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Title:

Who is data-driven learning for? Challenging the monolithic view of its relationship with learning styles

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Abstract:

This study examines the relationship between one type of data-driven learning (DDL) and inductive–deductive learning styles. Participants were 145 Japanese university learners of English as a foreign language, all of whom showed significant improvements in a grammar test after teacher-led guided DDL induction. Data were collected using a questionnaire on inductive–deductive learning styles and DDL task values. Weak correlations were found between the inductive–deductive continuum of learning styles and the DDL task value, but no differences in magnitude were found from an examination of the confidence interval for the two correlations. These findings indicate that depending on the type, guided DDL-type induction may be beneficial for both deductive and inductive learners irrespective of their learning styles. The paper concludes with suggestions that future DDL studies should carefully define the construct of DDL and explore its relationship with learner characteristics.

Keywords:

data-driven learning (DDL), learning styles, inductive, deductive, guided induction

1. Introduction

Advances in corpus studies from the end of the 20th century have had profound effects on language teaching and learning in various areas such as lexicography, grammar, textbooks and syllabi, and test development (Boulton, 2012a; Taylor & Barker, 2008). The most direct application of corpus studies has been when learners receive hands-on experience in directly working with a corpus for learning purposes with guided tasks or materials, a teaching method known as “data-driven learning” (DDL). Since being proposed by Johns (1991), DDL has been used as a language learning and teaching method and has attracted much attention from both researchers and practitioners (Mizumoto, Chujo, & Yokota, 2016). Although the term DDL implies that learners search corpora by themselves (hands-on uses or direct student DDL), the definition also includes hands-off uses such as when teachers prepare concordance printouts for classroom use (e.g., Römer, 2011), especially when introducing DDL to lower level learners. In recent years, there has been an increasing use of DDL in classrooms (e.g., Tribble, 2015).

Despite the diversification in the teaching methodologies for DDL, it has been found that inductive learners appear to benefit most from DDL (Chambers, 2005; Cresswell, 2007; Flowerdew, 2008) as it is inductive in nature (i.e., finding rules from examples). Meanwhile, Boulton (2009) suggested that “a DDL approach can appeal to learners with quite different styles” (p. 13). These contradictory views suggest, because of the wide range of DDL teaching methods, the relationship between DDL and learning styles has yet to be firmly established. This study therefore investigated the relationship between teacher-led, guided DDL induction and inductive–deductive learning styles.

2. Literature review

2.1. *Data-driven learning (DDL)*

DDL is a methodology that applies corpora to language teaching and learning (Aijmer, 2009; Aston, 2001; Flowerdew, 2012; O’Keeffe, McCarthy, & Carter, 2007; Sinclair, 2004). Current research on DDL has suggested that the advantages of DDL include (a) awareness raising (or noticing) from using a concordancer to recognize patterns and forms to enhance input (Azzaro, 2012; Chang & Sun, 2009; Daskalovska, 2015; Scott & Tribble, 2006), (b) improved teaching and learning of lexico-grammatical items (Huang, 2014; Smart, 2014), (c) error correction in writing and proofreading (Chambers & O’Sullivan, 2004; Chang, 2014; Gaskell & Cobb, 2004), (d) a rich exposure to authentic language use (Chen, 2011), (e) cognitive and meta-cognitive development (O’Sullivan, 2007; Yoon & Jo, 2014), and (f) learner centeredness (Biber, Conrad, & Reppen, 1998). All these benefits have been claimed to contribute to greater autonomy and life-long learning (Boulton, 2009b, 2010; Gilquin & Granger, 2010; Lin & Lee, 2015; Yoon, 2011).

