The Relationship between a Cognitive Linguistic Approach and the Right-Hemisphere

Masahiro Takimoto
Aoyama Gakuin University, Japan

Abstract

This study investigated the relationship between a metaphor-based approach to teaching English as a foreign language (EFL) and involvement of the brain's right hemisphere. Specifically, it examined learners' understanding of three levels of sureness associated with different expressions in English – those that are *certain, probable*, and *possible* items. The three target items were chosen because they are frequently used by native English speakers although Japanese EFL learners often fail to distinguish between them. The metaphor-based learners and the control group engaged in computer-based explicit learning based on the meaning of the target expressions with three-dimensional (3D) animated illustrations. The images were based on the spatial concept of distance for the metaphor-based learners and a list of target items for the control group. At post-test, it was found that the metaphor-based learners performed better than the control group in both comparison and speaking tests. Obviously, the participants better understood the degrees of certainty in relation to distance. This shows that teaching the degrees of certainty by applying the spatial concept of distance could help in second-language (L2) learning. The metaphor approach allowed participants to link the spatial concept of distance to the degree of certainty associated with expressions of certitude. In addition, recordings of lip movements showed that participants remembered the target items better by opening the left side of their mouths more than the right side. This indicates that the brain's right hemisphere is involved in deep processing of expressions that reflect different levels of certitude and creating stronger memory traces.

Keywords: cognitive linguistics approach, mouth-asymmetry, proximal-distal metaphor, relationship, right-hemisphere, left-hemisphere

Learning a language is one of the most complex of human accomplishments. Among the various approaches to language learning, the cognitive linguistic approach emphasizes that humans use their embodied experiences in a source domain to understand abstract concepts in a target domain. The source domain is an embodied conceptual field from which humans draw metaphorical expressions to comprehend abstract concepts in the target domain. The target domain is a conceptual field that humans attempt to understand via source domains. Lakoff and Johnson (1999) argued that embodied concepts based on personified experiences in a source domain can be extended to a target domain to understand a concept in the target domain. This process, called conceptual projection, is the basis of conceptual metaphor theory (CMT) (Lakoff & Johnson, 1999). For example, in the case of the metaphor *more is up* and *less is down* (Evan & Green, 2014), *quantity* is understood metaphorically in terms of *verticality* – when books are piled up on a desk, the more books are piled up, the higher the pile becomes. Here, humans transfer their understanding of *verticality* (*up, down*) in the source domain to the target domain to comprehend *quantity* (*more, less*) in the target domain. This study considers the concept projection as the metaphor-based approach.

This study is motivated by theoretical considerations of conceptual metaphor theory in cognitive linguistics applying the concept projection called the proximal-distal metaphor to develop Japanese learners' knowledge of the different degrees of certainty attached to *certain*, *probable*, and *possible* items of expression in English. The proximal-distal metaphor involves the use of *certain i*tems placed closer to the writer to indicate the highest degree of certainty in contrast to the use of *probable* items and *possible* items placed further from the writer at different distances to show lower degrees of sureness. Learners are guided to understand different degrees of certainty in terms of near-far relationships of *certain, probable,* and *possible* items.

Lakoff and Johnson (2003) and Littlemore (2004) suggested that understanding accumulated experiences in terms of metaphors based on spatial concepts leads to mapping embodied concepts onto non-embodied concepts and maintaining long-term memory, which may be associated with right hemisphere involvement. The brain can be described as divided into left and right hemispheres (LH and RH). The left side of the brain controls the right side of the body and is considered the superior verbal and analytical processor. The right hemisphere controls the left side of the body and is said to excel in non-verbal visual-spatial skills.

Although previous studies demonstrated that the metaphor-based approach proved more effective than the non-metaphor-based approach; however, whether the efficacy of the spatial concept-oriented metaphor-based approach has some connection to the RH involvement was not explored, and the question remains understudied. Therefore, this study considers it important to shed light on the causes of the effectiveness of the approach and examine it from the LH and RH involvement perspective. The purpose of the study is to discover the connection between metaphorical concept projection and RH dominance using measurement of mouth asymmetry.

Literature Review

Application of the Metaphor Awareness-Raising Approach in L2 Teaching

It is in the area of L2 vocabulary learning that much of the empirical work on the effects of application of the metaphor awareness-raising approach has been done so far. To date, many metaphor awareness-raising approaches have generated positive effects on language learning

(Berendi, Csábi, & Kövecses, 2008; Csábi, 2004; Tyler, Mueller, & Ho, 2010, 2012).

Boers (2000) conducted experiments to determine the effects of the metaphor awareness-raising approach in teaching EFL learners with different native language backgrounds English expressions related to *anger* and *upward* and *downward economic trends* using metaphors such as *more is up* and *less is down*. The results revealed that the metaphor awareness-raising groups outperformed the control groups. Similarly, Csábi (2004) and Berendi, Csábi, and Kövecses (2008) examined the relative effects of a metaphor awareness approach with and without explicit conceptual instruction on EFL learners' acquiring of idiomatic English expressions that include the words *hold* and *keep*. They demonstrated that the metaphor awareness-raising approach that included explicit conceptual information helped the learners not only in learning the idiomatic English expressions but also in maintaining long-term retention of those target expressions.

