A Study of Using Picture Associate English Vocabulary Learning with Physical Activity

Fengqin Liu
College of Sport Science, Dali University, People's Republic of China
Suchada Kornpetpanee
College of Research Methodology and Cognitive Science, Burapha University, Thailand
Remo Job
Department of Psychology and Cognitive Science, University of Trento, Italy

บทคัดย่อ

การวิจัยนี้มีจุดมุ่งหมายเพื่อตรวจสอบผลของการเรียนรู้คำศัพท์ภาษาอังกฤษด้วยวิธีการเชื่อมโยงคำศัพท์กับรูปภาพในขณะที่ทำกิจกรรมเคลื่อนไหวร่างกายของนักศึกษาสองภาษาชาวจีน กลุ่มตัวอย่างเป็นนักศึกษาระดับปริญญาตรี จำนวน 40 คน (อายุ 18-24 ปี) กำลังศึกษาอยู่ที่ Dali University สาธารณรัฐประชาชนจีน ในปีการศึกษา 2013 กลุ่มตัวอย่างถูกแบ่งออกเป็นสองกลุ่มให้มีความเท่าเทียมกันในด้านความสามารถทางภาษาอังกฤษและความสมบูรณ์ของร่างกาย กลุ่มทดลองได้รับการเรียนรู้คำศัพท์ภาษาอังกฤษขณะทำกิจกรรมเคลื่อนไหวทางกาย ส่วนกลุ่มควบคุมได้รับการเรียนรู้คำศัพท์ภาษาอังกฤษโดยนั่งอยู่กับที่ การทดลองประกอบด้วยการเรียนรู้คำศัพท์ภาษาอังกฤษและการทดสอบภายหลังการเรียนรู้รวม 8 สัปดาห์ สัปดาห์ละ 1 ครั้ง กลุ่มทดลองได้รับการทดสอบระยะติดตามผลคือหลังการทดลองเสร็จสิ้นแล้ว 1 เดือน เก็บรวบรวมข้อมูลโดยวัดระยะเวลาการตอบสนองและคะแนนความถูกต้องของการทำแบบทดสอบ word-picture verification task วิเคราะห์ข้อมูลด้วย t-test

ผลการวิจัยแสดงให้เห็นว่า นักศึกษาสองภาษาชาวจีนที่เรียนรู้คำศัพท์ภาษาอังกฤษด้วยวิธีการเชื่อมโยงคำศัพท์กับรูปภาพขณะทำกิจกรรมการเคลื่อนไหวร่างกายมีผลการเรียนรู้ดีกว่ากลุ่มควบคุมที่เรียนรู้ขณะนั่งอยู่กับที่ ผลการเรียนรู้ของกลุ่มทดลองยังคงทนไปถึงระยะติดตามผล ชี้ให้เห็นว่า การทำกิจกรรมเคลื่อนไหวร่างกายขณะเรียนรู้คำศัพท์ได้ผลดีและคงทน

***คำสำคัญ*:** picture associated, English vocabulary learning, physical activity

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College of Sport Science, Dali University, People's Republic of China
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Remo Job
Department of Psychology and Cognitive Science, University of Trento, Italy

Abstract

The aim of this study was to investigate the effects on English vocabulary learning by late Chinese - English bilingual students using the picture-association method while performing physical activity. Participants were 40 undergraduate students (18-24 years old) enrolled at Dali University in the 2013 academic year. Both the English proficiency level and the fitness level were determined in order to obtain two comparable groups of participants, the experimental group being requested to perform a physical activity during learning while the control group was in a stationary condition during learning. There were 8 sessions of the English lexical learning and testing in total, once per week. In addition, there was a follow up test for the experimental group one month after the 8th session, without intervening learning trials. Response times and accuracy rates were recorded for each task. An independent samples *t*-test was performed for data analysis.