Although DDL is not yet established as part of mainstream teaching practices (Boulton, 2010; Tribble, 2015), presumably due to limitations such as technology, logistics, and the beliefs of teachers and learners (Gilquin & Granger, 2010), it has been proven to be effective as a teaching and learning methodology based on both qualitative inquiries (e.g., Cheng, 2010) and quantitative syntheses (e.g., Cobb & Boulton, 2015). Cobb and Boulton (2015), in a meta-analysis of 116 DDL studies (from 1989 to 2012), found that corpus use (DDL) in the classroom was more effective for learners equipped with DDL skills than for those who did not have those skills and concluded that compared to instructed SLA (Second Language Acquisition) and CALL (Computer-assisted Language Learning), DDL usually resulted in better learning outcomes. DDL

studies, therefore, have generally found that when used appropriately, DDL can be a promising alternative, but is certainly not a “panacea” (Boulton, 2009b; Flowerdew, 1996), and has the potential to make positive and significant changes in the English language learning process.

Previous research and curriculum studies have identified and/or developed a wide range of DDL applications, as summarized in Table 1. The distinction between “hard DDL” and “soft DDL” shown in the table is based on Gabrielatos (2005). In this model, the hard version refers to more prototypical DDL, and the soft version can be more conventional instruction with light DDL elements. From the original definition given by Johns (1991), DDL applications have tended to be somewhat inclusive because of the “data-driven” rather than “corpus-driven” label (Boulton, 2012b). An example of this diversity can be seen in the number of DDL studies that have been conducted using Google and other online search engines as concordancers (e.g., Boulton, 2012b; Sha, 2010).

Another example is in the use of DDL in lower level classrooms. Boulton (2010) demonstrated a “paper-based” (i.e., concordance lines) DDL approach was found to be more beneficial for lower level learners than traditional teaching approaches. To lessen the cognitive burden on lower level language learners, bilingual concordancers (Chujo, Anthony, & Oghigian, 2009) or guided “convergent” tasks can also be useful (Bernardini, 2004) in combination with teacher-led activities and a deductive instructional approach (Smart, 2014). Another DDL approach for lower level learners is the ease of adjusting the concordancing corpus according to difficulty level (i.e., readability) (Allan, 2008; Chujo, Oghigian, Akasegawa, 2015). This type of text modification practice, however, is not without controversy as some researchers argue that the use of authentic language data is central to the premise of DDL (Daskalovska, 2015; Smart,

2014). Even so, as Boulton (2011) claimed as to DDL, “boundaries are fuzzy, and any identifiable cut-off point will necessarily be arbitrary” (p. 575).

Table 1

DDL variations from research.

Viewpoint	Possible dimensions and continuums		
	Hard DDL	← →	Soft DDL
Corpus data	Authentic	← →	Simplified
Corpus size	Large	← →	Small
Corpus purpose	General	← →	Specific
Concordancer	Web/Local computer	← →	Paper-based
Language	Monolingual	← →	Bilingual
Task	Divergent (No definite answers)	← →	Convergent (Definite answers)
Activity	Student-centered	← →	Teacher-led
Instruction	Inductive (Implicit)	← →	Deductive (Explicit)
Situation	Outside classroom	← →	In classroom
Grouping	Individual	← →	Pair/Group

DDL developments in the classroom are motivated by the belief that at an early stage of instruction, teachers are necessary guides for using concordancing in a structured approach if it is to be helpful for lower level learners (Boulton, 2010). Through guidance using “soft” or “deductive” DDL, learners can reach a level of competence whereby they can work with “hard” or “inductive” DDL on their own (Cresswell, 2007; Gabrielatos, 2005). As a result, using DDL in the classroom may cover the range of the dimensions and continuums shown in Table 1, with different degrees of scaffolding based on the needs and proficiency of the target learners.

2.2. Learning styles and DDL

Because of the wide range of DDL applications, there has been a continuing debate as to which method is the most effective for which learning styles. Learning styles, which have been found to have a broad influence on many aspects of learner behaviors (Lee, 2015; Lee, Yeung, & Ip, 2016), refer to “an individual’s natural, habitual, and preferred way(s) of absorbing, processing, and retaining new information and skills” (Reid, 1995, p. viii).

