

A Review and Prospects of Chinese Character Research in the Last Thirty Years

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Abstract. At this stage, the study of Chinese characters is undergoing a transformation of modern applications and technology, and research in this field is both deeply rooted in the traditional Chinese study of script and flourishing with new vitality. This paper analyses the five major components of Chinese character research, namely, the study of archaic characters, the study of the phonology, morphology and meaning of Chinese characters, the study of the application of Chinese characters in the computer field, the study of the cognitive processing of Chinese characters, and the study of Chinese character teaching, and the three methods of Chinese character research, namely, exegetical examination, corpus database and empirical research methods. This paper summarizes the literature on Chinese character research, analyses the trends in Chinese character research, and summarizes the review and outlook of Chinese character research in the past thirty years.

1 Introduction

The Chinese characters were created at the turn of the Xia and Shang dynasties, and are the only writing system of their own origin to have developed into a phonetic script, which has shown great vitality over the centuries. The study of Chinese characters began in the pre-Qin era, and the *Shuowen Jiezi* is the most comprehensive collection of traditional script research. In the twentieth century, under the impact and influence of Western academic culture, the infiltration of knowledge from disciplines such as education, information processing and psychology, and the application of research methods, the field of study of script has undergone an applied and technological transformation, and this traditional discipline has taken on a new life.

Based on the statistics and combing of literature over the past thirty years, this article discusses in detail the content of Chinese character studies, some basic theories and perspectives in Chinese character studies, the main methods of Chinese character studies, the interdisciplinary characteristics of Chinese character studies, and looks forward to the development trend of Chinese character studies, with a view to contributing to the disciplinary construction of Chinese character studies.

2 Literature and Statistics of Chinese Character Studies

The search was conducted on the China Knowledge Network using the subject term "Chinese characters", with the subject area restricted to Chinese language and writing and the journals selected as Peking University Core and Chinese Science Citation Index (CSSCI). A total of 12,616

papers were searched by hand. Figure 1 shows the number of papers published on the topic of "Chinese characters" by year, and Figure 2 shows the number of papers on specific categories of Chinese character research.

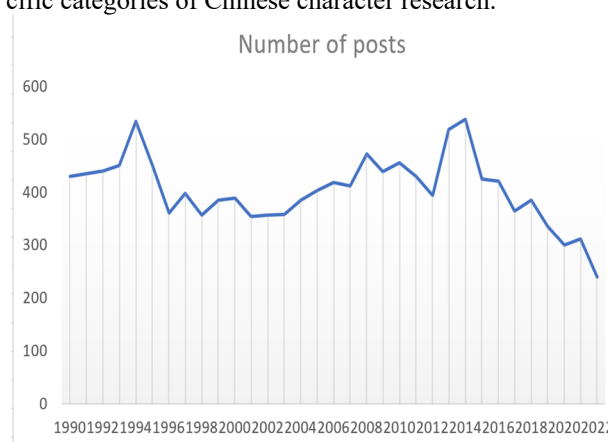


Fig. 1. Overall trend in the number of articles published in the textual studies literature, 1992-2022 (the self-made form)

As can be seen from Figure 1, the literature can be roughly divided into four stages: the first stage was 1990-1994, when the number of publications tended to increase, reaching a small climax with 533 publications in 1994; the second stage was 1995-1997, when the number of publications decreased sharply compared to 1994, and was even lower than the number of publications before 1994. The third stage is 1998-2012, although there are small twists and turns, the number of articles published is more or less the same, with a slow growth trend, with more articles published in 2008 and 2010; the fourth stage is from 2013 to the present, starting from 2013, the number of core jour-

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nal papers increased to a similar number of articles published in 1994, and the number of articles published is significantly higher than the previous stage, but only lasts until 2014. The number of articles published in the following years decreases significantly, indicating a decrease in the enthusiasm of the academic community for the study of Chinese characters. The trend in the number of articles has been flat overall over the thirty years, but 2022 is the lowest number of articles in the last thirty years, which also shows a downward trend in the enthusiasm for research on Chinese characters.