The preliminary results showed that the Chinese-English bilingual learner using the picture for the English learning method with physical activity performed better in the Word-Picture Verification Task. The better performance of the experimental group also emerged in the follow up test. This indicates that the effects of the physical activity on vocabulary learning are not only short-lasting but also long-lasting.

***Keywords*:** picture associated, English vocabulary learning, physical activity

Introduction

English as a second language (L2), or as a foreign language is widely used around the world. It is obvious that for language educators and learners it is very important to understand the L2 learning process and the factors involved. However, consensus on this issue has not yet been reached, and the arguments about effective L2 learning methods are continually being explored, especially so in the past two decades. Learning L2 involves the learning of several language subsystems, which include grammar, phonology, and vocabulary (De Groot & Van Hell, 2005). There is no doubt that L2 vocabulary learning plays an essential role in language learning. Nation (2001) stated that vocabulary is considered an important connection between the four skills (listening, speaking, reading, and writing), because vocabulary carries the content which people want to communicate. Moreover, Thornbury (2002) also claimed that while people are learning a new language nothing can be conveyed without vocabulary learning.

According to The Revised Hierarchical Model (Kroll & Stewart, 1994), a productive way to learn L2 vocabulary is by means of pictures that may help to build a stronger link between L2 and conceptual memory, as opposed to the use of mediating L1 words. A number of studies have used the L2 – picture association method to study lexical development and conceptual representation (Chen & Leung, 1989; Lotto & De Groot, 1998; Tonzar, Lotto, & Job, 2009). Most of the previous research focused on cognate and non-cognate status of the target language (L2). Thus, it is still interesting to explore and use the L2-picture association method to learn L2 by Chinese – English bilingual learners.

Physical activity affects cognition and can improve memory, but it can also affect language learning. Much empirical evidence is available on this topic. Several animal studies have shown a strong influence of physical activity on synaptic plasticity and in particular on the genesis of new neurons in the adult mammalian brain (Kempermann et al., 2010; Rojas Vega, S. et al., 2006; van Praag, Christie, Sejnowski, & Gage, 1999; Uda, Ishido, Kami, & Masuhara, 2006). Furthermore, there is cumulative evidence at the biochemical level that physical exercise leads to an increased release of several neurotrophic factors (Christie et al., 2008; Fabel & Kempermann, 2008). According to neuroscience and neurochemistry, there are many factors affecting memory, cognition and learning from physical activity, such as, brain plasticity and neurogenesis, BDNF (Brain-Derived Neurotrophic Factor) and IGF-1 (Insulin Growth Factor-1), Dopamine, Serotonin Norepinephrine, Glutamate and Structural Changes. The effects of physical activities on the brain have been extensively researched (Etnier et al., 1997; Ploughman, 2008; Trudeau & Shephard, 2010; Sibley & Etnier, 2003). Blaydes (2004) underlined the importance of movement and claimed that teaching academics kinesthetically can improve the learning process. Simple physical movements can bring about rapid and automatic improvements in skills like memorization, reading, concentration, and communication. In addition, there are noticeable gains in creativity, energy levels, and performance. Increased movement also tends to narrow attention to target tasks (Easterbrook, Hains, Muir, & Kisilevsky, 1999).

A few previous studies provided evidence that physical exercise can improve foreign language vocabulary learning (Schmidt-Kassow, Kulka, Gunter, Rothermich, & Kotz, 2010; Winter et al., 2007). Hence there is no doubt that physical activity positively improves language learning. So far, there is an ongoing debate on such issues as, the optimal duration of the exercise, the type of physical activity (aerobic or anaerobic), the intensity level of the exercise, and how they may affect the language learning results (Winter et al., 2007). There is also debate on the underlying causes of the effects of physical activity on language learning. The most accredited theories propose that physical activity may act at two levels. Firstly by increasing cerebral blood flow, changes in neurotransmitters, and an increased serotonin level which is associated with

improved memory during stimulus processing, and secondly by inducing long-lasting structural changes in the brain (brain plasticity). Interestingly, some of the effects due to the changes in neurotransmitters affect explicit verbal memory but leave other cognitive functions unaltered (Yasuno et al., 2003).

