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The Role of Phonological Awareness and Pinyin Knowledge in Chinese Character Reading among Arabic-Speaking Learners

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Chen Chen. THE ROLE OF PHONOLOGICAL AWARENESS AND PINYIN KNOWLEDGE IN CHINESE CHARACTER READING AMONG ARABIC-SPEAKING LEARNERS

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Abstract. With the growing enthusiasm for learning Chinese in Arabic-speaking countries, research on the learning patterns of Arabic-speaking learners of Chinese deserves greater attention. This study examines the role and pathway of phonological awareness and Pinyin knowledge in the Chinese character reading of Arabic-speaking learners at beginner and intermediate levels. The results show that Pinyin knowledge significantly predicts both reading accuracy and fluency at both proficiency levels, although its effect on reading fluency diminishes at the intermediate level. Auditory phonological awareness does not directly predict Chinese character reading, but exerts an indirect influence through the mediation of Pinyin knowledge. Furthermore, reading accuracy serves as a strong predictor of the development of reading fluency. Based on these findings, the study offers pedagogical suggestions for teaching Chinese characters to Arabic-speaking learners.

Keywords: phonological awareness, Pinyin knowledge, reading accuracy, reading fluency, Arabic-speaking learners

Чен Чен. РОЛЯТА НА ФОНОЛОГИЧНАТА ОСВЕДОМЕНОСТ И ПОЗНАВАНЕТО НА ПИНИН ПРИ РАЗЧИТАНЕТО НА КИТАЙСКИ ЙЕРОГЛИФИ СРЕД АРАБСКОГОВОРЕЩИ УЧАЩИ

Резюме. С нарастващия ентусиазъм за ученето на китайски език в арабскоговорящите страни, изследванията за обучителните методи на учещите китайски език арабскоговорящи заслужават по-голямо внимание. Това проучване изследва ролята и моделите на фонологичната информираност и познанието по Пинин през четенето на китайски символи от арабскоговорящите на начално и средно ниво. Резултатите показват, че познанията по Пинин значително предсказват както правилността на четене, така и отличното владеене на езика, макар и този ефект върху четенето да намалява на средно ниво. Слуховото фонологично познание не предсказва директно разчитането на китайските символи, но оказва индиректно влияние чрез медиацията на познанието по Пинин. Нещо повече, правилността на четене служи като значително средство за развитието на отличното владеене на четенето. Базирано на тези данни, изследването предоставя педагогически предложения за преподаването на китайски символи на учещите арабски език.

Ключови думи: фонологична информираност, познания по Пинин, правилност на четенето, отлично владеене на четене, учещи арабски език

Research/ Научно изследване

I. Introduction

With countries such as the United Arab Emirates, Saudi Arabia, and Egypt successively incorporating Chinese into their national education systems, Chinese language education has developed rapidly across the Arab world, drawing increasing attention from scholars. Studies have begun to explore topics such as the localisation of Chinese language education (Zhu, Lan and Chen, 2021) and strategies for optimising its integration into national curricula (Li, Wei, 2022). A growing number of Arabic-speaking learners have begun studying Chinese, yet research on the learning patterns specific to this group remains insufficient.

Chinese belongs to the Sino-Tibetan language family, while Arabic is a Semitic language within the Afro-Asiatic family. The two differ greatly in terms of phonology and orthography. The orthography of Chinese characters is highly opaque, with no stable grapheme–phoneme correspondence, posing considerable challenges for learners from alphabetic language backgrounds such as Arabic. Previous studies have shown that phonological awareness and Pinyin knowledge significantly influence Chinese character reading performance among both native Chinese-speaking children and second language learners (Hao, Zhou, 2019; Yu et al., 2023; Ju, Zhou and delMas, 2021; Wang, McBride, 2016). Phonological awareness may also exert

an indirect effect on Chinese reading through the mediating role of Pinyin (Li et al., 2016). However, findings in this area have been inconsistent (Chang, 2011; Sun, Hu and Curdt-Christiansen, 2020; Yin et al.， 2011), and few studies have distinguished learners by native language background. As a result, the relationship among these three variables remains unclear for Arabic-speaking learners. This study therefore focuses on the influence of phonological awareness and Pinyin knowledge on the Chinese character reading of Arabic-speaking learners, and investigates the mediating role of Pinyin between phonological awareness and reading performance. The aim is to contribute empirical evidence from this learner group to clarify the interrelations among these factors and to offer pedagogical suggestions for teaching Chinese characters to Arabic speakers.