There has been some recent discussion on the possible effects of DDL on certain learning styles (Flowerdew, 2012), but most research has tended to focus only on the inductive–deductive dimension (Boulton, 2009a), with some studies suggesting that inductive learners favor DDL more than deductive learners (Chan & Liou, 2005; Lee & Liou, 2003; Lewis, 2006). Boulton (2009a) claimed that many researchers seem to believe that “DDL may not be suitable for all learner profiles” (p. 4). By intentionally distancing himself from the dominant inductive–deductive continuum, Boulton (2009a) investigated the active–reflective, sensing–intuitive, visual–verbal, and sequential–global continuums and found that even though visual learners showed a greater preference for DDL, the correlations were not significant, which suggested that “DDL should be accessible to learners with a variety of different preferences” (p. 14).

The type of DDL that is used should be specified in this line of research investigating the relationship between DDL and learning styles (see Table 1). The previous argument is based on the premise that DDL is inductive in nature, and as such, is more effective for inductive learners; a statement Boulton (2009a) considered “something of a truism” (p. 4). Contrary to this common belief, as DDL has evolved, there is now a wide variety of DDL tasks, activities, and instructions available. Flowerdew (2012) noted in reference to DDL that “in reality, much corpus-based work also draws on the deductive approach” (p. 197). Thus, while some researchers regard DDL as

hard DDL, where learners independently use concordancers to determine rules, others may have soft DDL in mind, where teachers deductively guide learners. Obviously, the general understanding of the relationship between DDL and learning styles requires further, deeper empirical investigation.

The relationship between DDL instructional practices and learning styles is also crucial from an aptitude-treatment interaction (ATI) viewpoint (Cronbach & Snow, 1977). ATI assumes that the effects of educational interventions vary according to individual differences because aptitudes and treatments interact to produce learning performance. As such, matching instruction to individual differences creates a positive ATI, and it is considered to play a significant role in L2 learning as well (e.g., Hwu & Sun, 2012). If inductive learners do benefit more from DDL instruction, as widely believed, there needs to be some assistance given to deductive learners so that they do not get lost in an ATI mismatch. Conversely, if DDL instruction is found to be equally effective for both inductive and deductive learners, this could prove that all learners can benefit from DDL.

2.3. Research question

The literature review has revealed that there is a need for further research into the relationship between guided DDL and inductive–deductive learning styles. Therefore, the following research question was addressed:

Which type of learner (inductive or deductive) prefers teacher-led, guided induction DDL instruction in the classroom?

3. Method

3.1. Participants and settings

Participants in this study were 145 university English as a foreign language (EFL) learners (science and engineering majors, 116 males and 29 females, aged 18–20) from a private university in Japan. By using convenient sampling, the study was conducted in three classes as part of a compulsory English course at the university in the spring semester of 2014. Learner proficiency was measured using the Test of English for International Communication Bridge test scores prior to the intervention ($M = 131.26$, $SD = 16.03$). According to the Educational Testing Service (2013), learners with this level of proficiency are classified as a “Basic User” (A2) in the Common European Framework of Reference for Languages. Because it has been reported that approximately 80% of Japanese university graduates are at that level (Tono & Negishi, 2012), participants in this study were considered appropriate as a target population sample (i.e., Japanese EFL university students).

3.2. Instruments

To measure the participants’ learning styles, a questionnaire of seven items adapted from Cohen, Oxford, and Chi (2006) and Oxford and Lee (2007) was developed and administered at the beginning of the course.

In addition to the learning style scales, six items to measure task values (i.e., the extent to which the learners felt the tasks were useful for their learning) were adapted from the Motivated Strategies for Learning Questionnaire (Pintrich, Smith, Garcia, & Mckeachie, 1993) and administered to the same participants at the end of the course. This task value scale was used in the authors’ previous research and its validity and reliability were established (Mizumoto, Chujo,

& Yokota, 2016). This task value scale was used as an outcome measure for the correlation analysis with the two deductive and inductive learning style scales. If a strong correlation was observed between the task value scale and one or both of the learning style scales, it could be argued that learners with certain learning styles may prefer DDL learning activities. Participants responded on a six-point scale, from 1 (not at all true of me) to 6 (very true of me) for all items. Table 2 shows the questionnaire items used. However, the gain scores from the pretest to the posttest (i.e., a posttest score minus a pretest score) were not used as these tend to be an unreliable measure, and it is often inappropriate to correlate a gain score with other variables (Dimitrov & Rumrill, 2003).

