ISSN 0910-500X

英文學思潮

THOUGHT CURRENTS IN ENGLISH LITERATURE

VOLUME LXXXIX

2016

THE ENGLISH LITERARY SOCIETY
OF
AOYAMA GAKUIN UNIVERSITY

青山学院大学英文学会

Measuring Second Language Lexical Automaticity in a Classroom: A Feasibility Study

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ABSTRACT

The present study attempted to measure second language automaticity in a classroom by using an unconventional way, as opposed to those typically employed in lab-based studies, and tested the validity of the methodology through a partial replication of my previous lab-based study. In line with Segalowitz's notion of coefficient of variation of response time, automatic scrolled reading employed in the present study replicated a level of lexical automaticity that could be viewed as overall fast but temporally variable responses found in Tanabe (2016). The paper emphasizes the feasibility of eliciting second language lexical automaticity in classroom settings.

Keywords: second language acquisition, lexical knowledge, automaticity, fluency, reaction time

1. Introduction

Language automaticity is important in learning a second language because it is closely associated with the operationalization of learned knowledge. In studies of language acquisition, automaticity of lexical access has been measured mainly in lab-based settings by using timed lexical recognition tasks (Hulstijn et al., 2009). This suggests a few several difficulties to conduct research on automaticity. First, it requires researchers to have expensive psychological experiment software such as Super Lab or e-Prime, which are often difficult to purchase for financial reasons. Second, data collection is effortful. Researchers need to test their participants one by one, and chiefly,

recruiting a new participant is effortful. Third, lab-based papers often need to put a limitation statement such that lab-based results could not be applied to real educational settings straightforwardly.

This paper presents an example of data collection on second language automaticity in a classroom setting in line with Segalowitz's notion of coefficient of variation of response time (Segalowitz & Segalowitz, 1993; Segalowitz, Segalowitz & Wood, 1998). The methodology also emphasizes eliciting second language automaticity not using general experimental software and to obtain data for a number of participants at a time, as opposed to laboratory settings.

Since Segalowitz and his colleagues (Segalowitz & Segalowitz, 1993; Segalowitz, Segalowitz & Wood, 1998) proposed the coefficient of variation of response time (CVRT) as an indicator of automaticity, it has been widely used in studies on second language lexical fluency (Akamatsu, 2008; Fukkink et al., 2005; Harrington, 2006; Hulstijn et al., 2009; Lim & Godfroid, 2015; Tanabe, 2016). CVRT is calculated by dividing the standard deviation of response times by the mean response time. Therefore, it reflects a series of responses that are stable and invariable in speed.

The present study assumed that automatic scrolled reading meets the notion of CVRT. Automatic scrolled reading here refers to reading in which the article emerges from the bottom of the screen and keeps moving upwards in a fixed speed. Logically, such reading must involve automaticity in terms of CVRT because the reader needs continual processing of words keeping a certain speed.

2. Method

The present study attempted to test the methodological validity of automatic scrolled reading as a measure of second language automaticity. The validity of the method was made by checking whether this method replicated lab-based results taken in Tanabe (2016), served as a baseline. Note, here, that a direct comparison could not be made since one was lab-based and another was not. The way of testing will be described in the following but let me start with a

brief summary of Tanabe (2016).

In lab-based studies, word recognition tasks are typically performed on a computer so that response time (RT) to each item as well as the mean value are measured. This way of operation also allows calculating CVRTs. In Tanabe (2016), mean RT and CVRT on an English word recognition task were obtained in this way as indices of speed of second language lexical access and were compared with reading rate in English, an index of a practical use of the language, by means of a correlation analysis. Results showed that word recognition RTs were significantly correlated with reading speed (r = -.746, p < .001) but CVRTs were not (r = -.296, p = .205). This illustrated that able participants' responses to lexical items were relatively fast as a whole and they could be transferred into a practical usage, namely reading. Still, their responses were not temporally constant unlike first language processing which is often referred to as an example of a fully automatized process. As a result, the paper concluded that fast and accurate word recognition correlated with fast and accurate reading, but the current participants were still at some lower developmental stages of automaticity.