There are still open issues on the relationship between physical activity and cognition. In this study we explored a specific aspect of cognition, i.e. picture-mediated L2 vocabulary learning, investigating how it was affected by moderate-intensity physical activity and what its short and medium -lasting effects were. Thus, the purpose of this study was to investigate the influence of physical activity on language learning. More specifically we 1) compare English vocabulary learning by late Chinese – English bilingual learners under two experimental conditions: (a) while performing physical activities and (b) during conventional learning (no physical activity), and 2) investigated whether the postulated effects were short-lasting or whether they could be found also after the testing phase had stopped for a period of time (i.e. two months).

Methods

Participants

The sample used in this study comprises 40 late Chinese- English bilingual volunteers who were undergraduate students (18-24 years old) enrolled at Dali University in the academic year 2013. These students had taken the College English Test Band 4 (CET – 4) before they participated in this study. Twenty participants were randomly assigned to one of two conditions: physical activity during L2 learning (the experimental group), and static or conventional L2 learning (the control group). Note that in this study participants' College English Test Band 4 score (CET – 4) and their VO2 max value (McArdle et al., 1972) as measured by The Queens College Step test, were treated as possible confounders. However, we found that English proficiency and fitness levels of both groups were about equal. At the start of the experiment, all the participants were informed about the experiment and were asked to sign the consent forms.

Stimulus / Materials

All the English words (L2) and the paired pictures were obtained from the CRL International Picture- Naming Project database of the San Diego Center for Research in Language (University of California). The database Frequency counts were taken from the CELEX Lexical database (Baayen, Piepenbrock, & Gulikers, 1995). In accordance with Snodgrass and Yuditsky (1996), log natural transformation in (1 + raw frequency count) was applied to normalize the frequency measure for use in correlational analyses. Furthermore, other psycholinguistically relevant variables such as, semantic category and syllable length were controlled.

All 40 words were selected from specific semantic categories, i.e. food, animals, objects, and human being. Next all words were presented both visually and auditorily. To this end, a female and a male English teacher read aloud each word clearly. All reading was recorded and saved as a sound file (.wav format). Each word was then paired with a corresponding picture drawn in black and white. Once the stimuli were gathered, all of the L2 Word Picture pairs and the L2 well-formed and ill-formed sentences were coded into the DMDX software (version 4.2.2.0 Forster & Forster, 2003).

Procedure

1) **The learning phase**

In this phase, participants used the L2 Word/ Pictures pairs to learn the English vocabulary. Word/ Picture pairs were presented in 5 seconds (sec.), and the L2 sound via stereo equipment. Each learning session comprised three parts, after all the 20 Picture/ Word pairs were

presented once (part 1) they were re-presented in a different random order (part 2) and then again in a different random order (part 3). The participants were required to learn L2 in either one of the two following conditions:

a) In the experimental condition, participants were required to ride the bicycle ergo meter with specified workloads (intensity controlled), while looking at a screen, on which the Word/ Picture pairs were displayed, and listening to the spoken form of the words.

b) In the control condition, the procedure and the setting was the same as for the experimental group, except that during the learning phase participants were required to sit on a chair (static or conventional learning).

2) The test phase

In order to quantify learning, participants were asked to take a test immediately after completing each of the 8 learning sessions. In addition, a test session was run 4 weeks after completion of the last learning and test session.