Table 2

Questionnaire items used in the study.

Measure	No.	Items
Deductive (Learning Style)	1	I like to go from general patterns to the specific examples when learning the target language.
	2	I like to start with rules and theories rather than specific examples.
	3	I like to begin with generalizations and then find examples that relate to them.
Inductive (Learning Style)	1	I like to learn the rules of language indirectly by being exposed to many examples of grammatical structures.
	2	I like to discover underlying patterns by seeing many examples.
	3	I like to figure out rules based on the way I see language forms behaving over time.
	4	I like to learn concrete examples first and then generalizable rules later.
DDL Task Value	1	I was able to improve my English ability with DDL.
	2	They were useful for grammar learning.
	3	The learned grammar was easily fixed in my memory with DDL.
	4	The activities were enjoyable.
	5	I was able to understand the grammar items I did not know with DDL.
	6	They were helpful in understanding the target grammar items.

To assess the intervention effect, a pretest and a posttest were prepared. They were grammar tests with discrete point items measuring the knowledge and use of the taught noun phrases. Table 3 shows sample items from the test. Because the pretest and posttest contained the same items, steps were taken to control for a possible practice effect. The items in the posttest were shuffled and administered in a different and random order. The test items had been used in previous studies, so the appropriateness had been established (Chujo, Anthony, Oghigian, & Uchibori, 2012).

Table 3

Description and sample items of pretest and posttest.

Subsection	No. of items (score for each item)	Sample item
		<i>Complete the sentence.</i>
Producing NPs	15 (2)	これらのアメリカのコインは大変古いです。 () are very old.
		<i>Underline all the noun phrases.</i>
Identifying NPs	15 (1)	We are unable to meet <u>the present demand</u> .
		<i>Choose the best answer.</i>
Multiple- choice NPs	15 (1)	A husband and wife must respect each other in order to have a good _____. (A) marry (B) marrying (C) marriage (D) married

Note. Partial credit scoring (0, 1, or 2) was allowed for Producing NPs.

3.3. DDL instruction

All three classes ($N = 145$) focused on learning noun phrases using DDL. The classes met once a week for a 90-min class over a 15-week semester. The DDL instruction was conducted in the first 10 of the 15 classes for all three classes, all of which were taught by the second author of this article, an experienced DDL teacher for the target learners (i.e., false-beginner level learners) for more than 10 years. In the first half (45 min) of each class, participants focused on learning noun phrases using an online parallel concordancer, WebParaNews (<http://www.antlabsolutions.com/webparanews/>), a bilingual Japanese–English searchable newspaper corpus (Fig. 1) (Utiyama & Isahara, 2003). WebParaNews enables learners to understand the target language concordance lines and shows a richer context for both languages in a key word in context format. It also provides an L1 translation, which assist in overcoming the common lower level learner DDL difficulties of lack of confidence and difficulty in understanding the monolingual concordance lines (Chujo, Anthony, & Oghigian, 2009).

The screenshot shows the WebParaNews interface with the search term "organization *ing". The interface includes a search bar, a search button, and various options for sorting and viewing results. The search results are displayed in two sections: "Target Corpus" and "Reference Corpus".

