion and alignment within a word could be maintained. If the children failed to do so, they might be confused with the words which look similar (e.g., "陪" [accompany] and "部" [part]) but in different orientation.

The importance of SPA in Chinese character recognition was supported by previous studies (McBride-Chang & Kali, 2002; McBride-Chang et al., 2008, 2011a, 2011b). Previous studies suggested that SPA was useful in identifying the relationship between letters to form an English word (Franceschini, Gori, Ruffino, Pedrolli & Facoetti, 2012; Vidysagar & Pammer, 2010). Furthermore, SPA might be a crucial and interrelated factor with FGR for quick and accurate recognition in writing different orthographies (Chen & Kao, 2002). SPA could help children to develop a sense of the constructional and positional regularity of radicals, while FGR helped to schematize the radicals in a character so that meaningful forms can be derived from it. Deficits in these two skills could result in the problems of decoding

the position of strokes and radicals, and impede word recognition. However, English letters were similar in size and distinct to each other along the line. The distortion of one to two letters would not greatly affect the meaning or legibility. As the result, the role of SPA and FGR was less obvious in English handwriting.

In addition, SEQ is the third visual perceptual skill that is likely to contribute to handwriting performance, especially in Chinese. Unlike English words that consist of combinations of letters that children practice to write every day, the composition of Chinese characters requires the use of a specific stroke sequence that depends heavily on SEQ. It had been proved to be a significant predictor of speed for slow Chinese handwriters, as they were relying on visual processing skills, particularly in SEQ (Tseng & Chow, 2000).

Furthermore, as there are far more radicals to learn and memorize in Chinese than that of English, superior MEM allowed better retention of visual image while processing other information and retrieving information (Abu-Rabia & Siegel, 2002). It also facilitates the visual paired association with sound and meaning when learning a new Chinese character (Huang & Hanley, 1995; Siok & Fletcher, 2001).

Visual closure (CLO) and visual form constancy (CON) were found to be related to learning to read, but their roles in handwriting were found less significant on handwriting (Ho & Bryant, 1999; Zhou, McBride-Chang & Wong, 2014). CLO was the ability to recognize a whole character with incomplete features, while CON was related to identify radicals that embedded smaller/larger across characters (McBride-Chang et al., 2005). They helped

children to break down characters into the smallest meaningful units of semantic and phonetic radicals and using partial information to pronounce the character (Anderson, Li, Ku, Shu & Wu, 2003), and to evaluate the size of each component of a character or word and orient them within a space.

In eye-hand coordination, PB group performed significantly worse than both TD and PC groups in Fine Motor Precision (FMP) and Fine Motor Integration (FMI), while TD and PC groups were similar. FMP and FMI involved eye-hand coordination and tool manipulation, including paper and scissors, which was quite similar to handwriting. In contrast, manual dexterity (MD) was dominated by bilateral coordination tasks (e.g., threading cubes) and upper limb coordination (ULC) is composed of throwing and catching balls. They do not seem related to handwriting. Thus, it was expected to be insignificant differences in performance among three groups.

VMI involved the coordination between visual perception and motor execution (Bart, Hajami & Bar-Haim, 2007). Both FMI and VMI were significant predictors of Chinese and English handwriting proficiency in this study. It explained 30-40% of the variability. Chinese characters are visually complex and depend on various visual perceptual skills. If a child did not have adequate visual perceptual skills, he would be unable to break down a Chinese character into meaningful components correctly, such that affecting their performance in executing the movement. They are the pre-requisites for handwriting but require less cognitive and linguistic components. Thus, it is usually the essential component of a

handwriting readiness program or for identifying children who are at risk of handwriting difficulties (Donica, Goins & Wagner, 2013; Lifshitz & Har-Zvi, 2015; Marr, Windsor & Cermak, 2001; Van Hartingsveldt et al., 2015).

5.5.2.2 Linguistics aspects

The insignificant difference in performance of Chinese word reading among children with and without handwriting difficulties was contradictory to the previous assumption on the assumption that reading and writing problems would be existed together. Since reading was introduced before writing in kindergartens, it was assumed that reading problem could be an indicator of learning difficulties, including writing (Chan et al., 2007; Lam, 1999). But the results showed that Chinese children may exhibit difficulties in mastering handwriting by either visual/motoric deficits or lexical errors, which could be independent of phonology (Han, Zhang, Shu & Bi, 2007).

Although there were insignificant results in lexical decision tasks, TD children outperformed children with handwriting difficulties, the orthographic knowledge might have a role in learning to write Chinese characters. Lam and McBride-Chang (2013) and Packard et al. (2006) found a greater improvement in handwriting skills when orthographic knowledge was introduced when compared to direct copying. They found that when the children can decode the internal structure of a character, they could view the character in terms of meaningful radicals instead of individual strokes. It helps them to retrieve the right

pathway for writing. The insignificant results in this study could help that the awareness of orthographic structure might be more important for memorizing the character, such that its influence could not be reflected in copying.

In summary, these results suggested a hierarchy of Chinese and English handwriting difficulties. Handwriting difficulties in one or both orthographies might be originated from the deficits of different developmental skills for each child (Schneck & Amundson, 2010). Deficits in perceptual-motor skills appeared to have a greater impact on Chinese handwriting performance; thus, more children had difficulties learning to write Chinese than English. Results also revealed that handwriting difficulties in Chinese and English might not coexist. It would therefore be important to test children separately in Chinese and in English handwriting.

5.5.3 Performance on developmental skills between the child with English handwriting difficulties and his peers

As there was only one child with handwriting difficulties only in English, his case is analyzed separately. He did not show any problems in perceptual-motor skills. Aside from poorer results in the speed of oculomotor control, his performance was comparable to that of the controls. It might be explained that his challenges in writing English cannot be attributed to pure visual or motor skills, but to linguistic ones.

His linguistic deficits were shown by his poorer performance in reading both Chinese and English. He underperformed children with handwriting difficulties in both orthographies in RAST-K Chinese word reading subtests and the abilities to read aloud the Chinese characters and English words in our copying template. Even though the "look and say" teaching method and phonetics was not emphasized in kindergarten stage, phonological cues would facilitate the learning to write, especially in English. Because of the limited role of phonological awareness in Chinese handwriting, his deficits might be overcome by improving his perceptual-motor skills and use of writing rules in Chinese.

5.5.4 Cultural differences in developmental skills between Chinese and U.S. population

In this study, the performance in perceptual-motor skills was found not only among typically developing children, but also in those with handwriting difficulties in both orthographies when compared to the U.S. norms. Oculomotor control appeared to be more in demand for legible handwriting in Chinese communities. As some of our participants were younger than six years of age, they are expected to perform slightly slower than the proposed normative value by Pang, Lam and Woo (2010) of aged 6 to 6-11. But the higher accuracy rate reflected that Chinese children are trained to be attentive to details across characters in the fixation stage.

