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The Development of Preschool Children's Awareness of Semantic Radicals in Chinese Characters

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The present study investigated the development of Chinese preschool children's awareness of semantic radicals in Chinese characters. The two specific areas of focus were the development of awareness of the category consistency of the semantic radical and awareness of the semantic radical. A sample of 55 four-year-old children and 61 five-year-old children were randomly selected from a public preschool that did not include formal literacy education in its curriculum. Experiment 1 found that the children's awareness of the category consistency of semantic radicals had not yet developed, regardless of the configuration of characters. Experiment 2 found that the children showed no obvious awareness of the semantic radical and had a strong bias toward using phonetic radicals rather than semantic radicals to classify characters, with the bias being significant for characters of left-right configuration. The current findings suggest that Chinese preschool children have an awareness of radicals in Chinese characters and they are more sensitive to the phonetic radical than to the semantic radical and, consequently, prioritize the former.

Keywords: preschool children, chinese characters, semantic radicals, category consistency, phonetic radicals

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INTRODUCTION

Emergent Literacy theory emphasizes that preschool children develop literacy by learning words naturally in their daily living environments and through parent-child reading activities before receiving formal literacy education (Whitehurst and Lonigan, 1998; Sénéchal et al., 2001). Print knowledge, an important component of literacy, is closely related to preschool children's ability to decode words in the future (Whitehurst and Lonigan, 1998). Preschool children generally acquire preliminary print knowledge with age (Goodman, 1986). The Print Experience Model also suggests that even in the case of informal literacy education, preschool children can acquire print knowledge through natural contact with words (Justice & Lankford, 2002). Research on print knowledge of the alphabetic script has indicated that it includes the recognition of letters, written rules of letters, functions of text content, and the distinction between letters and pictures (Lonigan et al., 2000). Print knowledge in Chinese refers to the basic word awareness of children who speak Chinese as a native language, which includes the visual form of Chinese characters and Chinese orthographic awareness; a high-level print knowledge (Liu et al., 2014).

Chinese characters, as a form of ideographic writing, are profoundly different from alphabetic scripts such as English. The correspondence between orthography and phonology is not as straightforward in ideographic writing as it is in alphabetic scripts; rather, it is more indirect and arbitrary (Shu et al., 2000). Chinese characters have strong graphic features, ideographic features,

image integrity, and form (Zhou and Liu, 2010). Chinese characters comprise a cluster of strokes that do not directly correspond to phonetic or semantic meaning. In the past, it was assumed that Chinese characters could only be learned using mechanical memory. However, studies in recent decades have indicated that children undergo a course of analysis in the process of literacy learning, whether they speak an alphabetical language or Chinese. The letter is the most basic unit in alphabetic script, and children who speak alphabetical languages learn words by analyzing letters and letter strings in words. A Chinese character is a plane figure formed by a combination of strokes and radicals and changes in their positions (Wang et al., 2011). Most researchers have concluded that although the most basic unit of a Chinese character is a stroke, radicals play a crucial role in the process of Chinese character recognition (Peng et al., 1996; Li and Chen, 1999; Wu et al., 1999; Perfetti et al., 2005). Radicals are recurring sub-characters that are formed by combining strokes (Taft et al., 1999). Radicals are a crucial part of a Chinese character as they can promote Chinese character recognition (Zhou and Zeng, 2003). The speed at which a person judges whether Chinese characters are similar is affected by radicals rather than strokes. Thus, the radical is the primary unit of Chinese orthography (Chen et al., 1996).

Therefore, Chinese orthographic awareness refers to the cognition of Chinese characters' radicals and their appropriate positioning, as well as the function recognition of semantic radicals and phonetic radicals (Wang J. et al., 2017). The development of preschool children's Chinese orthographic awareness has been explored in multiple studies. Chan (1990) found that children in Hong Kong acquire the awareness of the radical and are able to distinguish pictures from words when they are 4 years old. Furthermore, 5-year-old children have got the initial knowledge of legal position of radicals. A study by Zhou and Liu (2010) showed that preschool children recognize Chinese characters as a whole in the early cognition of Chinese characters, but this cognitive disposition gradually disappears between the ages of 4 and 6 years old. Qian et al. (2013) found that 4–5 years old children have a certain awareness of orthography, that is, they can judge the integrity of Chinese characters based on a single radical and the awareness of the legal position of the radical develops rapidly. Additionally, they also pointed out that the rules of radical form and function has begun to germinate; however, they did not explain how this development occurs. Another study by Liu et al. (2014) also revealed that, by the age of 5 years old, preschool children have formed a primary orthographic awareness and have the awareness of the radical and its legal position. All in all, 4-year-old children show an emerging awareness of the fact that a radical is a part of a character, and most 5-year-old children show an increasing awareness of the correct position of radicals.

