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FUZZY TRACE THEORY'S IMPLICATIONS ON CHINESE LANGUAGE ACQUISITION: AN INNOVATIVE PSYCHOLINGUISTIC COGNITIVE APPROACH

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Synopsis:

Mastery of the Chinese characters could be considered as one of the most difficult and strenuous tasks for Chinese language learners. This research is designed to address how Chinese characters are processed and organized in the cognitive approaches between memory and high reasoning. In order to find out a competent way for students to acquire Chinese vocabulary, Fuzzy-Trace Memory Recognition Theory is introduced to facilitate and improve Chinese vocabulary acquisition.

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Topic: Language Education

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Abstract

Mastery of the Chinese characters could be considered one of the most difficult and strenuous tasks for Chinese language learners. This research is designed to address how Chinese characters are processed and organized in the cognitive approaches between memory and high reasoning. Chinese, a logographic language, builds upon an approximate minimum of 200 radicals, a characteristic that distinguishes it from alphabetic languages; radicals are used to aid the students in distinguishing the characters, however, they are not in every character. Relying on the presence of a radical in a character, therefore, may not be as effective as other methods. In order to discern a competent method for students to acquire Chinese vocabulary, Fuzzy-Trace Memory Recognition Theory (FTT) is introduced to facilitate and improve Chinese vocabulary acquisition. FTT is a cognitive reasoning process that correlates memory and reasoning along a continuum of precise to fuzzy-traces. The findings divulged how FTT benefits Chinese character learning and helps students become more independent and effective language learners. It also suggests that providing "Cues" to the students to form traces and visual-spatial analysis of the Chinese characters significantly increases students' performance. This research implicates that daily classroom practices should incorporate the formation of stories, or "Cues" that utilize students' visual-sensory cognitions in order to best acquire vocabulary in Chinese language learning. The use of "Cues" to create fuzzy-traces is one of the more effective methods to learn Chinese characters compared to verbatim memorization or memorization of radical presence for beginning-level students.

Key words: Fuzzy-Trace Memory Recognition Theory, Chinese language acquisition, learning strategy, cognitive functionings, Chinese characters, psycholinguistics, second-language teaching

Literature Review

Although Chinese has been spoken for millenniums, the earliest known written Chinese dates back to the Shang Dynasty (between 1700 and 1100 B.C.E.). The historic mediums of Chinese in its written form were tortoise shells, bones of animals, and metal instruments; the tools of which written Chinese appears on can be denoted as jiaguwen (shell-bone language) or jinwen (metal language) (San, 2007, p.5). As tradesmen, clergymen, and explorers began to travel to Chinese-speaking regions, the need to teach those alphabetic language speakers Chinese arose. According to Ni (1948), the first alphabetical writing system for Chinese was designed by the Italian missionary Matteo Ricci and published in Beijing in 1605. In subsequent decades, other missionaries designed various other alphabetical systems in an effort to teach foreigners Chinese (p.3). Even though the alphabetical writing system for Chinese was being taught to foreigners, it did not attract the attention of Chinese intellectuals until after the Opium War of 1840 (Ni, 1948, p.5). Prior to the war, Westerners were largely isolated from China's language and culture; moreover, there was not a plethora of individuals that wanted to learn the language. In subsequent decades since the War of 1840, China was forced to open up its borders for foreigners resulting in a pressing need to develop a language teaching system for non-native Chinese speakers. In recent times, one of the most common teaching methods used was the pinyin system which was developed to assist with the pronunciation of characters; however, this system did not assist the learner in writing, which is a key component for true literacy. Pinyin is still used as the most prominent standard teaching tool and there still exists problems of writing when teaching Chinese to Euroamerican students. The dependence of relying on the pinyin system in the classroom also leads to many students

depending on pinyin to read, which can result in apathy or disinterest to learn how to physically write characters.

The complex structural nature of Chinese characters creates a paradox of the brain's cognitive make-up and the teaching techniques used for Western students. In comparison to other languages, including those that are logographic, Chinese is distinct in its use of a logographic system that requires using visual and logical aspects (Yeh, Li, Takeuchi, Sun, & Liu, 2003, p.731). Logographic language writing systems are distinctive from alphabetic languages in that each character "represents one morpheme instead of an individual phoneme of the spoken language" (Kuo et al., 2015, p.4). Thus each character is in itself a word instead of being a distinctive sound that requires the use of two or more morphemes, as seen in an alphabetic language. Yeh et al.'s (2003) study examined Western and Eastern students' visual strategies of identifying and recalling the logographic language components of Chinese. The inclusion of organizing character complexity based on stroke count illuminated the perceived cognitive differences between the American, Taiwanese, and Japanese undergraduate student participants. The American undergraduate students compared to the Taiwanese and Japanese participants perceived the characters as picture drawings instead of representations of words. This difference in processing and perception of the characters was suggested by the authors to have potentially been from "certain preconceptions they [the American participants] possessed about Chinese characters, i.e., that Chinese is a pictographic, ideographic, or logographic system" (p.740). Moreover, Yeh et al.'s (2003) research highlights the unexpected challenges of predispositions and perceptions of the language that must be overcome before Western students can successfully learn it. From a cognitive standpoint those whose native tongue is alphabetic are at a disadvantage when learning Chinese because of the inherent visual nature of logographic

languages. When foundational learning programs of Chinese focus on character structure, radical positioning and meaning are often explored. However, radical presence, like the pictographic nature to foreigners, is at once a crucial learning block and yet is not going to be as advantageous to beginning learners as it is to the more advanced learner.