Because of the "look-and-say" method and whole word approach, Chinese children, especially those who write slowly, may rely on visual strategies for copying (Tseng & Chow, 2000). Children in our samples were performing much better in the perceptual-motor skills that are related to handwriting, such as spatial relations and visual/fine motor integration. Better performance on these skills enables children to analyze the orthographic structure of the words. On the other hand, even though Chinese children are as skilled as Western children, it still showed inadequacy to produce legible handwriting, especially in Chinese. Children with handwriting difficulties in English have similar performance in developmental skills with the norms, but they still could not accomplish the English handwriting task. It may due to the learning method of handwriting in Chinese communities. Chinese children in Hong Kong, particularly in kindergarten education, usually acquire writing skills through repetitive practice and rote learning. In contrast, children in Western countries usually learn to read through phonetic and word structure (i.e., letters and alphabets) before constructing words. Writing Chinese was even more demanding as there were no building blocks, but Chinese characters were built up by strokes and radicals. Although some guideline (e.g., rules of stroke sequence) was available, Chinese characters were far more complex than English words.

There are two implications on these findings. First, it points out the degree of developmental skills to be acquired such that the person is ready to produce legible handwriting in Chinese and English. According to Berninger et al. (1992) and Abbott and

Berninger (1993), there are three major prerequisite skills for handwriting: orthographic coding, visual-motor integration, and fine motor control. But none of these studies stated the variations of developmental skills to be required based on the visual complexity of the orthographies, and their relationships with sounds and meaning of a particular language. This study suggested that learning to write Chinese had greater demands on the developmental skills than English handwriting. It might alert educators and clinicians that the contents on handwriting readiness program should be adjusted in response to uniqueness of the language intended to learn to write in the later stage. Instead of writing full words, teachers might like to look into the teaching strategies by breaking words into radicals and strokes first.

Second, similar to reading development, there are positive relationships between the developments of developmental and handwriting skills. Traditionally, it is believed that developmental skills are the basis of handwriting. But McBride-Chang et al. (2005) suggested the development of visual skills is affected by the type of writing system to be learned. They showed that children in mainland China, who learn to read and write simplified scripts, showed greater improvement in visual skills than children who are learning to read and write traditional Chinese characters in Hong Kong. It is because simplified Chinese characters have fewer features but many similarities to distinguish. Children have to rely more on visual cues, and improve their visual skills (Chen & Yuen, 1991). This study expands this understanding on the influence of early writing exercise on the perceptual-motor development.

5.6 Limitations of the study

This phase had several limitations. First, the sample size was relatively small for the comparisons and prediction of handwriting performance, especially the limited number of children with difficulties in English handwriting only. Because of the differences in complexity between Chinese and English orthographies, children who struggled only with English handwriting difficulties are rare, and their problems tend to be explained by extrinsic factors (McBride-Chang et al., 2012). However, neuroimaging studies proved that different kinds of brain activation occurred in children with Chinese and English dyslexia (Hu et al., 2010; Siok et al., 2008). Since these studies were on reading performance, future study could look at the comparison of the clinical manifestations of children with different patterns of handwriting difficulties would be a breakthrough for both education and psychology.

Second, the sensitivity of the assessment tool in detecting the problems might need to be considered. DEM-2 is targeted for children older than six years of age. Although a pilot study was done and it worked well on typical children under 6 years old, some children with handwriting difficulties in our samples had difficulties in reading along a horizontal line, which appears more difficult. Since the manual stated that all additional numbers should be recorded, a large standard deviation was found. It might not generate a reliable result.

Finally, although some of the hypotheses set up in the initial stage might not be proven to be substantial, the study reflected that the developmental skills of children had implications

to their learning of copying Chinese characters and English words. There could be other confounding factors, such as cognition and memory, and previous learning of children which could affect the results. But this exploratory study opens a window for further study on preparing children to write Chinese characters and English words. Preparation of a child's basic development skills is essential prior to teach handwriting.

5.7 Conclusion

This phase of study reviewed how developmental deficits affected the writing abilities. The findings of this study showed that kindergarten children in Chinese communities may encounter handwriting difficulties in Chinese and in English separately. These difficulties may be different according to their developmental stages. It had brought up the issue of "handwriting readiness," the types and degree of developmental skills that should be acquired when the children learn to write. It is suggested that targeted interventions on these developmental skills be carried out in kindergarten prior to learning actual handwriting skills.

Another implication of this phase is that the extra demands on developmental skills for the proficiency in both Chinese and English handwriting, which is typical in Hong Kong. It is likely that Chinese children acquire some developmental skills which are comparable to those of Western children, they still exhibit problems when learning to write, particularly Chinese characters. Previous studies also showed the superior developmental skills among Chinese

children, this study had found that more advanced skills might be acquired for legible Chinese and English handwriting in Chinese communities. It might not be appropriate to reinforce learning to write Chinese or English too early in kindergarten education. However, certain pre-writing exercise should be strengthened prior to actual learning of writing the characters/ words.

In addition, it would be important to set up a curriculum in kindergarten education to build up the pre-requisite skills of handwriting, such as visual efficiency, visual perception, fine motor control and visual motor integration, before the formal instruction on handwriting. After that, the learning of phonetics may be a need for English handwriting. And for Chinese handwriting, introducing the knowledge of stroke sequence and radical formation may be a good starting point.

Chapter Six: General discussion

6.1 Developmental characteristics of Chinese handwriting among kindergarten children

The developmental characteristics of Chinese handwriting was studied by visuo-orthographic copying and name writing, the two main tasks should be learnt by kindergarten children.

Chinese handwriting development was in response to the uniqueness of Chinese characters and learning methods. There was a hierarchical progression of stroke, radical and character levels. Children started to learn how to write strokes in K1, such that they could combine the strokes to form radials and characters when their orthographic knowledge increased in K2 and K3. There is a great change in handwriting skills in K2, until they can competent to copy unfamiliar characters in K3. Their handwriting development was reflected by the visual complexity and spatial organization of the handwriting products.

On the other hand, name writing was developed as a continuum from scribbling to conventional writing, which was aligned with visuo-orthographic copying skills. After the sharing of scribbling stage, the language-specific characteristics were illustrated in their name writing products. Hence, differed from phonetic English name writing, which children start to write the first and then the last letters, Chinese children began to write the characters with the least number of strokes. The importance of formal instruction on Chinese handwriting had

also been identified, which explained why both age and grade had significant contribution on the development of Chinese handwriting instead of age alone in English handwriting. It is related to children's own capacity to be beneficial from formal instruction of handwriting at school.

Although Chinese parents stressed on children's academic development (Li & Rao, 2000; 2005), the findings showed that additional home training on handwriting and types of schooling did not have significant effects on Chinese handwriting development.

6.2 Types of handwriting problems among Chinese kindergarten children

Apart from the knowledge of Chinese handwriting development among kindergarten children, it would like to know how children who are at-risk of handwriting difficulties derived from their peers.

CHEST, which was developed in this study, provided an objective initial screening of handwriting difficulties as early as the final year of kindergartens. The assessment content and scoring criteria were designed based on current kindergarten curriculum and the requirement of legible Chinese handwriting. It also had a representative sample to demonstrate the validities and reliabilities of CHEST. It was convenient and effective to identify kindergarten children who were at-risk from handwriting difficulties. The findings showed that kindergarten children might have handwriting difficulties in either Chinese or

English only, or both. Their major problems were in legibility, where they could not organize the strokes properly in the designed space even time or writing tool was not the major concern. Based on the subscales score, it illustrated different profiles of handwriting difficulties.