Although preschoolers' orthographic awareness of radicals and awareness of their appropriate position has been well studied, relatively few studies have explored preschoolers' awareness of the semantic or phonetic function of radicals. As an ideographic writing system, over 80% of Chinese characters are phonetic-semantic compound characters that are composed of both a semantic radical and a phonetic radical (Li and Kang, 1993). The shape of the whole character is determined by both the semantic and phonetic radicals (She and Zhang, 1997). The semantic radical suggests the meaning or semantic category of the whole character, while the phonetic radical provides full or partial information on the pronunciation of the whole character. About 88% of semantic radicals effectively signify the semantic information of the whole character (Fang et al., 1986; Shu et al., 2000). The accuracy of predicting the meaning of the whole word based on the semantic radical can be measured at over 60% (Williams and Bever, 2010). Semantic radicals are the most basic and most frequently used radicals in Chinese characters (Qian et al., 2015). A semantic radical is not only the "radical" in the Chinese character configuration, but also the "radical" in Chinese character recognition as well as the "radical" in the semantic meaning of the Chinese character (Zhang and Zhang, 2016). Compared with phonetic radicals, the semantic radical that related to the meaning or semantic category information of the character is more helpful than the phonetic radical for Chinese character recognition and judgment (Wang and Zhang, 2015; Wang X. et al., 2017; Wang et al., 2018) Identifying the semantic radical is the default method for Chinese native speakers to recognize Chinese characters (Wang et al., 2015).

Category consistency is an important feature of the semantic radical (Wang and Zhang, 2016). *Category consistency* has two implications. The first is whether the category of the semantic radical of character is the same as that of the whole character, and the second is the concentrated degree of the semantic category of Chinese characters formed by the identical semantic radical (Wang and Zhang, 2016). Here, the term *category consistency* refers to whether the category of the semantic radical of character is identical to that of the whole character. For example, the semantic radical 犭refers to the category "mammal," and the Chinese characters 猫 (cat) and 狗 (dog), which include the radical 犭, both signify mammals; thus, the category of this semantic radical is consistent with that of the whole character, the sematic radical 犭of the Chinese characters 猫and 狗has *Category consistency*. However, the semantic radical 女 refers to the category "female," and the characters 姓 (surname) and 始 (beginning) which include the semantic radical 女, are not related to the female category; thus, the category of this semantic radical is not consistent with that of the whole character, the sematic radical 女of the Chinese characters 姓and 始has *Category inconsistency* (Zhang et al., 2014a).

Several studies have found that semantic radicals promote Chinese character recognition and semantic classification when the category of the semantic radical is consistent with that of the whole character. On the contrary, semantic radicals disrupt Chinese character recognition and semantic classification when the category of the semantic radical is inconsistent with that of the whole character (Zhang et al., 1990; Zhang et al., 1991; She and Zhang, 1997; Williams, 2013). In developmental studies, researchers have also found that *category consistency* is an important factor affecting children's vocabulary recognition and semantic extraction, and that its effect increases as the children's age increases (Meng et al., 2000; Liu et al., 2002; Wang et al., 2015). This leads to our research questions for Experiment 1: Do preschool children begin to develop an

awareness of the category consistency of the semantic radical? Further, if preschool children have not yet achieved the awareness of *category consistency* of the semantic radical, can they initially realize that semantic radicals can indicate the category of Chinese characters? This leads to our research question for Experiment 2: Do preschool children begin to develop a preliminary awareness of the semantic radical?