HIT	Target Corpus
1	owered to designate that locality as "an organization needing fiscal rehabilitation," making it subject
2	s all the drawbacks of any administering organization evaluating its own performance.
3	failure to shed its old skin as an organization campaigning to protect the interests of large co
4	s becoming more and more important as an organization enforcing collective security, and, therefore, i
5	An organization promoting home education was launched this summer
6	nts belonging to Green Konyu Network, an organization promoting the use of recycled paper, doubled fr
7	79 as the nation's first nongovernmental organization offering help to refugees, it has conducted vari
8	Japan Organ Transplant Network, the only organization dealing with registration of patients requiring
9	volved in the establishment of a private organization focusing on international labor culture, one of
10	kuta is a top executive of Kanyukai, the organization comprising about 60 Hazama subcontractors in the

HIT	Reference Corpus
1	地方財政は赤字が一定額を超えると、事業の実施などで厳しい制約を受ける「財政再建団体」になる。
2	外務省が、独自のODA評価報告を作成しているが、いわば主管官庁による自己評価である。
3	最大の理由は、「大企業、製造業、正社員、官公庁」中心の運動から脱皮できないところにある。
4	とりわけ国連の集団安全保障機能が重要性を増してくるのにもなって、国連憲章と日本国憲法の整合性を図る必要が生じている。
5	「日本ホームスクール支援協会」という団体もこの夏発足した。
6	再生系の優先的購入などを進めているグリーン購入ネットワーク（同）に加盟する企業や自治体も、前年の2倍以上の1230団体に増えた。
7	同会は日本最初の難民救済NGOとして、一九七九年に発足した。
8	施行と同時にスタートする「日本臓器移植ネットワーク」は、移植を受ける患者の登録や臓器提供者の情報を一元的に管理する唯一の機関である。
9	調べなどによると、浦西副知事が設立に関与していたのは、二つのダミー団体のうち「海外労働文化研究会」。
10	菊田社長は東北地方のハザマ下郡会社約六十社で組織する同社協力団体の最高幹部。

Fig. 1. A Screenshot of “organization *ing” using WebParaNews.

The following four-step procedure (Chujo & Oghigian, 2008) was employed for the DDL instruction:

Step 1: Hypothesis formation through inductive DDL tasks with hands-on tasks

Step 2: Explanations from the teacher to confirm or correct these hypotheses

Step 3: Hypothesis testing through follow-up exercises (homework) and teacher feedback on homework

Step 4: Production through follow-up exercises (in class) and teacher feedback on homework

In Step 1, participants worked in pairs or groups sharing their findings and offering support to each other, eventually arriving at hypotheses about the form and usage of the particular lexicogrammatical patterns in the tasks. In Step 2, the teacher explained the target items so that the participants could verify the validity of their hypotheses. In Step 3, participants worked on additional consolidation exercises as homework. In Step 4, participants worked together again to complete the production practice exercises in class and the teacher gave feedback on the exercise. This four-step procedure was a hybrid of an inductive DDL approach and a deductive grammar teaching method, one very similar to the “guided induction” (Flowerdew, 2009; Smart, 2014).

DDL literature has suggested that treatment groups who experience DDL instruction generally outperform comparison groups (Cobb & Boulton, 2015). To examine whether participants who received DDL instruction showed improvement, another group of learners (one class; $N = 41$) were used as a comparison group, which we referred to as the traditional grammar

teaching (TR) group. It should be stated here that the TR group ($N = 41$) was not part of the DDL group ($N = 145$). The TR group's demographic information was similar to the DDL group's, allowing it to serve as a comparison group. For the TR group, another experienced EFL instructor carried out a traditional TR procedure with a teacher-centered, deductive PPP (presentation, practice, and production) method to learn the same noun phrase patterns as the DDL treatment group. The procedure was as follows. First, the teacher explained the target grammar structure, which the students then practiced in a drill-like manner after completing a fill-in-the-blanks exercise. Finally, they produced the target structures in a short writing activity. Care was taken to control for content across the treatment types (DDL and TR) and the grammar content and information covered in each group were designed to be equivalent for ethical reasons. The difference between the DDL and TR groups was only in the mode of instruction, which made outcome comparisons possible.