Comparing the metaphor awareness-raising approach with the traditional teaching approach, Tyler, Mueller, and Ho (2010, 2012) investigated the efficacy of the metaphor awareness-raising approach with EFL learners in teaching English modals (2010) and teaching the English prepositions *to*, *for*, and *at* (2012) and found more improvement in the metaphor awareness-raising approach group than in the traditional group. However, most of the previous studies utilized metaphors embedded in the target expressions or included in the concrete meanings of the target expressions in order to observe the effectiveness of metaphor awareness-raising in memory enhancement. Conversely, Takimoto (2020) used metaphors that are not embedded in the target expressions and attempted to examine the real efficacy of the metaphor awareness-raising approach. He applied the proximal-distal metaphor to teaching different certainty-level expressions such as *certain, probable,* and *possible* items. The results demonstrated that the metaphor awareness-raising approach proved more effective than the non-metaphor awareness-raising approach.

Despite the general support for the metaphor approach based on the spatial concept, no previous study has explained its effectiveness. Considering the possibility of RH involvement behind its efficacy, it needs to be examined from a neurobiological perspective.

Left- and Right-Hemisphere Involvement in Metaphor Processing

Many cognitive neuroscience studies have adopted neuroimaging and electrophysiological techniques and investigated the relationship between metaphor processing and hemispheric lateralization. A number of studies support the contention that the RH is more involved in metaphor comprehension (Ahrens et al., 2007; Cardillo et al., 2012; Faust & Mashal, 2007; Schmidt, DeBuse, & Seger, 2007). However, other studies failed to show preferential RH metaphor processing (Benedek et al., 2014; Rapp et al., 2007; Stringaris et al., 2007).

As cognitive neuroscience studies differ methodologically in terms of data-gathering, task selection, and stimulus selection, care interpreting the results of previous studies is necessary. First, regarding data-collection methods, some studies used the divided visual field paradigm methodology (Faust & Mashal, 2007; Schmidt et al., 2007), others functional magnetic resonance imaging (Ahrens et al., 2007; Cardillo et al., 2012; Rapp et al., 2007; Stringaris et al., 2007). Second, concerning task selection, all studies except one (Benedek et al., 2014), the only metaphor production study) investigated metaphor comprehension. Most studies that examined metaphor comprehension asked participants to make plausible decisions (Faust & Mashal, 2007; Stringaris et al., 2007). Rapp et al. (2007) asked participants to make positive or negative connotation decisions; Ahrens and colleagues (2007), another exception, asked participants to read anomalous metaphorical sentences. Finally, concerning stimulus selection, less researchers examined metaphor comprehension at the word level (Ahrens et al., 2007; Faust & Mashal, 2007) than at the sentence level (Cardillo et al., 2012; Rapp et al., 2007; Schmidt et al., 2007; Stringaris et al., 2007), with the degree of saliency or novelty of the linguistic expressions controlled except in one study (i.e., Stringaris et al., 2007).

In sum, methodological differences in data-gathering and task and stimulus selection may have led to the mixed results when testing RH metaphor processing hypotheses. For example, participants in the Rapp et al. study could have treated the task of determining positive or negative connotation as a test of category knowledge rather than of ability to interpret metaphors. Moreover, in the Stringaris and colleagues' study, the degree of saliency or novelty was not controlled sufficiently and familiar metaphoric expressions may have been used. According to Beeman's (1998) coarse coding model, metaphoric meanings within familiar metaphors can become closely correlated through repeated use and as a result can be activated within a small semantic field in the LH. Thus, due to the given task in the Repp et al. study and to the possibility that familiar metaphors were used in the Stringaris and colleagues' study, their participants might have failed to display RH preference and might have recruited LH resources in metaphor processing.

Review of the aforementioned studies that used the divided visual field paradigm method and neuroimaging and electrophysiological techniques reveals that the involvement of the LH and RH in metaphor processing remains a controversial subject that yields mixed research results. Additionally, most studies examined the role of LH and RH in metaphor comprehension processing rather than in metaphor production processing and whether LH and RH are involved in metaphor production needs to be further explored. In order to analyze the relative involvement of each hemisphere in metaphoric production, real-time inspection during actual speech production is imperative and, to that end, measurement of mouth asymmetry may be suitable.

Mouth asymmetry measurement is being exploited based on evidence that speech articulation controlled mainly by one side of the normal brain results in the muscles on the opposite side of the mouth moving more during speech production (Graves & Landis, 1990). Typically, a healthy right-handed person opens more widely the right side of the mouth during verbal and analytical processing and the left side of the mouth during non-verbal visual-spatial processing (Graves & Landis, 1990; Lindell, 2006).

Few recent studies (Argyriou & Kita, 2013; Argyriou, Byfield, & Kita, 2015) have employed the mouth asymmetry technique to explore metaphor production in the first language (L1). The studies by Argyriou and Kita (2013) and Argyriou et al. (2015) measured mouth asymmetry to delve into the relation between real-time speech production and LH and RH contributions. Their studies demonstrated that mouth asymmetry technique allows the researcher to find each hemisphere's relative involvement from participants' less restrained movements, compared with neuroimaging and electrophysiological techniques that confine participants to small spaces wherein they are restrained from moving freely. Additionally, the mouth asymmetry technique is a non-invasive, inexpensive, and relatively quick means of inferring different hemispheric involvement in real-time during actual speech production.