In addition, both understanding of the configuration of Chinese characters and understanding of the function of semantic radicals is crucial for the development of preschool children's early spelling abilities (Lam and Mcbride, 2018). According to the spatial combination of radicals in the external form of Chinese characters, Chinese characters are mainly configured in either a left-right or top-bottom direction. The cognitive process of Chinese radicals and Chinese characters is influenced by these configurations (Bi and Weng, 2007; Luo, 2015). Thus, preschool children's cognitive performance in terms of the *category consistency* of the sematic radical and in terms of their bias toward either the phonetic radical or sematic radical are likely to be affected by the direction in which a Chinese character is configured.

Thus, with a basis in Emergent Literacy theory, this study investigated the development of Chinese preschool children's awareness of the function of semantic radicals in an informal literacy education environment. Further, it examined the two areas of preschool children's awareness of semantic radicals by observing how they classify phonetic-semantic compound characters. Experiment 1 investigated the development of preschool children's awareness of *category consistency* of the semantic radical. It attempted to answer the following questions:

1. Do preschool children make judgments based on the external characterization or *category consistency* of the semantic radical when they classify the phonetic-semantic compound characters that have an identical semantic radical?
2. Are there any differences seen in the children's judgments of characters with left-right configuration or top-bottom configuration?

Experiment 2 investigated the development of preschool children's awareness of the semantic radical. It addressed the following questions:

1. Do preschool children make judgments based on the semantic radical when they classify the phonetic-semantic compound characters that have an identical semantic radical and identical phonetic radical?
2. Is the awareness of semantic radical affected by the different character configurations?

METHODS

Experiment 1

Participants

The random sample consisted of a total of 57 children from a public kindergarten that did not include formal literacy education in its curriculum. There were 27 four-year-old children ($M = 4.63$, 13 boys and 14 girls) and 30 five-year-old children ($M = 5.74$, 18 boys and 12 girls). All of them were native Chinese speakers and volunteered to participate in the present study. Participants and their guardians provided their written informed consent to participate in this study and the study was reviewed and approved by the Human Research Ethics Committee before the study began.

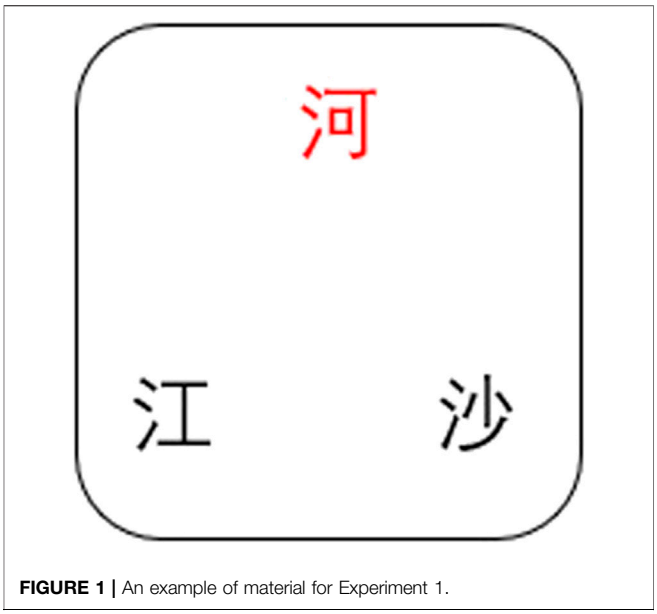

FIGURE 1 | An example of material for Experiment 1.

Measures

The children were presented with a group of three characters that had identical semantic radicals arranged in a triangle. See **Figure 1**. The stimulus characters, whose semantic radicals had *category consistency*, were presented in red font at the top of the triangle. Two target characters, presented in black font, were located at either end of the bottom of the triangle. One of the target characters showed *category consistency,* while the other showed *category inconsistency*. Two types of target characters appeared randomly at either end of the bottom of the triangle. The children were asked to choose which of the two black characters was similar to the red character. To understand the development of preschool children's awareness of the semantic radical, we analyzed the percentage of choices depending on *category consistency* or *category inconsistency* with respect to the semantic radical of Chinese character.