Both DDL and TR groups took the same grammar test (described in Table 3) as pretest and the posttest following the intervention. Table 4 shows the descriptive statistics, internal consistency reliability (Cronbach's alpha), change scores, and correlation coefficients between the pretest and posttest for the DDL and TR groups. Both groups showed improvement from the pretest to posttest: the DDL group (change score [95 % CI] = 9.93 [8.83, 11.03], d [95 % CI] = 1.16 [0.99, 1.32]) and the TR group (change score [95 % CI] = 4.42 [2.30, 6.53], d [95 % CI] = 0.55 [0.27, 0.83]). Comparing the two groups after controlling for the pretest effect, the ANCOVA showed that there was a significant effect for the different treatments (DDL or TR); $F(1, 183) = 35.87, p < .001, \eta^2$ [95 % CI] = 0.10 [0.03, 0.18], indicating that the DDL group outperformed the TR group.

Table 4

Pretest and the posttest descriptive statistics.

Group	<i>n</i>	Pretest		Posttest		Change	Correlation (Pretest & Posttest)
		<i>M (SD)</i>	α	<i>M (SD)</i>	α	<i>M (SD)</i>	<i>r</i>
DDL	145	28.50 (8.79)	.78	38.43 (8.35)	.80	9.93 (6.68)	.70
TR	41	25.63 (7.95)		30.05 (8.24)		4.42 (6.70)	.66

Note. Possible score range for the pretest and posttest: 0–60.

Prior to the instructional intervention, DDL group participants completed the learning-style questionnaire, and following the treatment, they completed the task value questionnaire.

3.4. Data analyses

All analyses in this study were conducted using R version 3.2.3 (R Core Team, 2015). To answer the research question, a correlation analysis was conducted to examine the relationship between DDL (i.e., task value) and learning styles (deductive and inductive). To conduct the correlation analysis, structural equation modeling (SEM) was used as correlation coefficients are often underestimated owing to measurement errors, which is especially the case with questionnaire studies because the measures tend to have low reliability coefficients. The advantage of using SEM over other conventional statistical methods is that it can simultaneously model observed variables (i.e., each questionnaire item), latent variables (i.e., underlying traits that can be represented with the questionnaire subscales: inductive, deductive, and task value in

this study), and measurement errors. As such, weakened correlation coefficients can be corrected (known as “correction for attenuation”), and the correlation confidence can be estimated more accurately using SEM (Kline, 2011, p. 71). Because SEM tests whether a hypothesized model is consistent with the observed data, several fit indices were examined to evaluate the overall fit of the structural model. In this study, the fit indices reported in the R package, lavaan (Rosseel, 2012), were checked for the measurement model fit evaluation: comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR).

Following the correlation analysis, the magnitude of the correlation coefficients was tested to examine whether there was any difference between a pair of correlation coefficients (i.e., Deductive and Task Value/Inductive and Task Value). With null hypothesis statistical testing (NHST), however, it is not possible to claim that there is no difference between the two coefficients (i.e., the two values are equivalent) because of the logic behind NHST (Larson-Hall, 2016, p. 319). For this reason, the confidence intervals of the two dependent correlations were compared (i.e., Deductive and Task Value/Inductive and Task Value) with one variable (i.e., Task Value) in common (Baguley, 2012, p. 225) using Zou’s modified asymptotic method (Zou, 2007).

To ensure reproducibility and transparency in the data analysis (Larson-Hall & Plonsky, 2015; Marsden, Mackey, & Plonsky, 2016), all data and R codes used in this study have been made publicly available via the Open Science Framework (<https://osf.io/9qbtp/>).

4. Results

Table 5 shows the descriptive statistics and reliability coefficients (Cronbach's alpha) for the scales used to measure the learning styles (i.e., Deductive and Inductive) and Task Values for the participants who received the DDL instruction ($N = 145$). The distributions for each measure were confirmed as normal using the Kolmogorov–Smirnov test. This test is used to test for the normality of data (i.e., normal distribution). The Cronbach's alphas were relatively high.

Table 5

Descriptive statistics of the scales ($N = 145$).

Measure	No. of Items	$M (SD)$	Min.	Max.	Skewness	Kurtosis	α
Deductive	3	4.07 (0.95)	1.67	6	0.05	-0.32	.85
Inductive	4	3.81 (0.95)	1.25	6	-0.27	0.13	.89
Task Value	6	3.92 (0.99)	1.33	6	-0.33	-0.22	.91

Note. Possible range of item response (M) for all measures is 1 to 6.