II. Literature review

2.1. Phonological Awareness and Chinese Character Reading

Phonological awareness refers to learners' ability to perceive and manipulate speech sound units (Goswami, 2002). According to the Universal Phonological Principle (Perfetti, Zhang and Berent, 1992) and the Psycholinguistic Grain Size Theory (Ziegler, Goswami, 2005), the development of reading ability depends on the processing of phonological information. As a key form of metalinguistic awareness, phonological awareness contributes to literacy acquisition; however, the extent and nature of this contribution vary depending on the writing system and the orthographic characteristics of the language. In alphabetic languages such as English, the importance of phonological awareness for reading skills has been widely confirmed (Al Ghanem, Kearns, 2014; Goswami, Bryant, 2016). In contrast, as Chinese is a non-alphabetic script, whether phonological awareness plays a similar role has been the subject of continued investigation.

Zhao et al. (2025), in a longitudinal study of 172 Chinese children, found no significant association between phonological awareness and Chinese character reading ability at the end of kindergarten, Grade 1, or Grade 3. Other studies have observed correlations between the two (Chung et al., 2013; Shu, Peng and McBride-Chang, 2008), although the strength of these associations is generally weaker than in English (Song et al., 2015). Moreover, the correlation between phonological awareness and reading is stronger in pre-school children than in primary school students (Yang, Zheng and Liu, 2023), and even at the primary level, phonological awareness appears to significantly impact only early-stage vocabulary reading (Liu et al., 2017). In addition, early Chinese reading may in turn facilitate the development of phonological awareness at various grain sizes (Li, Fan and Zhao 2025). These findings suggest a potentially reciprocal relationship between the two, with the link being more evident during the early stages of reading development.

Research on second language learners of Chinese has also yielded complex findings. For example, Wong and Zhou (2022) found that phonological awareness had no significant effect on Chinese reading among South Asian children living in Hong Kong. In contrast, studies involving heritage Chinese children learning Chinese as a second language in Singapore (Zhang, 2017), children in Indonesia (Hao, Dinda, 2020), and international students at beginner proficiency levels in China (Liu, Hao and Wang 2020) all found that phonological awareness significantly predicted Chinese character reading. Sun and O'Brien (2024) examined the factors influencing Chinese and English literacy among bilingual children in Singapore, whose home language was English. They found that phonological awareness, morphological awareness, and receptive vocabulary were all significant predictors of Chinese character reading in Grade 1; however, by Grade 3, only morphological awareness and receptive vocabulary remained significant. These findings suggest that the role of phonological awareness may change over the course of reading development.

2.2. Pinyin Knowledge and Chinese Character Reading

According to the Simple View of Reading (Gough, Tunmer, 1986), reading comprehension consists of two core components: word decoding and language comprehension. Decoding refers to the ability to access a word's pronunciation and meaning from its visual form (Hao, Sun and Cao, 2020). In alphabetic languages, children can often access meaning through grapheme–phoneme correspondence rules (Yu et al., 2023). However, as Chinese is a logographic language, children cannot accurately pronounce characters based on orthography alone. Consequently, Hanyu Pinyin is employed as an auxiliary tool to support character learning. As a phonetic encoding system, Pinyin helps children pronounce unfamiliar characters, enabling them to match the spoken forms with the phonological representations stored in their mental lexicon, thereby strengthening the connection between a character's form and sound. Theoretically, then, learning Pinyin should benefit both native Chinese-speaking children and second language learners in acquiring Chinese reading skills.

Existing research has explored the predictive role of Pinyin knowledge in character recognition (Lin et al., 2010; Wang, McBride, 2016; Zhang et al., 2020) and in learning new characters (Wu et al., 2002) among native Chinese-speaking children at different grade levels. In the field of second language acquisition, studies have shown that the way in which Pinyin is presented can affect beginners' reading outcomes. For instance, presenting characters first and providing Pinyin and English translations with a slight delay leads to more effective character acquisition than simultaneous presentation of all three elements (Chung, 2002).