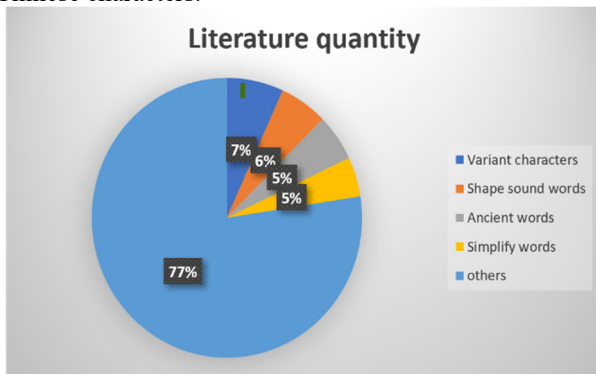


Fig. 2. Thematic distribution of textual studies literature, 1992-2022 (the self-made form)

As can be seen from Figure 2, the distribution of research content in Chinese character literature is dominated by variant characters, morphophonetic characters, ancient characters and simplified characters. Scholars have made the three elements of Chinese characters, morphology, phonology and meaning, the focus of discussion, and have paid close attention to issues such as the teaching of Chinese characters, Chinese character writing, Huiyi characters and the Six Books. The art of calligraphy and reform of Chinese characters are also major areas of research, while new directions have emerged in the study of Chinese characters, such as Chinese characters and computer linguistics, recognition and processing of Chinese characters, and other psycholinguistic directions.

According to the content of literature research, it can be roughly divided into the following five areas: (1) research on ancient characters, (2) research on the morphology, phonology and meaning of Chinese characters, (3) research on teaching Chinese characters to foreigners, (4) research on the application of Chinese characters in computers, and (5) research on the cognitive processing of Chinese characters. According to the division of Chinese character research methods, they can be roughly divided into exegetical examination, database research and empirical research methods.

3 Analysis of the content of Chinese character studies

3.1 The study of ancient writing

The study of oracle bones is an important part of the study of ancient writing, and there are many studies of oracle bones, mostly focusing on the relationship between oracle

bones and the evolution of Chinese character form and structure, and the preservation of oracle bones, focusing mostly on the discovered oracle bones, and less on the continued search for the discovery of oracle bones. The study of oracle bone inscriptions is basically combined with the history of the Shang dynasty, with analysis of the Shang dynasty's simple books and documents, and with an examination of the Shang dynasty's shrine culture. There are also studies that construct the functions of the components of the oracle bone script and explore the cultural transmission of the oracle bone script in the context of digital media (Wang Qian 2022) [1].

Scholars in the last three decades have studied ancient scripts in greater depth. Zhang Qingsong (2017) [2] conducts a comprehensive and in-depth examination of a large number of variant characters in the book of characters arranged according to the morphological divisions of Chinese characters, the *Zhengzitong*, written by Zhang Zili, and makes a relatively objective summary and evaluation, which has high academic significance and theoretical value. Gao Xingquan (2015) [3] analyses textual phenomena in the evolution and standardisation of characters, such as orthography and variants, ancient and modern, passages and falsehoods, and traditional and simplified calico.

Xia Nengquan (2015) [4] analyses the causes of differences in variants in ancient documents, and Wang Lijun (2015) [5] proposes basic principles for optimising contemporary Chinese character systems based on variants of traditional and simplified characters.

In the 1980s, scholars developed a new understanding of the 'abundance of pseudonyms in ancient books'. Studies in both exegesis and ancient literature have noted the existence of a large number of pseudoborrowed characters in the ancient books of the pre-Qin dynasty and have come to a new understanding, linking pseudoborrowing to the rationality of Chinese characters.

Chen Yachuan (1982)[6], in his study of the Six Books, simplified characters and the teaching of Chinese characters, suggested that the use of the Six Books to diagram the structure of Chinese characters could not be said to be a genuine departure from modern Chinese character forms, nor could it reflect an overview of the structure of Chinese characters, a view shared by researchers in the early twentieth century, when the term 'modern Chinese characters' emerged and scholars began to link the study of 'modern Chinese characters' to the traditional 'six books' theory, further deepening and refining the concepts of the earliest monograph on Chinese characters, *Shuowen Jiezi*.

