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The Influence of Learners' Cognitive Style and Testing Environment Supported by Virtual Reality on English-Speaking Learning Achievement

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Abstract: Although VR technology can provide an ideal learning and application environment for learners' language skill acquisition, the learning performance of different types of learners in virtual environments and differences in their knowledge transfer ability from the virtual to the real environment still need further discussion. Therefore, we developed a VR English speaking training and testing system to understand the influence of cognitive style and test environment on the learners' learning effect. The results indicated that: (1) the learning effect of the field-independent learners was lower than that of the field-dependent learners in the real testing environment, but significantly higher than that of the field-dependent learners in the virtual testing environment. Meanwhile, there was a more significant difference in the real and virtual learning effect between the field-dependent and field-independent learners; (2) there was a significant interaction between cognitive style and test environment in the learners' learning effect. Besides, cognitive style and test environment had an influence on the spoken English learning effect based on VR. The field-independent learners were more likely to transfer what they had learned in the virtual environment to the real application.

Keywords: virtual reality; spoken English learning; VR-based training and testing system; cognitive style; learning achievement



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1. Introduction

Education is the central element of sustainable development, along with other relevant indicators within the Sustainable Development Goals. In a global community with more than 6000 languages, one of the impediments to a unified education for sustainable development is a lack of communication across linguistic and cultural boundaries [1]. Some scientists and educationalists in the area of language teaching think that the universities should integrate foreign language education into their curriculum in order to enable future professionals to cope with issues of sustainable development in their work and to reinforce the sustainability competencies of students [2]. Therefore, if we want to realize the sustainable development of individuals and even society, we must focus on language education. Language learning is a complex subject focusing on real application. Learners need to go through a long and complex learning process, especially for spoken English learning. Language learning is not a cognitive activity that is isolated from context and language use, but is more of a social interaction activity which takes place in real social language situations. The linguist Atkinson (2002) believed that the social attribute of language in language learning is reflected in the practicality of language [3]. People can convey, construct and express their thoughts, feelings, behaviors, identity and other information and states via language, and language communication and expression must also be based on a certain social environment. Krashen (1982) stressed that context can promote the acquisition of comprehensible input for language learners and can influence learners' language learning, and has a great influence on language learning effects [4].

Therefore, the influence of context on language learning has become a hot issue in the field. However, previous language learning environments were usually located in the classroom and were based on text and audio materials, which failed to bring the learners a more realistic and intuitive learning experience. Today, the application of technology can break down the barriers of the classroom, thus providing learners with a more diverse and richer application environment. Virtual reality technology is a three-dimensional simulation technology used to create a virtual learning environment and promote learners' skill acquisition. It can provide learners with a more diversified and rich language application environment.

Since the 1980s, technology has been developing continuously towards the direction of informatization, and fields such as computer-assisted language learning (CALL) and mobile-assisted language learning (MALL) have gradually become the focus of studies on language learning around the world. Language learning has begun to break through theoretical discussion and embark on the stage of the practical application of technology. It has become normal for learners to engage in interactions in order to promote their language learning via computer networks and mobile devices. For example, in the work of Hung, Young and Lin (2015), compared with the traditional classroom environment, the game-based teaching environment that they created with mobile devices achieved better teaching effects [5]. Besides, students not only maintained relative independence during the process of learning, but they also fully reflected on their cooperation. Evseeva and Solozhenko (2015) proposed that students could study in e-learning and classroom environments and could be the subject of learning [6]. In the learning process, students' autonomy is improved and, finally, good learning results are achieved. Although these technologies have created good learning conditions for language learning, in the long run, there are still some problems, such as the single activity form, insufficient restoration of the environment and situation, and insufficient application of strategies. Therefore, we should not only provide a platform for communication, cooperation, recording and analysis, but also provide learners with a real social environment experience, so as to give full play to language learning. Virtual reality (VR) technology can break the limitations of traditional technology and create a more ideal language learning environment, which mainly benefits from immersion and the presence of the VR technology.