When it comes to the facilitative effect of Pinyin at the intermediate level, Xiao, Xu and Rusamy (2020), in a study of 158 intermediate-level primary school students at an international school in Indonesia, found that Pinyin continued to exert diverse and lasting effects on advanced second-language skills in Chinese, such

as depth of vocabulary knowledge and reading comprehension. Zhang and Roberts (2021) found that Pinyin spelling could predict both reading and writing skills among learners at pre-intermediate and intermediate levels. However, the former study did not differentiate between heritage and non-heritage learners, while the latter relied solely on a Pinyin invented spelling task, which involves complex processing, including phonological discrimination, and is therefore considered a phonological awareness task (Hao, Zhao, 2022). Thus, the role of Pinyin in Chinese reading at the intermediate level warrants further investigation.

Learners' processing of Pinyin symbols may also be influenced by their native language background (Li et al., 2019). The consonant-based orthographic system of Arabic differs substantially from the alphabetic representation of Hanyu Pinyin, raising the question of whether and how this difference may affect the role of Pinyin in reading acquisition.

2.3. The Relationship Among Phonological Awareness, Pinyin Knowledge, and Chinese Character Reading

Phonological awareness and Pinyin knowledge are closely related. Learning Pinyin supports both native Chinese-speaking children (Yin et al., 2011) and second language learners (Li et al., 2019) in processing tonal information, and can help learners develop more accurate phonological representations of Chinese consonants (Liu, Xu, 2023). At the same time, children's performance on phonological awareness tasks has been shown to significantly predict their Pinyin reading ability (Ma et al., 2020). These findings suggest a potentially reciprocal relationship between phonological awareness and Pinyin knowledge. However, the two constructs should not be conflated. Research has found that, compared with phonological awareness, Pinyin knowledge makes a stronger contribution to Chinese reading performance (Ju, Zhou and delMas, 2021; Ma et al., 2020).

As discussed above, phonological awareness influences Pinyin ability, while Pinyin ability is an important predictor of Chinese reading. This raises the question of whether phonological awareness might indirectly affect Chinese reading through the mediating role of Pinyin. Some studies have proposed that phonological awareness primarily contributes to Chinese reading by facilitating the development of Pinyin knowledge (Li et al., 2016; Siok, Fletcher, 2001). However, these studies were conducted with native Chinese-speaking children. Whether a similar pattern exists among second language learners remains an open question and requires further investigation.

This study examines two dimensions of Chinese character reading: accuracy and fluency. Reading fluency refers to the ability to read accurately and rapidly, and it involves a range of complex processes and skills (Hudson et al., 2008). Both accuracy and fluency are key indicators of reading comprehension. The two are closely related in Chinese reading (Hao, Dinda, 2020), but their development relies

on different cognitive skills (Hao, Zhou, 2019; Liu et al., 2017). Accordingly, this study investigates whether phonological awareness and Pinyin knowledge predict reading accuracy and fluency among Arabic-speaking learners of Chinese, as well as the relationship between the two reading dimensions. With a focus on Arabic-speaking learners of Chinese at the elementary and intermediate proficiency levels, the study aims to address the following three research questions:

1. Do phonological awareness and Pinyin knowledge influence the Chinese character reading performance of Arabic-speaking learners?

2. Does phonological awareness facilitate the development of Pinyin knowledge among Arabic-speaking learners, and does it affect Chinese character reading through the mediation of Pinyin?

3. What is the relationship between reading accuracy and fluency in Chinese character reading among Arabic-speaking learners?

III. Methods

3.1. Participants

A total of 60 participants took part in the experiment. All were students majoring in Chinese at a university in Egypt and were grouped by Chinese proficiency level: elementary (HSK Levels 1–3) and intermediate (HSK Levels 4–5), with 30 participants in each group. Participants were aged between 18 and 35, including both current students and graduates. All participants had normal intelligence, with no visual or auditory impairments. All 60 participants were native speakers of Arabic, and none were heritage learners of Chinese.

3.2. Experimental Design

3.2.1. Pinyin Knowledge Test

The Pinyin knowledge test consisted of two components: Pinyin reading and Pinyin writing. Each task included three types of items: (1) common and relatively simple Pinyin syllables, such as *bǎ*; (2) reduced forms of Pinyin syllables (e.g., *guī*, where the *e* is omitted, and *jù*, where the two dots in *ü* are omitted); (3) zero-initial syllables containing *y* or *w*.

The reading section included 40 Pinyin syllables, covering 21 consonantal initials (including zero consonants), 39 finals, and all four tones. The 40 syllables were printed horizontally on an A4 sheet, and participants were asked to read them aloud in sequence. The examiner recorded and scored their responses. The internal consistency reliability (Cronbach's alpha) of this task was .81.