3.2 Study of the morphology, phonology and meaning of Chinese characters

Chinese characters are two-dimensional phonetic-semantic scripts with a certain degree of rationality in their configuration, with a wide range of symbols and complex structures. Li Yunfu (2014) argues that Chinese characters are difficult to learn because of their characteristics, which are manifested in three aspects: form, function and rationale, and compares these three attributes of Chinese

characters with different languages from the same perspective, providing new ideas for the study of Chinese characters [7]. The common "sound, form and meaning" are the basic elements of Chinese characters, but they are always closely related in the study of Chinese characters, with the form being the external visual aspect, the rationale being the explanation of the cause of the form, and the function being the value of the form's existence. It is difficult to distinguish between them.

Form.

Number of strokes, parts and orthography

In addition to traditional script morphology, which investigates the strokes and parts of Chinese characters, many scholars have also conducted research on the morphological elements of Chinese characters with the help of corpus and psychological experiments. You Haojie (2003) [8] empirically investigates the findings related to stroke count, part count and topology with the help of a corpus of mediated languages. By examining the effect of stroke count on the visual word processing of second language learners of Chinese at different language levels, it was revealed that second language speakers of Chinese differ from native speakers in their processing, with speakers of languages with shallow orthography tending towards analytical processing and native speakers with deep orthography tending to adopt holistic processing (Zhou Ying and Jiang Nan 2023) [9]. A paper-and-pencil test illustrates that the budding development of orthographic awareness among international students and the development of part-position awareness precede part-awareness (Hao, Meiling 2007) [10]. A study of the distinguishing features of Chinese character parts, part position information, the structural symmetry features of Chinese characters on the processing mechanism of Chinese character recognition, and the influence of part features and structural types on international students' Chinese character writing (Hao Meiling, Fan Huiqin 2008) [11].

Variant characters and a large number of pseudonyms still exist in the Chinese character system, and Chinese character orthography has been emphasized in recent years. The main elements of Chinese character orthography include the restriction of traditional characters, the abolition of variant characters, and the use of standard simplified characters, so that the simplification of Chinese characters has become an important trend in the evolution of Chinese characters in the past fifty years. Chen Shuangxin and Dong Yue (2016) put forward several focal issues concerning the current research and application of modern Chinese characters, namely the issue of traditional and simplified characters and the issue of variant characters [12]. Scholars have also done a great deal of research on the collation of variant character lists, such as Shao Wenli's survey and analysis of the first batch of variant character collation lists and pointed out the main problems and causes [13][14], and this trend is reflected in the 1956 Chinese Character Simplification Scheme, the 1977 Mandarin Chinese Character List, the 1986 Modern Chinese General Character List, and the 2013 Master List of Simplified Characters. With the gradual popularisation of Mandarin, the trend towards simplification of Chinese characters is also increasing.

Due to the gradual simplification, digitisation and diversification of Chinese characters, the study of Chinese characters has developed from the traditional study of glyphs to a multifaceted trend, and the intersection of multidisciplinary theories and methods has become increasingly evident.

Rationale.

Lin Yan (2006), based on a dialectical analysis of the views of Saussure, Jakobson, Greenberg, Xu Guozhang, Shen JiaXuan and many other linguists, affirms that there is both arbitrariness and rationality in the linguistic symbol system, and that linguistic symbols are a unity of arbitrariness and rationality [15]. The Chinese characters are a combination of phonetic, morphological and semantic characters, which have a scientific rationality.

Study of the "building blocks" of the rationale unit.

The components of Chinese characters are pictograms, signs, ideograms or phonograms, and those that have lost their function due to changes in character form or language are called marks. Chinese characters are a flat, square-shaped symbol system that uses ideographic components (including pictographic, denotative and marking components) as well as phonetic and notational components to record Chinese morphemes and syllables. The main characteristics of Chinese characters are their square shape, their multifunctional and complex rationale, and the uncertainty of their recording function. According to Li Yunfu (2014), the rationale unit is often called a component, which refers to a form that has a certain function in constructing a character to express a speech position [7].