2.1.3 Materials

The materials included two types of phonetic-semantic compound characters: One in which the semantic radical showed *category consistency*, and the other in which the semantic radical showed *category inconsistency*. An example of the first type is the character 河 or 江, which means a form of or body of water, such as "river." The semantic radical 氵 belongs to the water category. In this case, the radical and the character are both related to water, so the radical of both characters 河 and 江

has *category consistency*. An example of the second type is the character 沙, which means "extremely exquisite particles." This character is unrelated to the category of the semantic radical 氵, which is related to water. Thus, the semantic radical of character 沙 has *category inconsistency*. Another example of the first type is the character 苗 or 芒, which means sprout and silvergrass. The semantic radical 艹 belongs to the plant category. The radical and the character are both related to plants. Thus, the radical of character 苗 or 芒 has *category consistency*. Another example of the second type is the character 若, which means "if" or "like." This character is unrelated to plants yet contains the radical 艹. Thus, the semantic radical of character 若 has *category inconsistency*. Characters 河 and 江 and 沙 are of left-right configuration, while 苗 and 芒 and 若 are characters of top-bottom configuration. These formed two groups of three phonetic-semantic compound characters arranged in a triangle. Altogether, there were 15 groups of each configuration, with a total of 30 groups.

The number of strokes in a character and the familiarity a child has with Chinese characters have significant effects on the process of Chinese character recognition (Feng and Fang, 2004). To ensure the effectiveness of the experimental materials, the researchers controlled the number of strokes, ensuring they were within the range of 4–16. There were no significant differences between the number of strokes in Chinese characters used as stimulus characters (M = 9.10, SD = 2.17) and the number of strokes in characters whose semantic radicals had *category consistency* (M = 9.23, SD = 2.67) and the number of strokes in characters whose semantic radical had *category inconsistency* (M = 9.07, SD = 2.65); F (2, 87) = 0.04, $p > 0.05$. Meanwhile, 22 preschool teachers were invited to rate the Chinese characters' degree of familiarity from a child's perspective. There were no significant differences between the degree of familiarity of Chinese characters used as stimulus characters (M = 3.26, SD = 0.91) and characters whose semantic radical had *category consistency* (M = 3.17, SD = 0.81), nor that of characters whose semantic radical had *category inconsistency* (M = 3.25, SD = 0.77); F (2, 87) = 0.10, $p > 0.05$.

Procedure

The experiment was carried out on computers using the software, E-Prime 2.0. The instructions were as follows: "Hello. Let's play a little game, shall we? Now, please look at the two black words. Which of them is similar to the red word? If you think the black word on the left is similar to the red word, press the E key. But, if you think the black word on the right is similar to the red word, press the P key. Please choose according to your first feeling. There is no right or wrong answer." Each triangle of characters was randomly presented and a red "+" sign appeared as a fixation point before each stimulus. The fixation point appeared for 1 s and then disappeared. The steps were as follows; a triangle of characters was presented, the child made a response, and then the trial was over. Then, the next fixation point was presented, followed by a new triangle of characters and the participant's response. Before conducting the formal test, we gave the children four practice trials to help ensure they understood the rules.

Results

The overall results are presented in **Table 1**. Chi-square tests, done for the categorical data, showed that, overall, there was no significant difference between the percentage of choices depending on the *category consistency* and *category inconsistency* of the semantic radical among different age groups, χ^2 (1) = 0.67, $p > 0.05$. Binomial test on categorical data of all subjects found that for characters of left-right configuration, there was no significant difference between the percentage of choices depending on the *category consistency* (52.16%) and *category inconsistency* (47.84%) of the semantic radical, $p > 0.05$; and for characters of top-bottom configuration, there was also no significant difference between the percentage of choices depending on *category consistency* (47.95%) and *category inconsistency* (52.05%) of the semantic radical, $p > 0.05$.

In the 4-year-old group, there was a similar percentage of choices for *category consistency* and *category inconsistency*, $p > 0.05$. For characters of left-right configuration, there was no significant difference between the percentage of choices for the *category consistency* (52.35%) and *category inconsistency* (47.65%) of the semantic radical, $p > 0.05$. For characters of top-bottom configuration, there was no difference between the percentage of choices for the *category consistency* (45.68%) and *category inconsistency* (54.32%) of the semantic radical, $p > 0.05$.