The point to make in the present study is that whether a method not using common experimental software captures a series of lexical processes that are moderately fast in total but are variable in speed at each item. Postulating that automatic scrolled reading involves temporally constant processing of words, the following null hypothesis was established.

Null hypothesis:

> Accuracy on a timed lexical processing measure correlates with accuracy in timed static reading but does not correlate with that in automatic scrolled reading.

Figure 1: A rationale for the present methodology

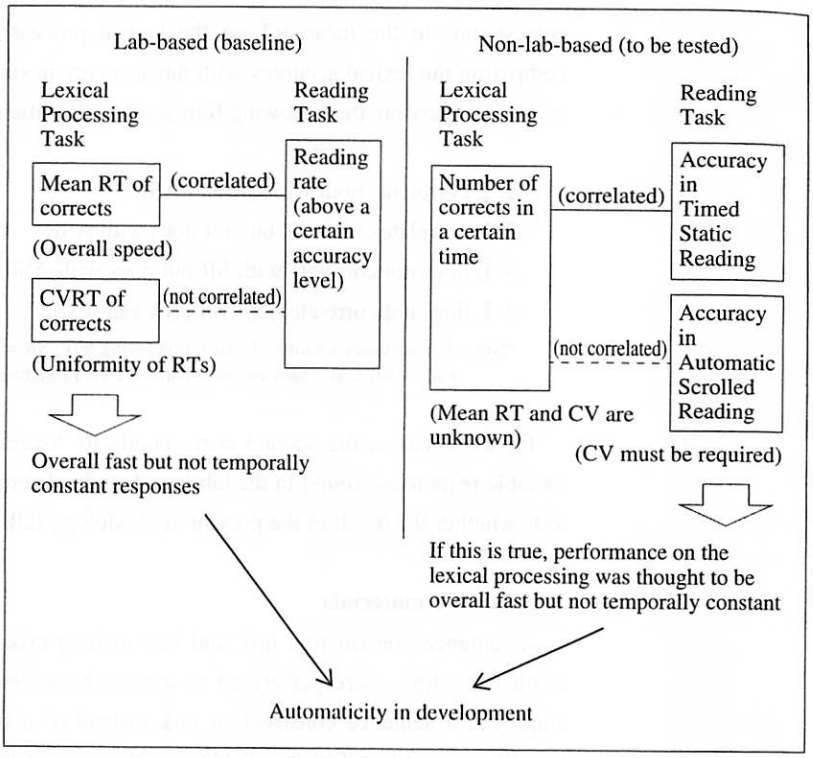


Figure 1 illustrates the logic for the hypothesis. In lab-based studies using experimental software, response variability to each lexical item can readily be obtained. However, it is not possible in traditional classroom settings. Therefore, the present methodology employed two kinds of reading, one in which a consistency of speed of word processing is not necessarily imposed and another that requires it, which are static reading and automatic scrolled reading, respectively.

In the present method, the index that corresponds to lexical CVRT was obtained retrospectively by checking whether the accuracy on an individual word processing task correlated with the accuracy on automatic scrolled reading. A lack of accuracy in reading needed continuous processing of words

suggests a lack of fluency on word recognition. Similarly, the index that corresponds to the mean RT on the lexical processing task was made by comparing the lexical accuracy with the accuracy in static reading. As a result of this comparison, the following four cases were anticipated.

1. L correlates both with SR and ASR.
2. L correlates with SR but not does with ASR.
3. L does not correlate with SR but does with ASR.
4. L does not correlate both with SR and ASR.

*Note: L = accuracy on timed Lexical processing task; SR = accuracy on Static Reading task; ASR = accuracy on Automatic Scrolled Reading

Of these cases, the second corresponds to "overall fast but temporally variable responses" found in the lab-based study. Therefore, the present study tests whether the result of the present methodology falls on this case.