Nonetheless, this technique has not been put into practice to explore relative hemispheric involvement in second language (L2) metaphorical speech production, and hemispheric involvement in L2 speech production is still an under-researched area. Therefore, it is vital that this study delves deeper into whether the spatial concept-based metaphor awareness-raising approach to visualization of the instructional content can enhance RH involvement and thus facilitate acquisition of L2 expressions of certainty-levels.

Methodology

Research Design

To date, although the efficacy of the metaphor-based approach has been supported, which may be connected with RH involvement, no studies have examined the effects of the metaphor-based approach in teaching the L2 markers of *certain, probable,* and *possible* items on RH involvement. To address this gap, the following research question was investigated in this study.

> What effect does a metaphor-based approach have on RH involvement in developing EFL learners' knowledge of the different degrees of sureness attached to *certain, probable*, and *possible* items?

Participants of the Study

A total of 57 right-handed university students from two large classes at a private university in Japan participated in this study. The participants were science majors with an average age of 20. The participants' first language was Japanese, and they were learning English as a foreign language. All the participants had studied English for eight years at schools in Japan and had roughly intermediate level English proficiency, as defined by the Test of English for International Communication (TOEIC). The participants from the two classes were randomly assigned to the metaphor-based approach (MA; *n*=28: women=4, men=24) and the control group (*n*=29: women=3, men=26). The researcher gave each participant a clear statement on the purpose of the study and explained to participants how their confidentiality would be protected.

Target Expressions

Table 1 shows the classification of three different degrees of sureness (e.g., very high, high, and low); the classification was acknowledged as reasonable by native speakers of English. This study used the proximal-distal metaphor as a mnemonic device involving three different types of items, *certain, probable*, and *possible* items of expression, to indicate three different degrees of certainty in terms of three different degrees of distance (see Table 1).

Table 1
Target Expressions in This Study

	Certain items (very high)	Probable items (high)	Possible items (low)
Adjectives	certain clear obvious	likely presumable probable	conceivable possible potential
Adverbs	certainly clearly obviously	likely presumably probably	conceivably possibly potentially

Learning Treatments

Each 30-minute learning session for the metaphor-based approach and the control groups was conducted on Zoom by the same instructor once a week for two weeks in two intact classes at a university in Japan. During each learning session, the instructor had primary control of the online computer program, gave no feedback to the participants, and adhered to the information available in the online computer program.

The metaphor-based approach and control groups were guided to engage in instructor-directed computer-based explicit learning on the meanings of the target expressions for 10 minutes, with 3D image content based on the proximal-distal metaphor for the metaphor-based approach group and a list of target items for the control group. Afterwards, the metaphor-based approach and control groups worked on the same acceptability judgement and listening tasks for 20 minutes.

The acceptability judgement and listening tasks provided an equal amount of exposure to each of the three types of target items. The acceptability judgement task asked the participants to read three passages (each about 145 words long) on everyday topics. Each passage included an underlined part with three options, (a), (b), and (c). Participants were to select the most appropriate form from the three underlined options by selecting (a), (b), or (c). Then, for the listening task, the instructor guided the participants to listen to recordings of each passage and to select the actual word used in each underlined part. Some sample items from the acceptability judgment and listening tasks are presented below:

When we talk face to face, regardless of 1. (a) presumable (b) potential (c) certain cultural differences, we communicate with more than words. We communicate with our eyes and our hands. We communicate with our entire bodies.

Acceptability judgement task: Suppose that the writer's certainty-level is high in their opinion and select the most appropriate word out of the three offered in each underlined part.
Listening task: Listen to a recording of the passage and select the actual word used in each underlined part.

The metaphor-based approach adopted 3D image content to make it easier for the participants to grasp spatial relationships between *certain*, *probable*, and *possible* items and to assist the participants in comprehending the degrees of certainty according to their knowledge of the spatial concept of distance. The online computer program required participants to watch and assess the differences in distance between the three items objectively in the first scene reproduced below (see Figure 1). The control group viewed the list of target expressions in several scenes on a computer (see Figure 2). The list the computer program showed participants was created to promote their memorization of the forms and meanings of the *certain, probable,* and *possible* items.