6.3 Influence of developmental skills on handwriting performance

From the two-tier model in Figure 2.5, the deficits of development skills would be the underlying causes of handwriting difficulties. Deficits of these skills prevent children from making correct judgment even though they had adequate phonological awareness and morphological awareness, in turn, which had been identified to be related to reading and handwriting development. The findings showed that VMI, FMI, SPA, DIS and rapid naming were significant predictors of Chinese or/and English handwriting

The requirement of development skills would be varied across languages. It was also proposed that learning to write Chinese was more difficult than English. In general, Chinese children in our sample (both typical developing children and children with handwriting difficulties) performed significantly better developmental skills that were related to handwriting performance (i.e., DIS, MEM, SPA, SEQ, FGR, FMP, FMI and VMI). Therefore, the thickness of arrows in Figure 2.5 illustrated the how each type of developmental skills contributed to Chinese and English handwriting difficulties respectively.

Chapter Seven: Conclusion

7.1 Summary of the research findings

This research study covers three phases regarding the handwriting development of Chinese kindergarten children in Hong Kong, the screening of children who have difficulties in learning how to write and the deficits in developmental skills among them.

Phase 1 of the study aimed to examine the developmental characteristics of Chinese handwriting via visuo-orthographic copying and name writing in kindergarten stage from samples of 316 K1 to K3 children, in response to formal instruction and practice by direct copying (i.e., the green bracket of Figure 7.1). With reference to the construction of English words by letters, made up of straight lines and semi-circles, Chinese visuo-orthographic copying skills were investigated in terms of the hierarchical representation of a Chinese character: namely strokes, radicals and characters (Taft, Zhu & Peng, 1999). It was assumed that Chinese children would progress from combining strokes into radicals as English children do.

While the difficulties and visual complexity of English words are determined by the number of letters it contains, for Chinese characters they are based on the number of strokes in a character. Although radicals are the functional units, like letters in the English writing system, the ability to write radicals is only a transitional stage between strokes and characters because they consist of fewer strokes and a simpler structure than a character, making them

easier to manage; and because proficiency in writing radicals prepared the children to combine them into correctly formed and aligned characters. The learning process is nearly completed at the end of kindergarten education. Children's understanding of orthographic structure and writing rules (e.g., left-right orientation, stroke sequence) is essential for smooth transition to primary education, where they learn to analyze and write new characters by themselves in other subjects. Besides, there was a similar progression of Chinese name writing skill as previous studies in English do regarding age, demonstrating some unique features of Chinese characters and names in the process.

The findings in Phase 1 provided evidence to support the signs of handwriting difficulties could be observed and identified as early as the final year of kindergarten education. It pointed out the levels and types of handwriting skills should be equipped in K3 children. If children did not have such skills, it should be intervened. In contrast, since nearly 100% of 3-6-year-olds children are receiving kindergarten education in Hong Kong, the environmental factors were not the major causes of handwriting difficulties. Therefore, the shadowed color of environmental factors was used to illustrate their insignificant effects.

In Phase 2, 128 typically developing children and 26 children with handwriting difficulties were enlisted to establish the norms and the psychometric properties of CHEST, an objective initial handwriting screening tool for K3 children (i.e., the orange bracket of Figure 7.1). There were reasonable and satisfactory results regarding validity and reliability. This phase also proved that visuo-orthographic copying was effectively to identify children with

handwriting difficulties. As some children had handwriting difficulties in Chinese but not in English, it suggested that Chinese handwriting was harder than English handwriting.

In general, these children performed worse than their peers in both tasks, especially in stroke formation and proportion. In view of the distinct features between Chinese and English orthographies, CHEST is highlighted to evaluate Chinese and English handwriting performance separately. Children may suffer from different types of handwriting difficulties in Chinese (and English). In addition, personal factors, including gender, hand dominance and pencil grip pattern were not associated with handwriting difficulties (i.e., shadowed color in Figure 7.1). From the previous studies, it may expect that more boys would seek for help (Chan et al., 2007), while the development of hand dominance and the use of pencil grip should be taken into account only during the evaluation.

The findings in Phase 2 led us to explore the underlying mechanism that causes these difficulties in Phase 3 (i.e., the dark-blue bracket of Figure 7.1). Phase 3 extended Berninger et al.'s (1992) findings on the interrelationship of the lower-level developmental skills in perceptual-motor and linguistics aspects on writing acquisition across writing systems and their impact upon legible handwriting. A two-tier model of developmental and handwriting skills was hypothesized to explain the differences.

Hong Kong education system allows us to break a new ground in comparing the developmental skills that should precede formal training in handwriting across orthographies, within the same group of children. Although many studies have pointed out the importance

and predictability of perceptual-motor and linguistic skills in handwriting development, they did not compare the levels of skills required of a particular writing system for the same subject.

The results from comparing the performance of 65 children with handwriting difficulties in Chinese, both Chinese and English, and typically developing children revealed superior performance in developmental skills among typically developing children in Chinese communities, and that even Chinese children who had handwriting difficulties showed, had average to above-average developmental skills as their Western peers.

It also demonstrated that children with handwriting difficulties in both Chinese and English had lower scores in most of the standardized assessments than children with Chinese handwriting difficulties only. From the proposed two-tier framework, the differences in handwriting performance between orthographies might have originated from the variations of deficits in developmental skills. Instead of the general perception that Chinese characters are more visually complex than English words and thus should be more demanding to write, this phase provides empirical support for the importance of advanced skills from the developmental level. Children may be able to write one kind of orthography, but this does not mean that they can write others.

On the other hand, linguistic skills such as reading abilities and orthographic awareness (e.g. positional regularity) were not differed between children with and without handwriting difficulties. It meant that some kindergarten children with handwriting difficulties were