Rationale study.

The study of the rationale of Chinese characters has evolved, and the general view is that it is a process of 'weakening of rationale - reconstruction of rationale - return of rationale'. The simplification of Chinese characters also weakens the rationale. However, most of the knowledge of the rationale of Chinese characters comes from ancient texts, such as the Six Books Theory in the Shuowen Jiezi, and although there are a few studies that have kept pace with the times and reflect the diversity of Chinese character development, they are relatively traditional and outdated, and need to be investigated by scholars.

Functionality.

Chinese characters are a combination of sound, form and meaning; the form is subordinate to the character itself, while the sound and meaning are the elements that express the language. Only by understanding the relationship between the form, sound and meaning of a Chinese character can the function of the character be fully utilised. If the relationship between the sound and the meaning of the character is not understood, the character's function cannot be fully exploited. Therefore, in the study of Chinese characters in terms of their function, scholars have focused on the sense of the meaning and sound of the morpheme.

The morphophonetic advantage of Chinese characters was gradually established in the course of their evolutionary development. Early on, the function of Chinese characters was mainly to record phonetic sounds, but later on they embarked on the path of morphophoneticization, which has continued since the formation of the Spring and

Autumn period and the Warring States period. During this process, a large number of morpho-sounding characters were created by adding morphemes (ideograms). This suggests that Chinese characters cannot fully meet the needs of their corresponding linguistic units through the recording of phonology alone, which is determined by the characteristics of the Chinese language. The function of Chinese characters is characterised by the uncertainty of their recording function and the difficulty of fully corresponding words. In terms of morphology, the process of morphophonetisation of the Chinese character symbol system is clearly a process of flourishing. This is the reason why Chinese characters parted ways with other ancient writing systems and took a unique path of development, and why Pinyin cannot replace Chinese characters.

At present, scholars still do not pay enough attention to the symbolic system of Chinese characters, and their attitude towards pronunciation cognition appears to be "emphasizing the meaning symbols but not the phonetic symbols". The reasons for this are: the large number of phonetic symbols, the weak ability to form characters, the fact that the frequency of the same phonetic symbol is much lower than that of the meaning symbols, and the fact that the common use of phonetic symbols limits the adoption of the rule-based approach to the perception of Chinese character pronunciation (Wan Yexin 2007) [16]. Many scholars have reached diametrically opposed conclusions about the perception of the formation of the morpho-phonetic advantage of Chinese characters. One is that Chinese characters have increased their epigraphic component, and the other is that the tendency to mnemonicize Chinese characters has been suppressed. It has been argued that the latter is more consistent with historical facts.

A functional understanding of the morphology, phonology and meaning of Chinese characters not only provides a better understanding of the morphological aspects of Chinese characters, but also, and more importantly, a better understanding of how the relationship between language and writing is perceived and dealt with. This understanding is still relevant to the teaching of Chinese characters today.

3.3 Research on teaching Chinese characters to foreigners

Teaching philosophy: Chinese character orientation and language teaching.

Research on teaching Chinese characters to foreigners has flourished as a result of China's rising international status and comprehensive strength. The teaching of Chinese characters to foreigners in China started late, and it is only since the Fifth International Symposium on Chinese Language Teaching held in 1996 that Chinese character teaching has received great attention. However, in the whole process of teaching Chinese as a foreign language, the teaching of Chinese characters is still in a weak link.