Radical presence is one of the most critical components in Chinese vocabulary acquisition. Kuo et al. (2015) argues that the comprehension of a radical's position and meaning influences the brain's processing of the Chinese character in such a way that the radical itself "contributes to accurate identification [of] a character…[from] its semantic function" (p. 8). Radicals, therefore, provide a foundational basis of the character's meaning in terms of its semantic or phonetic value. The differentiation of the purpose of a radical, says Su and Kim (2014), indicates the "semantic category of...compound characters" or indicates a proper pronunciation (p. 132). Wang, Inhoff, and Chen (2010) state that there are approximately 200 semantic radicals and around 800 to 1,100 phonetic radicals (p.20). Therefore, being able to identify and utilize radicals in the characters with radicals is an effective learning tool for Chinese users of all levels. Even though knowledge of radicals can be beneficial to reading and writing characters, beginning-level students generally do not possess the capability of memorizing the approximately 2000 radicals in characters and will most likely not be able to fully utilize radical knowledge.

Mastery of radical meaning is a slow process that requires exposing oneself to the grammatical and linguistic components of the language. Although radicals are positively related to Chinese character recognition, a more thorough comprehension of radical knowledge that beginning-level students will not have is required to have significant impact on vocabulary recognition (Su & Kim, 2014, p. 144). A study based on student's language and cultural

background pointed out that the linguistic similarities of the students' with Asian-based native tongues perceived organizational categories of Chinese differently than their Western counterparts. It was found that the American undergraduate students in the study could not differentiate the nuances in the characters and thus got lost in the translation (Yeh et al., 2003, p. 38). Radicals have different levels of influence depending on students' proficiency level and language background. Since not all Chinese characters contain radicals, the sole ability to identify the presence and interpretation of a radical will not be of a significant aid to comprehend the plethora of non-radical containing characters. Once the structural components of the character are understood, language learners need to be able to read characters as the representations of words that they are. For beginning-level Chinese language learners from Euroamerican native tongues, this ability from a cognitive standpoint is hindered by the unnatural form the word is visually presented in.

The cognitive processes of the human brain that allow reading of a language create another cognitive disadvantage for Euroamerican-based native speakers. Kuo et al. (2015) argues that one of the major components to reading is associative processing in which the initial activation within a verbal code creates a connection to a personal comprehension in the brain (p. 6). Reading requires the brain to form connections to objects the reader already has knowledge of. The human brain mirrors and abstractifies characteristics of the visual environment which then creates a cognitive system based on the environmental characteristics and abstract concepts, says Yongming (2014, p. 295). For Western students, the cultural and environmental connection may be harder to acquire when the abstract concepts that constitute the subjective psychological space in individuals is not similar to the visual representation that a Chinese character presents. Yongming (2014) further elaborates by arguing that the biological model that is created from

associative processing helps to shape how our brain classifies and forms the structural features of visual linguistic form (p. 295). The visual structural forms of written language in a non-logographic writing system are not congruous with the visual structural forms in the psychological spaces of logographic language speakers, like Chinese. If forms and rules of the word, in this case the visual representation known as a character, do not conform to the psychological space one has created, the sensory organs may intentionally miss certain parts of the word or ignore the word all together (Yongming, 2014, p. 296). Characters are not going to be inherently aesthetically pleasing to the Westerner's eyes nor are they going to conform to the natural confines and boundaries that lay the groundwork for reading to an alphabetic language native speaker. The conflicting visual sensory information being sent to be processed in the brain creates a phenomenon in Euroamerican-based native speakers who are reading Chinese where character nuances receive the attention of the student instead of the whole picture.

The logographic nature of Chinese lends itself to being cognitively processed differently than all other languages. From the visual cortex to storage in the brain, there are certain structural elements that the brain is primed for to code information. Compared to Chinese, alphabetic languages are orthographic, phonological, and use the left hemisphere for processing, organizing and storage. The structure of the brain's occipital lobes' neuron itself and how it deconstructs visual stimuli into abstract idea creates the human interpretation of linear morphology. Since the neural cells of the visual cortex concentrate on nuances, the brain typically fixates on storing linear information into the short-term memory (Yongming, 2014, p. 295). The brain's morphological cognition is thus a linear morphology like that found in alphabetic languages. In a comparison study of rapid extraction of phonological information of Chinese and alphabetic languages, it was found that Chinese is processed rapidly and automatically into the visual

sensory memory (Wang, Liu, Wu, & Wang, 2013, p. 5). Since Chinese phonology and morphology do not necessarily correspond, the rapid and automatic translation from the visual cortex to the short-term memory is processed in the right hemisphere of the brain. Upon reading a Chinese character, unlike in an alphabetic word, the logographic word is organized and stored in the same region of the brain used for patterns and specific shape information (Wang et al., 2013, p. 6). The brain's priming for storing characters into the hemisphere not typically allocated for language processing and storage, suggests a cognitive handicap that Western students must overcome in order to learn how to read in Chinese. The lack of traditional alphabetic language-based orthography also creates a challenge for Western students who wish to learn Chinese. Previous research and teaching practices used in Chinese language classrooms to teach Chinese use alphabetic language structures and priming morphologies, thereby effectively further challenging their non-logographic native speakers.

Prior to this research study, the literature on character learning for Chinese as a second language focused on orthographic knowledge-based tools and their advantages. In lieu of the language's distinct lack of an alphabetic language-based orthography (since the character is the morpheme), the vast majority of teaching and learning techniques are various forms and styles of rote memorization, the use of graphic and context clues, and a basic knowledge of radicals (Shen, 2004, p. 53; Liu & Jiang, 2014; Kuo et al., 2015). These teaching methods, although effective to some extent, are not by themselves applicable to every character and are usually used in conjunction with each other as the basis for most Chinese as a second language classrooms. One of the lesser-documented strategies of using graphic clues found in the character itself has been shown to increase the likelihood that during associative processing the visual information is translated into the long-term memory (Shen, 2004). In research done by Shen (2004), cues based

on sound, shape, and meaning behind characters were the primary learning tool utilized by a majority of Western participants (p.59). Even though the use of cues as a learning strategy is not the only valid strategy, it has great potential to be used as a widespread practice because of its utilization of the brain's natural progression in visual to neural pathways of pictures. Fuzzy-Trace Theory (FTT), which is founded on the premise of using associative processing and the right hemisphere of the brain to best learn a second language, could be employed more in classrooms, especially ones with a high number of alphabetic language speakers.