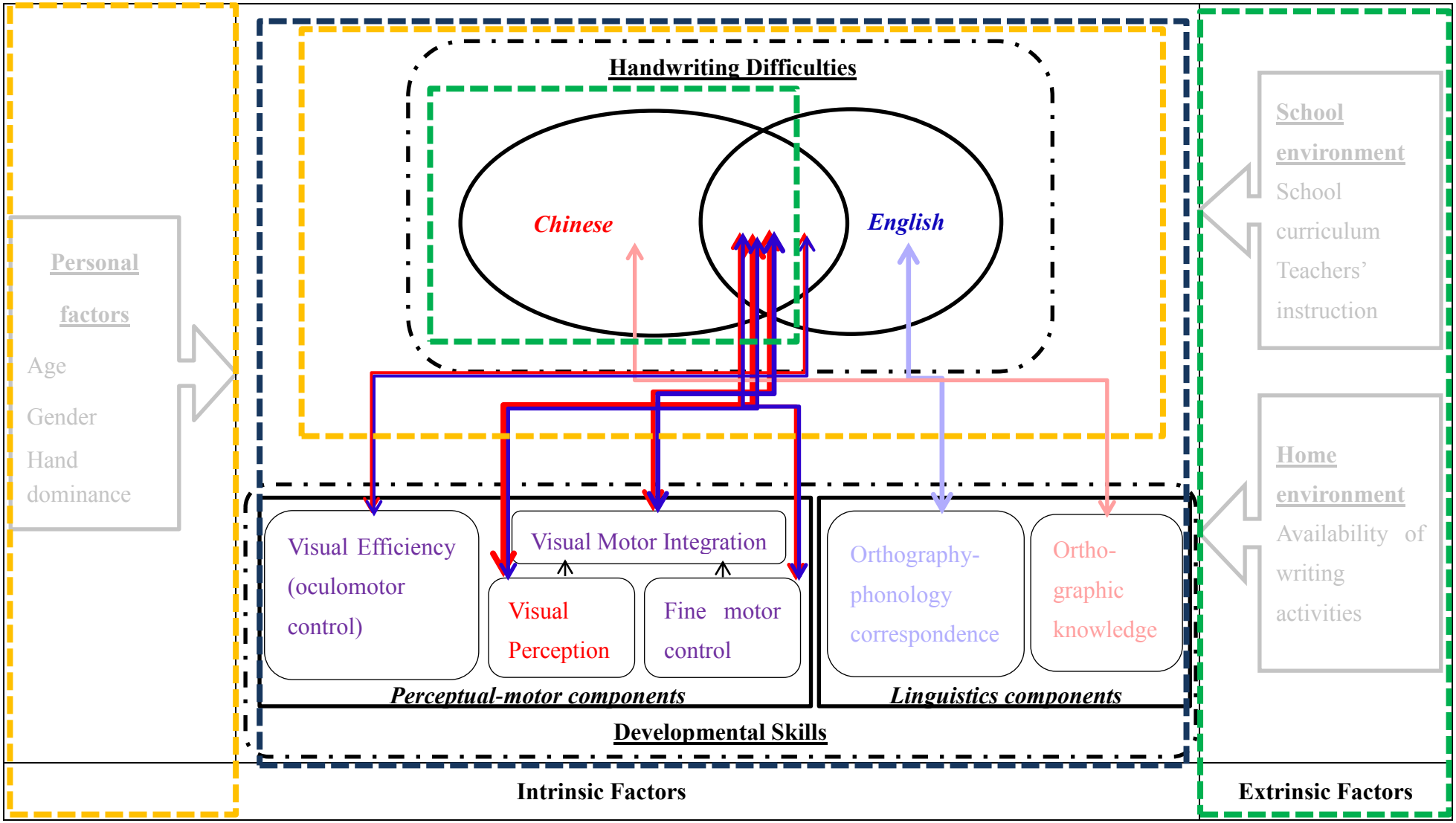


Figure 7.1. Revised conceptual framework on the intrinsic and extrinsic factors affecting handwriting performance

masked by current screening methods. The implication of these findings will be discussed later.

7.2 Clinical and educational implications

7.2.1 Kindergarten curriculum in Chinese communities

In the view of the association between sound, meaning and shapes, reading and writing were usually taught together in language education (Chan et al., 2006; Tse, 2006). According to Yeung et al. (2011), six important reading-related basic skills (i.e., phonological awareness, rapid naming, orthographic skills, morphological awareness, listening comprehension, and syntactic skills) were also related to Chinese handwriting and spelling. They explained that there were interrelationships between the basic skills and reading and writing in the literacy development.

But in the newest guideline on kindergarten education (Education Bureau, 2017), handwriting practice should be prohibited. The findings of this study showed to the public about the types of handwriting skills should be mastered by K3 children. It also provided two suggestions on the current kindergarten education. First, adequate amount handwriting practice with appropriate level of difficulty should be allowed. It helped the children to increase the awareness of literacy-related skills, and prepared them to be ready for self-directed learning of language in the primary education. Second, before formal instruction of

handwriting skills, the kindergarten curriculum should consider some activities that trained up basic developmental skills in visual efficiency, visual perceptual skills, fine motor control and visual motor integration. Well-acquired developmental skills were essential to help children profit satisfactorily from the formal instruction of handwriting (Marr et al., 2001; van Hartingsveldt, et al., 2014).

7.2.2 Early screening on kindergarten children who might have handwriting difficulties

Another key finding of this study was the understanding on the developmental characteristics of handwriting and supported the fact that K3 children should acquire certain skills for handwriting, and early signs of handwriting difficulties appear at the kindergarten stage could be identified as a preventive measure.

CHEST is a tailor-made handwriting screening tool for the needs of Chinese-English biliterate kindergarten children in Hong Kong. It examines the visuo-orthographic copying skill, which is necessary for beginning writers to learn to write. Together with the name writing task, it is aimed for alerting teachers and parents to potential problems. Since Chinese and English have two distinct orthographies, CHEST was composed of the screening tasks of both separately. This could effectively identify whether the children had difficulties in learning to write Chinese, English or both.

Finally, the disparity in the developmental skills required for Chinese and English handwriting should caution professionals in using assessment tools to evaluate the developmental skills in a Chinese population. This could be solved by establishing local norms or raising the standards of performance. It is suggested that the profile of handwriting performance provided by CHEST could be matched with the performance on developmental skills to find the underlying reasons for handwriting difficulties so that professionals can offer remediation.

7.2.3 Design of a handwriting readiness program for disadvantaged children

The two-tier framework showed the importance of ensuring that children possess adequate developmental skills before beginning formal instruction in handwriting. Apart from supporting children who already exhibit handwriting difficulties, it provides a frame of reference for designing a preventive program for children who are prone to have difficulties in learning how to write, such as those were born preterm or have a history of developmental delays.

The efficacy of a writing readiness program for beginning writers has been previously shown (Lifshitz & Har-Zvi, 2015; Ratzon, Efraim & Bart, 2007). Children benefit from using visual cueing and graphmotor practice, even if handwriting skills are not taught directly (Case-Smith, Holland & Bishop, 2011; Case-Smith, Weaver & Holland, 2014). The results

obtained in this study fill a gap in the research by suggesting ways to modify these programs based on the writing system that children learn. Due to the differences in visual complexity and structure between Chinese and English, the content and requirement for the same tasks should be modified. For instance, while tracing curves continuously frequently appeared in the prewriting activities of Western children, tracing angles maybe more suitable for Chinese children. These programs emphasize preparation for handwriting but avoid placing children under extra pressure or making them feel inadequate when their handwriting skills are not as advanced as those of their peers.

7.3 Recommendations for future research

This study is only preliminary to explore the arena on how Chinese-English biliterate children learn to write Chinese and English during kindergarten stage, further in-depth studies would be beneficial to clinicians, educators and children.

First, longitudinal studies on the handwriting difficulties during the transition from kindergarten to primary education are necessary. Slow or poor endurance of handwriting speed, weak in self-initiation to learn new characters and difficulty in dictation are frequently encountered by primary school students. It is valuable to know how the untreated handwriting difficulties in kindergarten children resulted in the above problems observed.

Besides, the evaluation of handwriting performance could be enhanced by using advanced technologies. Since children with developmental coordination disorders were found to have difficulties in maintaining consistent velocity and pressure on paper, but not in speed (Chang & Yu, 2009; Prunty, Barnett, Wilmut & Plum, 2014; Rosenblum & Livneh-Zirinski, 2008), these parameters should be measured by digital devices. A computerized program could provide a more holistic picture of children's handwriting performance. It could also enable educators and clinicians to concentrate on tailoring interventions for children's main deficits.