Some studies have found that good outcomes can be achieved by using technology to create virtual environments which promote language learning. For example, Ebert, Gupta and Makedon (2016) explored the possibility of realizing language acquisition by constructing Ogma's VR system, and found that VR technology has a potential promoting effect on language acquisition in comparison with traditional learning methods [7]. By using interactive VR tools to support Chinese learners' language learning, scholars found that the virtual environment not only provided real situations for learners, but also stimulated learners' interest in the target culture, which was conducive to promoting the language learners' cross-cultural communication [8,9]. Although VR technology can provide the necessary social context for language learning, the influence of social culture and background on the practical application of language cannot be ignored. The ultimate goal for learners lies in the practical application of language, but most studies have aimed at verifying whether VR can promote language learning, while ignoring whether learners' learning outcomes can achieve a smooth transfer from virtual learning to real application and the factors affecting such a transfer. From the perspective of learners' cognitive style, this study explores the internal characteristic factors that influence learners' learning outcomes, and significantly focuses on the application effect of language learners transferring virtual language learning outcomes to reality.

Based on previous research, this study independently designed and constructed a complete English learning and testing system to answer the following research questions:

- (1) Is there any difference between field-dependent and field-independent learners' oral learning performance in a virtual environment?
- (2) Whether or not the performance achieved when field-dependent and independent learners learned in a virtual environment can be transferred to real situations.

2. Literature Review

2.1. Research on Language Learning Supported by Virtual Reality

It is normal that the development of information technology delivers benefits to education and learning activities. The development and creation of context and interaction are the key elements of the development of technology-supported language learning. With the continuous update of various technologies, mobile learning and VR technologies stand out from many information technologies and have become important technical and research tools for language learning [9,10]. However, some researchers have suggested that the convenience of digital devices not only helps learners to achieve the goal of “studying in any place and at any time,” but also leads to the risk that learners may become addicted to social media and digital devices [11]. In addition, relevant research has shown that language learners can have higher learning motivation in a familiar and real environment [12]. As a result, VR technology provides an effective way for language learners to experience richer and more realistic language scenes, especially for spoken language learners from non-English-speaking countries. Language learners need to conduct training in and application of the target language environment, and use their experience to master spoken English language skills. The interactivity and immersion provided by VR technology to virtual situations can meet the environmental and situational needs of language learning [13,14]. With the support of high-performance computers, it can generate a simulated three-dimensional environment and bring learners multi-channel sensory stimuli, such as the visual sense, auditory sense and the sense of touch, and realize natural interaction modes, such as voice interaction, tactile interaction, gesture interaction and multi-channel interaction. It can realize interaction, cooperation, creation and immersion, and enhance learners’ perceptions of the environment [15]. Therefore, it has great potential and value in the field of education, which is conducive to creating a more ideal learning environment for language learning. According to the level of immersion, virtual reality can be divided into three types. Among them, desktop VR technology is the most widely used in language learning research, which is called non-immersive VR. Many studies have proved the effectiveness of desktop VR in language learning, showing that it can improve learning motivation and achievement [16], develop cognitive abilities [17] and facilitate completion of complicated foreign language learning goals in collaboration [18]. In contrast, researchers have rarely used immersive VR. Regarding CAVE-style VR, one example is the study of Urun, Aksoy and Comez (2017) [19], which used a large interactive display screen and a Kinect device to build a CAVE-like VR environment, and achieved the goal of learning words through game-based learning. Regarding headset VR, a typical case is a study which confirmed that the Oculus Rift can provide the most ideal interaction experience, generate a sense of real existence and contribute more to the development of language learning in comparison with a desktop VR system [20].

Although the promoting effect of VR technology on language learning has been confirmed by relevant studies, researchers believe that in language learning, immersive VR has more advantages than desktop VR, which can provide more channels of sensory stimulation and create a more realistic and ideal learning environment [21]. In addition, headset VR can also provide multi-channel interaction, which can make the presentation of non-verbal information more expressive [22]. However, the application of immersive VR technology in language learning has just been launched and there is still a great deal of room for further research. The language learning activities of the current research were carried out with the support of headset VR technology. On the one hand, it pays attention to the importance of scene construction; on the other, it also explores the learning effect of learners’ language skill training.