There has always been a controversy between the "word-based" and "character-based" concepts in Chinese language teaching theory. Influenced by the acquisition of English as a second language, the 'word-based' teaching philosophy dominated Chinese as a foreign language in

China until the 1990s, when the 'word-based' teaching philosophy originated, with Bai Lesang and Zhang Pengpeng writing 'The Enlightenment of Chinese Language and Script'. It was only in the 1990s that the idea of "word-based" teaching emerged and became more and more vocal. In response to the controversial development of Chinese character teaching, the first question is whether, in the overall design of Chinese character teaching, the tasks of writing and reading can be separated and reasonably matched to the tasks of language teaching; the second question is whether the process of reading can be elevated to a cognitive approach to Chinese characters, and whether the clarification of word-word correspondence can be developed into a comprehensive understanding of the relationship between words, morphemes and words (Wan Yexin 2007)[16]. In 2008, Shi Zhengyu proposed a teaching philosophy based on the basic framework of "word-phoneme and Chinese character"[17], which is different from the new teaching philosophy of "word-based" and "word-based", and represents a breakthrough in theoretical research on Chinese character teaching. However, most of the prevailing methods of teaching Chinese characters still follow the "word-based" concept, with the phonetic and semantic structure of Chinese characters being the main focus, such as the "language" view and the "language teaching" view, which take the specificity of Chinese characters as the origin. The "language" view and the "language teaching" view are based on the specificity of Chinese characters.

In the early 1950s, the 'language first, then text' approach was discussed and experimented with in relation to the teaching of language and Chinese characters, but due to the poor results, it was changed to the 'language in parallel' approach, which is still used today (Wan Yexin 2015) [18]. However, in the past decade or so, the 'language integration' approach has been under constant review. There is a consensus that the disadvantages of this approach - that the teaching of Chinese characters is subordinate to the teaching of words, that the teaching of Chinese characters is essentially based on the teaching of writing and the correction of misspellings, and that it is not conducive to the learning of Chinese characters by foreign students - have largely been identified.

At the same time, there is a significant minority who believe that the disadvantage lies first in the inability to follow the system of the Chinese characters themselves, first in their individual form and then in their combined form; from the simple to the complex, from the easy to the difficult, in a gradual manner. Others, however, have noted that the simplicity of teaching characters is bound to limit the choice and arrangement of words and sentences in textbooks, and have therefore reintroduced the idea of 'language separation'. The difference is that Li Yunfu (2014) further emphasises the importance of teaching and practising the functions of Chinese characters as the main task [7], but this is not the case in the current situation of teaching Chinese characters, and there is no corresponding teaching content.

The innovation of teaching models and teaching methods for teaching Chinese as a second language must, in the final analysis, be based on the characteristics of Chinese language and Chinese characters, and must be integrated

with the characteristics of Chinese language and Chinese character applications, rather than being rigidly applied to ready-made language teaching methods designed for Indo-European languages. The study of Chinese characters in terms of their phonetics, morphology and meaning is integrated into the study of teaching Chinese characters to foreigners and becomes the cornerstone of the study of teaching Chinese characters to foreigners. There are several innovative directions of research in the teaching of Chinese characters to foreigners, with Chinese characters as the base, teaching philosophy, teaching content, teaching methods and teaching tools all having a focus.

Teaching content: Chinese character materials and literacy scales for the international student community.

The globalisation of the Chinese Language Proficiency Standard levels for international Chinese language education proposed in 2021 is important for the development of Chinese character studies. Chinese character research should also have a global perspective, thus promoting the development of literacy scales for the international student population and the innovation of Chinese character teaching materials. For example, in the field of Chinese character acquisition, the Rasch model and item response theory were used to demonstrate that the reliability and validity of the literacy scales developed for international students were generally good, and Wu Qiuping, Hong Wei and Deng Shulan (2017) [19] constructed test indicators through regression models, and the form of Chinese character recognition measurement provided a new perspective for placement tests. The study has significant practical implications for teaching Chinese as a foreign language. In 2019, the Handbook of Chinese Character Recognition and Reading [20], and in 2021, the Handbook of Chinese Character Writing [21] will be published, which will be of reference value for the assessment of Chinese character teaching, acquisition research and the development of measurement tools.