The writing (dictation) section consisted of 20 Pinyin items. The examiner played audio recordings of each item, and participants were instructed to write the Pinyin syllables on an answer sheet. The internal consistency reliability of this task was .78.

3.2.2. Phonological Awareness Test

The phonological awareness test consisted of four subtasks, regarding initials, finals, tones, and phoneme. The first three subtasks employed an oddity paradigm. Participants were auditorily presented with three monosyllabic Chinese words, two of which shared the same initial/final/tone, while the third differed. The task was to identify the item with the distinct phonological feature. The test was administered in a paper-based format.

For example, in the final-awareness subtask, the examiner would say: *"māi, zāo, māo – which of these three words has a different final sound from the other two?"* The correct answer is *māi*, and participants would mark option ① corresponding to that item on the answer sheet. Each of the three subtasks (initial consonants, finals, and tones) consisted of 30 items. The internal consistency reliability (Cronbach's alpha) was .76 for the initial consonant task, .72 for the final task, and .78 for the tone task.

The phoneme deletion task involved presenting a monosyllabic Chinese word auditorily and asking participants to delete one phoneme and say the remaining part. For example, given the word *cháng*, participants were asked to delete the initial phoneme *ch* and respond with *áng*. The deleted phonemes appeared in initial, medial, and final positions, with 6 items for each position, totalling 18 items. The internal consistency reliability of this task was .76.

For all tasks, participants received 1 point for each correct response and 0 points for incorrect or missing answers. If a participant revised an initial response and the correction was accurate, the item was still counted as correct. Before each formal task, participants completed three practice items to ensure they fully understood the task requirements. The final analysis was based on the average accuracy rate for each task.

3.2.3. Chinese Character Reading Test

This component included two tasks: reading accuracy and reading fluency. All test materials were adapted from the participants' Chinese textbook, *HSK Standard Course*.

The reading accuracy task involved the visual presentation of 120 Chinese characters. Among them, 40 characters were familiar to both groups; another 40 were relatively unfamiliar to the elementary group but more familiar to the intermediate group; the remaining 40 were unfamiliar to both groups. Characters were selected with consideration of frequency, number of strokes, and number of components, and were arranged in order of increasing difficulty. The characters were printed on an A4 sheet, and participants were asked to read them aloud. The examiner recorded their responses and scored them. Reading accuracy rate served as the primary measure for analysis. The internal consistency reliability (Cronbach's alpha) of this task was .90.

The reading fluency task consisted of 100 simple, high-frequency Chinese characters printed on an A4 sheet. Participants were instructed to read the characters as quickly and accurately as possible within one minute. The number of correctly read characters within the time limit was recorded as the measure of fluency.

3.3. Experimental Procedure

All experimental tasks were conducted in a quiet Chinese-language classroom on campus. The initial consonant, final, tone awareness tasks, and the Pinyin dictation task were administered in group settings, while all other tasks were conducted individually. The experiment was implemented by five Chinese language teachers from the university's Confucius Institute. Upon completion, valid data were collected and organised using Excel. The entire set of tasks took approximately 45 minutes to complete. Participants were allowed to take breaks if they felt fatigued and received a small reward upon completing the experiment.

IV. Results

Table 1 presents the mean accuracy rates and standard deviations for all test measures. Independent samples t-tests were conducted to compare the performance of the two proficiency groups. The results indicated that there were no significant differences between the elementary and intermediate groups in either Pinyin knowledge or phonological awareness scores. However, significant differences were observed in both character reading accuracy and reading fluency, with the intermediate group outperforming the elementary group. These findings suggest that while elementary-level learners had already developed solid Pinyin knowledge and phonological awareness, intermediate learners demonstrated substantially stronger performance in Chinese character reading.

Table 1. Descriptive Statistics and Independent Samples t-Tests for Each Task

	Elementary		Intermediate		*t*-test (*p*)
	M	SD	M	SD	
Pinyin Knowledge	.76	.16	.81	.13	.20
Phonological Awareness	.84	.09	.87	.07	.10
Character Reading Accuracy	.41	.14	.56	.17	<.001
Character Reading Fluency	.51	.18	.68	.20	.00

Note: M = Mean; SD = Standard Deviation.