Fig. 2 shows the SEM results. The fit indices of the three correlated factor model in the SEM revealed that the hypothesized model provided a good fit to the data ($CFI = .97$, $TLI = .97$, $RMSEA = 0.06$ [90% CI = 0.03–0.08], $SRMR = .05$). The correlation coefficients between the scales, however, were relatively low: Deductive and Inductive (r [95 % CI] = $-.19$ [$-.34, .03$]), Deductive and Task Value (r [95 % CI] = $.21$ [$.05, .36$]), and Inductive and Task Value (r [95 % CI] = $.20$ [$.04, .3$]). According to Dörnyei (2007), “in applied linguistics research we can find meaningful correlations of as low as 0.3–0.5” (p. 223). Considering this rule of thumb, the correlations between the two learning style scales (Deductive and Inductive) and the Task Value

were relatively low. This was especially true for the current analysis as SEM was employed to deal with the correlation coefficient attenuation correction. The low negative correlation coefficient between Deductive and Inductive can be explained theoretically; that is, the more deductive learners are, the less inductive they are, but by definition, they are placed on a point along the inductive–deductive continuum (Reid, 1995). The correlation coefficient between Inductive and Task Value ($r = .20$) was lower than expected considering the common belief that DDL is related to an inductive learning style. A similar correlation coefficient magnitude was observed between Deductive and Task Value ($r = .21$).

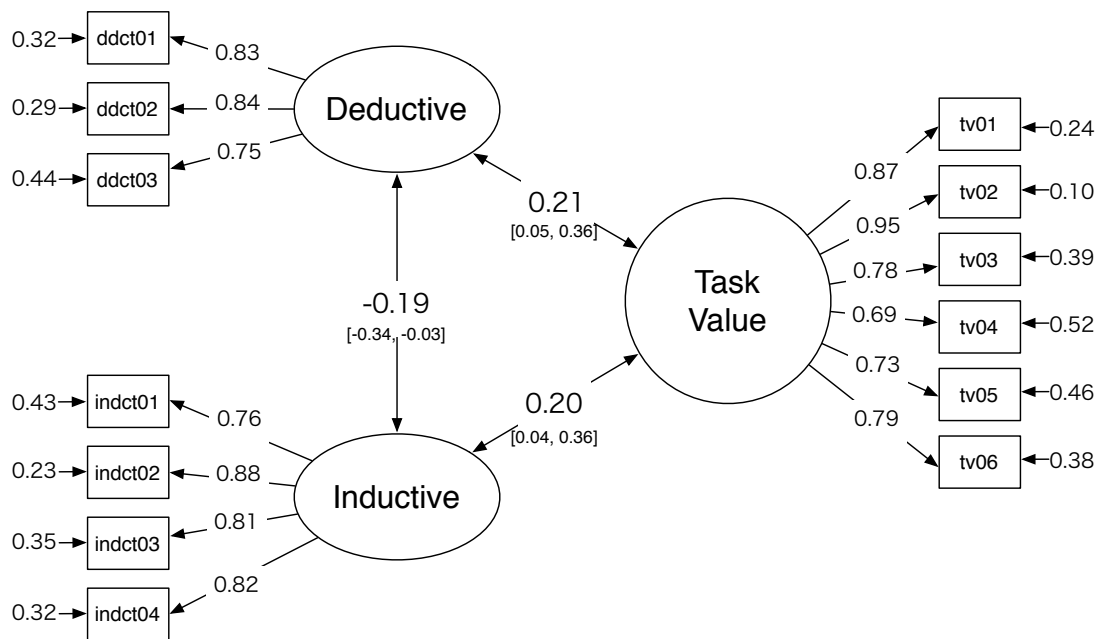


Fig. 2. Path diagram for the SEM result ($n = 145$). Numbers in parentheses show 95% confidence intervals (from the lower limit to the upper limit).

