The Impact of the Use of Electronic Device Input Methods on Children's Writing Ability and Coping Strategies

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Abstract: Against the backdrop of the widespread use of electronic input methods, this study focused on 594 upper-grade primary school students and explored the impact of different electronic input methods on Chinese character writing ability through dictation tests and questionnaires. The results showed that the duration of voice input was significantly negatively correlated with dictation accuracy, while the duration of pinyin and handwriting input was not significantly correlated with accuracy. Speech input bypassing glyph processing and weakening the connection between form, sound, and meaning is not conducive to the development of writing automation and may increase the risk of developmental dysgraphia. In contrast, pinyin and handwriting input retain some of the glyph processing and have less adverse effect on writing ability.

Keywords: Children's writing ability; Language learning; Developmental dysgraphia; Input method

1. The issue of the impact of electronic device use on children's writing ability

With the rapid development of information technology, electronic devices have become important tools for children to learn and communicate. The popularity of pinyin input methods, handwriting input methods, speech-to-text input methods, etc., has significantly improved the efficiency of Chinese input, but their potential impact on the development of children's writing ability remains controversial. Chinese characters, as a system of ideographic writing, rely on fine visual analysis of character structure, stroke order, and component combination, as well as a lot of handwriting practice [1]. However, using pinyin to input Chinese characters or generating characters directly by pronunciation bypasses the deep processing of character features in traditional writing, which may weaken children's understanding of the character-semantic-phonetic connection of Chinese characters. Long-term reliance on such input methods can lead to a decrease in sensitivity to the structure of Chinese characters, and problems such as missing strokes and component confusion may occur when writing,

thereby affecting the formation of writing ability [2]. In addition, handwriting practice promotes the development of key brain regions such as the left middle frontal gyrus, which are crucial for Chinese reading and writing, by strengthening visual-motor integration. Could the use of handwriting input methods on electronic devices also activate similar cognitive pathways to improve children's ability to write Chinese characters?

2. Based on developmental dyslexia screening and electronic device use surveys

First, the researchers designed and conducted Chinese character dictation tests and recognition tests. The words used in the test were selected from the list of new characters in the Ministry of Education's primary school Chinese textbook (2020 edition), and the number was about 10% of the total number of characters learned in the fifth and sixth grades (180 and 220, respectively). To ensure a balanced level of difficulty, the dictation and recognition of characters are strictly controlled in terms of stroke count, frequency, structure, and phonogram ratio. In terms of stroke count, the average stroke count of characters tested in grades five and six was approximately 9.63. In terms of character frequency, the average occurrence frequency of the tested characters was approximately 0.03 per thousand. In terms of character structure, it was close to the ratio of approximately 21.1%:64.9%:15% for all characters. The structure distribution of the fifth grade tested characters was 26.67% for top and bottom, 53.89% for left and right, and 19.44% for other characters, and 26.81% for top and bottom, 53.63% for left and right, and 19.56% for other characters. As for phonogram characters, according to the statistics of Shu Hua et al., the proportions of regular phonogram characters, semi-regular phonogram characters, ancient phonogram characters, and non-phonogram characters in the test characters were controlled at around 29%, 29%, 9%, and 33%, respectively. During the dictation test, students were asked to write the target character of a disyllabic word (for example, the character " 欢 " in " 欢乐 ") on the answer sheet based on the recording. For characters they cannot write, use a circle instead. When corrections are needed, cross out the wrong word and rewrite it in the blank space beside it. Before the formal test, the researchers explained the test requirements to the students and demonstrated exercises to ensure that all students knew how to write properly [3]. Two days after the dictation test was completed, a recognition test was conducted. The target characters in the recognition test are the same as those in the dictation test, but in jumbled order, and students are required to pronounce each character. If the student does not know the pinyin, write a homophone instead, or ask the teacher to pronounce the character orally. Both tests should be demonstrated and practiced first to reduce test anxiety. A total of 594 students completed the dictation and recognition tests and received 1,188 valid answers.