In the 5-year-old group, there was a similar percentage of choices for *category consistency* and *category inconsistency*, $p > 0.05$. For characters of left-right configuration, there was no significant difference between the percentage of choices for the *category consistency* (52%) and *category inconsistency* (48%) of the semantic radical, $p > 0.05$. For characters of top-bottom configuration, there was no significant difference between the percentage of choices for the *category consistency* (50%) and *category inconsistency* (50%) of the semantic radical, $p > 0.05$. See **Table 2**.

Discussion

The results of Experiment 1 indicated that there was no significant difference between 4- and 5-year-old children's percentage of choices for *category consistency* and *category inconsistency* of the semantic radical. The percentage of choices was not affected by the child's age or the configuration of Chinese characters. In general, 4- and 5-year-old preschool children's awareness of the *category consistency* of semantic radicals was shown to have not yet developed, regardless of the configuration of characters. Similarly, Wang et al.'s (2016) study of primary school pupils showed that children in grade one had not yet formed ideographic awareness of the semantic radical, that by grade two ideographic awareness of the semantic radical was emerging, and that by grade three they had formed perfect ideographic awareness of the semantic radical. Another study also reported that some children above the second grade had mastered the orthographic rules of semantic radical and phonetic radical combinations (Shu and Liu, 1997). By contrast, the research of Wang et al. (2015) indicated that the development of semantic radical functional awareness in children from grades three to five is not perfect; however, it also revealed

TABLE 1 | The percentage of all children's choices for the *category consistency* of semantic radical.

Configurations of character	*category consistency*	*category inconsistency*
	% n	% n
left-right configuration	52.16 446/855	47.84 409/855
top-bottom configuration	47.95 410/855	52.05 445/855

TABLE 2 | Four to-five-year-old children's percentage of choices for *category consistency* of semantic radical.

Age	Configurations of character	*category consistency*	*category inconsistency*
		% *n*	% n
4-year-old	left-right configuration	52.35 212/405	47.65 193/405
	top-bottom configuration	45.68 185/405	54.32 220/405
5-year-old	left-right configuration	52.00 234/450	48.00 216/450
	top-bottom configuration	50.00 225/450	50.00 225/450

that pupils in grade six understood the relationship between the semantic radical and the whole word. These findings are consistent with the trend of results of Experiment 1, which fully shows that it is difficult for preschool children to understand *category consistency* of the semantic radical even though they have sprouted a certain knowledge and awareness of characters. In other words, this ability is closely related to the cognitive development of preschool children (Richard and Philip, 2011; Wang et al., 2016).

Although the results of Experiment 1 showed that 4- and 5-year-old children have not yet achieved the awareness of *category consistency* of the semantic radical, it cannot be inferred that they do not have awareness of semantic radical. Therefore, we conducted Experiment 2 to further investigate whether preschool children gain awareness of the semantic radical and realize that semantic radicals can indicate the category and mean of Chinese characters.

Experiment 2

Participants

The random sample consisted of a total of 59 children from a public kindergarten that did not include formal literacy education in its curriculum. There were 28 four-year-old children ($M = 4.58$, 14 boys and 14 girls) and 31 five-year-old children ($M = 5.63$, 18 boys and 13 girls). All of them were native Chinese speakers and volunteered to participate in the present study. The ethics procedures used were identical to Experiment 1.

Measure

The children were presented with 30 groups of three phonetic-semantic compound characters arranged in a triangle, as shown in **Figure 2**. The stimulus character was in red font at the top of the triangle. Two target characters in black font were located at either end of the bottom of the triangle. One of the target characters had a semantic radical that was identical to that of the stimulus character. The other had a phonetic radical identical to that of the stimulus character. Two types of target characters appeared randomly at either end of the bottom of the triangle. The children were asked to choose which of the two black characters was similar to the red character. Thus, we investigated the preschool children's bias toward semantic radicals or phonetic radicals by analyzing the percentage of choices for identical semantic radical and identical phonetic radical.