Fuzzy Trace Theory (FTT) postulates that the human brain interfaces memory and high reasoning cognitive processes and works on a continuum of phonetic, orthographic, and optical information. Reyna and Brainerd's (1995) FTT argues that reasoning is the "flexible application of generic principles to imprecise representations" which are referred to as "traces" (p.15). As information is coded in the brain depending on where on the spectrum of type of "trace" the information lies, that data will be stored in either the short or long-term memory. When encoding information, according to this theory, the most remembered and easily accessed traces are known as "fuzzy-traces," which are imprecise memory representations of the environmental stimuli (Fuzzy Trace). An indicator of neural plasticity of second language learners is an increase in fuzzy processing or the brain's quicker recall and access to fuzzy-traces; the ability to store more abstract representations into long-term memory is attributed, says Reyna and Brainerd (1995), to mature reasoners and aids in decreasing errors in memory (p. 42). Since most information is stored in the short-term memory, this theory predicts a loophole to the short capacity of the long-term memory and provides a learning strategy to increase the effectiveness of language studied to information learned. The particular neural pathway that memory development takes is

hypothesized to build off of already encoded information in long-term storage in the cerebral cortex.

Memory development in the brain, according to FTT, is dependent on the heightened deviations of true and false-memory recognition as well as recall through verbatim and gist traces. Verbatim traces are the coded and abstractified information from the optical neural network; verbatim traces are integrated cohesive abstract representations of the object that are composed of associative cues already inside one's memory and can be instantaneously related back to the new object (Brainerd & Reyna, 2004, p. 399-401). Gist traces are also abstract representations of the object, but focus on the semantic and relational information to objects around it; according to Brainerd and Reyna (2004), gist traces are episodic representations or elaborations of concepts already stored in memory (p. 401). In terms of written language acquisition, the reader of a Chinese character forms an initial verbatim trace (a collection of already known images and vocabulary that are associated with the new character) which becomes the foundational basis for a gist trace (the number of character strokes, presence of a radical, or even the shape itself of the character forms a collective association to the new word). Characters with the fewest strokes, says Kuo et al. (2015), are the easiest characters to recall (p.17). The more visually complicated the character is, the less information the long-term memory already has to connect to; more complex characters are going to be harder to remember and build verbatim and gist traces for. Through FTT's interpretation of memory and reasoning cognitive processes, a challenge is presented for Chinese language learners since not many characters are comprised of simple strokes. A secondary learning tool can be incorporated alongside FTT's reliance on cues to increase the chances of verbatim and gist creation; physical movement as a teaching practice is one potential learning aid for Chinese language acquisition.

The combination of physical movement and language learning has produced a higher rate of recall from the long-term memory. Physical movement has been shown through Electroencephalography (EEG) data to increase the brain's activation in the neural cortex and other brain structures. EEGs study Event Related Potential (ERP), which are "small voltages generated in the brain structures in response to...stimuli;" moreover, an ERP, which is measured in waves, is a physical manifestation of neurotransmission activity detected by EEGs after stimuli was sent to the brain (Sur & Sinha, 2009, p. 70). Research done by Hillman et al. (2002) showed that P3b waves are increased in those that were physically active compared to the non-active participants when learning vocabulary (Schmidt-Kassow, Kulka, Gunter, Rothermich, & Kotz, 2010, p. 40). Increases in P3 waves are indicative of neurotransmission and the active process of encoding data into the brain's memory. In the 2010 study conducted by Schmidt-Kassow et al., French vocabulary rote memorization was combined with a three week cycling course; EEG data from the study concluded that N400 ERP waves were larger in those that combined learning techniques compared to those who engaged in only one (p. 41-42). Not only does physical movement create new neural pathways, it also allows gist and verbatim traces to be formed quicker. Despite the increased awareness in the teaching field of kinetic movement's role in learning, there is little practical application in higher education foreign language classrooms.

Total Physical Response (TPR) is one of the most prominent practical applications of combined physical movement with foreign language learning and relies on coordinating associative physical action to a command vocabulary word. According to Asher (1969), TPR is effective regardless of the complexity of the word and produces a "highly significant [rate of] acceleration in comprehension" (p.5). This teaching technique is very effective in utilizing the interconnected neural pathways of memory and reasoning by significantly increasing the amount

of information that is encoded into the long-term memory. Although TPR can be an effective vocabulary acquisition tool for both alphabetic and logographic languages, according to Asher's (1969) research studies, it is only effective for command vocabulary, thereby, leaving out a significant portion of any language that cannot utilize this technique's strengths.

Our research experiment was created to determine a more effective method of memorizing and recognizing Chinese vocabulary. Despite the contemporary second language techniques that are applied to Chinese, many Western students still struggle at the beginning-level. Through the application of FTT and a new adaption of physical movement which we term "Physical Response" (PR), we hypothesize that the combination of cues and PR when reading a character will significantly increase the number of characters memorized compared to those that use no PR and cues; the coordinated cue and PR technique, we suggest, will create the best results for student recollection of beginning Chinese characters. We also hypothesize that the usage of cues as a tool for associative processing will significantly improve character recognition.