2.2. The Effect of Cognitive Style on Language Learning

Cognitive style, as an important part of learning style, can embody the learners’ problem-solving perspective and memory mode [23]. It is also an important topic in the field of education discussing learners’ thinking process and information processing

mode [24]. Ehrman and Leaver (2003) subdivided cognitive styles into 10 categories according to the dimensions of learners' conscious control over the foreign language learning process: field-independent/field-dependent, field-sensitive/field-insensitive, random/sequential, global/particular, inductive/deductive, synthetic/analytic, analog/digital, concrete/abstract, leveling/sharpening and impulsive/reflective [25]. Among these, field-independent/field-dependent can be used by foreign language learners as the criterion to select learning strategies and methods. Relevant studies have confirmed that English teaching activities based on the learners' cognitive style are beneficial for stimulating learners to achieve better learning performance [26]. In general, field-independent learners tend to be good at specific analysis of different language inputs and have a certain degree of autonomy. Field-dependent learners are sensitive to the overall perceptual background and tend to analyze information by means of external forces.

Based on the influence of cognitive style on language learning skills, researchers have carried out empirical studies on language skills such as listening, reading comprehension, vocabulary knowledge and grammar knowledge. For example, [27] Hwang (1999) found that field-independent learners have stronger comprehension ability in listening. In view of reading comprehension ability, Salmani-Nodoushan (2006) studied the scores of different types of reading in field-independent and field-dependent learners, and concluded that the learning realization of field-dependent learners was significantly better than that of field-independent learners in terms of judgment, overview and inspiration tasks, while in supplementary sentence question types, field-independent learners performed significantly better than field-dependent learners [28]. Rostampour and Niroomand (2014) tested the correlation between learners' English vocabulary level and cognitive style, and found that there was a highly significant correlation between English vocabulary level and cognitive style in intermediate and advanced learners [29]. In the choice of learning strategies, fewer field-dependent learners will choose social and emotional learning strategies that are more suitable for their own cognitive style [30]. In addition, the difference in cognitive style leads to a difference in the learning environment that is suitable for language learners. For example, in a regular classroom environment, field-independent learners can achieve better improvements in their vocabulary, listening and grammar [30–32], while in a social environment with social orientation, field-dependent learners can have better learning achievements [33].

Nowadays, people pay more and more attention to the influence of the learning environment on individuals in foreign language learning research, which can provide strong support for improving the learners' cognitive effect. With the background of the development of VR technology, how to reduce the learning effect difference caused by cognitive style in the virtual environment should also become the focus of future research. Analyzing the effect of learners' cognitive style on language learning will be helpful for improving language learning activities in the virtual environment.

3. The Spoken English Training and Testing System Based on Virtual Reality

3.1. System Architecture

This study took MindShow (<https://mindshow.com/> (accessed on 20 July 2021)) as the system development platform for the design and development of the system scenarios. System developers made full use of the rich resources in the MindShow material library to construct the corresponding scenarios with different dialogue content. In addition, the VR devices used by the Research Institute are HTC Vive's Headset VR, including locators, helmets and controllers that can be used to interact with virtual personas. The spoken English training and testing system developed in this study helps learners to complete training and testing on daily situational dialogues by providing virtual scenes conforming to the conversation content for learners of spoken English.

The spoken English training and testing system based on VR includes a user interface, a visual panel and the two agents of scene and corpus. The system architecture is shown in Figure 1. The visual panel is the entrance and mediation to realize the interaction between

learners and virtual roles; the user interface is connected with the learner information database, and with the support of the behavior recording database and the audio recording database, the learning process is recorded to save the learning information and establish a learning log for learners. The most important is the scene and corpus management agent. Their connected database stores a large number of social scenes and situational dialogues, which is the learning resource base for learners to conduct spoken English training and testing.

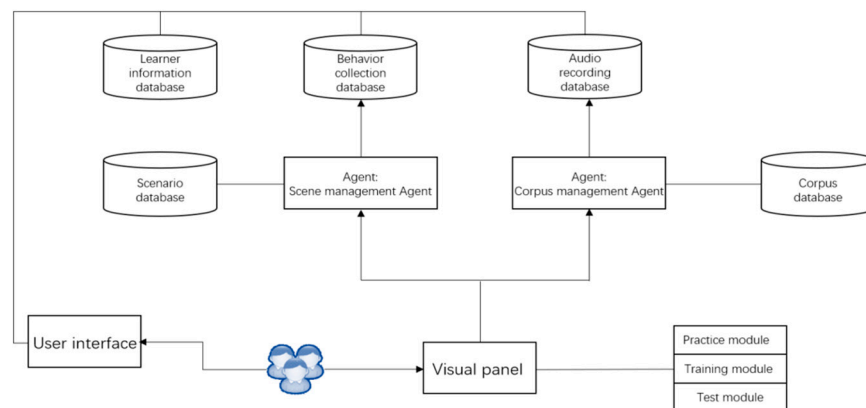


Figure 1. System architecture diagram.