Materials

The materials included 30 groups of three phonetic-semantic compound characters arranged in a triangle. Two of the three phonetic-semantic compound characters had an identical semantic radical (好 and 奶 both have the semantic radical 女, while 忽 and 忘 both have the semantic radical 心). Two of the three phonetic-semantic compound characters had an identical phonetic radical (e.g., 仍and 奶 have the phonetic radical 乃,妄 and 忘 have the phonetic radical 亡). Characters

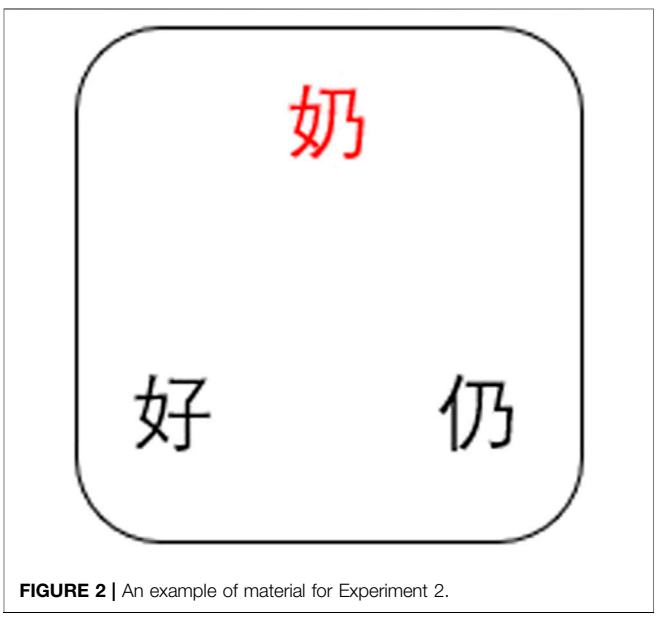

FIGURE 2 | An example of material for Experiment 2.

TABLE 3 | The percentage of all children's choices for the identical radical.

Configurations of character	Sematic radical	Phonetic radical
	% n	% n
left-right configuration	29.83 264/885	70.17 621/885
top-bottom configuration	46.33 410/885	53.67 475/885

奶 and 好 and 仍 are of left-right configuration. Characters 忘 and 忽 and 妄 are of top-bottom configuration. There were 15 groups for each configuration.

There were no significant differences between the number of strokes in the Chinese characters used as stimulus characters (M = 6.73, SD = 2.29) and that of characters that had a semantic radical identical to the stimulus character's semantic radical (M = 6.97, SD = 2.37), nor that of characters that had a phonetic radical identical to the stimulus character's phonetic radical (M = 6.70, SD = 2.31); F (2,87) = 0.12, $p > 0.05$. Furthermore, there was no significant difference between the degree of familiarity of the Chinese characters that served as stimulus characters (M = 3.86, SD = 0.77) and that of characters that had a semantic radical identical to that of the stimulus character's semantic radical (M = 3.86, SD = 1.12), nor that of characters that had a phonetic radical identical to that of the stimulus character's phonetic radical (M = 3.59, SD = 0.78); F (2, 87) = 0.89, $p > 0.05$.

Procedure

The procedure was identical to that in Experiment 1.

Results

The overall results are presented in **Table 3**. Chi-square tests, done for the categorical data, showed that, there was no significant difference between the percentage of choices for identical semantic radical and identical phonetic radical among different age groups, $\chi^2(1) = 0.76$, $p > 0.05$. Binomial test on categorical data of all subjects found that there was a significant difference between the percentage of choices for identical semantic radical (38.08%) and identical phonetic radical (61.92%), $p < 0.001$. The results revealed that for characters of left-right configuration, there was a significant difference between the percentage of choices for identical semantic radical and identical phonetic radical, $p < 0.001$; the percentage of choices for identical phonetic radical (70.17%) was more than identical semantic radicals (29.83%). For characters of the top-bottom configuration, there was a significant difference between the percentage of choices for identical semantic radical and identical phonetic radical, $p < 0.05$; the percentage of choices for identical phonetic radical (53.67%) was more than that of identical semantic radical (46.33%).

In the 4-year-old group, there was a significant difference between the percentage of choices for identical semantic radical and identical phonetic radical, $p < 0.001$. For characters of left-right configuration, there was a significant difference between the percentage of choices for identical phonetic radical and identical semantic radical, $p < 0.001$; the percentage of choices for identical phonetic radical (70%) was more than identical semantic radical (30%). For characters of the top-bottom configuration, there was a significant difference between the percentage of choices for identical phonetic radical and identical semantic radical, $p < 0.05$; the percentage of choices for identical phonetic radical (55.95%) was more than identical semantic radical (44.05%).