Table 2 presents the correlation matrices for all test variables. Correlational analyses revealed that among both elementary and intermediate Arabic-speaking learners, Pinyin knowledge was highly correlated with both Chinese character

reading accuracy and fluency (*r* ranging from .73 to .81). Phonological awareness showed low to moderate correlations with reading accuracy and fluency (*r* ranging from .46 to .65). The correlation between Pinyin knowledge and phonological awareness was moderate (*r* = .66) at the elementary level and strong (*r* = .83) at the intermediate level. Character reading accuracy and fluency were strongly correlated in both groups (*r* = .84 and .86, respectively).

Table 2. Correlation Matrix for Each Test Variable

		1	2	3	4
Elementary	1 Pinyin Knowledge				
	2 Phonological Awareness	.66***			
	3 Reading Accuracy	.73***	.51**		
	4 Reading Fluency	.76***	.46*	.84***	
Intermediate	1 Pinyin Knowledge				
	2 Phonological Awareness	.83***			
	3 Reading Accuracy	.81***	.65***		
	4 Reading Fluency	.74***	.65***	.86***	

Note: p < .05, **p** < .01**, ***p*** < .001.*

Research Question 1: Regression Analyses of Phonological Awareness and Pinyin Knowledge as Predictors of Chinese Character Reading

Separate regression analyses were conducted for elementary and intermediate learners, with character reading accuracy and reading fluency as the dependent variables, and phonological awareness and Pinyin knowledge as predictors.

For elementary-level learners, the regression models were significant. The two predictors jointly explained 49.4% of the variance in reading accuracy and 54.6% of the variance in reading fluency. Pinyin knowledge alone accounted for 27% of the variance in reading accuracy and 36.9% in fluency. Phonological awareness did not make a significant independent contribution to either outcome.

For intermediate-level learners, the two predictors jointly explained 62.8% of the variance in reading accuracy and 52.1% of the variance in fluency. Pinyin knowledge accounted for 23.5% and 13.7% of the variance in reading accuracy and fluency, respectively, while the independent predictive effect of phonological awareness was not significant. Although phonological awareness and Pinyin knowledge were highly correlated in the intermediate group (*r* = .83), the variance inflation factor (VIF = 3.265) indicated that multicollinearity was not at a problematic level. See Tables 3 and 4 for full regression results.

Table 3. Regression Analysis Predicting Chinese Character Reading Accuracy

	Variable	B	SE	β	t	VIF	R^2 / adj. R^2	F change
Elementary	Pinyin Knowledge	.590	.150	.694	3.939***	1.783	.529/.494	15.178***
	Phonological Awareness	.075	.275	.048	.275	1.783		
Intermediate	Pinyin Knowledge	1.204	.282	.876	4.279***	3.265	.654/.628	25.483***
	Phonological Awareness	–.192	.478	–.082	–.401	3.265		

Table 4. Regression Analysis Predicting Chinese Character Reading Fluency

	Variable	B	SE	β	t	VIF	R^2 / adj. R^2	F change
Elementary	Pinyin Knowledge	.935	.192	.812	4.862***	1.783	.577/.546	18.449***
	Phonological Awareness	–.174	.353	–.083	–.495	1.783		
Intermediate	Pinyin Knowledge	1.075	.373	.669	2.879**	3.265	.554/.521	16.747***
	Phonological Awareness	.242	.634	.089	.381	3.265		

Research Question 2: Regression Analysis of Phonological Awareness Predicting Pinyin Knowledge and Mediation Analysis of Pinyin Knowledge

To examine whether phonological awareness predicts Pinyin knowledge, regression analyses were conducted with Pinyin knowledge as the dependent variable and phonological awareness as the independent variable. For elementary-level learners, the model was significant, $F(1, 28) = 21.917$, $p < .001$, with an adjusted $R^2 = .419$. Phonological awareness accounted for 41.9% of the variance in Pinyin knowledge. For intermediate-level learners, the model was also significant, $F(1, 28) = 63.421$, $p < .001$, with an adjusted R^2 of .683, indicating that phonological awareness explained 68.3% of the variance in Pinyin knowledge (see Table 5).

Table 5. Regression Analysis of Pinyin Knowledge

	Variable	B	SE	β	t	R^2 / adj. R^2	F change
Elementary	Phonological Awareness	1.215	.260	.663	4.682***	.439/.419	21.917
Intermediate	Phonological Awareness	1.415	.178	.833	7.964***	.694/.683	63.421

To examine whether Pinyin knowledge mediates the relationship between phonological awareness and Chinese character reading accuracy, a path analysis was conducted using SPSS PROCESS Macro (Model 4). Phonological awareness was entered as the independent variable, Pinyin knowledge as the mediator, and character reading accuracy as the dependent variable. The results are presented in Table 6.