Figure 1
First Scene of the 3D Image Content Watched by the MA Group

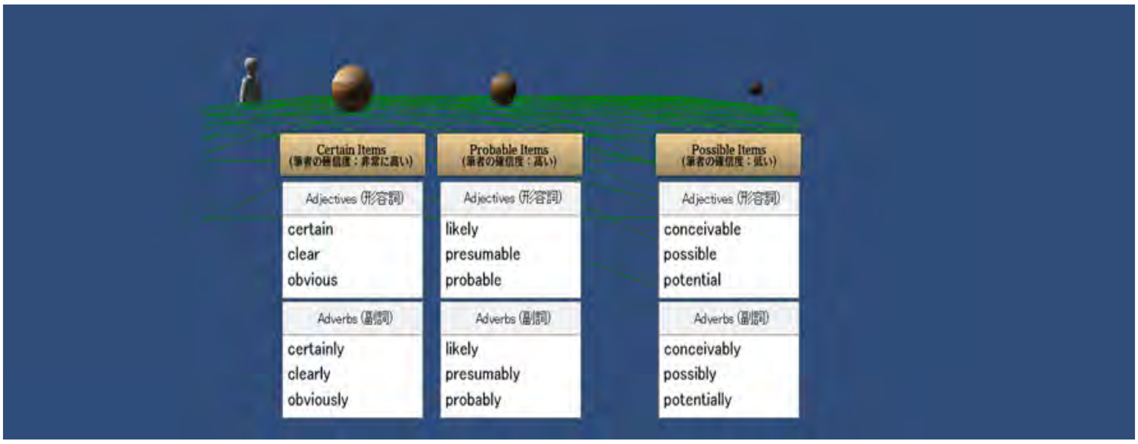


Figure 2
A Scene from the List Viewed by the Control Group

	Certain Items （筆者の確信度：非常に高い）	Probable Items （筆者の確信度：高い）	Possible Items （筆者の確信度：低い）
Adjectives （形容詞）	certain clear obvious	likely presumable probable	conceivable possible potential
Adverbs （副詞）	certainly clearly obviously	likely presumably probably	conceivably possibly potentially

Testing Instruments and Procedures

This study adopted a pre-test post-test design (Brown, 2014) to reconfirm the effect of the metaphor-based approach and its connection with RH involvement. Since the focal point of this study was to pursue the possibility that the metaphor-based approach to developing EFL learners' knowledge of the different degrees of sureness entailed RH involvement, the present researcher decided not to administer a delayed post-test. Pre-test was administered a week prior to the first learning treatment, and post-test was conducted a week after the treatment.

The pre-test consisted of a comparison test only, while the post-test included a comparison test and a speaking test. The comparison test was administered online through CoursePower, a learning management system, whereas the speaking test was administered online individually through Zoom.

Two versions of the comparison test were developed and administered in order to minimize the testing effect. The comparison test was administered to check participants ability to produce a correct contrast/similarity judgment about the spatial relationships between *certain, probable,* and *possible* items. The speaking test, which also involved both contrast and similarity judgments, was conducted to check participants' ability to produce appropriate target words in line with different situations and observe whether the development of their knowledge about differences between degrees of certainty was related to the involvement of RH dominance. The participants were asked to complete the comparison tests and speaking tests within 5 minutes each.

Comparison Test

The participants were required to read 12 statements and then evaluate the difference between the writer's certainty-levels as expressed by two underlined words according to whether the levels of certainty were "completely different," "fairly different," "slightly different," or "not different at all." Participants' judgments were compared with the model answers and scored by the researcher. When a participant rated the difference between the writer's certainty-level in the underlined words appropriately on the 4-point scale above in line with the model answers, five points were given. The test contained 12 items, for a maximum possible score of 60. A sample item from the comparison test is presented below:

Directions: Assess the difference in the writer's or the subject's certainty level of the two underlined words.

Other (a) potential (b) certain factors could be involved in the longevity of happy people.

not different at all **1** — **2** (slightly different) — **3** (fairly different) — **4** completely different

Speaking Test

During the speaking test, the participants were asked to sit directly in front of the computer screen and keep both hands still and on the same table as their computers. The researcher and the participants were facing each other through the computer screen and the researcher video-recorded the participants' responses in "Active Speaker View" mode with Zoom. The participants were instructed to speak in sentences in response to the tables about the expected number of participants for the overseas program. Group names such as Group A, Group B, and Group C on a white sheet of paper (72-point font) were presented one by one by the researcher, who held the paper up until the participant began responding. After video recording, the researcher transcribed the participants' responses, and two native speakers of English (one British and one New Zealander) scored the participants' transcribed responses on a 5-point scale according to appropriateness in reporting the main ideas and using the target expressions. The test contained *certain, probable*, and *possible* items (1 each), with the maximum score being 15. Some sample items from the speaking test follow:

Direction: The table below shows the expected number of participants for the overseas program in 2021 as predicted by you. You are planning to participate in the overseas program. For each group, tell your friend the number of people expected to participate in the overseas program and express the degree of certainty, in English. Please start speaking now.

Expected number of participants for the overseas program in 2021

	The overseas program 2021
Group A	2 participants （certainty-level：very high)
Group B	3 participants (certainty-level：high)
Group C	5 participants (certainty-level：low)

Reliability

The inter-rater reliability of the two native English raters for the speaking test was evaluated by means of an intraclass correlation coefficient to investigate whether their scores were correlated. The intraclass correlation coefficients for single measures and average measures were .943 and .971 each, which shows statistically significant values ($p < .001$).

Cronbach's alpha Brown (2014) reliability estimates for each of the testing instruments were investigated by means of the internal consistency, and Version B of the comparison test .868 and Version A of the speaking test .884 were fairly high. However, the exception was Version A of the comparison test .682 which was lower than the other tests in reliability, but still within an acceptable range of reliability.

Validity

Since the comparison test and speaking test in this study were criterion-referenced tests, only content validity and construct validity were investigated. Concerning content validity, the situations for administering the two testing instruments were carefully planned to ensure validity and matched to the theoretical framework according to the *certain, probable*, and *possible* variables.