In the 5-year-old group, there was a significant difference between the percentage of choices for identical semantic radical and identical phonetic radical, $p < 0.001$. For characters of left-right configuration, there was a significant difference between the percentage of choices for identical phonetic radical and identical semantic radical, $p < 0.001$; the percentage of choices for identical phonetic radical (70.32%) was more than identical semantic radicals (29.68%). For characters of the top-bottom configuration, there was no difference between the percentage of choices for identical semantic radical (48.39%) and identical phonetic radical (51.61%), $p > 0.05$ (**Table 4**).

Discussion

The results of Experiment 2 indicated that 4- and 5-year-old children's percentage of choices for identical phonetic radicals was more than identical semantic radicals. For characters of top-bottom configuration, there were significant differences between 4-year-old children's percentage of choices for identical phonetic radical and identical semantic radical, but this was not found in 5-year-old children. In other words, both groups of children had a strong bias toward using phonetic radicals rather than semantic radicals to classify characters; the bias was significant for characters of left-right configuration.

Qian et al. (2013) found that 4-year-old preschool children already have an awareness of phonetic-semantic compound characters, which are composed of a semantic radical and a phonetic radical. Children aged between 4 and 5 years gradually develop an awareness of the function of radicals. The results of Qian et al. (2013) study also showed that, although 4- and 5-year-old children recognized the radicals of phonetic-semantic compound characters, they gave priority to the phonetic radical in the early stages of developing an awareness of functional radicals. The finding is consistent with the results of Experiment 2, which fully show that 4 and 5-year-old children showed no obvious awareness of the semantic radical and that they are more sensitive to the phonetic radical than to the semantic radical and give priority to phonetic radicals before they received formal literacy education. This is closely related to the visual preference of preschool children (Karmel, 1969a; Karmel, 1969b; McCall and Melson, 1970) and the external characteristics of phonetic radicals in phonetic-semantic compound characters (Wang et al., 2016).

GENERAL DISCUSSION

This study examined the development of preschool children's awareness of semantic and phonetic radicals (functional radicals) in Chinese characters. The findings suggest that preschool children already have an awareness of radicals in Chinese characters. Most children pointed out identical radicals in different Chinese characters. For example, they pointed out that there was the identical radical 白 in the character 怕 and

TABLE 4 | Four to-five-year-old children's percentage of choices for the identical radical.

Age	Configurations of character	Identical sematic radical	Identical phonetic radical
		% n	% n
4-year-old	left-right configuration	30.00 126/420	70.00 294/420
	top-bottom configuration	44.05 185/420	55.95 235/420
5-year-old	left-right configuration	29.68 138/465	70.32 327/465
	top-bottom configuration	48.39 225/465	51.61 240/465

拍, or that there was the identical radical 女 in the character 奶 and 好. As Emergent Literacy points out, preschool children's literacy awareness naturally germinates and gradually acquires print knowledge in daily life. Although the 4- and 5-year-old preschool children in this study had not yet systematically learned about Chinese characters, they could still distinguish between configurations of Chinese characters and pay attention to the radical, which is the basic unit of Chinese characters. The preschool children observed in this study had already acquired radical awareness and could analyze the Chinese characters with radicals as the basic units and could identify identical radicals in different Chinese characters.

Experiment 1 found that 4- and 5-year-old preschool children's awareness of the *category consistency* of semantic radicals had not yet developed, regardless of the configurations of characters, which is consistent with the results of previous research (Shu and Liu, 1997; Wang et al., 2015; Wang, 2016). The development of preschool children's awareness of semantic radicals is closely related to their level of cognitive development. Piaget's cognitive development theory holds that the cognitive development of children can be divided into four stages based on cognitive structure, namely, the stage of perception movement, the pre-operational stage, the specific operational stage, and the formal operation stage. Preschool children aged 2 to 7, who are in the pre-operational stage, internalize their perceptual skills into representations, thus establishing symbolic functions to enable thought. One of the characteristics of children's thinking at this stage is an inability to conceptualize the relationship between the part and the whole (Richard and Philip, 2011). In the composition and construction of Chinese characters, the semantic radical represents the semantic category of the whole character. Children first need to understand the general relationship between the semantic radical and the whole character before they can use the semantic radical to infer the semantic meaning and category of the whole character (Wang et al., 2016). However, the cognitive development of preschool children, situated in the pre-operational stage, has not yet reached a level that allows them to understand the relationship between the part and the whole. Thus, they do not have an awareness of the *category consistency* of semantic radicals at this stage, as demonstrated by the results of Experiment 1.