3.2. System Function and Design

According to the research requirements, the system developers designed three different modules: exercise, training and testing. The learners could select the required system modules via the visual interface after entering the system.

The practice module was mainly used by the initial virtual environment learners so that they could become proficient in their use of the equipment and have an opportunity to adapt to the learning environment. The VR devices adopted in this study included a headset VR for presenting the language training scenes and recording sounds, a VR locator for defining the learner's mobile area, and a VR controller for convenient operation and interaction. With this VR equipment, learners could enter the practice scene to complete the preliminary experience of the virtual environment and gain an understanding of the formal training process. A practice scene is shown in Figure 2. During the experimental practice, if the subjects felt dizzy or uncomfortable, they could give feedback to the staff at any time, terminate and quit the experiment.



Figure 2. Practice scene interface.

We must be clear that the practice scene is completely different from the formal learning scene, so the learner's perceptions of the practice scene did not affect the subsequent experimental outcomes. The systematic training module was also the learners' spoken English learning link, in which the system showed the learners the social situation conforming to the dialogue content. The training link was mainly divided into dialogue listening, reading and role play. When learning new dialogue content, learners could autonomously control the play of the dialogue via the VR controller, including the playing speed and progress. In order to ensure the reasonableness of the experiment, the learners' dialogue, listening and reading time was required to be controlled within 3 min during the experiment. At the start of the role play activity, the learner no longer adopted a third person view, but completed the dialogue by playing the role itself. It is worth noting that during the process of role play, learners could start the recording function of the system, which was convenient for replaying the video after training so as to strengthen self-reflection. Figure 3 shows the system interface of dialogue, listening, reading and role play.



Figure 3. Interface of conversational listening, reading and role playing.

As the application environment of the post-test served as the study variable, the system developer added a test module to the system, which allowed the learners to complete, in coordination with the virtual character, the outcome test of the conversation they had learned. In this study, the test module was used as the virtual test. The real test was conducted by two English teachers to check the learners' learning content outside the virtual environment.

MindShow (<https://mindshow.com/> accessed on 20 July 2021) was selected for scene construction. MindShow offers a library of scenes and characters of its own. Therefore, users can directly make use of the materials in the library to build an environment that meet their experimental needs, as well as putting the virtual characters into the scene, dubbing the characters, and creating and changing their body movements and expressions. These functions can create a more realistic learning scene for spoken English. The software, however, has certain limitations: a conversation in a learning scene is limited to 30 s, with no more than three characters in the same scene. Despite all the limitations that disable complex language interaction activities, MindShow can effectively establish a simple conversation scene and meet the learning needs of short English conversations, and therefore met the expectations of this experiment.

4. Experiment Method

In a bid to explore the effects of cognitive style on learners' learning outcomes of spoken English in the virtual environment, this study conducted an experiment of spoken English training in the VR context with college students, and reproduced different situations in a virtual scene where learners could complete conversation training through imitation based on experience.

4.1. Participants

The study conducted an experiment of spoken English training in a virtual scene among 69 undergraduates who were not majoring in English. The age of participants ranged from 18 to 21 years old, with an average age of 19.3 years, including 36 women and 33 men. All the participants were informed of the experimental facts prior to the experiment, and were advised to interrupt the experiment immediately if they became unwell. In the experiment, the participants were numbered according to their sign-in sequence, and they were tested to identify whether their cognitive style was field-dependent or field-independent in the pre-test phase. The participants were grouped as shown in Table 1.

Table 1. Grouping of participants.

Scene Arrangement	Virtual Testing Environment	Real Testing Environment
Cognitive Style		
Field-dependent	35	35
Field-independent	34	34

To compare the two experimental groups, we tested their performance in oral English before the experiment. The results of independent sample *t*-test analysis are shown in Table 2. This shows that participants with different cognitive styles had no significant difference in oral English level ($t(67) = 0.77, p = 0.443$; field-dependent learners' oral English learning level: $M = 11.73, SD = 0.98$; and field-independent learners' oral English learning level: $M = 10.96, SD = 1.05$). The group performances were at the same level.

Table 2. Results of an independent samples *t*-test of oral English performance between two groups.