Method

Participants

Forty participants, who were randomly selected from the University of North Carolina at Pembroke, were recruited for this research study. The participants were required to have no Chinese language learning experience, which was confirmed through verbal and written affirmation. All the participants were above 18 years old. Although the specific ethnicities, age, and genders were not documented, the majority of our participants were White undergraduate students approximately eighteen to twenty-two years of age. Participants were incentivized to participate with a free meal after the completion of the study.

Material and Design

The thirty test characters that were chosen for this experiment were basic Chinese vocabulary that is taught in many beginning-level Chinese courses to Euroamerican students. Of these common characters, twelve had radicals and eighteen did not. In this experimental research study there were two dependent variables, making it a 2x2 factorial design. The dependent variables are the "Cues" and "Physical Response" (PR). The 2x2 factorial design is shown below:

Table 1: 2x2 Factorial Design:

	Cues	No Cues
PR	Control 1	Normal 1
No PR	Control 2	Normal 2

Forty participants were randomly appointed to either the control or normal groups, which were then subdivided into two groups of approximately ten participants each. The experiment consisted of four groups total: "No Cues and PR," "No Cues and No PR," "Cues and PR," and "Cues and No PR."

All the participants in all four experimental groups went through a series of three steps. The thirty test characters were printed and arranged in a random ordering on one side of each of the three handouts. Handout one consisted of the test characters printed alongside the English translation in two distinct columns. Handout two followed the same formatting as handout one with the exception of the ordering of the characters and English translation, which were randomly rearranged to help reduce interference caused by character repetition. Handout three consisted of the character, English translation, and a photographic representation of the definition.

The three elements that accompanied each of the thirty characters were arranged in such a way that there were two distinct columns per page of the character, translation, and picture. Participants were allowed to write on all three handouts.

Oral interview questions were prepared and asked in an open discussion after the experiment ended. The purpose of the interview was to evaluate the participant's strategies used to study and analyze the characters. Questions were open-ended and answers were recorded in writing by one of the researchers. The interview was not mandatory, but all the participants were encouraged to participate.

"Physical Response" (PR) was tested through a hand matching examination after the viewing of all three handouts for their designated time frame. In the examination, the Chinese character was matched to the correct English translation. The Chinese and English translations were printed on pre-cut pieces of paper that were then separated into individual envelopes. The completed examinations were arranged in varying numbers of rows of matched Chinese to English and then photographed by the researchers. The opposing examinations for the non-PR groups were paper matching of the Chinese character to English translation with a pencil. The paper examinations were collected after the experiment.

Procedure

A series of three steps were conducted. During step one, handout one was disseminated to participants and researchers gave all four groups five minutes to view it in silence after students signed the consent form. Step two consisted of one of the researchers reading each character and its translation out loud from the randomized ordering found on handout two while participants viewed the handout silently. Each character and its corresponding English meaning were read trice followed by the researcher recollecting the handout. Step three consisted of the participants

viewing handout three for five minutes and the procedure during this step differed depending on the normal and control group that was being tested. The “Cues and PR” and the “Cues and No PR” groups were shown cues for memorizing the test characters on the whiteboard by the researchers. One of the researchers wrote the character and showed common semantic and other associative tips to remember the character. The “No Cues and PR” and “No Cues and No PR” groups were told to silently view handout three and study its contents for the duration of this step.

After the three handouts were disseminated and then collected, a matching test was performed. The “No Cue and No PR” and “Cue and No PR” groups were given a paper matching examination whereas the “No Cue and PR” and “Cue and PR” groups were given a hand-matching examination. There was no time limit given for the exam in any of the four experimental groups; testing on average lasted about twenty minutes. After all the participants in the non-PR groups finished, their paper examinations were collected and a demarcation was put on them to indicate which group they belonged to. The two PR groups were given cut out pieces of paper with the Chinese character and English translation and told to match the character to the translation. After the participants in the PR groups finished their examinations, one of the researchers took a photograph of the completed assessments after which point the characters and their English meaning were returned to their envelopes. After all testing materials were collected and returned, a debriefing of the experimental rationale was given to the participants. A group interview was conducted after each session. Discussion questions regarding which handout was most effective and what methods participants used to memorize the characters were asked. To view the complete list of discussion questions view Appendix II.

Results

We hypothesized that the “Cues and PR” group would be the most effective learning strategy for Chinese characters. Figure 1 illustrates the average score of the four test groups. An ANOVA analysis indicates that the “Cues with No PR” group had the highest average score compared to the other participants. Moreover, the “No Cues and No PR” group had the lowest average score. There is a moderate difference between “No Cue and PR” and “Cue with No PR” groups.

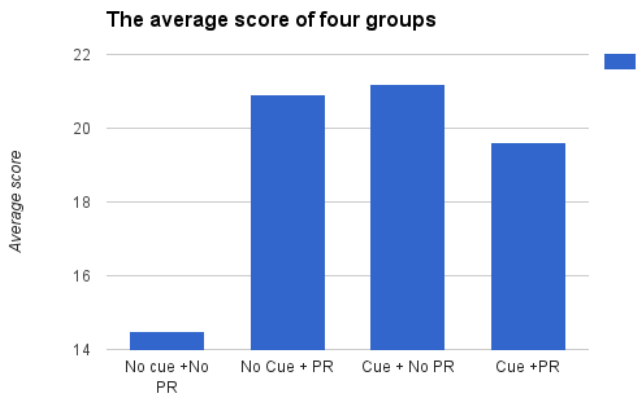


Figure 1. “Cue and No PR” had the highest score and “No Cue and No PR” had the lowest.