3. Tasks and materials

A sentence construction task and two reading tasks, static and automatic scrolled reading, were performed to test the hypotheses. The present study employed a sentence construction task instead of a four-choice vocabulary breadth test used in Tanabe (2016) as a measure of lexical processing. This was because it measures knowledge of word use in addition to word meaning so that lexical knowledge could be measured more correctively. In addition to these main tasks, a vocabulary size test and an English proficiency test were prepared to grasp a rough picture of participants' profile.

3-1. Sentence construction task

Word processing accuracy and speed were measured by a sentence construction task used in Lim and Godfroid (2015). In this task, the beginning part of a sentence (e.g. The tiger is . . .) and two possible options followed (e.g. than / stronger) were given. Participants were asked to choose the word that best continued the phrase as quickly as possible. The task was paper-based

and timed. There were 40 questions in total and participants completed them as far as they could in 40 seconds. The full list of the testing items was found in Appendix A.

3-2. Reading tasks (preparation)

In order to make reading tasks in different way of presentation, two articles on a news site for EFL learners[1] were selected and edited so that each article contained the same number of words (Appendix B, C).

Content difficulties of the two articles were analyzed on *Coh-Metrix 3.0*, a web-based text analysis tool[2]. The readability balance of the articles was confirmed by referring to Flesch Reading Ease calculated on the tool. In addition, lexical frequency of all words in the two articles were analyzed on *JACET Level Marker*, a web-based word level checker that uses the JACET8000 word list as a basic lexicon[3]. The articles consisted only of simple SVO sentences, suggesting that knowledge of complex syntax was not required. Information of the articles is summarized in Table 1.

Table 1: A summary of content difficulties of Article 1 and Article 2

	Word count	Flesch Reading Ease*	Word Frequency ratio			
			1,000	2,000	3,000	4,000+
Article 1	158	68.322	85%	4%	5%	7%
Article 2	158	68.516	81%	7%	5%	7%

*Note: The output of the Flesch Reading Ease formula is a number from 0 to 100, with a higher score indicating easier reading. The average document has a Flesch Reading Ease score between 6 and 70.

Each article was then applied to both the static reading task and the automatic scrolled reading task described below, producing two sets of readings: Set A = Article 1 in the static reading and Article 2 in the automatic scrolled reading, and Set B = Article 2 in the static reading and Article 1 in the

1 http://www.breakingnewsenglish.com/
2 http://cohmetrix.com/
3 http://www.tcp-ip.or.jp/~shim/J8LevelMarker/j8lm.cgi

automatic scrolled reading.

3-2-1. Static reading task

Ahead of the task, participants received a paper with comprehension questions and were asked not to read it until the reading finishes. This set of comprehension questions was designed in which three questions for the beginning part of the article, three for the middle, and three for the bottom part to cover the whole content evenly (See Appendix D, E). In the task, one of the news articles was projected on the overhead screen using Microsoft Power Point (Figure 2). The exposure time was set at 67 seconds. This was identical to that of the automatic scrolled reading task. Since the articles each contained 158 words, this was equivalent to reading at 141 words per minute. Participants read the article silently. Note-taking was not allowed. After the reading, they completed the comprehension questions in five minutes.

Figure 2: A screenshot of the static reading presentation

BUDWEISER BEER RENAMED "AMERICA"

A famous beer company is changing the name of its best-selling beer. Anheuser-Busch (AB) is the USA's largest maker of beer. It is going to change the name of its Budweiser beer to 'America'. The change will happen between May and November.

A spokesperson said the change is to try and increase sales. Budweiser used to be the USA's most popular beer but sales have been falling. The word 'America' will replace the word 'Budweiser' on its cans. It will also use the same font that AB uses for Budweiser. In addition, the initials "US" will replace "AB".

The new name is part of a Budweiser campaign called "America is in Your Hands". There are many events during the campaign period, starting with Memorial Day on May 30 and ending with the U.S. elections in November. In between are the summer Olympics and Labor Day. AB wants Americans to feel proud of America – the company and the beer.