Group	N	Mean	SD	t	p
Pretest score					
Field-dependent	35	11.73	0.98	0.77	0.443
Field-independent	34	10.96	1.05		

4.2. Instruments

4.2.1. Learning Content and Post-Test

In order to ensure the reliability of the content of the spoken English learning, and the scientific validity of the scoring in the experiment, short conversations from the listening part of the TOEIC (Test of English for International Communication) were selected as the learning content. The content focuses on two daily scenes: passenger check-in and a discussion of their views on business trips abroad. The two scenes are similar in terms of both duration and difficulty. In the post-test stage, the spoken English learning outcomes in the virtual scene and the real scene were presented. The test content allowed the learners to express themselves in English and reproduce the conversations they had learned.

The grading standard for the post-test was mainly based on the TOEIC standard with reference to their IELTS speaking level. Two experienced spoken English teachers scored the participants' fluency and coherence, body language, accuracy and pronunciation. Each index accounted for 5 points, and the final score was obtained by adding the scores of each index.

4.2.2. Psychological Questionnaire

In this study, the cognitive style questionnaire originated from the questionnaire developed by Witkin et al. (1971) [34]. It consists of 18 graphic questions, with a full score of 18. The Cronbach's alpha values of the two dimensions are 0.85 and 0.5. The cognitive styles of the participants were divided into the field-independent type and the field-dependent type. Field-independent learners are good at defining their own learning strategies in accordance with internal criteria, while field-dependent learners tend

to process information based on their perceptions of the surrounding environment and contextual analysis. The higher the score, the more field-independent the learner, and the lower the score, the more field-dependent the learner. The study determined that half of the learners with the top scores were field-independent and the other half were field-dependent [35].

4.3. Experimental Procedure

At the beginning of the experiment, the participants signed into the system. The participants, who had completed the cognitive style questionnaire in the pre-test stage, were divided into field-dependent and field-independent groups, and underwent a unified training on conversation in the virtual scene. The training process was conducted twice. After the training, all of the learners began to take tests in both the virtual and real environments. In the virtual environment, learners had a conversation with the virtual examiner in the spoken English training and testing system, while in the real environment, they answered the test questions asked by experienced English teachers. A virtual scene for selected daily conversations was developed and built. All the participants underwent situational conversation training in the virtual environment, and were tested in the virtual scene and a real scene to see whether their acquired knowledge of spoken English learners in the virtual scene was affected by the testing environment. The experimental process is shown in Figure 4.

Prior to the formal learning, the participants needed to be familiar with operating the equipment in the practice scene to ensure smooth learning. Besides, they had to spend 3 min previewing the conversation materials before entering a learning scene. Each training scene included a 30-s conversation between two people. The participants practiced each scene three times. The learning included “conversational listening and reading” and “role playing.” “Conversational listening and reading” involved listening to and reading the conversation segments of the virtual characters repeatedly in the scene within 2 min. The participants participated in a role play, in which they played a role and recreated the conversation. Each participant trained on two scenes and each scene took 20 min. In addition to the above training process, participants had enough time to reflect and digest in the rest of the 20 min. The total training time of each subject was 40 min. In the wake of the two practice conversations, the participants completed the post-test in the virtual environment in accordance with the conversation content. The post-test in the real environment was conducted in the classroom, where two English teachers scored the spoken English proficiency of the participants according to the scoring criteria.

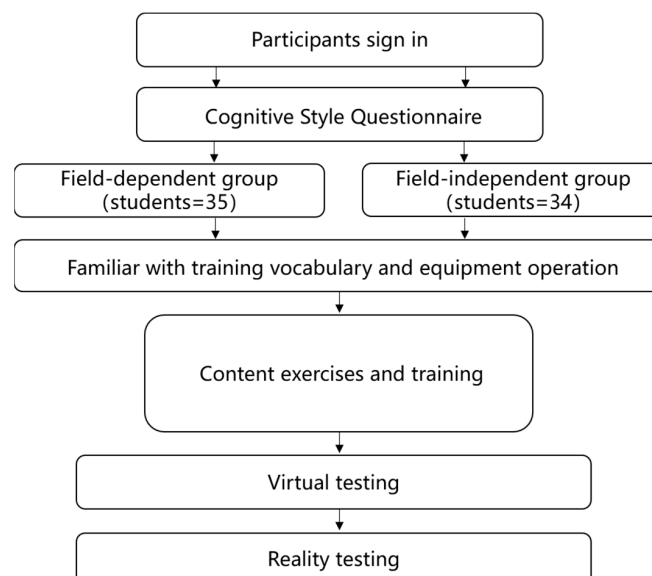


Figure 4. Experimental process.