Furthermore, the bi-directional relationships between developmental and handwriting skills help to design and evaluate the effectiveness of "handwriting readiness" program. Instead of direct drilling on handwriting skills, activities that promote pre-requisite developmental skills or strategies to compensate the deficits should be provided. There were some programs suggested in the previous studies (Lust & Donica, 2011; Gormley, Phillips & Gayer, 2008; Ratzon, Efraim & Bart, 2007), but they should be modified specifically for the need to write Chinese.

The strategies of "handwriting readiness" program could be extended in helping children from minority groups in learning to write Chinese. Their limited exposure to Chinese and the needs of advanced developmental skills of Chinese handwriting in consequence of the handwriting performance of children from minority groups usually lag behind their Chinese peers since kindergarten stage. The "handwriting readiness" program could be

served as an enhancement program for acquiring the developmental skills as well as the strategies before formal handwriting training in class.

7.4 Conclusion

Some message would like to deliver to the policy-makers, clinicians and educators with the evidence of quantitative date by this study. Traditionally, repetitive copying is emphasized as the effective way to learn to write Chinese. However, this study pointed out the importance of “handwriting readiness”, at which the skills needed to understand language-related rules such as orthographic and morphological knowledge. Activities that promote the developmental skills, such as visual perception and fine motor, could be aligned with the writing practice. In addition, children who are at-risk of handwriting difficulties could be identified as early as in kindergarten education. The understanding of the relationship between developmental skills and handwriting performance is not only promote the design of kindergarten curriculum, but also the remediation program and strategies for disadvantaged children.

Appendix A: summary of selected studies that used English Name Writing Scales

Study	N	Age range	Name writing scale used
Cabell, Justice, Zucker, & McGinty (2009)	Study 1: 59 with language impairments Study 2: 46 (23 controls and 23 with language impairments)	48-60 months	Graphic: 1. No distinction between drawing and writing, with scribbling intertwined with picture; 2. No distinction between drawing and writing, with some discrete letter-like graphemes intertwined with picture; 3. Distinction between drawing and writing; 4. Continuous zigzag scribble; 5. Continuous zigzag scribble with the beginnings of distinct graphemes. Character-like: 6. Discrete, letter-like symbols; 7. Approximately one to three symbols, with at least one pertinent, recognisable letter present; 8. A string of writing with pertinent letters and/or placeholders; 9. A string of unordered, pertinent letters. Some letters may be omitted or added. No placeholders are present. Symbolic: 10. A string of ordered, pertinent letters. Some letters may be omitted or added. No placeholders are present; 11. A string of pertinent letters and placeholders equal to the number of letters in the child's name; 12. Complete ordered name is written using recognizable but not conventional letters; 13. Complete name is written using conventional letters, but letters are unordered; 14. Complete name is written using conventional letters in a correct order.
Diamond, Gerde, & Powell (2008)	236	39-67 months	Graphic: 1. Refusal to write; 2. Scribbling; 3. Drawing as writing; 4. Scribble writing. Character-like: 5. Letter-like shapes; 6. Writing combining at least one letter and letter-like shapes. Symbolic: 7. Writing includes two or more letters and does not include letter-like shapes; 8. All name letters are written but in incorrect

Study	N	Age range	Name writing scale used
			order; 9. Correct spelling of the first name.
Drouin & Harman (2009)	114	M = 4 years and 5 months	Graphic: 1. Some writing, either drawing, scribbles, or random letters. Character-like: 1. First letter of name written, regardless of good form; 2. First letter of name written with good form; 3. More than the first letter of name written, regardless of good form. Symbolic: 1. More than the first letter of name written, with good form; 2. All letters of name written, regardless of good form; 3. All letters of name written, with good form.
Gerde et al. (2012)	103	37-61 months	Graphic: 1. Refusal to write; 2. Scribbling; 3. Drawing as writing; 4. Scribble writing. Character-like: 5. Letter-like shapes; 6. Writing combining at least one letter and letter-like shapes. Symbolic: 7. Writing includes two or more letters and does not include letter-like shapes; 8. All name letters are written but in incorrect order; 9. Correct spelling of the first name.
Molfese et al. (2006)	286	47-62 months	Graphic: 0. No attempt or refusal; 1. Wrote something, including drawings, scribbles, or random letters. Character-like: 2. Wrote one or two letters of the name in a recognizable manner; 3. Wrote one or two letters of the name with good form; 4. Wrote several letters of the name in a recognizable manner. Symbolic: 5. Wrote several letters of the name with good form; 6. Wrote all letters of the name in a recognizable manner;

Study	N	Age range	Name writing scale used
			7. All letters of the name were written with good form.
Puranik & Lonigan (2011)	372	36-48 months	The sum of presence (1) or absence (0) of the nine features: 1: linearity, 2: segmentation, 3: simple characters, 4: left-to-right orientation, 5: complex characters, 6: first letter of name, 7: random letters, 8: many letters, 9: correctly spell first name.
Puranik & Lonigan (2012)	Study 1: 296 Study 2: 104	51-65 months 37-71 months	Graphic: 0. No response or scribble; 1. A scribble, which is linear; 2. Writing contains distinguishable/separate units. Character-like: 3. Writing contains simple characters; 4. Writing contains simple characters and is written demonstrating left-to-right orientation; 5. Writing contains first letter of name and other letters may be represented by simple characters. Symbolic: 6. Writing contains first letter of name and other letters may be represented by complex characters; 7. Writes name using correct first letter and represents other sounds in name with random letters; 8. Writes more than half of the letters contained in their first name; 9. Correctly spells first name using conventional spelling.
Yang & Noel (2006)	17	4-5 years	Character-like: 1. Letter patterns; 2. Letter-name elements. Symbolic: 3. Invented spelling-syllabic; 4. Invented spelling-intermediate; 5. Invented spelling-full; 6. Conventional.

Appendix B: Penal review on the appropriateness of copying assignment and name writing scale

Review on the appropriateness of Chinese handwriting evaluation and name writing scale for kindergarten children

Name of reviewer:

Professional (please tick one): ☐ Kindergarten teacher ☐ Parent ☐ Occupational Therapist

Date of review:

INSTRUCTION TO REVIEWERS:

This document consists of Parts A and B.

Part A	There is a list of Chinese strokes, radicals and characters for evaluating the developmental progression of Chinese handwriting skills among kindergarten children, please comment on: 1. The appropriateness of using these strokes/radicals/characters to evaluate the development of Chinese handwriting 2. The difficulty level of each grade of kindergarten children to complete the task
Part B	Attached is the scoring criteria and description of the name writing scale, please comment on: 1. The appropriateness of the scale in assessing the name writing development of kindergarten children 2. The appropriateness of the scoring criteria in each item 3. The relevancy of the description for the scoring criteria in each item

PART A: PREWRITING EVALUATION FOR PRESCHOOL CHILDREN

a) Kindergarten children will be requested to copy the following items. They might not experience on writing these items, but encourage to copy as same as they can. How *appropriate for assessing* and *difficult to complete* the following items for each grade?