The design of Chinese character teaching materials has also provided innovative directions in recent years. Zhao Jinming (2008) argues that in order to break through the bottleneck of Chinese character teaching, the first step should be to clarify misconceptions about Chinese characters and to establish a scientific view of Chinese characters [22]. Chinese characters themselves are a complete scientific system. Zhao Jinming (2009) [23] goes on to deepen the concept proposed that the relationship between teaching Chinese and teaching Chinese characters is a key issue that teaching materials must deal with. How to lift the fear of Chinese characters and break through the bottleneck of teaching Chinese characters is a problem that the textbook should focus on and address. Wan Yexin (2015) [18] takes the same attitude, changing the pursuit of "literacy quantity" to learning from the past, which complements the aforementioned literacy scale for international students, echoing the enhancement of the cognitive function of Chinese characters and the transformation of the cognitive pathway of Chinese characters; the student-centred approach and the teaching materials as a supplementary platform are meant to break the bottleneck of Chinese character teaching. This shows that scholars already have a philosophy of valuing Chinese character teaching and Chinese character teaching materials.

However, the current implementation of Chinese character teaching materials remains unreasonable, and Xu Rui (2016) argues that due to the lack of initial attention to the teaching of Chinese characters, Chinese character teaching materials are more lacking compared to other aspects, with some focusing on pictorial teaching methods, others on Chinese character radical teaching methods, and few comprehensive and systematic teaching materials, and the difficulty level of Chinese characters is not differentiated, making it difficult to teach Chinese characters [24].

Wan Yexin (2015) suggests that using exercises and games as the main body of teaching materials can maximise word recurrence [18]. Efforts are made to realise the principles of practicality, fun and science in Chinese character teaching materials. After proposing a direction of change for Chinese character teaching materials, the subsequent practical teaching has not followed suit. As mentioned above, the synchronisation of languages has made the teaching of Chinese characters dependent on the teaching of Chinese, and whether Chinese characters should be taught as a stand-alone subject has been the focus of debate among scholars, with one advocating that Chinese characters should be taught as a stand-alone subject (Zhao, 1999; Liu, Yanmei, 2002; Ma, Yanhua, 2002; You, Haojie, 2003 [8]; Chen, Jing, 2010) and the other opposing that Chinese characters should be taught as a stand-alone subject. The other is against the establishment of separate classes for teaching Chinese characters (Shi Dingguo and Wan Yexin, 1998) [25].

The systematic and comprehensive nature of Chinese character materials and the direction of their focus are closely related to whether or not Chinese characters are taught as a stand-alone subject. At present, the content of the Chinese character textbook dominates the curriculum and the development of a comprehensive and systematic textbook will help to make the Chinese character curriculum independent.

Teaching methods.

The more popular methods of teaching Chinese characters, such as stroke teaching, component teaching, morpho-sounding character teaching and character family theory teaching, are closely related to the development of Chinese character studies and are complementary to each other. The focus of academic attention is on the discussion of 'traditional teaching methods' and 'new teaching methods'. Some representative student-centred, cognitive approaches to teaching Chinese characters include the two-brain approach to literacy, the peculiar association approach to literacy, and the tethered classification approach to literacy. These new teaching methods also provide international Chinese language teachers with new ideas for innovative and effective teaching of Chinese characters.

Liu Yanmei's (2009) [26] experimental study of Chinese character strategy training proved that it is necessary to develop Chinese character learning strategies to help students learn Chinese characters and to reduce the burden of writing them from memory. It is important to focus on the teaching of 'phonetic notes' in the teaching of Chinese characters to avoid the phenomenon of 'emphasising form over sound'.

3.4 Research on the application of Chinese characters in computers

Study of Chinese Character Formation.

The study of Chinese character conformation is a fundamental research in computerized Chinese character information processing. In recent years, research on data compression techniques with high compression ratios has been carried out in China, of which superposition and contouring techniques are two important ones. This is also an innovative point of combining Chinese character conformation research with computer technology.

Study of Chinese character morphological analysis.

Chinese character research is mainly related to the tendency to digitise Chinese characters, such as Chinese character morphological analysis techniques, which have received enthusiastic attention in Japan and China. Japanese research has used this technique to analyse Chinese characters in addition to many Japanese textual applications, such as the analysis of mapping relationships based on Chinese character morphological features and shell aspects to predict the formal structure of sentences of a particular grammatical form. Research is also being carried out abroad on the structural description of kanji forms, which abstractly decomposes kanji forms into interconnectable defined parts or elements, and decomposes kanji figures into separate parts through text parsing and image recognition to achieve the goals of structural parsing, text recognition and graphical analysis, which are important for the computer analysis of kanji forms.