5. Results and Discussion

This section presents the analysis and discussion of the data obtained in the experiment: Section 5.1 provides a verification of the effects of the cognitive styles on the learners' learning outcomes of spoken English, Section 5.2 presents a verification of the effects of the spoken English testing environment on the learners' learning outcomes and Section 5.3 provides the verification of the effects of cognitive style and the spoken English testing environment on learners' learning outcomes.

5.1. Verification of the Effects of the Spoken English Testing Environment on the Spoken English Learning Outcomes of Learners with Different Cognitive Styles

This part elaborates whether there are differences in the spoken English learning outcomes of the field-dependent and field-independent learners in the real and virtual testing environments. An independent sample *t*-test was used for data analysis. The results are shown in Table 3. The results show that there was a significant difference in the spoken English learning outcomes of the field-dependent and field-independent learners ($t = -2.17^*$, $p = 0.033$), and that the scores of the field-independent learners were significantly higher than those of the field-dependent learners. However, there was no significant difference in the spoken English scores of the field-dependent and field-independent learners in the virtual environment ($t = 0.7$, $p = 0.337$). In other words, both groups of learners had similar scores in the virtual testing environment.

Table 3. Verification of the effects of different cognitive styles on spoken English learning outcomes.

	Group	N	Mean	SD	t	p
Scores in the real testing environment	Field-dependent	35	9.96	0.81	−2.17	0.033 *
	Field-independent	34	11.52	0.64		
Scores in the virtual testing environment	Field-dependent	35	10.12	0.79	0.97	0.337
	Field-independent	34	9.36	0.84		

* $p < 0.05$.

5.2. Verification of the Effects of Cognitive Style on Learners' Learning Outcomes in the Different Spoken English Testing Environments

This part will expound on the differences in the spoken English learning outcomes of the field-independent and field-dependent learners in the real and virtual testing environments. A paired sample *t*-test was used for data analysis. The experimental results are shown in Table 4. According to the results, for the field-dependent learners, there was no significant difference in the spoken English learning outcomes in the virtual and real testing environments ($t = 0.186$, $p = 0.853$). However, for the field-independent learners, there was a significant difference in the spoken English learning outcomes in the virtual and real testing environments ($t = -2.95$, $p = 0.004$), namely that they had better outcomes in the real than in the virtual testing environment. The results show that the virtual test and the real test had little effect on the spoken English learning outcomes of the field-dependent learners. Nevertheless, the difference in testing environment had a significant effect on the spoken English learning outcomes of the field-independent learners. Besides, the field-independent learners had better learning outcomes in the real test environment than in the virtual test environment. Moreover, a statistical analysis of the scores for the virtual environment and in the real environment showed that there was no significant difference between them ($t = -1.67$, $p = 0.096$). Therefore, it was the cognitive style of the learners that caused the difference between the virtual and real outcomes.

Table 4. Verification of the effects of cognitive style on learners' learning outcomes in different spoken English testing environments.

	Group	N	Mean	SD	t	p
Field-dependent	Scores in the virtual testing environment	35	10.12	0.79	0.186	0.853
	Scores in the real testing environment	35	9.96	0.81		
Field-independent	Scores in the virtual testing environment	34	9.36	0.84	−2.95	0.004 **
	Scores in the real testing environment	34	11.52	0.64		

** $p < 0.01$.

The results reveal a significant difference in task performance. In comparison, the oral learning effects and performance of field-independent learners were greater than that of field-dependent learners in the real testing environment. We conjectured that field-independent learners prefer to transfer knowledge to a better extent so that the knowledge can be more deeply internalized. It is more obvious that they can apply it to actual communication.

5.3. Verification of the Effects of Cognitive Style and the Spoken English Testing Environment on Learners' Learning Outcomes

This section explores the effects of cognitive style and the learning environment on spoken English learning outcomes. A two-factor mixed design ANOVA analysis was used in the experiment, where cognitive style served as an independent variable and the testing environment as a dependent variable. The descriptive statistics are shown in Table 5 and the results are shown in Table 6.

Table 5. Descriptive statistics.