Table 6. Mediation Analysis of Pinyin Knowledge Between Phonological Awareness and Character Reading Accuracy

	Effect	BootSE	BootLLCI	BootULCI	Proportion of Effect
Total Effect	1.23	0.22	0.79	1.67	
Direct Effect	0.23	0.28	–0.32	0.78	18.84%
Indirect Effect	1.00	0.24	0.63	1.56	81.16%

The direct effect of phonological awareness on Chinese character reading accuracy was not significant, as the 95% confidence interval included zero (95% CI = [–0.32, 0.78]). But the indirect effect via Pinyin knowledge was significant (95% CI = [0.63, 1.56]), accounting for 81.16% of the total effect. As shown in Figure 1, phonological awareness does not directly predict character reading accuracy, but exerts an indirect influence through Pinyin knowledge.

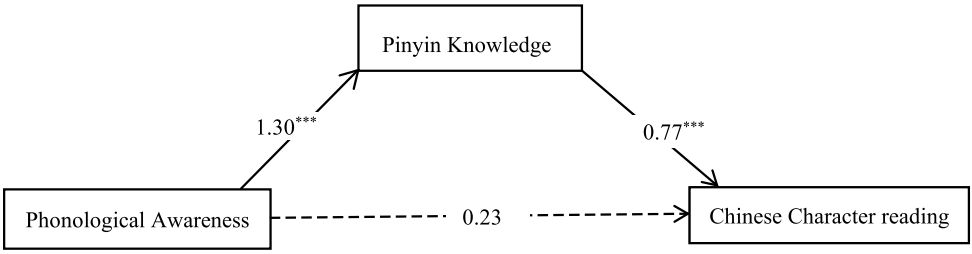

Figure 1. *Path analysis of phonological awareness, Pinyin knowledge and Chinese character reading*

Research Question 3: The Relationship Between Chinese Character Reading Accuracy and Fluency

To examine the relationship between reading accuracy and fluency in Chinese character reading, regression analyses were conducted separately for the two proficiency groups, using reading fluency as the dependent variable and reading accuracy as the predictor. For elementary-level Arabic-speaking learners, the regression model was significant, $F(1, 28) = 65.317$, $p < .001$, with an adjusted R^2 of .689. This indicates that character reading accuracy accounted for 68.9% of the variance in reading fluency. For intermediate-level learners, the model was also significant, $F(1, 28) = 76.052$, $p < .001$, with an adjusted R^2 of .721. Reading accuracy thus explained 72.1% of the variance in fluency (see Table 7).

Table 7. Regression Analysis Predicting Chinese Character Reading Fluency from Reading Accuracy

	Predictor	B	SE	β	t	R^2 / adj. R^2	F change
Elementary	Reading accuracy	1.135	.140	.837	8.082***	.700/.689	65.317
I Intermediate	Reading accuracy	.999	.115	.855	8.721***	.731/.721	76.052

V. Discussion

5.1. The Direct Effect of Pinyin Knowledge in Chinese Character Reading

Pinyin provides the pronunciation of Chinese characters and facilitates the acquisition of their phonological forms (Chen, Zhou and Wang, 2016). At the elementary to intermediate stages of Chinese as a second language (L2) reading development, learners have limited character recognition abilities. Since Chinese characters do not directly encode phonology, Pinyin is commonly placed above characters in textbooks to help learners access pronunciation. This supports the strengthening of orthography-phonology connections in the mental lexicon, thereby promoting reading development. The role of Pinyin has been widely supported in empirical studies on early character recognition among children (Wang, McBride, 2016) and on L2 reading among beginner learners (Yu, Sun and Pang 2022).

On this basis, the present study further explored this issue among Arabic-speaking learners at the elementary and intermediate levels. It was found that Pinyin knowledge significantly and independently predicted both reading accuracy and fluency. After controlling for phonological awareness, Pinyin knowledge explained 27% and 36.9% of the variance in reading accuracy and fluency, respectively, at the elementary level, and continued to contribute at the intermediate level (23.5% and 13.7%). These findings suggest that Pinyin serves as a crucial bridge between character form and sound, enabling learners to recognise and read characters accurately and fluently. Moreover, its impact is not confined to early stages of reading but persists into intermediate proficiency.