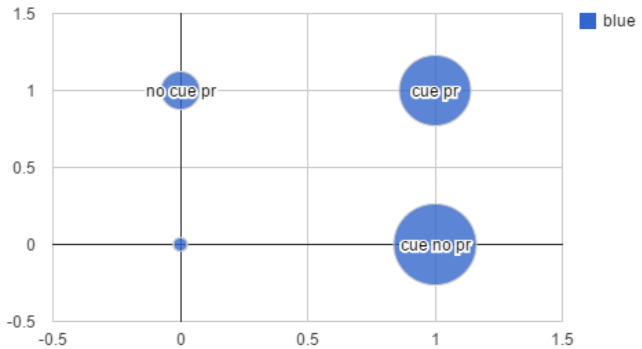
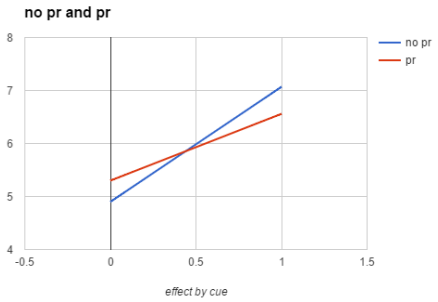
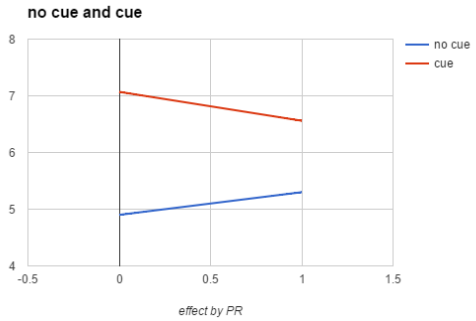


Figure 2. The above graph illustrates the intersectionality of the independent variables (“Cues” and “PR”) to the dependent variable of the outcome of Chinese language learning. “Cues and No PR”

have the greatest effect towards Chinese language learning whereas “No Cue and No PR” had the least effect on the dependent variable.

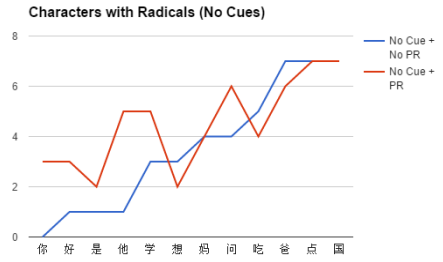


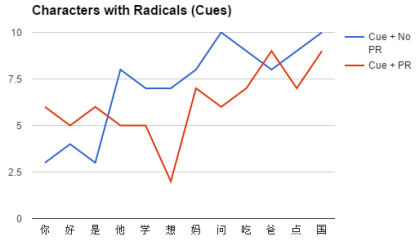


Figures 3 & 4. The graph on the left illustrates the positive relationship between the two independent variables as it is related to PR. Cues were found to improve character recognition score only when PR was not combined as a learning strategy. PR had a negative correlation when coupled with cues; the exclusion of the PR helped participants memorize the test characters better. The most effective learning strategy was “Cues and No PR.” The second most effective learning strategy was “PR and No Cues.” Figure 4 provides an explanation of the effect of PR on Cues. Cues are more effective than No Cues. When Cues are not provided there is a positive correlation with PR, whereas when both independent variables are present there is a negative correlation.

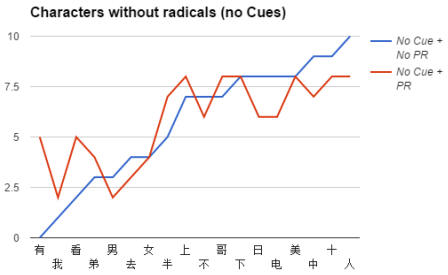
The “Cues and No PR” group had the highest consistent number of correctly matched characters; the “No cues and PR” group had the second highest consistent number of correctly matched characters by the greatest number of participants. The characters “人,” “美,” “哥,” and “十” were the most recognized in all four experimental groups. The characters recalled most consistently in the “Cue and No PR” group were “问,” “电,” “十,” “国,” “美,” and “人.” The characters remembered most consistently in the “No Cues and PR” group were “美,” “十,” “下,” “哥,” and “上.” All experimental groups, except the “No Cues and PR,” correctly identified the character “人.” The only character easily recognized by the normal group without both variables

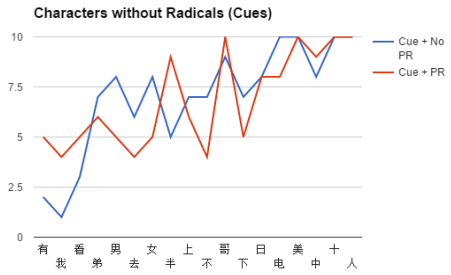
was “人.” The character “想” had the lowest correctly matched rate compared to all characters when just Cues or just PR were tested.





Figures 5 & 6. Both figures express the relationship of Cues to test characters with radicals. Regardless of radical presence, both Cue groups have the highest average correct matching identification. In regards to radicals, Cues did not significantly affect character recognition. Students who were not given Cues had a relatively low accuracy rate for characters that had radicals. PR was found to not significantly affect character recognition when radicals were not present. When radicals were present, however, PR did significantly raise the rate of recall.





Figures 7 & 8. Both figures express the relationship of Cues to test characters without radicals. When PR was not present, Cues made a significant positive impact on character recognition; moreover, the introduction of Cues when PR was present did not mediate a statistically significant difference in recollection ability. Inclusion of PR in the learning process improved the overall scores of the students; whereas, the addition Cues did not meet on a significant level.