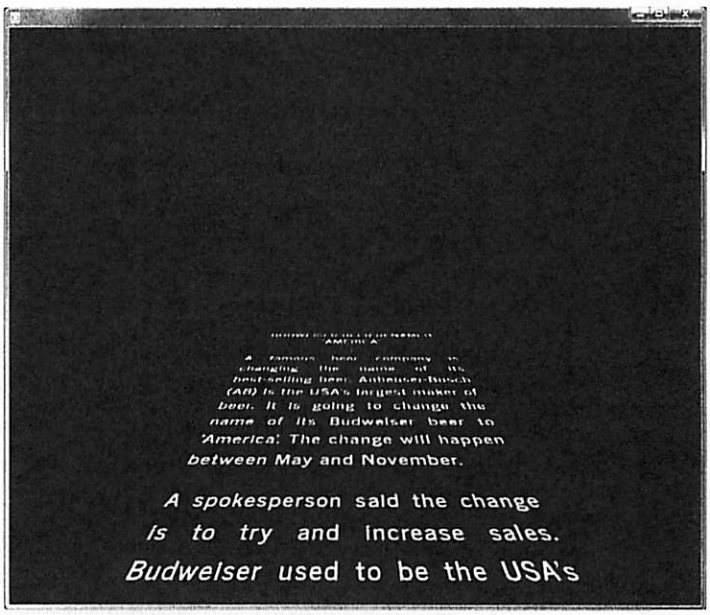
3-2-2. Automatic scrolled reading task

The automatic scrolled reading was made based on a web-based

entertainment tool, *Star Wars Intro Creator*[4]. This tool emulates the auto-scrolling introduction to the episode that appears in the beginning part of *Star Wars*, a U.S. sci-fi movie. Users of this tool put any alphabetic text in the textbox of the tool. Then, by pressing the Start button below the textbox, the text written flies slowly from the bottom of the screen and disappears into the upper-middle interior of the screen, with the theme music of *Star Wars* (Figure 3). In this way, the prepared articles were put in the textbox and played on the tool. The visual and aural output of the tool were then recorded by using a screen capture software, producing a WAV file that can be played on the Microsoft Media Player.

Similarly to the static reading task, papers with comprehension questions were distributed to participants beforehand. The reading article was then projected on the overhead screen using Microsoft Media Player with the full-

Figure 3: A screenshot of the automatic scrolled reading presentation



4 https://brorlandi.github.io/StarWarsIntroCreator/

screen mode. Since the two articles prepared contained the same number of words, the exposure duration of the reading Set A and Set B was identical, 67 seconds. Participants were asked to complete the comprehension questions in five minutes after the reading.

3-2-3. Vocabulary size test

Vocabulary Size Test (bilingual Japanese version) being published on the Paul Nation's homepage[5] (Nation & Beglar, 2007) was used to assess participants' written receptive vocabulary sizes in English. Each item consisted of a target English word and four option words in Japanese containing a correct translation equivalent to the target word. There were 60 questions in total, ten from each 1,000 word level, which a full mark was assumed that the participant knew the most frequent 6,000 word families in English. The test was carried out on a paper-and-pencil based and the time allowed to complete it was ten minutes. The following shows an example of the 1,000 level questions (Figure 4).

Figure 4: An example of the vocabulary size test

9. Her **standards** are very high.
   a. かかと b. 成績 c. 費用 d. 基準

3-2-4. Proficiency test

In order to grasp a rough picture of the participants' English proficiency, a web-based English proficiency check[6] was performed. In a language laboratory room, participants completed the assessment in their own pace and reported their results to the researcher. The results were originally in Cambridge English scale. The researcher then converted the collected data into CEFR scale based on the Cambridge-CEFR diagram available on the

5 http://www.victoria.ac.nz/lals/about/staff/publications/paul-nation/Vocab_Size_Test_Japanese.pdf

6 http://www.cambridgeenglish.org/jp/test-your-english/

Cambridge website[7].