It is however also observed in this study that the contribution of Pinyin to reading fluency diminishes as L2 learners' Chinese proficiency increases (from 36.9% to 13.7%). A longitudinal eye-tracking study by Yu, Sun and Pang (2022) reported a similar pattern. Across four stages over the course of one year, they found that while Pinyin significantly enhanced reading efficiency at all stages, dependence on Pinyin decreased by the final stage, as learners allocated greater attention to characters. This may be attributed to learners' growing ability to access meaning directly through orthography as their proficiency improves (Chen et al., 2019). By the intermediate stage, learners in this study had accumulated sufficient reading experience, and previously unfamiliar words had likely become part of their visual

lexicon (Ehri, 2005). As cognitive resources required to process Pinyin decrease, learners become progressively less reliant on it.

5.2. The Indirect Effect of Auditory Phonological Awareness on Chinese Character Reading

This study did not find a significant direct effect of auditory phonological awareness on Chinese character reading among Arabic-speaking learners. In contrast, Zhang and Roberts (2019), in a study of 83 Chinese L2 learners from English- and Arabic-speaking backgrounds, reported a significant predictive effect of phonological awareness on Chinese character recognition. The discrepancy between their findings and those of the present study may be attributed to the limitations of auditory phonological awareness as a construct.

Phonological awareness can be divided into two types. The first is auditory phonological awareness, which measures a learner's ability to perceive and manipulate units of spoken language (Goswami, 2002). The second is visual phonological awareness, which focuses on the ability to convert written forms to phonological representations (Li, Li, 2012). Since Chinese characters are directly linked to meaning through orthography, morphological awareness is often more important than phonological awareness in character recognition (Li et al., 2016). Moreover, the predictive power of auditory phonological awareness for character reading has been shown to be inconsistent (Hao, Zhang, 2006; Zhang et al., 2020). In contrast, visual phonological tasks, which assess the strength of orthography–phonology mapping, are more closely related to visual word reading and tend to show more consistent predictive effects (Hao, Zhou, 2019).

This study revealed the indirect effect of auditory phonological awareness on Chinese reading. Although auditory phonological awareness did not directly predict character reading ability, it exerted a significant indirect effect through the mediating role of Pinyin knowledge. The findings showed strong correlations between phonological awareness and Pinyin knowledge at both proficiency levels (r = .66 and .83 respectively), and regression analyses indicated that phonological awareness accounted for 41.9% and 68.3% of the variance in Pinyin knowledge, respectively. Path analysis confirmed that Pinyin knowledge fully mediated the relationship between auditory phonological awareness and Chinese reading performance, a pattern consistent with previous findings in studies on native Chinese-speaking children (Li et al., 2016; Siok, Fletcher, 2001).

This suggests that learners with higher levels of phonological awareness are better able to recognize and produce accurate Pinyin pronunciation, enabling them to better perform Pinyin writing tasks, and thus indirectly enhancing their reading ability. For example, a learner with well-developed auditory phonological awareness may accurately spell *qīng tíng* (蜻蜓). When encountering new words annotated with Pinyin, they can quickly decode the pronunciation and link it to known

spoken vocabulary, facilitating comprehension. In contrast, a learner with weak phonological awareness might confuse tones and incorrectly spell the word as *qǐng tíng*, failing to match it with any known lexical item, thereby impeding reading. Thus, an advantage in phonological awareness can be translated into Pinyin accuracy, which in turn serves as a decoding tool for reading.

This study also found that different modalities of phonological awareness may contribute to reading via distinct pathways. Hao and Zhao (2022) assessed both auditory and visual phonological awareness and found that Pinyin knowledge indirectly influenced character learning through visual phonological awareness, while auditory phonological awareness did not play a mediating role. In other words, Pinyin can enhance learners' sensitivity to initials, finals, and tones, thereby supporting the development of visual phonological awareness, which in turn promotes character learning. For instance, when learners see characters like *biǎn* (扁) and *biàn* (遍), they may notice that the initial and final are identical but the tones differ; similarly, in *biān* (编) and *piān* (篇), the final and tone are identical but the initials differ. This helps them more accurately map orthographic forms to phonological representations. These two pathways likely reflect differences in cognitive processing between auditory and visual phonological awareness. Auditory phonological awareness relies more on phonological working memory and emphasizes the accuracy of phonological decoding, while visual phonological awareness contributes by supporting the development of precise orthography–phonology mappings.