Therefore, although Emergent Literacy theory claims that preschool children's literacy awareness and literacy knowledge will develop before they receive formal literacy education, research has shown that children's development is still at a perceptual level at this stage and has not yet reached the semantic level. Preschool children are not yet able to understand the semantic radical's function as a foundation for Chinese character recognition and semantic analysis. Preschool children's judgements on classifying Chinese characters mainly depend on the image characterization of the semantic radical. The preschool children who participated in this study had not yet acquired awareness of the *category consistency* of the semantic radicals.

Experiment 2 found that 4-year-old preschoolers showed a bias toward using the phonetic radical rather than the semantic radical to classify characters. Meanwhile, 5-year-old children paid more attention to the phonetic radical than to the semantic radical when classifying Chinese characters. Zhang et al. (2014b) showed that the phonetic radical has the advantage of attention resource allocation in literacy analysis processing. Adults tend to pay more attention to the phonetic radicals of phonograms. This may be because the number of strokes, the area, the complexity, and the variability of the phonetic radical are significantly higher than those of the semantic radical in the majority of phonograms. Thus, the phonetic radical is more likely to draw attention in the process of phonogram analysis (Wang et al., 2016). Analogous findings have been found in studies observing infants' attention selectivity, which have shown that infants display a preference for complex objects (McCall and Melson, 1970; Bond, 1972; Greenberg and O' Donnell, 1972). Compared to figures with simple configurations and lower contour density, figures with complex configurations and higher contour density or symmetrical stimuli are more likely to draw infants' attention (Karmel, 1969a; 1969b). Therefore, preschoolers pay more attention to more complex phonetic radicals than they do to simpler semantic radicals in the recognition process of Chinese characters and mainly choose the identical phonetic radical as the standard for classifying Chinese characters.

Further analysis of the research data showed that the configuration of characters affected the 4- and 5-year-old preschool children's bias in attention to phonetic and semantic radicals. Preschool children's bias toward classifying Chinese characters based on the phonetic radical in characters of left-right configuration is significant; nevertheless, this was more likely to attract children's attention. This may be because the number and percentage of characters with the left-right configuration is much larger than that of characters with the top-bottom configuration in the Chinese script (Luo, 2015). Therefore, children encounter more characters with the left-right configuration in their lives, and thus they are more sensitive to cognition of these characters. In addition, some researchers believe that the structure of characters with the top-bottom configuration is tighter than that of characters with the left-right configuration. This means that children will

encounter greater cognitive resistance when they are decomposing the radical of characters with top-bottom configuration. The radicals of a character with left-right configuration are easier for children to interpret in the process of literacy (Yu et al., 1990). Overall, we found that the development of literacy skills and the orthographic awareness of preschool children were influenced by the configuration of characters. Our findings show that characters with left-right configuration had a positive effect on the development of cognition of radicals in 4- and 5-year-old preschool children. The characters with left-right configuration were more conducive for preschool children's early Chinese character recognition and radical analysis.

CONCLUSION

The results of this study show that preschool children can naturally develop literary knowledge and radical awareness, as posited by the concept of Emergent Literacy. However, 4- and 5-year-old children had not acquired awareness of the *category consistency* of semantic radicals, regardless of the configurations of the characters. Meanwhile, these children showed no obvious awareness of the semantic radical and they were more sensitive to the phonetic radical than to the semantic radical and paid more attention to the phonetic radical, and their attention to radicals was influenced by the configurations of the characters. The phonetic radicals in the characters with left-right configuration were more likely to attract children's attention.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Ethics Review Committee (IRB) of Education School, Guangzhou University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

SC contributed to conception and design of the study. ML and SW collected the data. SC and ML performed the statistical analysis. ML wrote the first draft of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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