3.5 A study of the cognitive processing of Chinese characters

The academic community has focused on the cognitive mechanisms in the process of Chinese character acquisition from a psycholinguistic perspective. Dong Xiaoyu (2003) proposed a theoretical concept of a 'multi-level Gestalt bi-directional processing model' for Chinese character recognition, suggesting that Chinese character cognition involves a 'whole-part-whole' process [27]. Peng Danning (1997) points out that parts are also a unit of Chinese character recognition. Compared to the characterisation of strokes, the analysis of parts occurs at a higher level [28]. Zhang Zhenjun, Ding Guosheng and Chen Baoguo (2011) used the age effect on Chinese character acquisition to complete a teaching study on the phonological integrity hypothesis [29]. Bai, Lili and Chen, Baoguo (2011) used a word category judgment task to examine the effect of age of acquisition on word category information processing [30]. Although there are many related studies, such as an experimental study of foreign students' recognition of morphemic characters (Chen Hui and Wang Kuijing 2001) [31], an experimental study of foreign students' awareness of morphemic phonological cues (Jiang Xin 2001) [32], and the role of phonological information next to sounds in international students' Chinese character learning (Hao Meiling and Shu Hua 2005) [33], there is still little progress.

These studies provide a paradigm for empirical research on the cognition of Chinese character acquisition,

which is of great significance as a good foundation for future research on Chinese character acquisition in the field of psychology.

4 Overview of Chinese character research methods

The field of textual research has continued to expand, the theoretical system of textual studies has been constructed, the research content has become extensive, and the research methods have become more scientific and rigorous. Throughout the past three decades, the main methods of Chinese character research have involved: exegetical examination, corpus data, and empirical methods.

4.1 An exegetical examination

Wang Yankun (2006) [34] divided the methods of precept research into three categories, the first of which --- the method of exploring the meaning of words by word form, including three subcategories: seeking meaning according to shape, seeking meaning by sound, and dialect proof; The second major category - methods of seeking the meaning of words by virtue of context, including three sub-categories of inferring meaning from the text, clarifying meaning from the compound language, and seeking meaning in the text; the third major category - methods of seeking the meaning of words by virtue of relevant documentary materials, including three sub-categories of seeking meaning from the original text, knowing meaning from different texts, and seeing meaning from the set of examples. Modern scholars have become more systematic and structured in their approach to exegesis, strengthening theoretical summaries and guidance. Exegetical methods have also gradually become more modern, with the use of computers and the Internet as key features. The study of Chinese characters using exegetical methods is mostly the study of ancient texts, which are closely linked to Chinese cultural traditions.

4.2 Corpus data

The number of corpora available for Chinese character research is constantly improving and increasing. The data corpus system is becoming more and more scientific and systematic, and the large-scale electronic text database through scientific sampling and processing has greatly improved the efficiency of scholars' Chinese character research, and is a solid foundation for the development of Chinese character digitization. At present, most foreign research on Chinese character shape analysis is based on database design, which enables fuzzy retrieval of Chinese character shapes. The database system stores information on Chinese character shape characteristics, forming computer-recognisable shapes that can be used to support multi-character recognition and multi-character text analysis applications, and can also develop applications relating to the recognition of Chinese characters from pinyin to Chinese character shapes.

4.3 Empirical Methods

In the last thirty years, empirical methods for Chinese character research have been largely based on questionnaires and reflective summaries of literature on practical teaching research, but there have also been innovative breakthroughs. For example, the combination of eye-movement research and scientific experiments in the field of psychology has greatly improved the efficiency of Chinese character research by setting up instruments and procedures for computational science and using eye-movement devices to test the patterns of Chinese character acquisition.