Rating (please *circle/highlight* your choice):

1. Appropriate:

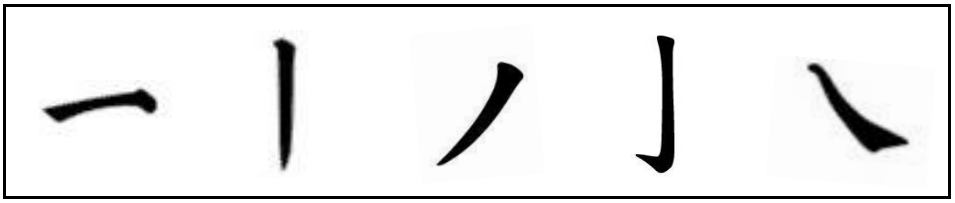
1	2	3	4	5
Strongly inappropriate	Inappropriate	Neutral	Appropriate	Strongly appropriate

2. Difficulty:

1	2	3	4	5
Very easy	Easy	Neutral	Difficult	Very difficult

A. STROKES

I.

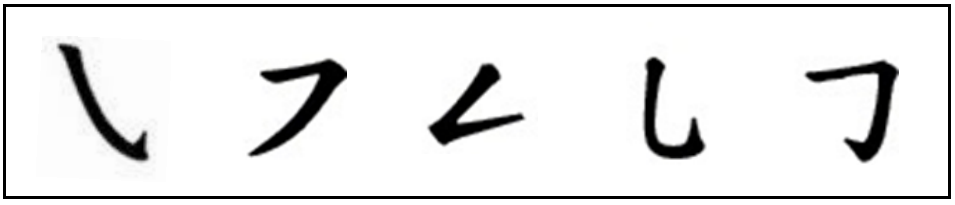


K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

II.



K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

B. RADICALS

I.

K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

II.

K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

C. CHARACTERS

I.

十 人 口 山 小

K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

II.

木 火 月 牛 手

K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

III.

心 天 水 米 光

K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

IV.

K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

V.

魚	朋	右	花	同

K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

VI.

星	西	毛	草	石

K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

VII.

方	果	狗	樹	出

K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly

inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

VIII.

紅 弟 病 家 我

K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

IX.

具 年 穿

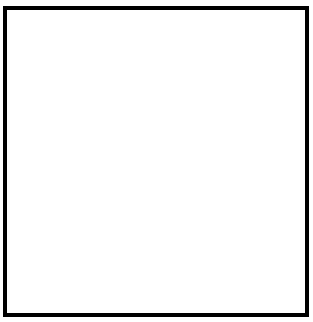
K1	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K2	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5
K3	Appropriate:	1	2	3	4	5
	Difficulty:	1	2	3	4	5

Please provide with suggestion on appropriateness especially on strongly inappropriate/inappropriate rating:

Please provide with suggestion on difficulty especially on extreme rating (e.g. which one to be too easy/difficult):

b) Preschool children will be required to copy the items within the grid. How appropriateness of suggestion on the grid size for each grade?

For K1 children, is it appropriate to write with 4 cm grid?



4cm grid

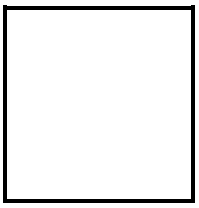
Rating (please *circle/highlight* your choice):

1	2	3	4	5
Strongly inappropriate	Inappropriate	Neutral	Appropriate	Strongly appropriate

Suggestion on the grid size for K1 children (please *circle/highlight* your choice):

3.5 cm	4 cm	4.5 cm	5 cm	Others (please specify):_____

For K2 children, is it appropriate to write with 2.5 cm grid?



2.5 cm grid

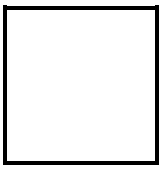
Rating (please *circle/highlight* your choice):

1	2	3	4	5
Strongly inappropriate	Inappropriate	Neutral	Appropriate	Strongly appropriate

Suggestion on the grid size for K2 children (please *circle/highlight* your choice):

2 cm	2.5 cm	3 cm	3.5 cm	Others (please specify):_____

For K3 children, is it appropriate to write with 2 cm grid?

 2 cm grid

Rating (please *circle/highlight* your choice):

1	2	3	4	5
Strongly inappropriate	Inappropriate	Neutral	Appropriate	Strongly appropriate

Suggestion on the grid size for K3 children (please *circle/highlight* your choice):

1.5 cm	2 cm	2.5 cm	3 cm	Others (please specify):_____

PART B: NAME WRITING SCALE

For each item, please comment on how well the scoring criteria to describe Chinese name writing development

Rating (please *circle/highlight* your choice):

1	2	3	4	5
Very poor	Poor	Neutral	Good	Very good

Level	Description	Rating				
Points 0:	No response or aimless scribble (未能書寫或隨意塗鴉)	1	2	3	4	5
Point 1:	Straight and curved lines with turning angle (能運用不同的線條書寫，如：橫/直線、曲條或轉角線條)	1	2	3	4	5
Points 2:	Contains separate and complex units that combined with strokes (能運用不同的筆劃組合來嘗試書寫自己的名字)	1	2	3	4	5
Points 3:	Contains parts of a character that demonstrated with square configuration (能書寫名字中的一些部件)	1	2	3	4	5
Points 4:	Generally written one of the characters, while others either unable to write or by simple stroke patterns (大致上能書寫自己的名字中的其中一字，其餘的則用筆劃線條代替)	1	2	3	4	5
Points 5:	At least one character is correctly written, while others are represented by simple stroke pattern (能正確地書寫自己的名字中的其中一字，其餘的則用筆劃線條代替)	1	2	3	4	5
Points 6:	At least one character is correctly written, while others are partly written or using character with similar sound/ shape (能正確地書寫自己的名字中的其中一字，其餘的只能寫出部件或相近讀音/字型的字代替)	1	2	3	4	5
Points 7:	All characters are generally written, with mistakes on stroke formation or poor alignment (大致上能書寫自己的名字，惟仍有少許筆劃上的錯誤或部件比例不當)	1	2	3	4	5
Points 8:	All characters are correctly written with good alignment and proportion (能完全正確地書寫自己的名字)	1	2	3	4	5

Please provide with suggestion especially on poor/very poor rating:

As a whole, how well the name writing scale represents and indicates the developmental progression of name writing skills?

Rating (please *circle/highlight* your choice):

1	2	3	4	5
Very poor	Poor	Neutral	Good	Very good

Please provide with suggestion especially on poor/very poor rating:

THANK YOU FOR YOUR PARTICIPATION

Appendix C1: Ethical approval of this study (Phase 1)

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

To	Tsang Wai Ping Cecilia (Department of Rehabilitation Sciences)		
From	TSANG Wing Hong Hector, Chair, Departmental Research Committee		
Email	rshtsang@	Date	13-Sep-2014

Application for Ethical Review for Teaching/Research Involving Human Subjects

I write to inform you that approval has been given to your application for human subjects ethics review of the following project for a period from 01-Sep-2014 to 31-Dec-2016:

Project Title:	Developmental trend of Chinese handwriting performance in kindergarten children in Hong Kong
Department:	Department of Rehabilitation Sciences
Principal Investigator:	Tsang Wai Ping Cecilia
Reference Number:	HSEARS20140829001

Please note that you will be held responsible for the ethical approval granted for the project and the ethical conduct of the personnel involved in the project. In the case of the Co-PI, if any, has also obtained ethical approval for the project, the Co-PI will also assume the responsibility in respect of the ethical approval (in relation to the areas of expertise of respective Co-PI in accordance with the stipulations given by the approving authority).