Cognitive Style	n	Test B1 in Virtual Environment	Test B2 in Real Environment
		M (SD)	M (SD)
Field-dependent A1	35	10.12 (0.79)	9.96 (0.81)
Field-independent A2	34	9.36 (0.84)	11.52 (0.75)

Table 6. Effects of testing environment on the spoken English learning outcomes of students with different cognitive styles.

Source	SS	df	MS	F	p	η_p^2
A: cognitive style	0.32	1	0.32	0.34	0.56	0.005
Error (between groups)	62.53	67	0.93			
B: testing environment	3.47	1	2.17	8.00	0.006 **	0.107
A * B	541.37	1	2.83	10.44	0.002 **	0.135
Error (within group)	18.142	67	0.27			

** $p < 0.01$.

The results show that cognitive style and testing environment had a significant interaction effect on the spoken English learning outcomes, $F(1,67) = 10.44$, $p = 0.002$, $\eta^2 = 0.135$. The interaction is shown in Figure 5. A simple main effect test was further conducted, and the results are shown in Table 7.

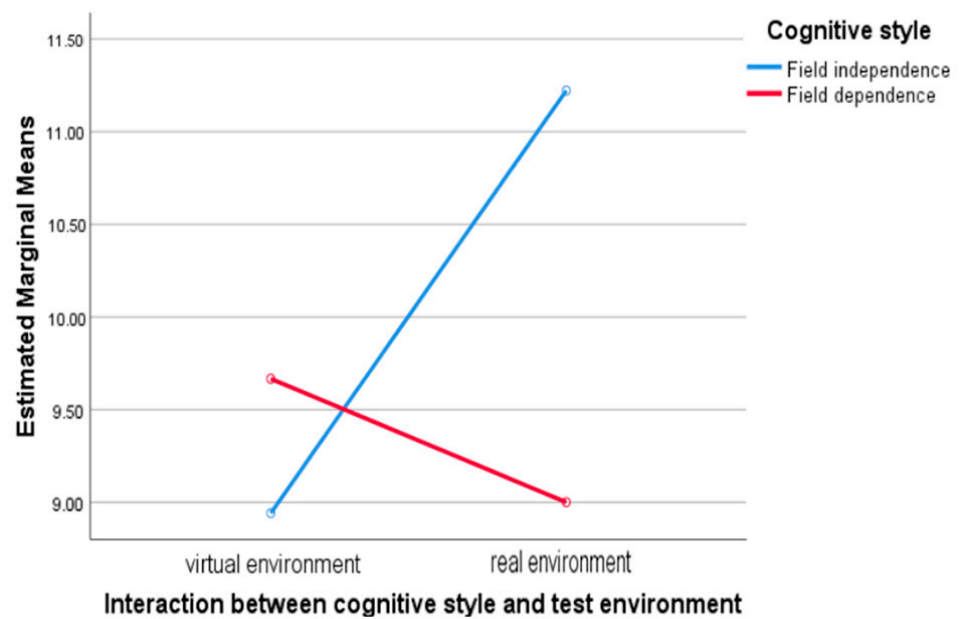


Figure 5. Diagram of the interaction between cognitive style and testing environment.

Table 7. Verification of the simple main effect.

Source	SS	df	MS	F	p	η_p^2
Cognitive style (A)						
Virtual environment(B1)	0.60	1	0.69	1.15	0.286	0.009
Real environment(B2)	2.26	1	2.26	4.36	0.039 *	0.032
Error	80.67	134	0.60			
Testing environment (B)						
Field-dependence (A1)	0.03	1	0.03	0.10	0.749	0.002
Field-independence (A2)	5.14	1	5.14	18.98	<0.001 ***	0.221
Error	18.16	67	0.27			

* $p < 0.05$; *** $p < 0.001$.

In the test of spoken English application by learners in the virtual environment, the learners' cognitive style had no significant simple main effect ($F(1,134) = 1.15$, $p = 0.286$, $\eta^2 = 0.009$). In the test of learners' spoken English learning outcomes in the real environment, the learners' cognitive style showed a significant simple main effect ($F(1,134) = 4.36$, $p = 0.039$, $\eta^2 = 0.032$; 84). Field-dependent learners had better spoken English learning outcomes in the real environment ($M = 2.49$, $SD = 0.81$) than field-independent learners in the same environment ($M = 2.88$, $SD = 0.75$). For field-dependent learners, the testing environment had no significant simple effect ($F(1,67) = 0.10$, $p = 0.749$, $\eta^2 = 0.002$). Nevertheless, for the field-independent learners, the testing environment had a significant simple main effect ($F(1,67) = 18.98$, $p < 0.001$, $\eta^2 = 0.221$). Field-independent learners had higher spoken English test scores in the real environment ($M = 2.88$, $SD = 0.75$) than in the virtual environment ($M = 2.33$, $SD = 0.84$).