4. Participants

The researcher had taught English at a university of engineering in Japan. Participants of this study were 63 Japanese undergraduate students from three English classes (53 male, 10 female) that were assigned to the researcher. They were majoring in mechatronics, information technology, or life science.

5. Data Collection

In conducting his classes, the researcher typically had assigned a half of his class time to a lecture and the other half to English activities. The tasks of the present study were taken place in this English activity time. Two weeks before a series of the present tasks begun, the researcher informed his students that the results of the forthcoming activities would be used for a personal study in an anonymized form and took their agreement. The tasks were given in the following order. The intervals between Day 1, Day 2 and Day 3 were one week each.

Day 1: Proficiency test
Day 2: Vocabulary size test
Day 3: Static reading task → Automatic scrolled reading task →
Sentence construction task

In the reading tasks on Day 3, the reading Set A was given in one class (N = 31) and Set B in the other classes (N = 32) so that the content variability of the prepared articles was counterbalanced.

6. Results

6-1. Participants' profile

The proficiency check suggested that the present participants were of basic

7 http://www.cambridgeenglish.org/jp/exams/cefr/

users of English, overall being at A1, the lowest, to A2, the second lowest level, on the CEFR scale. Also, the vocabulary size test showed that they knew about 3,790 word families (SD = 470) in English.

6-2. Descriptive analysis

Overall results of the main tasks were summarized in Table 2. The mean score of the sentence construction task was 8.65, indicating that participants took 4.62 seconds to make a correct response in average since 40 seconds were given to complete the task. The most able participants made 17 correct responses, which was equivalent to spending 2.35 seconds per item. There were no participants who did not make any responses on the task. Therefore, zero in the minimum score meant no correct response was made. There were no samples discarded. The Shapiro-Wilk test for normality showed the samples were normally distributed.

Of the reading tasks, the mean score was 2.68 for the static reading and 2.48 for the automatic scrolled reading, which both were short of one third of the full mark, nine. This implied the reading tasks were yet difficult for the participants though the researcher thought he had chosen appropriate articles for beginners. The comprehension results of the two reading tasks were both positively skewed, and were not normally distributed.

Table 2: Overall results of the main tasks

	Sentence Const.	Static Reading	Scrolled Reading
N	63	63	63
Mean	8.65	2.68	2.48
S.D.	4.08	1.69	1.65
Min.	0	0	0
Max.	17	7	8
Max. possible	40	9	9
Skewness	-.233	.334	.584
Kurtosis	-.033	-.200	.765

6-3. Correlation analysis

In order to test the present hypothesis, participants' performance on the sentence construction task, an indicator of speed of sentence processing, and two reading tasks, static and auto scrolled reading, an indicator of overall speed and an indicator of speed variability between processes, respectively, were analyzed in a correlation analysis.

As shown in Table 3, a weak but significant correlation was found between the sentence construction task and the static reading task. The sentence construction, however, did not correlate with the automatic scrolled reading task. Therefore, the hypothesis was supported.

Table 3: Correlation coefficient and statistical significance

	Static Reading	Scrolled Reading
Sentence Const.	.327 (p = .009)	.156 (p = .221)

7. Discussion

In a classroom setting, this study replicated a level of second language automaticity that could be viewed as overall fast but temporally variable responses on receptive written-word processing which was found in Tanabe (2016), a lab-based study.

What the present methodology measured was whether the participants' rate of processing was above a certain level that was set up in the present study. The sentence construction task correlated with the static reading task because they were basically done in a participants' own pace on an open-ended basis. In contrast, automatic scrolled reading has a benchmark nature, which it tests whether the reader can sustain his or her reading on a basis made artificially in terms of consistency of speed. Therefore, the reader must read in the same degree on both static and scrolled reading, if he or she satisfies this basis. In fact, proficient readers of English comprehend the opening introduction actually appeared in *Star Wars*.