You are responsible for informing the Departmental Research Committee in advance of any changes in the proposal or procedures which may affect the validity of this ethical approval.

You will receive separate email notification should you be required to obtain fresh approval.

TSANG Wing Hong Hector

Chair

Departmental Research Committee

Appendix C2: Ethical approval of this study (Phase 2)

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

To	Tsang Wai Ping Cecilia (Department of Rehabilitation Sciences)		
From	TSANG Wing Hong Hector, Chair, Departmental Research Committee		
Email	rshtsang@	Date	02-Oct-2015

Application for Ethical Review for Teaching/Research Involving Human Subjects

I write to inform you that approval has been given to your application for human subjects ethics review of the following project for a period from 01-Sep-2015 to 31-Dec-2016:

Project Title:	Chinese and English handwriting performance among upper kindergarten (K.3) children in Hong Kong
Department:	Department of Rehabilitation Sciences
Principal Investigator:	Tsang Wai Ping Cecilia
Reference Number:	HSEARS20150912001

Please note that you will be held responsible for the ethical approval granted for the project and the ethical conduct of the personnel involved in the project. In the case of the Co-PI, if any, has also obtained ethical approval for the project, the Co-PI will also assume the responsibility in respect of the ethical approval (in relation to the areas of expertise of respective Co-PI in accordance with the stipulations given by the approving authority).

You are responsible for informing the Departmental Research Committee in advance of any changes in the proposal or procedures which may affect the validity of this ethical approval.

You will receive separate email notification should you be required to obtain fresh approval.

TSANG Wing Hong Hector

Chair

Departmental Research Committee

Appendix C3: Ethical approval of this study (Phase 3)

To	Tsang Wai Ping Cecilia (Department of Rehabilitation Sciences)		
From	TSANG Wing Hong Hector, Chair, Departmental Research Committee		
Email	rshtsang@	Date	25-Mar-2016

Application for Ethical Review for Teaching/Research Involving Human Subjects

I write to inform you that approval has been given to your application for human subjects ethics review of the following project for a period from 01-Mar-2016 to 28-Feb-2017:

Project Title:	Influence of fundamental skills onto handwriting performance among upper kindergarten (K.3) children in Hong Kong
Department:	Department of Rehabilitation Sciences
Principal Investigator:	Tsang Wai Ping Cecilia
Reference Number:	HSEARS20160305001

Please note that you will be held responsible for the ethical approval granted for the project and the ethical conduct of the personnel involved in the project. In the case of the Co-PI, if any, has also obtained ethical approval for the project, the Co-PI will also assume the responsibility in respect of the ethical approval (in relation to the areas of expertise of respective Co-PI in accordance with the stipulations given by the approving authority).

You are responsible for informing the Departmental Research Committee in advance of any changes in the proposal or procedures which may affect the validity of this ethical approval.

You will receive separate email notification should you be required to obtain fresh approval.

TSANG Wing Hong Hector

Chair

Departmental Research Committee

Appendix D1: Informed consent form (Phase 1)

THE HONG KONG
POLYTECHNIC UNIVERSITY
香港理工大學
Department of Rehabilitation Sciences

香港理工大學康復治療科學系科研同意書

科研題目：幼稚園生中文書寫能力發展階段之研究

科研人員：李曾慧平教授，香港理工大學康復治療科學系教授
謝鳳玲小姐，註冊職業治療師、香港理工大學康復治療科學系博士研究生

科研內容：
書寫能力對於課堂上學習有著重要的影響，研究指出書寫能力能反映學童的學業成績。從幼稚園教育開始，學童已學習掌握如何運用書寫工具及規律，以便在小學階段學習不同科目的知識。由於香港是亞洲少數仍沿用繁體字的地區，因而欠缺幼稚園學童中文書寫發展階段的資料，亦缺乏有關的文獻支持。此研究旨在 (1) 收集本港幼稚園幼兒班至高班學童之中文書寫表現的數據，從而分析幼稚園學童之中文書寫能力的發展；及 (2) 了解幼稚園學童如何學習書寫中文字，以及影響書寫能力發展的因素。參與學童須進行中文書寫能力及仿畫圖形的測試，需時約三十分鐘。

對項目參與人士和社會的益處：
此研究旨在收集及研究本港幼稚園學童之中文書寫能力表現，了解幼稚園生書寫中文字能力的發展，以便設計合適的評估工具及早篩查有可能有書寫困難的學童，從而提早讓他們接受適切的治療。

潛在危險性：
此計劃沒有直接或潛在的危險性。

資料保密：
所有資料將會絕對保密。過程中或會拍照或攝錄作記錄，惟不會涉及貴 子女的樣貌。除研究人員外，任何人均不能取閱收集所得的資料；貴 子女的檔案亦只會以編號識別。研究結果發表時，將綜合全組的資料，而貴 子女的身份，包括：姓名、就讀學校、出生日期等將會保密。

同意書：

本人_____(子女姓名：_____，出生日期：_____ 年 _____ 月 _____ 日 *[只用作與發展階模比較]*）已瞭解此次研究的具體情況。本人願意參加此次研究, 本人有權在任何時候、無任何原因放棄參與此次研究, 而此舉不會導致我受到任何懲罰或不公平對待。本人明白參加此研究課題的潛在危險性以及本人的資料將不會洩露給與此研究無關的人員，我的名字或相片不會出現在任何出版物上。

本人可以用電話 2766-6715 來聯繫此次研究課題負責人李曾慧平教授。若本人對此研究人員有任何投訴，可以聯繫文女士（部門科研委員會秘書），電話：2766-4394。本人亦明白，參與此研究課題需要本人簽署一份同意書。

家長簽署：_____　　日期：_____

Appendix D2: Informed consent form (Phase 2)

THE HONG KONG
POLYTECHNIC UNIVERSITY
香港理工大學
Department of Rehabilitation Sciences

香港理工大學康復治療科學系科研同意書

科研題目：幼稚園高班學童書寫能力發展之研究

科研人員：李曾慧平教授，香港理工大學康復治療科學系教授
謝鳳玲小姐，註冊職業治療師、香港理工大學康復治療科學系博士研究生

科研內容：

書寫能力對於課堂上學習有著重要的影響，研究指出書寫能力能反映學童的學業成績。從幼稚園教育開始，學童已學習掌握如何運用書寫工具及規律，以便在小學階段學習不同科目的知識。由於香港學童需同時學習書寫中文及英文，因而欠缺幼稚園學童書寫兩種文字發展階段的資料及比較，亦缺乏有關的文獻支持。此研究旨在 (1) 收集本港幼稚園高班學童之中文及英文書寫表現的數據，從而分析幼稚園學童之書寫能力的發展；及 (2) 了解幼稚園高班學童如何分別掌握書寫兩種文字的技巧，以及影響書寫能力發展的因素。參與學童須進行仿畫圖形、中文及英文書寫能力的測試，需時約五十分鐘。