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	39.621	3	.000
	Block	39.621	3	.000
	Model	39.621	3	.000

Classification Table[a]					
	Observed		Predicted		
			Correct		Percentage Correct
			0	1	
Step 1	Correct	0	153	332	31.5
		1	147	568	79.4
	Overall Percentage				60.1

a. The cut value is .500

Figures 9 & 10. The logistic linear regression statistic method was used to analyze the data. The logistic linear regression model is a regression model that is used to measure the relationship between dependent variable and one or more independent variables. The data from this research study fit the ordinal logistic regression, which the dependent variables are ordered for. Common examples of using ordinal logistic regression include job performance (good or bad), opinions (strongly agree, strongly disagree), and so on (Homers and Lemeshow, 2000, p.288). In figure 10, it showed prediction and actual observed data. According to Homers and Lemeshow (2000), the outcome is usually coded as “0” or “1;” if the dependent variable is successful it is coded as “1”, while failure is coded as “0”. According to the chart, the percentage that is predicted of the participants that get a correct result is 79.4 %. Therefore, this model fits the research data very well. Figure 9: Omnibus test model shows the significance level is 0, which also confirmed with the result from Figure 10 that the linear regression model is a good tool to analyze the research data.

Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp()
Step 1[a]	Cue	.919	.172	28.724	1	.000	2.507
	PR	.160	.163	.960	1	.327	1.174
	CuexPR	-.391	.240	2.654	1	.103	.676
	Constant	-.040	.115	.120	1	.729	.961

a. Variable(s) entered on step 1: Cue, PR, CuexPR.

Figure 11.

The linear regression model shows that "Cues" are a significant variable.

Log (odd ratio) =0+$_1$Cue + $_2$PR+$_3$(Cuex PR)

Log (odd ratio)= - 0.04 +0.919 Cue +0.16 PR -0.391(Cue xPR)

Exp () =$_e$ The factor by which the odds ratio is increased when cue=1 instead of 0. The Exp() indicates that the success of getting characters right by using cues increased 2.5 times.

Discussion

This study was built to test the practical application of new learning and teaching methods of Chinese characters. It builds upon the assumptions of FTT and proposes that teachers in Chinese classrooms can model cues that aid in the natural associative processing of the brain's reasoning and memory channels. This paper acts as a continuation in this regard for furthering supportive data on FTT's credibility and application in foreign language classrooms. Secondly our other independent variable of PR is a variation of what has already been researched in regards to second language learning and is our proposed version of a general physical movement learning tool that can be used in any foreign language classroom, but especially in a Chinese language one. The limitation of physical movements to simple and mundane gestures of the

hands and arms is a different approach to kinetic movement and language acquisition that has not been presented in the literature prior to this study (Asher, 1969; Schmidt-Kassow et al., 2010).

Contrary to our hypothesis, there was a negative correlation between PR and Cues lending to a hindrance in the encoding and recall of Chinese characters. One such explanation for this negative correlation could be that the simultaneous tasks of PR and forming cues created too much interference within the already small amount of storage in the working memory. Encoding of the associative information of this new character while attempting to activate the body's muscle memory may have slowed down the brain's ability to form fuzzy-traces; thus in the small window of time the student had to study the handouts, multitasking was not the most efficient learning technique. Real-life multitasking involves the simultaneous cognitive processing and task switching that can be seen in matching games and examinations; in particular, when performing simultaneous learning tasks, the cognitive processes of encoding, storage, and retrieval from the working memory are all competing for attention (Carrier, Rosen, Cheever, & Lim, 2015, p.69). Individual tasking of study techniques, in this case the sole use of either cue formation or PR would be a more efficient use of cognitive resources. Unfortunately, there was not enough time or resources to further test the effects on the working memory of forming verbatim traces and using PR when these techniques are utilized over an extended period of time. Research needs to be done on the plausibility of the benefits of the multitasking of both independent variables as it relates to muscle memory.

Individual task cognitive processing allows for better recognition of characters compared to multitasking of different memory techniques. The test groups with the highest recall of characters were "Cue and no PR" and "No Cue and PR." The "Cue and no PR" group's characters with the highest recall rate were "问," "电," "国," whereas in the "No Cue with PR"

group the characters “下” and “上” had a higher storage and retrieval rate. The different characters that had the highest recall rate between the “Cue and no PR” and “No Cue and PR” groups suggests that cue use was more effective than PR use. The different learning tools of cue and PR impacted which characters were more easily remembered. These particular characters may have been recalled more easily because of their low stroke count. However, the cues that were chosen and presented to the students may not have been the most effective clues to be used for their associative processing. The thirty test characters as well as cues were chosen for their commonality but there are certainly other test characters and other cues that may have been given. Individual students may not have agreed that the cue that was presented was a pictographic representation of the character or that the cue given was the most obvious choice. The character “爸” was introduced as a father who is ardently smiling with the “巴” component being the teeth; however, some students during the interviews stated that the top portion of “爸” looked like a coat of arms, which was then associated with a man (their father) holding a gun. The particular geographic region of our study has a very strong opinion on guns and is open to freely using and firing weapons. This cue may have been better to use instead of the one that was presented.

Radical presence was studied and found to not be a reliable study tool for beginner Euroamerican students of Chinese. Previous research corroborates the conclusion that for radicals to affect vocabulary recognition, a higher level of radical comprehension is required, one that beginning-level Chinese language students lack (Su & Kim, 2014, p. 144). One suggestion for this conclusion is that the psychological space that has been created from exposure to Euroamerican culture and languages makes it so that the students’ brains’ could not view the characters as morphemes. Characters were thus in a manner of speaking lost in translation from

trying to fit the character into the already known parameters of the student's psychological space. The limited study time of the test characters may also have not been sufficient time to not only recognize the commonalities in semantics or phonetic meaning of characters with radicals, but also to apply that radical information as a memorization tool. Even in instances when recognizing radical meaning was possibly used, characters with radicals did not seem to be a learning aid used by many of the students since the four most recognized characters did not have radicals. "人," "美," "哥," and "十," the four most recognizable characters in this study, may have been the most discernable because of their small stroke count compared to the other test characters. Characters with a small stroke count have been shown in Kuo et al.'s (2015) research to be easier to recall. The small stroke count could have also helped to facilitate trace formation with the low amount of resources required of the working memory to store. Out of all thirty test characters, these four are also arguably the least "foreign looking" from a Euroamerican student perspective and will most likely fit more easily into their psychological space thus making it easier than the other test characters to be stored in the working memory (Wang et. al, 2013; Kuo et al., 2015).