Regarding the construct validity, Brown (2014) argued that construct validity for criterion-referenced tests is expected to be high in the pre-test-post-test design indicating the degree to which the test is measuring the construct for which it was designed. This study with the pre-test-post-test design was able to compare the participants' performance on the pre-tests with their performance on the post-tests. As this study discovered significant differences between the pre-test scores and post-test scores for the comparison test ($p<.001$, $np^2= .643$). Therefore, it can be concluded that these results confirmed the construct validity of the comparison test.

Results

Data Analysis

Quantitative analyses were performed for the comparison and speaking tests using SPSS 27.0 (IBM Corp., 2020). Additionally, the recordings of the participants' mouths' openings were analyzed by using two-dimensional motion analysis software (Move-tr/2D, Library Inc., Tokyo, Japan), which processed the participants' mouth movements on a scene-by-scene (1/25 second) basis during the participants' responses.

Results from Comparison and Speaking Tests

The descriptive statistics (see Appendix A) reflect the performance of the metaphor-based approach and control group participants on the pre- and post-test comparison and speaking tests in this study. In each case, the number of participants (*n*), mean (*M*), and standard deviation (*SD*) are shown.

Analysis of variance (ANOVA) was run for the comparison test and the independent- measures *t*-test was performed for the speaking test. Although this study checked the assumptions for the statistical analysis, the assumptions of normality and of homogeneity of variances were not met because of the nature of the criterion-referenced test. As the ANOVA and *t*-test were robust with respect to departures from the normality assumption and from the equal variance assumption (at least when sample sizes are equal or near equal) and more powerful than non-parametric tests (Tabachnick & Fidell, 2007), the present researcher decided to run the parametric tests. Results of the two-way repeated-measures ANOVA for the comparison test showed a significant main effect for Instruction, F (1, 55)=15.75, p=.000 < .001, ηp^2=.223. A significant main effect for Time across the pre- and post-test was also found, F (1, 55)=99.19.57, p=.000 < .001, ηp^2=.643. There was no significant interaction effect between Instruction and Time, F (1, 55)=12.66, p=.001, ηp^2=.187.

Additionally, results of the independent-measures t-test for the speaking test demonstrated a significant main effect for Instruction, t(55)=5.10, p<.001, d=2.83. Accordingly, two important characteristics of the comparison test and speaking test results were revealed: (1) although there were no statistically significant differences between the metaphor-based approach and control groups on pre-test scores, F(1, 55)=.920, p=.342>.01, ηp^2=.016, the metaphor-based approach group made significant gains from pre-test to post-test on the comparison test; and (2) significant positive effects for the metaphor-based approach group were also confirmed with the speaking test. The pre- and post-test scores for the comparison and speaking tests offer a study in contrast (see Appendix A):

Comparison test: Metaphor-based approach > Control
Speaking test: Metaphor-based approach > Control

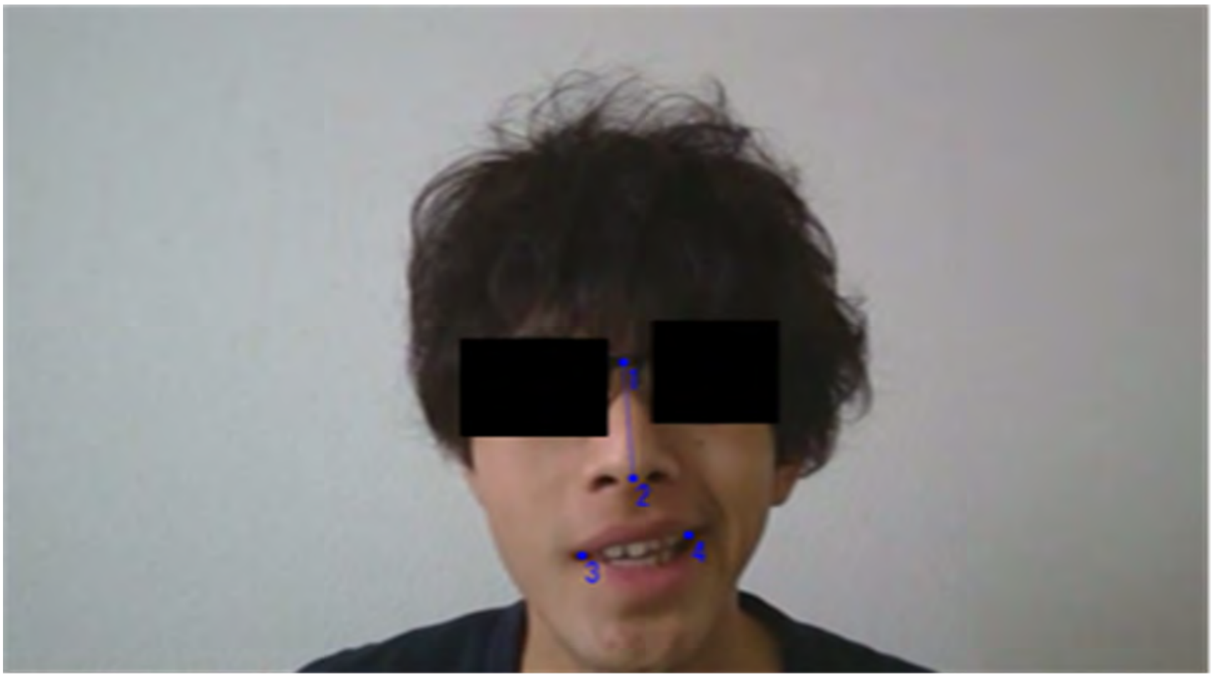
These results suggest that the metaphor-based approach was more effective than the rote-learning approach in promoting learners' acquisition of the knowledge of differences in degrees of certainty between *certain, probable,* and *possible* items.