Word – Picture Verification task: Participants were requested to discriminate between correct and wrong word/ picture pairs. To do so, 20 "old" and 20 "new" picture-word pairs were used in each test. "Old" pairs referred to the picture-word combinations presented during learning (e.g. the picture of a queen and the word illustrated "queen") and were thus correct word/ picture pairs. "New" pairs were constructed by rearranging pictures and words presented during the learning phase, in such a way as to give rise to incongruent pairs (e.g. the picture of a walnut with the word camel). Hence new pairs represented wrong word/picture combinations. Each picture and each word could appear only once during the test phase. All the 20 "old" and 20 "new" picture-word pairs were randomly administered via a computer. At the beginning of each trial, after task instructions, a cross (+) was shown for 500 ms followed by a black and with drawing together with a written L2 word for 1,500 ms. From the onset of the pair presentation, it was possible for the participants to provide their response by pressing a key on the key board labeled " Z" (for congruent), or "M" (for in-congruent). Participants were given a maximum of 2,000 ms to give a response. If the participants did respond within 2,000 ms, the accuracy and the response time were automatically displayed on the screen. If the participants did not respond within 2,000 ms, no response was recorded. In both cases, the computer automatically moved on to the next pair. As the familiarity with the stimulus material increased rapidly, after 4 sessions the test phase was adjusted so that the stimulus pair lasted only 1,200 ms while the maximum time for responding remained 1,500 ms.

Results

In order to investigate the influence of physical activity on language learning, we compared the means of the Reaction times and the Accuracy rates on the Word-Picture Verification Tasks of the experimental and the control group over the 8 test sessions. The preliminary results showed the following:

As can be seen in Table 1, there was no difference between the experimental and the control group on first two L2 learning with Physical activity in test sessions 1 and 2. However, there was a significant difference between the experimental and the control group after two L2 learning sessions. Obviously, the experimental group performed better than the control group even though there was an increase of RTs for both groups over time (see Figure 1).

Also, the preliminary results shown in Table 3, indicated that there was a significant difference between the experimental and the control group through 8 L2 learning sessions. In the experimental group, the proportion of correct responses steadily increased from test session 1 to test session 7. There was a slight decrease in test session 8. However, table 3 also indicated that the

proportion of correct responses over the eight sessions was steadily higher in the experimental group than in the control group. The preliminary results indicated that L2 learners using pictures for L2 lexical learning while performing physical activities had higher accuracy rates than L2 learners learning without physical activities (see Figure 2).

Table 1 Comparison of the reaction time means from experimental and control group in Word – Picture Verification Tasks

Test session	Group	n	M	SD	*t*	*df*	*p*
	Experimental	20	740.00	134.89			
Test 01	Control	20	834.91	156.18	-2.06	37	.05
	Experimental	20	703.25	123.82			
Test 02	Control	20	750.12	116.16	-1.23	38	.23
	Experimental	20	651.82	78.93			
Test 03	Control	20	711.44	94.77	-2.16*	37	.04
	Experimental	20	579.31	45.25			
Test 04	Control	20	691.81	48.60	-7.58**	38	.00
	Experimental	20	552.72	66.21			
Test 05	Control	20	648.07	60.47	-4.72**	38	.00
	Experimental	20	532.72	54.04			
Test 06	Control	20	617.56	67.70	-4.38**	36	.00
	Experimental	20	505.81	22.36			
Test 07	Control	20	586.08	40.28	-7.79**	30	.00
	Experimental	20	488.85	20.72			
Test 08	Control	20	576.36	23.65	-12.44**	37	.00

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

Table 2 Comparison of accuracy rates (correct responses) for the 8 sessions of Word –Picture Verification Tasks

Test session	Group	Accuracy Rate (%)	M	SD	*t*	*df*	*p*
	Experimental	86.00	34.40	4.37			
Test 01	Control	74.86	29.95	4.22	3.28**	38	.00
	Experimental	88.25	35.30	2.81			
Test 02	Control	80.75	32.30	5.10	2.30*	38	.03