One of the difficulties that a majority of the students experienced was discerning the correct orientation of the character. This suggests that Western students are at a cognitive thinking disadvantage when first beginning their Chinese language learning. A combination of a difference in fundamental language processing elements, such as the use of the right hemisphere of the brain and the priming of orthographic visual sensory information, could contribute to this problem the student's experienced. The inability to orient the character so that it is literate suggests that a certain "blindness" to the characters is present even beyond the inability to recognize the nuances of the character (Yeh et al., 2003). Within the assumptions and parameters

that FTT is a reflection of the cognitive processes of memory and reasoning, alphabetic language speakers may have to retrain how their brain processes and remembers information in order to learn Chinese.

Our results confirm the notion that cue formation is an effective learning strategy for Chinese. Out of all the study techniques employed in this study, the use of cues was found to be the most effective. In the cue groups, the cues that were given to aid in the associative processing of "人," "美," "哥," and "十" were reflective of images in Western culture that most participants agreed during the interview sessions resembled the pictographic qualities of each character. The character "人" was explained to be a pictographic image of a person with their hands by their sides and their feet shoulder width apart. "美" was described as resembling a beautiful tree with the top portion of the tree being its branches and the bottom portion representative of tree roots. The cue for "哥" was bunkbeds with "口" being a representation of windows; we argued to the students that brothers share bunk beds ergo an association of brother to bunk beds could be made. Finally, the character "十" was elucidated with a particularly Western and local connotation that many of the students in our study could potentially relate to which was the Christian symbol of the cross. Although these were the mental images and associative ideas that we gave to the students in this study, other cues could have been used. The cues that were chosen were done so because of their relative redundancy of these images in Euroamerican culture, but also for their particular relevance to the socio-cultural environment that our participants came from. Cues should be chosen with the participant's own cultural environment in mind by teachers who wish to use this technique and by researchers who may want to replicate this study.

The characters “问,” “电,” and “国” were the easiest to form verbatim to gist traces for and thus were, in all four groups, the most recalled. Beyond their simple stroke pattern and low stroke count, these three character’s cues were culturally relevant to the participant population. The vocabulary words themselves were simple and likely very common in our participants’ daily conversations. The presence of these vocabulary words in the student’s long-term memories combined with their commonality in daily speech helped ensure the relative easiness of verbatim trace formation. The words “to ask,” “electricity,” and “country” seem to be of significant relevance to the participants. In a cosmopolitan collegiate atmosphere, it would not be unusual for those three morphemes to consistently be in one’s working memory. The particular easiness in trace formation may have also been due to these particular cues being more abstract visual representative associations of the words rather than abstract associations to the morpheme (Yet et al., 2003). “电” and “国” in particular could have been viewed as abstract representations of the images we provided participants on handout three (Yongming, 2014, p. 295). The cue given for “电” was an electrical wall socket, which was reinforced on the third handout with a picture representation. It may not have been difficult for a verbatim trace to form because it required little associative processing to relate the image of a common wall socket to the notion that electricity comes from it. “国’s” cue was of a flag with some pictures or symbols drawn within and “问’s” was that to ask a question one needs to use their “口,” or mouth.

PR as a learning strategy is more effectual when employed to memorize characters with radicals. PR can be employed in a practical setting as a learning tool like cues and perhaps be a tool to better help students learn radicals. Even though radicals are not as effective for beginner-level students, they should still be taught radical meanings so that they have a foundation to build from if he or she continues their Chinese language study. Radical memorization as a single-task

learning tool cannot be applied to a plethora of Chinese characters; however, it can be effective in memorization of a few hundred to about a thousand characters. Since radical knowledge in beginning-level students will not be advanced enough to effectively improve the amount of trace formation, PR can be used on characters with radicals to better recall them. Even though multitasking of cues and PR was not effective, the multitasking of PR and radical use could be. The allocation of cognitive resources may not be as competitive between radical use and PR since radical understanding will not be advanced enough to utilize as a memory strategy. The beginner student, without the explanation of the significance of a radical is forced to rely on their own cognitive ability to recognize the pattern. For the majority of beginning Chinese language learners this pattern recognition will not occur without extensive studying and thus radicals are going to be the part of the character that Western students neglect. Since the radical will most likely also not fit within the student's psychological space (there are no radicals in alphabetic languages), the radicals will be ignored by the brain (Yeh et al., 2003).

"想" was, even with cues and PR, the most difficult character to remember and the only character with a significantly low rate of trace formation. Out of all the test characters that we presented to the students, "想" had the highest stroke count, which perhaps can account for why few students correctly matched this character. The high stroke count may have made it a low priority for the student's working memory and thus the word was pushed aside in favor of the lower stroke count characters, which would have been easier to form a trace for; the brain, tasked with having to store and then retrieve the maximum amount of characters in our short testing time, may have forced the brain to allocate more of its attention and resources on the easier characters. Participant's own analytical and reasoning skills may have also played an important role in deciding which character was considered harder to be stored in the memory. Those with

more advanced analytical and reasoning skills may have been quicker to form traces and valued quantity over quality, thus characters with more strokes were considered too complicated to allocate their limited resources and time to memorize. Future research on FFT theory on more advanced Chinese language students could help to evaluate the extent of where the brain draws the line for effective resource allocation.