Results from Mouth Asymmetry Analysis

During the participants' responses, only scenes of the participants' mouth movements when using target words were included in analyses. For the metaphor-based approach group, 590 scenes were subject to mouth asymmetry analysis (172 for *certain* items, 199 for *probable* items, 219 for *possible* items). For the control group, 329 scenes were captured (123 for *certain* items, 76 for *probable* items, 130 for *possible* items).

Using the first scene of the recording as the basic scene, the center of the participant's forehead (Point 1 in Fig. 3) was fixed as the reference point. Based on the reference point and the tip of the nose (Point 2 in Fig. 3), the vertical axis on the coordinates was determined. Then, using the vertical axis as the reference axis, the left end of the mouth (Point 4 in Fig. 3) and the right end of the mouth (Point 3 in Fig. 3) were set as measurement points, and the horizontal axis was determined from those coordinates. Comparative coordinate conversion was performed on recordings after the basic scene. Namely, the coordinates were converted with the reference point in the center of the participants' foreheads as (x, y)= (0, 0) and assuming that the reference axis connecting the reference point and the tip of the nose was immobile. The coordinate displacements of measurement points 3 and 4 were calculated based on the reference axis. The mouth asymmetry in this study was defined as right-side dominant (the left side of the mouth opens wider than the right side of the mouth) or left-side dominant (the right side of the mouth opens wider than the left side of the mouth).

Figure 3
Enlarged Picture Depicting the Left Side of the Mouth Opening Wider than the Right Side of the Mouth during Target Word Production



First, this study analyzed whether the right-side and left-side mouth-opening widths differed between the metaphor-based approach and control groups. As shown in Table 2, the results of two independent measures *t*-tests yielded significant differences between the left-side mouth-opening width (L) and the right-side mouth-opening width minus the left-side mouth-open width (R-L) in *certain, probable*, and *possible* items; no significant differences were observed in the right-side mouth-opening width (R). Second, in order to find where the differences lie, this study ran two paired-samples *t*-tests. The results revealed significant differences between L and R within the metaphor-based approach group ($t(27)=-2.87$, $p<.01$, $d=2.77$ for *certain* items; $t(27)=-6.60$, $p<.01$, $d=1.39$ for *probable* items; and $t(27)=-4.31$, $p<.01$, $d=2.24$ for POSSIBLE ITEMS); no significant differences between L and R were found within the control group ($t(28)=.37$, $p=.711$, $d=1.73$. for *certain* items; t $(28)=-1.2$, $p=.250$, $d=1.29$ for *probable* items; and $t(28)=.77$, $p=.446$, $d=1.90$ for *possible* items).

In summary, there were significant differences in L and R widths between the metaphor-based approach and control groups with the metaphor-based approach group's L being significantly wider than R; this leads this study to consider that the metaphor-based approach group increased left-side bias in mouth openings during their production of the target words (see Fig. 4), which could be translated as RH involvement in the participants' metaphorical processing of the target words in use.

Table 2
Right and Left-Side Mouth-Opening Widths and the Difference between Right-Side Mouth-Opening Width Minus Left-Side Mouth-Opening Width during Target Word Production

	Treatment	Mean	SD	*t*	*p*	*d*
Certain R	MA	2.10	2.06	1.54	.131	1.65
	Control	1.41	1.12			
Certain L	MA	3.60	2.29	4.52	.000	1.91
	Control	1.29	1.46			
Certain R-L	MA	-1.50	2.77	-2.65	.011	1.03
	Control	.12	1.73			
Probable R	MA	1.36	1.03	-.009	.993	1.03
	Control	1.36	1.03			
Probable L	MA	3.10	1.49	3.82	.000	1.43
	Control	1.65	1.37			
Probable R-L	MA	-1.74	1.39	-4.09	.000	1.34
	Control	-.28	1.29			
Possible R	MA	1.35	1.42	-1.28	2.03	1.64
	Control	1.90	1.82			
Possible L	MA	3.17	1.86	3.63	.001	1.59
	Control	1.63	1.27			
Possible R-L	MA	-1.82	2.24	-3.80	.000	2.07
	Control	.27	1.90			

Note: R=right-side mouth-opening width; L= left-side mouth-opening width; R-L= R minus; MA = metaphor-based approach

Discussion and Conclusion

The results indicated that the metaphor-based approach group outperformed the control group in comparison and speaking tests. These results showed that the proximal-distal metaphor enabled the participants to connect the spatially visualized concept of distance with different degrees of sureness attached to the use of the *certain, probable,* and *possible* items and remember them; during this process, their left side mouth-openings were wider than their right mouth-openings, thereby lending support to findings in previous studies (Argyriou & Kita, 2013; Argyriou, Byfield, & Kita; 2015) on possible RH involvement in metaphor processing.