The next question to be examined is whether the Arabic L1 background influences the relationship among phonological awareness, Pinyin knowledge, and Chinese Character reading. In a study involving adult L2 Chinese learners with Arabic and English language backgrounds, Zhang and Roberts (2019), found that English native speakers significantly outperformed Arabic native speakers in phonological awareness tasks (mean accuracy rates = .87 vs. .74, $p < .001$). This difference may be attributed to the phonological similarity between English and Pinyin. According to the transfer facilitation model (Koda, 2008), English speakers can transfer their well-developed phonological awareness from English to Chinese. In contrast, Arabic, being a consonant-based language with fewer vowel distinctions, differs more substantially from Chinese phonology, which may pose greater challenges for Arabic speakers in developing phonological awareness in Chinese. The influence of learners' L1 background may be particularly evident in Pinyin pronunciation accuracy and phonological awareness (Hao, Zhao, 2022). In our study, a total of 60 participants were tested, most of whom were at HSK Levels 3 and 4. Both elementary and intermediate learners performed well on the Pinyin knowledge and phonological awareness tasks. Except for the elementary group's Pinyin accuracy (mean = .76), all other accuracy rates exceeded .80, and there were no significant differences between the two groups on either task ($p = .20$ and .10, respectively). This suggests that participants had already acquired solid Pinyin knowledge and

relatively mature Chinese phonological awareness. Taken together, these findings suggest that the influence of an Arabic L1 background on the relationship among phonological awareness, Pinyin knowledge, and Chinese character reading may be more pronounced at the early stages of Chinese reading development.

5.3. Chinese Character Reading Accuracy and Fluency

Previous research has shown that reading accuracy in early grades is a strong predictor of reading fluency, and this relationship follows a similar pattern across different orthographic systems, such as English and Greek (Altani et al., 2020). In the present study, a high correlation was observed between Chinese character reading accuracy and fluency at both the elementary (r = .84) and intermediate (r = .86) levels; reading accuracy accounted for 68.9% and 72.1% of the variance in fluency, respectively. These findings suggest that the development of Chinese reading fluency is premised on a solid foundation in reading accuracy (Hao, Dinda, 2020), and that the relationship between accuracy and fluency may exhibit cross-linguistic consistency, with limited influence from orthographic transparency.

Additionally, the present study found that while the predictive effect of Pinyin knowledge on reading accuracy remained stable through the intermediate level, its effect on reading fluency declined notably. This may indicate that once a certain level of reading accuracy is achieved, learners require higher-level cognitive processing abilities to progress from word-by-word reading to fluent reading.

VI. Conclusion and Implications

This study investigated the roles and pathways of phonological awareness and Pinyin knowledge in Chinese character reading among Arabic-speaking learners at elementary and intermediate proficiency levels. The findings revealed that Pinyin knowledge significantly predicted both reading accuracy and fluency at both stages, although its effect on fluency declined at the intermediate level. Auditory phonological awareness did not have a direct predictive effect on character reading, but exerted a significant indirect effect through the mediation of Pinyin knowledge. In addition, reading accuracy was found to be a strong predictor of the development of reading fluency. These results provide useful insights for Chinese character instruction targeting Arabic-speaking learners.

First, it is essential to emphasize the role of Pinyin. Given its sustained impact on Chinese reading, systematic practice in both Pinyin reading and writing is necessary. The mastery of Pinyin could maximize its facilitative role in character learning. Exercises involving segmentation and blending of Pinyin syllables can help learners build stable, fine-grained phonological representations (Xu, Xiao, 2023), promote the development of visual phonological awareness, and strengthen the connection between orthographic, phonological, and semantic forms. At the same

time, auditory phonological training including imitation and discrimination tasks might help learners avoid common pronunciation errors.

Second, the development of reading skills should follow the principle of "accuracy before fluency." Accuracy serves as the foundation for fluent reading. In the early stages, instructional focus should be placed on reinforcing accurate single-character recognition. Gradual progression toward fluency can be achieved through scaffolded activities such as flashcard drills and timed reading of short phrases. Additional techniques including such as tongue twisters and rhythmic reading can enhance learners' ability to process visual information sequentially, facilitating a smooth transition from accurate decoding to natural and fluent reading.

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