A major limitation of the present methodology is that the speed of scrolling cannot be modified since it capitalized a web tool developed for other

purposes. Therefore it would be difficult to apply to wide variety of learners, especially those who are supposed to have grater automaticity. Still, the current scrolled reading is thought to be an appropriate measure for a minimum standard of real-life language automaticity because it follows a way of presentation to be understood for many people in an actual movie. In a pedagogical sense, this level of language automaticity could be a tentative goal to achieve first for beginners.

8. Conclusion

The present study attempted to measure second language automaticity in a classroom by using an unconventional way, as opposed to those typically employed in lab-based studies, and tested the validity of the methodology by confirming whether it replicates results in a lab-based study. In line with Segalowitz's notion of CVRT, coefficient variation of response time, it was found that automatic scrolled reading could be a possible way of presentation to measure learners' second language lexical automaticity that could be viewed as overall fast but temporally variable series of responses.

It is recognized that the present methodology still needs improvements. The paper would like to conclude that feasibility studies should continuously be taken place though they are not in the mainstream of the field.

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Appendix A: Sentence construction task

1.	Mr. and Ms. Smith ...	☐ go	☐ to
2.	What does that ...	☐ she	☐ mean
3.	Jane's cat ...	☐ cute	☐ is
4.	The students ...	☐ went	☐ angry
5.	I know what	☐ she	☐ does
6.	I expect ...	☐ them	☐ go
7.	In the past ...	☐ happy	☐ she
8.	Does ...	☐ Jane	☐ come
9.	Aren't ...	☐ busy	☐ you
10.	It was ...	☐ write	☐ written
11.	Would you ...	☐ a book	☐ bring
12.	It is not true ...	☐ you	☐ what
13.	He gave me	☐ a letter	☐ to
14.	Does he ...	☐ know	☐ Jane
15.	Isn't it ...	☐ can	☐ true
16.	Where ...	☐ do	☐ you
17.	Students are ...	☐ leave	☐ asked
18.	These students ...	☐ are	☐ angry
19.	They believe that ...	☐ God	☐ exists
20.	Yesterday ...	☐ happy	☐ Mary
21.	Would you ...	☐ do	☐ going
22.	The boy who ...	☐ kind	☐ is
23.	Jane let him ...	☐ go	☐ going
24.	The letter ...	☐ was	☐ writes
25.	Football players ...	☐ make	☐ lots
26.	After some time ...	☐ woke	☐ she
27.	It is ...	☐ not	☐ does
28.	They are ...	☐ expected	☐ expect
29.	All students ...	☐ have	☐ not
30.	You think that ...	☐ Jane	☐ does
31.	I wonder ...	☐ if	☐ he
32.	Say hello ...	☐ my	☐ to
33.	Can I ...	☐ have	☐ some
34.	He seems ...	☐ be	☐ to
35.	Let me tell ...	☐ to	☐ you
36.	You weren't there, ...	☐ was	☐ were
37.	I had ...	☐ had	☐ have
38.	Let me ...	☐ think	☐ about
39.	Both he ...	☐ and	☐ or
40.	To what ...	☐ extent	☐ extend

(Lim & Godfroid, 2015: Appendix A)

Appendix B: Article 1

BUDWEISER BEER RENAMED "AMERICA"

A famous beer company is changing the name of its best-selling beer. Anheuser-Busch (AB) is the USA's largest maker of beer. It is going to change the name of its Budweiser beer to 'America'. The change will happen between May and November.

A spokesperson said the change is to try and increase sales. Budweiser used to be the USA's most popular beer but sales have been falling. The word 'America' will replace the word 'Budweiser' on its cans. It will also use the same font that AB uses for Budweiser. In addition, the initials "US" will replace "AB".

The new name is part of a Budweiser campaign called "America is in Your Hands". There are many events during the campaign period, starting with Memorial Day on May 30 and ending with the U.S. elections in November. In between are the summer Olympics and Labor Day. AB wants Americans to feel proud of America – the company and the beer.