There are two possible factors behind the supposed RH involvement in the metaphor-based approach on the possible involvement of the RH. The first factor is associated with the proximal-distal metaphor that generates cross domain mapping between source and target domains. During the learning sessions and post-test, the metaphor-based approach group practiced concept projection; through this process, participants understood the abstract concept degrees of certainty, in terms of the spatial concept distance, which entailed RH involvement in the process. Conversely, the control group did not practice concept projection but instead engaged in rote memorization of a list of target words expressing degrees of certainty, which probably reduced RH dominance (Graves & Landis, 1990; Lindell, 2006).

The second factor may be related to low degrees of saliency in expressions of certainty-levels. During the speaking test, the metaphor-based approach group engaged in metaphorical concept mapping from the concept of distance in the source domain to the concept of degree of certainty in the target domain. This specific process of metaphorical mapping is participants' effort to bring two distant concepts closer together to comprehend the differences in degrees of Certainty between the *certain, probable*, and *possible* items.

According to Beeman's Fine Coarse Coding theory (Beeman, 1998), RH processing activates distantly associated concepts and peripheral aspects of meanings and simultaneously maintains activation of multiple meanings, while LH processing selects and maintains activation of closely associated concepts and central aspects of meanings. That is, metaphorical expressions with low degrees of saliency such as certainty degrees are inclined to be maintained in the RH, whereas literal expressions with high degrees of saliency are treated in the LH.

As Japanese EFL learners have difficulty identifying and categorizing *certain, probable*, and *possible* items according to their degrees of certainty and tend to confuse *probable* and *possible* items especially, metaphorically speaking, *certain, probable,* and *possible* items are less salient metaphoric expressions, and the *probable* and *possible* items display even less saliency than *certain* items. In fact, the R-L values of *probable* and *possible* items are more significant than the R-L value of *certain* items in the metaphor-based approach group. This suggests even stronger RH dominance when participants used *probable* and *possible* items, likely due to the less salient nature of those items. Thus, activation of RH process with metaphorical mappings from source to target domains is a more naturally occurring phenomenon that inoculates participants with understanding of different degrees of certainty differently than the LH process involved with the rote memorization of the list. Kacinik and Chiarello (2007) argued that RH processing is better suited than LH processing for understanding metaphoric expressions because it leads to deep processing of these experiences and creates stronger memory traces of them (Lakoff & Johnson, 2003; Littlemore, 2004).

Regarding limitations, although the present study checked the assumptions for the statistical analysis, the assumptions of normality and of homogeneity of variances were not met because of the nature of the criterion-referenced test. Brown (2014) argued that violations of the normality assumption are only problematic on norm-referenced tests and a skewed distribution may actually be a desirable outcome on criterion-referenced tests like the comparison and speaking tests in this study.

Meanwhile, even with some limitations, this study will provide guidance to researchers and practitioners for applying the metaphor-based approach based on the spatial concept to teaching abstract concepts and creating stronger memory traces of them in an EFL context.

To extend the current findings, given the apparent efficacy of the spatial concept-oriented metaphor-based approach is related to both the right and left hemispheres in the brain, deeper insights can be gained from future studies that investigate the effects of the spatial concept-oriented metaphor-based approach on relative involvement of the right and left hemispheres in EFL learners' metaphoric processing. Further analysis of the spatial concept-oriented metaphor-based approach from the perspectives of brain science would be beneficial for fellow researchers and teacher to gain an insight into the true nature of the approach and expand its application in an EFL context.

References

Ahrens, K., Liu, H. L., Lee, C. Y., Gong, S. P., Fang, S. Y., & Hsu, Y. Y. (2007). Functional MRI of conventional and anomalous metaphors in Mandarin Chinese. *Brain and Language, 100*, 163–171. https://doi.org/10.1016/j.bandl.2005.10.004

Argyriou, P., & Kita, S. (2013). The effect of left-hand gestures on metaphor explanation. In M. Knauff, M. Pauen, N. Sebanz, & I. Wachsmuth (Eds.), *The 35th Annual Conference of the Cognitive Science Society*, 1762–1767. Berlin and Austin, TX: Cognitive Science Society.

Argyriou, P., Byfield, S., & Kita, S. (2015). Semantics is crucial for the right-hemisphere involvement in metaphor processing: Evidence from mouth asymmetry during speaking. *Laterality: Asymmetries of Body, Brain, and Cognition*, *20*, 191–210. https://doi.org/10.1080/1357650X.2014.951654

Beeman, M. (1998). Coarse semantic coding and discourse comprehension. In M. Beeman & C. Chiarello (Eds.), *Right Hemisphere Language Comprehension: Perspectives From Cognitive Neuroscience* (pp. 255–284). Mahwah, NJ: Lawrence Erlbaum.

Benedek, M., Beaty, R., Jauk, E., Koschutnig, K., Fink, A., Silvia, P. J., & Neubauer, A. C. (2014). Creating metaphors: The neural basis of figurative language production. *NeuroImage, 90*, 99–106. https://doi.org/10.1016/j.neuroimage.2013.12.046

Berendi, M., Csábi, S., & Kövecses, Z. (2008). Using conceptual metaphors and metonymies in vocabulary teaching. In F. Boers & S. Lindstromberg (Eds.), *Cognitive Linguistic Approaches to Teaching Vocabulary and Phraseology*, 101–132. Berlin, New York: Mouton de Gruyter. https://doi.org/10.1515/9783110199161.2.65

Boers, F. (2000). Metaphor awareness and vocabulary retention. *Applied Linguistics, 21,* 553–571. https://doi.org/10.1093/applin/21.4.553

Brown, J. D. (2014). *Testing in language programs: A comprehensive guide to English language assessment.* McGraw Hill.