Further reflection on the experimental results suggested the causes of the experimental results as follows. On the one hand, the results may be related to the tendency of different types of learners to deal with situational conversations. Field-independent and field-dependent learners have different interpersonal orientations. Field-dependent learners rely on the social environment in situations and are good at analyzing social situations and establishing interpersonal relationships, whereas field-independent learners are more likely to separate themselves from social interaction and characters and use their cognitive analysis and knowledge-building skills to address problems [35]. In the process of learning spoken English in the virtual environment, field-dependent learners will pay more attention to adaptation to and analysis of the environment, while ignoring

the knowledge content conveyed by the scene, which will influence their learning outcomes. On the other hand, cognitive style can also exert an effect on the learning transfer outcomes. Relevant studies have shown that in response to problems with different degrees of similarity, the transfer outcomes of field-dependent learners in solving high-similarity problems are better than those of field-independent learners, but the results are opposite when solving low-similarity problems [36]. This also provides evidence that learners with a field-dependent cognitive style mainly rely on the use and imitation of the learned knowledge, while field-independent learners tend to understand and reconstruct the knowledge itself. As the early training took place in the virtual environment and the field-dependent learners were more likely affected by the environment than the field-independent learners, when the testing environment changed from virtual to real, the field-dependent learners may have found it hard to adapt to the changes, which may have taken a toll on the occurrence of spoken English skill transfer. For the field-independent learners, their knowledge analysis and internalization procedure could have reduced the interference caused by the change in the testing environment, so they could complete the smooth transfer of their spoken English skills from virtual learning to practical application, and thus obtained better English learning outcomes [37]. This explains the reason why the field-dependent learners had similar learning outcomes in the different testing environments, while the field-independent learners had significantly different learning outcomes in the virtual test and the real test.

6. Conclusions and Suggestions

As a new contribution to the field of language learning based on virtual reality system, this research, based on the work of Legault et al. [38], Scholz and Schulze [39] and Ibrahim et al. [40], designed and developed an immersive oral training and testing system to explore the influence of learners' cognitive style and the testing environment on oral learning results. The system was divided into two functions: spoken English training and spoken English testing. The process of spoken English training provided a unified virtual scene that is consistent with conversation content for spoken English learners. Learners can participate in the interactive conversational situations in the first person. The spoken English testing aimed to investigate the training content. Learners answered relevant questions asked by virtual characters. In this study, the learners were divided into two groups with different cognitive styles (field-dependent and field-independent) through questionnaires. After completion of the training, the learners completed tests in the virtual and real environments. Besides, data analysis was conducted on the learners' learning outcomes according to their different cognitive styles in the different testing environments.

This study had some deficiencies which should be noted. Due to the constraint of time and the dispersion of the participants, it was not possible to perform long-term periodic experiments. In addition, the platform on which the study system was developed provides only a short training time for learners, which may lead to insufficient training preparation. Finally, the study results provide suggestions for the developers and teaching material designers of spoken English virtual learning environments. They should account for the effect of cognitive style on learners' spoken English learning outcomes in virtual environments, conduct diversified representations of knowledge, pay attention to the learning characteristics of different types of learners and help them learn in an effective manner. In light of the results and findings of the study, there is much room for further development of VR technology in the study of language learning. In addition to the educational application, the psychological level of learners should also become the focus of future study, especially in game teaching. Learners' psychological changes are influencing factors that can by no means be ignored by researchers. Based on the gains and deficiencies of this study, the future research should further use effective development tools to establish a language learning environment to meet the long-term development needs of language learners, so that they can carry out larger and longer-term experimental research. It is hoped that this study can lend impetus to the further application of VR technology in language

learning. Finally, we believe that with the continuous enrichment of more research on the application of VR to language learning in the future, we can effectively promote the sustainable development of education, thus achieving world sustainability.

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