Test session	Group	Accuracy Rate (%)	M	SD	*t*	*df*	*p*
Test 03	Experimental	93.36	37.35	1.76	5.56**	38	.00
	Control	79.88	31.95	4.44			
Test 04	Experimental	94.63	37.85	1.81	3.92**	38	.00
	Control	84.25	33.70	4.38			
Test 05	Experimental	95.00	38.00	3.52	1.95**	38	.00
	Control	90.00	36.00	2.96			
Test 06	Experimental	97.25	38.90	1.12	4.13**	38	.00
	Control	90.13	36.05	2.87			
Test 07	Experimental	98.00	39.20	.89	3.98**	38	.00
	Control	90.75	36.30	3.13			
Test 08	Experimental	96.63	38.65	1.04	3.94**	38	.00
	Control	89.38	35.75	3.13			

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

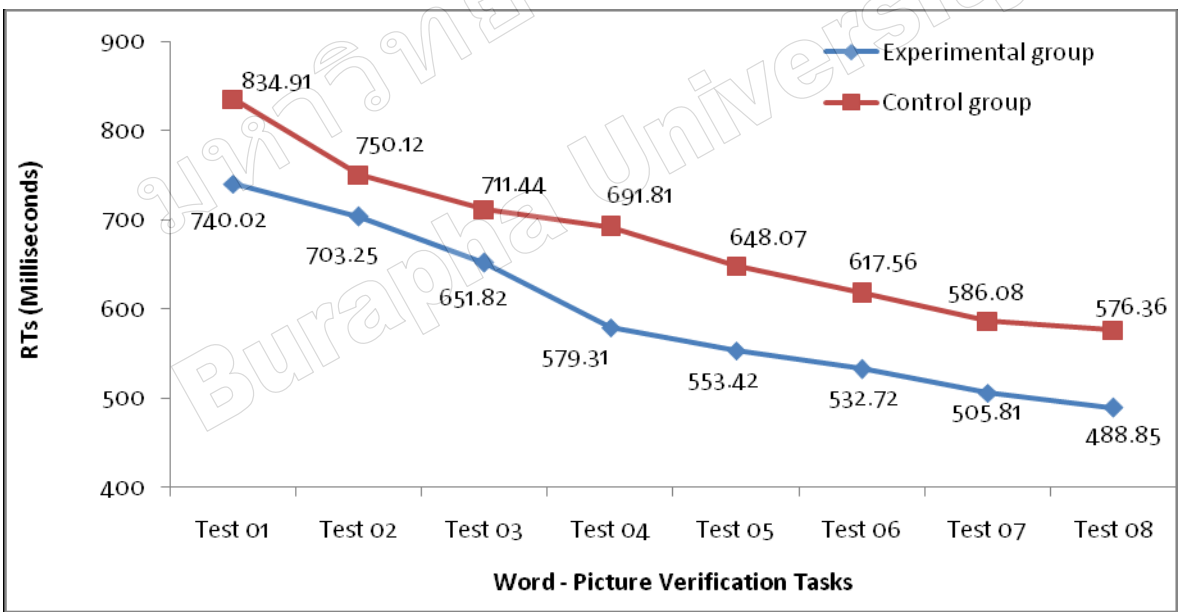

Figure 1 Means of the reaction times (milliseconds) for 8 Word –Picture Verification Task tests