Appendix C: Article 2

RUSSIAN WEAPONS MAKER NOW A FASHION BRAND

The Russian gun maker Kalashnikov will move into fashion. Kalashnikov is one of Russia's most famous companies. It makes the AK-47 rifle. The company said it has to make different things because Western countries stopped buying Russian weapons. This was because of the conflict in Ukraine. Before the conflict, Kalashnikov sold a lot of weapons to Europe and the USA.

Kalashnikov's fashion label will make 'military style' casual clothing and accessories. The company also plans to open 60 clothes stores across Russia by the end of this year.

Kalashnikov is not the first Russian arms company to sell clothes. A tank maker opened a shop in 2014 selling T-shirts, jackets, shoes and bags. Most of its products have images of its tanks on them. The Kalashnikov CEO said his company would still make most of its money from making guns. He said it would develop new products. He also wants to double the sales of guns by 2017.

Appendix D: Comprehension questions for Article 1

BUDWEISER BEER RENAMED "AMERICA"

1. According to the article, what is Budweiser beer?
   A) the only beer in America B) most famous beer in America
   C) the best-selling brand of a beer company D) the largest beer in America
   E) not mentioned
2. From when does the name of Budweiser change?
   A) April B) May C) June D) July E) not mentioned
3. In what month does the renaming end?
   A) September B) October C) November D) December E) not mentioned
4. Why did the company decide to change the name of its beer?
   A) To make their beer more famous B) To celebrate a holiday season
   C) To make more money D) To attract women's eye E) not mentioned
5. According to the article, which of the following will not be changed during the renaming period?
   A) taste of the beer B) capacity of the can C) looks of the can
   D) printing font on the can E) everything will change
6. Who will benefit the most from the renaming?
   A) American citizens B) Budweiser's employees C) pub owners
   D) young generations E) not mentioned
7. In America what day is May 30th?
   A) Halloween B) Independence Day C) Labor Day D) Memorial Day
   E) not mentioned
8. According to the article, which of the following orders are correct?
   A) Labor Day → Memorial Day B) Labor Day → Summer Olympic
   C) Memorial Day → Summer Olympic
   D) Presidential election → Labor Day E) not mentioned
9. Why did the company name the Budweiser campaign "America is in Your Hands" ?
   A) They want Americans to love their country.
   B) They want Americans to drink Budweiser a lot.
   C) They want American athletes to win in the Olympics.
   D) They want Americans to celebrate the next President. E) not mentioned

Appendix E : Comprehension questions for Article 2

RUSSIAN WEAPONS MAKER NOW A FASHION BRAND

1. What kind of guns does Kalashnikov mainly make?
   A) hand guns B) magnums C) shotguns D) rifles E) not mentioned
2. Why did the company decide to sell things other than weapons?
   A) the Russian president said so B) they needed more customers
   C) their products became outdated D) their country is in trouble
   E) not mentioned
3. What was a cause of the conflict in Ukraine?
   A) economic depression B) political failure C) unreasonable invasion
   D) death of the ruler E) not mentioned
4. Who was one of their primary customers?
   A) America B) Russia C) North Korea D) Iraq E) not mentioned
5. What kind of products will the company probably sell?
   A) formal suits B) sports towels C) casual shoes D) necklaces
   E) not mentioned
6. Where does the company plan to open their stores?
   A) Only in Russia B) in Russia and Ukraine C) in Russia and Europe
   D) in Russia and 60 other countries E) not mentioned
7. What happened in 2014?
   A) The conflict in Ukraine broke out.
   B) Kalashnikov stopped making guns.
   C) Other military company went into the fashion market.
   D) A tank maker started to sell guns. E) not mentioned
8. According to the Kalashnikov CEO, what is the purpose for selling different things?
   A) to make the company more famous
   B) to adopt the recent economic trend
   C) to attract young men's attention D) to make more guns
   E) not mentioned
9. What does the company think the sales of their guns in the future?
   A) the sales will decrease B) the sales will increase
   C) the sales will not be changed D) the sales will be zero
   E) not mentioned