Secondly, the differences in reading and writing abilities of the students were calculated and screened based on the criteria proposed by Yang Shuang et al. The specific approach was to calculate the correct rate of Chinese character recognition for each student and identify those whose recognition rate was higher than the overall average; Then count the number of dictation errors among the correct characters that each student made, and divide that number by the total number of correct readings to obtain the rate of difference in reading and writing for each student; After calculating the average and standard deviation of the reading and writing difference rates of all such students, students whose reading and writing difference rates were 1.5 standard deviations higher than the average were identified as suspected subjects of developmental dyslexia [4]. To eliminate distractions of attention deficit and intellectual factors, the study also evaluated the students' cognitive abilities: the class teacher filled out the attention rating scale based on the Diagnostic and Statistical Manual of Mental Disorders (4th Edition) (DSM-IV) criteria to screen out individuals who might have abnormal attention; The Raven's standard reasoning test was used to assess

students' intelligence levels, and those with significantly lower intelligence than the norm were excluded. After the above assessment, one student with cognitive deficits was excluded [5].

Finally, a self-compiled "Student After-school Time Allocation Questionnaire" was used to collect information on children's use of electronic devices after school. The questionnaire consists of two parts: basic information (gender, age, etc.) and time allocation, the latter covering sleep time, outdoor activity time, electronic device usage time, reading time, calligraphy practice time, pinyin input method usage time, speech-to-text usage time, handwriting input method usage time, homework time and other interest activity time. The questions in the questionnaire are mostly multiple-choice, with duration options at intervals of 0.5 hours for quantitative statistics, and an open item of "other" for supplementation when necessary. Each student should fill in the situation for a consecutive week to reduce the single-day chance of error. A total of 2,177 original questionnaires were collected, and 377 people completed the questionnaire, among which 342 were valid questionnaires that matched their dictation test scores.

3. The impact of electronic device use on Chinese character writing ability and academic performance of upper-grade primary school children

Among 594 upper-grade primary school children, 57 students with developmental dyslexia were first screened out, with a dyslexia detection rate of 9.60 percent. The results of the correlation analysis showed a very significant negative correlation between the total time children spent using electronic devices and the accuracy of Chinese dictation (r = -0.221, $P < 0.001$). Among all input methods, the usage time of the speech-to-text input method was significantly negatively correlated with dictation accuracy (r = -0.220, $P < 0.001$), and an independent negative correlation was maintained after controlling for the total usage time of electronic devices (partial correlation coefficient r = -0.146, $P < 0.01$). In contrast, the correlation coefficient between the duration of handwriting input and dictation accuracy was negative (r = -0.108), which was statistically significant ($P < 0.05$), but this correlation disappeared when the total duration of electronic device usage was controlled (the partial correlation coefficient was close to 0). The initial weak negative correlation showed by the handwriting input method was mainly due to the prolonged use of the electronic screen, rather than the adverse effect of the input method itself. The correlation between the duration of use of pinyin input and the accuracy of writing was weak and not significant (r = -0.075, $P > 0.05$). The results suggest that there are significant differences in the effects of different types of electronic input methods on Chinese character writing ability. The high usage rate of voice input was associated with lower writing accuracy, while the use of pinyin input and handwriting input did not show a significant direct association with writing performance.

Further comprehensive comparative analysis of students' performance revealed that prolonged use of electronic devices not only affected writing accuracy but also had a negative impact on students' Chinese academic performance and overall academic performance. Among them, Chinese grades were significantly negatively correlated with the total time spent using electronic devices (r = -0.3108, $P < 0.001$), and overall academic performance showed a similar negative correlation trend (r = -0.3033, $P < 0.001$). This means that excessive use of electronic devices may not only weaken children's writing skills but also have adverse effects on their language comprehension and expression abilities, as well as interdisciplinary cognitive integration abilities [6]. It is notable that this finding echoes the recent trend of recognition that digital environments pose challenges to children's deep learning abilities, that being immersed in electronic media may make it difficult

for children to engage in in-depth, focused learning and information processing.

4. The mechanism of the influence of electronic input methods on Chinese character writing ability

4.1. The destructive effect of voice input on the mechanism of Chinese character writing

From a linguistic perspective, Chinese characters are a highly graphical ideographic system, and the integration of form, sound, and meaning is crucial for the development of children's writing ability. Speech-to-text input method skips the processing of the correspondence between form and sound in Chinese character writing, allowing children to retrieve the characters by pronunciation alone, depriving them of visual attention to the structure of the characters and memory of writing actions [7]. This "de-graphical" input approach is a serious departure from the traditional Chinese character learning strategy of promoting character shape recognition and internalization of meaning through handwriting, weakening children's sensitivity to the internal components of Chinese characters and blocking the construction process of the form-sound-meaning trinity. It is worth noting that this conclusion is consistent with the findings of neuroimaging studies: Tan et al.'s research show that handwriting practice can activate important regions of the brain related to Chinese character processing, such as the left middle frontal gyrus, and premature reliance on speech input may interfere with the establishment and reinforcement of this neural pathway [8]. This suggests that the overuse of speech input has a destructive effect on the cognitive mechanisms of Chinese character writing. The findings highlight the cognitive risks associated with bypassing glyphs. Recent studies have also expressed concerns that over-reliance on such phonetic input methods may lead to negative cognitive consequences.