Cardillo, E. R., Watson, C. E., Schmidt, G. L., Kranjec, A., & Chatterjee, A. (2012). From novel to familiar: Tuning the brain for metaphors. *NeuroImage, 59,* 3212–3221. https://doi.org/10.1016/j.neuroimage.2011.11.079

Csábi, S. (2004). A cognitive linguistic view of polysemy in English and its implication for teaching. In M. Achard & S. Niemeier (Eds.), *Cognitive Linguistics, Second Language Acquisition and Foreign Language Teaching,* 233–256). Berlin, New York: Mouton de Gruyter. https://doi.org/10.1515/9783110199857.233

Evan, V., & Green, M. (2014). *Cognitive linguistics: An introduction*. Edinburgh: Edinburgh University Press.

Faust, M., & Mashal, N. (2007). The role of the right cerebral hemisphere in processing novel metaphoric expressions taken from poetry: A divided visual field study. *Neuropsychologia, 45*, 860–870. https://doi.org/10.1016/j.neuropsychologia.2006.08.010

Graves, R., & Landis, T. (1990). Asymmetry in mouth opening during different speech tasks. *International Journal of Psychology*, *25*, 179–189. https://doi.org/10.1080/00207599008247856

IBM Corp. (2020). *IBM SPSS Statistics for Windows, Version 27.0.* Armonk, NY: IBM Corp.

Kacinik, N. & Chiarello, C. (2007). Understanding metaphors: Is the right hemisphere uniquely involved? *Brain and Language,* 100, 188–207. https://doi.org/10.1016/j.bandl.2005.10.010

Lakoff, G. & Johnson, M. (1999). *Philosophy in the flesh.* New York: Basic Books.

Lakoff, G. & Johnson, M. (2003). *Metaphors we live by*. Chicago: The University of

Chicago Press. https://doi.org/10.7208/chicago/9780226470993.001.0001

Lindell, A. K. (2006). In your right mind: Right hemisphere contributions to language processing and production. *Neuropschology Review*, *16*, 131–148. https://doi.org/10.1007/s11065-006-9011-9

Littlemore, J. (2004). Interpreting metaphors in the language classroom. *Les Cahiers de I'APLIUT, 23*(2), 57–70. https://doi.org/10.4000/apliut.3339

Rapp, A. M., Leube, D. T., Erb, M., Grodd, W., & Kircher, T. T. J. (2007). Laterality in metaphor processing: Lack of evidence from functional magnetic resonance imaging for the right hemisphere theory. *Brain and Language, 100*(2), 142–149. https://doi.org/10.1016/j.bandl.2006.04.004

Schmidt, G. L., DeBuse, C. J., & Seger, C. A. (2007). Right hemisphere metaphor processing? Characterizing the lateralization of semantic processes. *Brain and Language, 100*(2), 127–141. https://doi.org/10.1016/j.bandl.2005.03.002

Stringaris, A. K., Medford, N. C., Giampietro, V., Brammer, M. J., & David, A. S. (2007). Deriving meaning: Distinct neural mechanisms for metaphoric, literal, and non-meaningful sentences. *Brain and Language, 100*, 150–162. https://doi.org/10.1016/j.bandl.2005.08.001

Tabachnick, B., & Fidell, L. (2007). *Using multivariate statistics*. Boston: Allyn and Bacon.

Takimoto, M. (2020). Exploring the effects of proximal-distal metaphor on the development of EFL learners' knowledge of the degree of certainty. *Language Teaching Research, 24*(3), 317–337. https://doi.org/10.1177/1362168818782259

Tyler, A., Mueller, C., & Ho, V. (2010). Applying cognitive linguistics to instructed L2 learning: The English modals. *AILA Review, 23*, 30–49. https://doi.org/10.1075/aila.23.03tyl

Tyler, A., Mueller, C., & Ho, V. (2012). Experiment #2: Comparing the efficacy of a CL-based approach with a traditional approach to teaching *to, for* and *at*. In A. Tyler (Ed.), *Cognitive linguistics and second language learning* (pp. 160-164). New York: Routledge.

Corresponding author: Masahiro Takimoto
Email: ra57482@rd5.so-net.ne.jp

Appendix A

Descriptive Statistics for Two Testing Instruments

	Comparison Test				Speaking Test				
Time	Treatment	*n*	*M*	*SD*	Time	Treatment	*n*	*M*	*SD*
Pre	MA	28	18.57	7.68					
	Control	29	16.72	6.85	N/A				
	Total	57	17.63	7.27					
Post	MA	28	46.61	13.95	Post	MA	28	15.00	0.00
	Control	29	30.00	15.87		Control	29	11.24	3.97
	Total	57	38.16	17.02		Total	57	13.09	3.39

Note: MA = metaphor-based approach; Pre = pre-test; Post = post-test