Eye-movement research involves using instruments to measure the eye movement patterns of users as they observe and use products, and analysing them. In the eye-movement study of second language learners reading phonetic texts at different levels of Chinese language proficiency [35], it was concluded that although the learners' reading speed increased as their Chinese language proficiency improved, there was still a large gap with native speakers. The main focus was on learning Chinese characters, and even beginners did not pay too much attention to reading phonetics at the expense of writing Chinese characters. Even the frequency of attention to pinyin decreases as Chinese proficiency improves. This may be related to the fact that Chinese characters are ideographic, thus not only addressing the fact that Chinese character teachers do not know whether their students neglect to master Chinese character forms in the acquisition process, but also enhancing the depth of research into the ideographic features of Chinese characters.

The use of eye-movement technology is a hot trend in the study of bilingual word processing in Chinese second language learners. As Chinese language proficiency increases, second language learners rely less on analytical processing and more on holistic processing, resulting in more efficient word recognition, but high-level second language learners have not yet made the transition from analytical to holistic processing. Previous studies have only examined the 'word length effect' and the 'stroke count effect', which selected mostly native speakers, with inconsistent results, and fewer studies of Chinese second language involving the stroke count effect. Within the framework of holistic and analytical processing, there are two studies that specifically focus on the effect of stroke count in Chinese bilinguals with reference to native Chinese speakers, which examined the effect of double-word stroke count in bilinguals, and the other examined the effect of single-word stroke count in this group, but neither of these studies. However, neither of these studies examined the effect of language level on the stroke count effect.

5 Shortcomings and Prospects of Chinese Character Research

In summary, there have been many categories of Chinese character research in the last thirty years, and interdisciplinary research has been innovative. However, the late start of Chinese character research and the lack of attention it has received have led to the fact that there are currently

many ideas or perspectives on Chinese character research that are not clearly implemented at a later stage, and that the results of the proposed ideas are less likely to be validated. Moreover, due to the differences in root concepts and academic backgrounds, the same area of Chinese character research may yield very different results. Solutions to the same problems are similar or repeated, and there is a great deal of repetition of ideas within fifty years, concentrating on Chinese character morphology, component orthography, and language teaching philosophy. Although there have been breakthroughs in scientific experiments and in the field of cognitive psychology in the cognition of Chinese character acquisition, they are not obvious and need to be concretely implemented in practical Chinese character research.

Of course, in the light of the current state of Chinese character research, the author also has the following perspectives on the future of Chinese character research. Some Chinese universities and research institutions are currently carrying out transformative research on Chinese characters. For example, the Laboratory of Chinese Character Research and Modern Applications at Beijing Normal University has built a multidisciplinary platform for integrated research on Chinese characters. The first is a multidisciplinary approach to innovative Chinese character research. For example, it has been developing a platform for organising and building resources for ancient and modern Chinese characters; researching automatic character acquisition technology and developing a system for annotating the attributes of Chinese character structures; and developing a platform for humanistic computing and data mining based on Chinese character big data. The second is the construction of a Chinese character big data resource base: a repository of Chinese character morphological resources and evolutionary relationships over the ages; a repository of Chinese character holographic attributes; a repository of academic resources for ancient and modern Chinese character research; a language corpus and knowledge map based on Chinese character morphology, phonology and meaning. There are also products and services for modern applications of Chinese characters: the development of a big data service platform for Chinese character constructions; the development of a big data service platform for canonical texts; the development of a knowledge base of Chinese sentence patterns and an automatic graphical sentence analysis system; and the construction of a Chinese character education platform.

6 Concluding remarks

In the last thirty years, Chinese character research has tended to be multi-perspective and diversified, with research content going deeper, research theories and research methods taking on an interdisciplinary character, and innovations and breakthroughs increasing, but in the specific teaching of Chinese characters, the pedagogical effects are not significant, and the visual development of tools for Chinese characters is weak. More and more young scholars are devoting themselves to the study of Chinese characters, and with the simplification, diversification and digitalisation of Chinese characters, the study

of Chinese characters combined with computer applications and the field of psychology has taken a new direction. We must not only actively explore the theoretical directions of Chinese character research, but also put our feet on the ground to implement concrete measures in the teaching of Chinese characters to show the light of hope for Chinese character research.

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