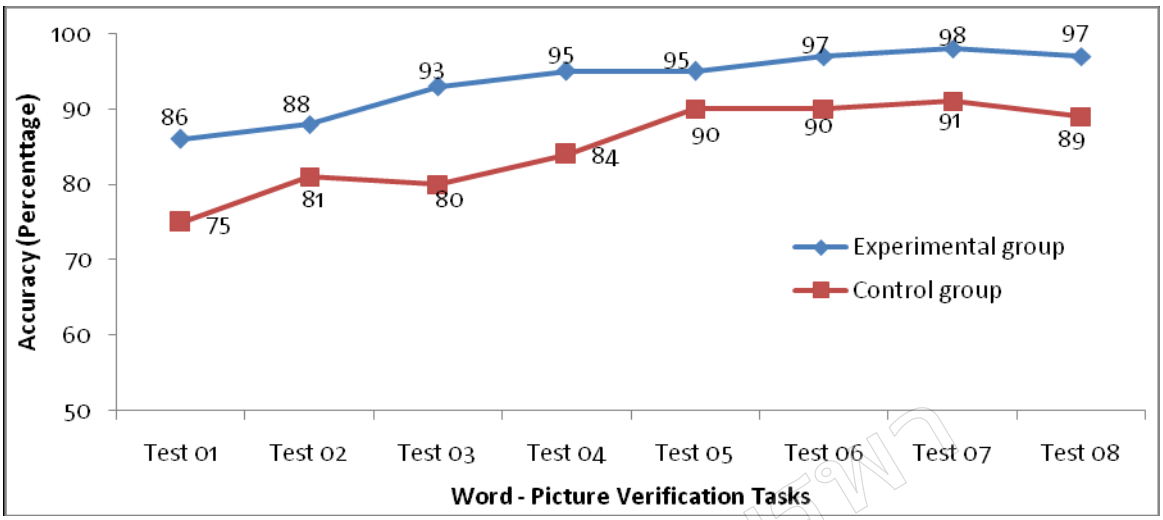

Figure 2 Means of the accuracy rate (percentage) for 8 session Word –Picture Verification Task tests

Results of the follow up test

In order to verify possible long-lasting effects in L2 vocabulary learning, a follow up test was conducted 4 weeks after the last learning-and-test session. The test was the same as the test at the end of each session. In order to have a reference point for the follow up test, the result of the test performed at the end of session 8 were also reported.

The results of RTs from the follow up test shown in Table 3, indicated that there was a significant difference between the experimental and control group. As expected, the experimental group showed faster reaction time in the Word – Picture Verification Tasks than the control group even in the follow up test. Moreover, reaction times increased in the follow up test for both groups, but the increase in response time was analogous for both groups. Thus, the beneficial effects of the physical activity on L2 learning could be long-lasting (see Figure 3).

Moreover, the results of the accuracy rates represented in Table 4, shown there was a significant difference between the experimental and the control group in the follow up test session. As expected, the experimental group made fewer errors than the control group. Moreover, even if the accuracy rate decreased in the follow up test session, such decrease affected both groups analogously, indicating that the beneficial effects of the physical activity on L2 learning were long-lasting and manifest themselves also after 4 weeks without intervening trials (see Figure 4).

Table 3 Comparison of the means of the reaction time of the experimental group and the control group in the follow up test session

Test session	Group	n	M	SD	*t*	*df*	*p*
	Experimental	20	488.85	20.72			
Test 08	Control	20	576.36	23.65	-12.44**	37.35	.00
Follow up	Experimental	20	591.67	46.69			
Test	Control	20	661.32	75.09	-3.52**	31.78	.00

Note: **p < .01

Table 4 Comparison of the means of the Accuracy rates of the experimental group and the control group in the follow up test session

Test session	Group	Accuracy rate (%)	M	SD	*t*	*df*	*p*
	Experimental	96.63	38.65	1.04			
Test 08	Control group	89.38	35.75	3.13	3.94**	38.00	.00
Follow up	Experimental	94.25	37.70	1.75			
Test	Control group	83.13	33.25	5.02	3.74**	38.00	.00

Note: **p < .01

Discussion

Some studies have already focused on a specific aspect of cognition, namely verbal learning (e.g. Winter et al., 2007; Schmidt-Kassow, 2010), and have shown that there was a positive effect of physical intervention/activity on vocabulary learning. In addition, some studies also recommended visual-spatial learning for further research. Several explanatory hypotheses have been put forward to account for the relationship between physical activity and cognition, and several studies are now available that make finer distinction as to what type of physical activity (e.g. moderate, continuous, single burst, etc) and what aspects of cognition (e.g. working memory, executive function, verbal learning, etc) are involved. By and large, physical activity is supposed on the one hand to favor synaptic plasticity and on the other hand to increase the availability of specific neurotrophic substances in the brain, such as BDNF (Brain-Derived Neurotrophic Factor) (Gold et al., 2003; Uysal et al., 2005), that facilitate learning.