對項目參與人士和社會的益處：

此研究旨在收集及研究本港幼稚園高班學童之書寫能力表現，了解他們書寫能力的發展，以便設計合適的評估工具及早篩查有書寫困難的學童，從而提早讓他們接受適切的治療。

潛在危險性：

此計劃沒有直接或潛在的危險性。

資料保密：

所有資料將會絕對保密。除研究人員外，任何人均不能取閱收集所得的資料；貴 子女的檔案亦只會以編號識別。研究結果發表時，將綜合全組的資料，而貴 子女的身份將會保密。

同意書：

本人_____(子女姓名：_____，出生日期：_____ 年 _____ 月 _____ 日 *[只用作與發展階模比較]*）已瞭解此次研究的具體情況。本人願意參加此次研究, 本人有權在任何時候、無任何原因放棄參與此次研究, 而此舉不會導致我受到任何懲罰或不公平對待。本人明白參加此研究課題的潛在危險性以及本人的資料將不會洩露給與此研究無關的人員，我的名字或相片不會出現在任何出版物上。

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家長簽署：_____ 日期：_____

Appendix D3: Informed consent form (Phase 3)

THE HONG KONG
POLYTECHNIC UNIVERSITY
香港理工大學
Department of Rehabilitation Sciences

香港理工大學康復治療科學系科研同意書

科研題目：幼稚園高班學童視覺肌動與書寫能力之研究

科研人員：李曾慧平教授，香港理工大學康復治療科學系教授
謝鳳玲小姐，註冊職業治療師、香港理工大學康復治療科學系博士研究生

科研內容：

書寫能力對於課堂上學習有著重要的影響，研究指出書寫能力能反映學童的學業成績。從幼稚園教育開始，學童已學習掌握如何運用書寫工具及規律，以便在小學階段學習不同科目的知識。由於香港學童需同時學習書寫中文及英文，因而欠缺幼稚園學童視覺肌動、字形結構分析與書寫能力發展的資料及比較，亦缺乏有關的文獻支持。此研究旨在了解幼稚園高班學童如何分別掌握書寫兩種文字的技巧，以及視覺肌動及對字形結構理解如何影響書寫能力的發展。參與學童將於香港理工大學進行視覺感知能力、手眼協調能力及抄寫中、英文字能力的測試，需時約兩小時。被選拔之學童將會安排參與視覺及字形結構分析的訓練，以幫助他們提昇書寫能力。

對項目參與人士和社會的益處：

此研究旨在收集及研究本港幼稚園高班學童之書寫能力表現，了解他們書寫能力的發展，以便設計合適的評估工具及協助方案予有書寫困難的學童，從而讓他們提早接受適切的治療。

潛在危險性：

此計劃沒有直接或潛在的危險性。

資料保密：

所有資料將會絕對保密。除研究人員外，任何人均不能取閱收集所得的資料；貴 子女的檔案亦只會以編號識別。研究結果發表時，將綜合全組的資料，而貴 子女的身份將會保密。

同意書：

本人 _____(子女姓名：_____，出生日期：_____ 年 _____ 月 _____ 日 *[只用作與發展階模比較]*）已瞭解此次研究的具體情況。本人願意參加此次研究，本人有權在任何時候、無任何原因放棄參與此次研究，而此舉不會導致我受到任何懲罰或不公平對待。本人明白需提供所有影響是次研究結果的資料，及過程將有機會被攝錄 (只限於手部及桌面範圍)，唯以上資料將不會洩露給與此研究無關的人員，我的名字或相片不會出現在任何出版物上。

本人可以用電話 2766-6715 來聯繫此次研究課題負責人李曾慧平教授。若本人對此研究人員有任何投訴，可以聯繫鍾女士（部門科研委員會秘書），電話：2766-4329。本人亦明白，參與此研究課題需要本人簽署一份同意書。

家長簽署：_____ 日期：_____

見証人簽署：_____ 日期：_____

Appendix E: Parents' questionnaire

香港理工大學

康復治療科學系

幼稚園生中文書寫發展能力評估－家長問卷

1. 現在就讀之級別：

☐ 幼兒班 (K1)　　☐ 幼稚園低班 (K2)

☐ 幼稚園高班 (K3)

2. 請問會否在家中教導子女寫字? (不包括連線、填色等)

☐ 會　　☐ 否 (完，多謝參與)

3. 請問從何時起教導子女寫字?

☐ 幼兒班上學期　　☐ 幼兒班下學期

☐ 中班上學期　　☐ 中班下學期

☐ 高班上學期　　☐ 高班下學期

☐ 其他 (請註明) ：_____

4. 現在在家中教導寫字的內容包括：(可選多於一項)

☐ 數字　　☐ 英文字母

☐ 中文字 (如：上、木)　　☐ 英文字 (如：red, apple, boy)

☐ 中文詞語 (如：小狗)

姓名

☐ 中文　　☐ 英文

5. 每星期的學習寫字數量 (不包括家課)：

☐ 少於 10 個　　☐ 10-20 個

☐ 20-40 個　　☐ 多於 40 個

~ 問卷完，多謝參與 ~

Appendix F: Teachers' questionnaire

THE HONG KONG
POLYTECHNIC UNIVERSITY
香港理工大學
Department of Rehabilitation Sciences

幼稚園學童中文書寫能力及教學方法－老師問卷

本問卷是由香港理工大學康復治療科學系策劃，旨在收集您對幼稚園學童書寫能力和及對日後升讀小學的重要性。
您的意見對幼稚園學童提升書寫能力以協助幼小銜接有直接幫助。

本問卷是以不記名做方式進行。謝謝您的積極參與！

1. 背景資料

1.1 職級

☐ 幼稚園老師	☐ 主任
☐ 校長	

1.2 年資

☐ 0-2 年	☐ 3-5 年
☐ 6-10 年	☐ 10 年或以上

1.3 負責學童所屬年級

☐ 幼兒班	☐ 高班
☐ 低班	☐ 沒有

2. 中文書寫訓練

2.1 您所任教的幼稚園/幼兒學校會否包括書寫活動

☐ 會	☐ 否 (請往 2.7)

2.2 開始教導學童書寫的年級

☐ 幼兒班上學期	☐ 幼兒班下學期
☐ 低班上學期	☐ 低班下學期
☐ 高班上學期	☐ 高班下學期

2.3 您教導學童書寫的方法 (可選多個答案)

☐ 直接抄寫 (copy)	☐ 解釋字的形、音、義
☐ 運用正確筆順 (先左後右)	
☐ 教導部件/部首名稱 (艸=草字部)	☐ 其他 (請註明) _____

2.5 在你所負責的年級裡，教導書寫的時間佔整個教學時數的百分比是：

☐ 0-20%	☐ 21-40%
☐ 41-60%	☐ 61-80%
☐ 81-100%	

2.6 寫字教學評估方法

☐ 平日習作	☐ 教師觀察紀錄
☐ 測驗考試	☐ 家長觀察紀錄
☐ 默書	☐ 比賽

2.7 你認為書寫能力對學童適應小學課程有多重要

☐ 非常不重要	☐ 不重要
☐ 重要	☐ 非常重要
☐ 中立	

2.9 在你的教學經驗中，學童的書寫問題包括 (可選多於一項) ：

☐ 執筆方法不正確	☐ 坐姿不正確
☐ 筆劃不正確 (缺少/多餘筆劃)	☐ 筆順不正確
☐ 部件比例不正確	☐ 容易混淆相近字
☐ 其他 (請註明) _____	

3. 如你對幼兒書寫教學有任何意見，請寫下你的意見

_____

_____

_____

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