4.2. The "pseudo-handwriting" feature of handwriting input methods and their limited functions

Theoretically, using a handwriting input method on an electronic screen may partially reproduce the visual-motor integration process of pen and paper handwriting, but the results of this study show that the correlation between the duration of use and the accuracy of writing is no longer significant after controlling for the total screen time. This means that the direct promotion of writing ability by handwriting input itself is very limited, and the negative correlation effect it shows is mainly due to the overall crowding effect caused by excessive use of electronic devices, rather than the decline in writing ability caused by the input method itself [9]. In other words, the act of "writing" on a touchscreen does not truly activate the deep graphic cognition and action memory mechanisms involved in traditional handwriting; rather, it is more of a formal imitation of writing. This finding echoes the doubts raised by Li and others about the effectiveness of "formalized" practice that overly relies on screens, and supports the view that excessive screen time has an overall negative impact on children's reading and writing development [10].

4.3. From input method to writing ability

From a psycholinguistic perspective, the adoption of different input methods actually reconstructs the processing path of Chinese characters. In the traditional pen-and-paper writing mode, children need to go through a multi-level construction process of pronunciation-form, character-meaning, and pronunciation-meaning. In the context of electronic input, especially when using voice input, children may skip the in-depth processing of character shapes directly, thus forming incomplete or biased mental representations of Chinese

characters [11]. This change in the processing path may not be noticeable in the short term, but over the long term, it can lead to typographical errors, component omissions, and other such phenomena when children write independently, which can be seen as a cognitive "laziness" tendency in writing. As Wolf et al. have emphasized, when reading and writing rely too much on quick digital means and lack deep processing, children's ability to process text and textual details may be weakened. This phenomenon may explain why, in higher grades, the proportion of children with writing difficulties is not decreasing with the accumulation of training, but remains at a non-negligible level [12].

5. Coping strategies

5.1. Educational intervention: Strengthen writing training and input method usage norms

In school education, the training of children's basic skills in Chinese character writing should be strengthened, and their electronic input behavior should be regulated. First, increase children's daily pen and paper writing time. For example, arrange specialized calligraphy exercises in the curriculum, ensuring at least 15 minutes of handwriting practice each day, with a focus on strengthening the memory of the structure and stroke order of Chinese characters [13]. Secondly, limit the use of voice input methods. It is recommended that children use electronic devices after completing the necessary pen-writing work to avoid voice input prematurely replacing the shaping process in Chinese character writing. In addition, incorporate the analysis of the form of Chinese characters into pinyin input teaching, and guide children to pay more attention to the structural features of candidate characters when choosing characters for pinyin input, so as to enhance the connection between form, sound, and meaning [14].

5.2. Technological improvements: Develop digital tools to assist in writing

From a technical perspective, digital tools can be developed and utilized to assist in the development of children's Chinese character writing skills. For example, develop an intelligent handwriting feedback system that uses styluses and pressure sensing technology to provide real-time feedback on the order of strokes and the structure of characters, helping children identify and correct writing errors in a timely manner [15]. Another example is the design of a "character decomposition" learning application, which demonstrates the combination sequence of Chinese character components through animation and combines voice prompts to enhance children's memory of the character shape features. These human-computer interaction tools aim to transform digital technology into a positive force for Chinese character learning, making up for the lack of pure electronic input for writing practice while providing fun.

6. Conclusions

To sum up, there are significant differences in the effects of different types of electronic input methods on children's Chinese character writing ability. Voice input, due to its "de-graphical" feature, has an independent and persistent negative effect on writing ability; Pinyin input methods and handwriting input methods have relatively limited and indirect effects on writing ability. In a digital learning environment, educators and parents should pay close attention to the potential threat of excessive use of electronic devices to children's writing ability and help children balance the use of technology and the development of traditional writing skills in the digital age through measures such as strengthening pen-and-paper writing training, optimizing input method teaching and creating a supportive family writing atmosphere. Future studies could further track the long-term

effects of different intervention strategies and explore the specific mechanisms by which input method use affects language function development in children's brains.

Disclosure statement

The author declares no conflict of interest.

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