The results of this study imply that participants showed the effects of physical activity when re-tested after four weeks without intervening trials. The findings of this study rule out the possibility that the effect of physical activity may be due to a general arousal level that boosts immediate performance rather than prompting a true learning effect with consequences at the level of memory encoding. If the latter were the case, the performance on the follow up test for the experimental and the control groups should not have been statistically different, with a better performance for the former group. Thus, from this pattern we may infer that it is indeed the process of learning L2 that is affected by physical activity. As an aside, we may wonder if the effect reported for the experimental group was somewhat underestimated (or, conversely, the effect of the control group was overestimated). It is known, in fact, that memory performance is sensitive to the so-called "context" effect (Godden & Baddeley, 1975). This effect is stronger for free recall but it is also present for recognition. Since in the present study the encoding and the verification phases were quite similar for the control group (static at encoding and static at verification) but differed markedly for the experimental group (moving at encoding but static at verification), the better performance of the latter group was even more noteworthy. The word–picture verification task required memorization and could be performed on the basis of a memory search (see e.g. Schmidt-Kassow et al., 2010 who extended the results of Winter et al., 2007, and concluded that simultaneous physical activity during vocabulary learning facilitates memorization of new items). Indeed, in some conditions of the present study, performance on the word-picture verification task was almost at ceiling level.

According to the Revised Hierarchical Model by Kroll and Stewart (1994), during the early stages of L2 acquisition, the learner exploits the existing word-to-concept connections in L1 to access meaning for new words in L2. Thus, a strong lexical connection from L2 to L1 will be established during learning. Over time, reliance on the L1-to-L2 connections decreases and the connection between L2-picture-concept becomes more important. This is facilitated when the task does not require the involvement of L1, as is the case with the word-picture association method. It is further facilitated when no cognate words are used in the experiment, as cognate words tend to trigger L1 mediation (see, e.g. Tonzar et al., 2009). In the present study with Chinese-English participants: a) a word-picture association method was used and b) cognate words were obviously not present, these two characteristics of the experiment increase the possibility of semantic processing of the experimental words. On the basis of the data collected, it can be hypothesized that the physical activity may have improved learning and memory for L2 words by strengthening the association between the word/ picture pair and the long-term conceptual representation as well as the recently acquired L2 lexical representation.

While the data do not allow to distinguish among these alternatives they are all possible since physical activity can improve learning due, among other things, to the high level of oxygen present in the brain as a consequence of an increased cerebral blood flow, and/or to increased level of serotonin, that can lead to the enhancement of memory consolidation, specifically verbal memory consolidation (see, e.g. Yasuno et al., 2003; Harmer, Bhagwagar, Cowen, & Goodwin, 2002). While structural changes to the brain have also been postulated as a result of physical activity (see, e.g. Etnier, et al., 1997; Ploughman, 2008) our data do not allow claiming that such changes occurred in the participants in the present study.

Conclusion

The results of this study are clear-cut: learning a foreign vocabulary while performing a concurrent physical activity yields better performance than learning the same vocabulary while being in a static situation. Therefore, using pictures for L2 lexical learning with an associated physical activity program can be a productive procedure, and L2 language instructors who want to develop L2 vocabulary learning may want to use or adapt such a procedure. The preliminary results of this study also suggest that the authorities of educational institutions should consider introducing learning-supportive environments relying on physical activity in the school setting. The latter can be achieved, for example, by organizing exercise either during learning itself, during the breaks of the learning sessions or by setting the L2 language class after the PE class. Furthermore, the results should be considered for possible generalization to treatment of language impairments, such as aphasia.

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