Implications

In many Chinese language classrooms, instructors put much of their focus on grammar and communication skills rather than using even small amount of classroom time to provide extra assistance in vocabulary acquisition for beginning-level students, which can result in students struggling in reading comprehension; not allocating daily classroom time for vocabulary can lead to students losing confidence in their capabilities to further their language studies or succeed in the classroom. Contemporary teaching practices in Chinese classrooms' involve tools such as rote and radical memorization, which although can be effective learning tools in a foreign language classroom, are not utilizing the brain's cognitive processing to the teacher's advantage. Common methods that are used in a majority of Chinese language classrooms also do not take into account the disadvantages that Euroamerican students have when learning a logographic language because their native tongue differs in type of writing system.

This study aims to encourage Chinese language instructors who are teaching Euroamerican students to introduce FTT into their own teaching practices. PR can also be used as an effective method of teaching Chinese to Euroamerican students in the lower grades. Instead of using and reusing the traditional teaching techniques and practices that have been the primary styles and tools used by Chinese language teachers, instructors at all levels of education can use what we have proposed as PR and cues to aid their students in garnering Chinese literacy.

Where cues can be used in daily time allotted for vocabulary learning, PR can be used as an alternative to traditional paper assessments. The muscle movements not only help the process of retrieving the information from the memory but can also help create a stronger connection between the vocabulary within the memory. PR can also be applied to other classroom activities that provide a hands on approach to keep students interested in learning and provide variability in the teacher's planning.

Conclusion

Building a solid Chinese lexicon foundation can be a challenge to many Euroamerican Chinese language learners. Many Chinese language teachers make it their goal to find an effective teaching and learning mechanism that allows the most amount of students to memorize and recall the vocabulary. Through the frame of FTT teachers and students can use their cognitive processes to their advantage and be more effective second language learners. The effective learning strategy of knowledge of radical presence and meaning is not the most efficient learning strategy for beginning-level students since it provides little advantage to memorization except in more advanced learners. Cue formation can be implemented as a more generalized learning strategy because it is based on the human brain's cognitive workings and organizations. PR too is more effective than radical presence comprehension for beginners because, like cue formation, it relies on forming verbatim traces and increasing cortical plasticity. This research serves as a stepping stone for the literature of using cue and body movements to learn second language vocabulary.

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Appendix I handouts and test

Handout 1

爸 father	妈 mother
你 you	我 me; I
他 he	国 country
中 middle	点 o’clock
日 sun; day	十 ten
是 to be	美 beautiful
好 good	问 to ask
不 no; not	女 female; woman
男 male; man	弟 little brother
哥 older brother	有 to have
吃 to eat	半 half
上 up	下 down
人 people	看 to see; to watch
电 electricity	去 to go
想 to want to; to desire to	学 to study; learn

Handout 2

爸 father

你 you

我 me; I

美 beautiful

中 middle

日 sun; day

不 no; not

电 electricity

男 male; man

好 good

有 to have

吃 to eat

问 to ask

妈 mother

学 to study;to learn

人 people

去 to go

他 he

国 country

看 to see; to watch

下 down

十 ten

女 female; woman

弟 younger brother

哥 older brother

点 o’clock

半 half

上 up

想 to want to;to desire to

是 to be

Handout 3

爸 father

半 half

弟 younger brother

你 you

他 he

学 to study；to learn

点 o’clock

吃 to eat

我 I; me

好 good

问 to ask

不 no; not

女 female; woman

十 ten

哥 older brother

有 to have

男 male; man

国 country

是 to be

上 up

下 down

人 person

中 middle

看 to see; watch

电 electricity

美 beautiful

去 to go

想 to want to;to desire to

日 day; sun

妈 mother

Test

1. 上		2. 学		3. 妈		4. 爸		5. 你	
6. 半		7. 中		8. 不		9. 问		10. 哥	
11. 电		12. 下		13. 十		14. 日		15. 国	
16. 我		17. 吃		18. 有		19. 男		20. 好	
21. 美		22. 点		23. 女		24. 想		25. 看	
26. 去		27. 人		28. 他		29. 弟		30. 是	

A. Half B. person C. He D. good E. country F. older brother
G. to have H. Eat I. to go J. up K. to study, learn L. mother
M.down N.to look, to watch O. ten P. no,not Q. middle
R. to want, to desire to S.to ask T. day; sun U. father V. younger brother W. electric X. you Y. beautiful Z. Female,woman
A1.o'clock A2. I, me A3. Man; Male A4. to be

Appendix II

Interview Questions:

1. What cues did you use during experiment one to best memorize the Chinese characters? Why do you feel those cues were the most effective for this?

2. What cues did you use during experiment two to best memorize the Chinese characters? Why do you feel those cues were the most effective for this?

3. What cues did you use during experiment three to best memorize the Chinese characters? Why do you feel those cues were the most effective for this?

4. Did seeing the picture aid you in memorizing the Chinese character? If so, please elaborate as to why you believe this was true.

5. Did hearing the Chinese help you recognize the Chinese character better? If so, please elaborate as to why you believe this was true.

6. Did the repetition of viewing the characters help you in any shape or form better remember the definition and meaning of them in English?

7. What methods would you suggest to second language learners to help them better learn that target language?

8. Would you agree or disagree in saying that using physical movements in correlation to a vocabulary term helps one to better remember the word? Please elaborate on your chosen answer.6

9. Would the inclusion of full body movement methods of memorization, in your opinion, have better helped you to remember the Chinese characters? Please elaborate on your answer.