To show the relationship between the learning styles and Task Value in more detail, Fig. 3 displays scatterplots for the correlations between learning styles and Task Value in scale scores. The Bayesian alternative to correlation was used (Bååth, 2014) to create these scatterplots. In this figure, the two ellipses show that 50% (center darker area) and 95% (outer lighter area) were the highest regions, which predicted the likely data distribution if more data were added in future studies. The histograms and superimposed densities were drawn from the posterior predictive distributions. These scatterplots also suggested that the relationship between the learning styles and Task Value was not so strong and that the predictive distributions were similar for both correlations.

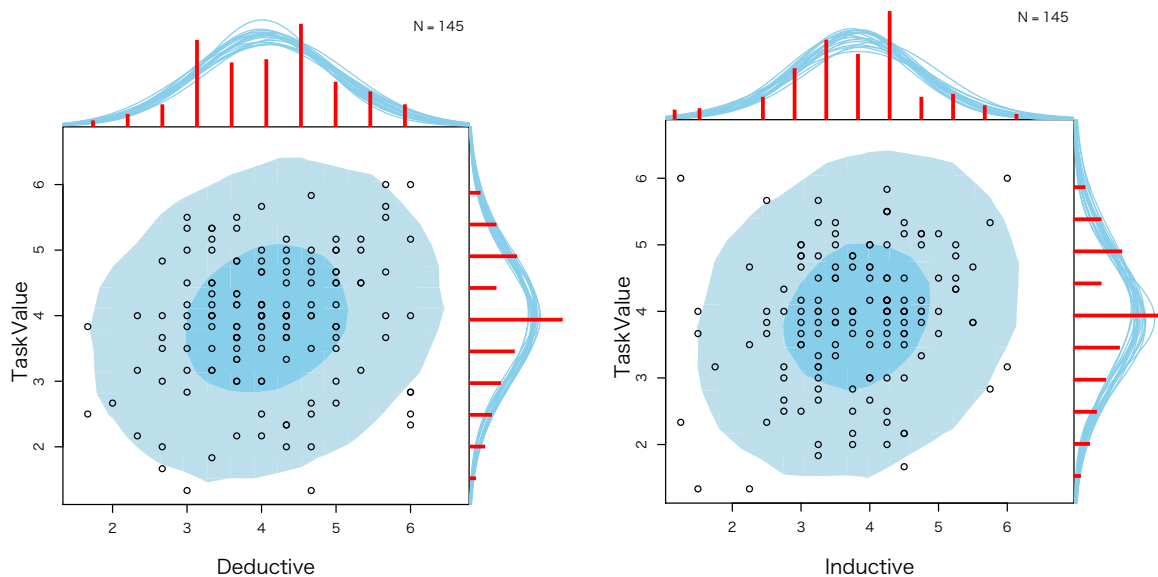


Fig. 3. Scatterplots for correlation and predictive distributions using Bayes estimation between learning styles and Task Value.

The same pattern was found when comparing the confidence intervals between a pair of correlation coefficients. The difference in the confidence intervals of the two correlations, Deductive and Task Value ($r = .21$) and Inductive and Task Value ($r = .20$), with Task Value as a common variable was $[-.24, .25]$, indicating that the two correlations did not differ in magnitude as the confidence interval, which included zero, was in the middle of the range.

The findings of this study are at odds with those in previous studies (Chan & Liou, 2005; Lee & Liou, 2003; Lewis, 2006), which suggest that inductive learners benefit more from DDL than deductive learners. This is because the DDL tasks, activities, and instructions in the current study were teacher-led guided induction (i.e., softer DDL), whereas those in previous studies were without explicit instruction or teacher's guidance (i.e., harder DDL). That is, the only difference between this study and the previous ones was in the differences of DDL instructional practices. The results of this study, therefore, highlight the possibility that the differences in DDL tasks, activities, and instructions would bring about varying degrees of success for learners with different learning styles.

5. Discussion

To question the dominant view in DDL literature that inductive learners benefit more from DDL learning, this study examined the relationship between DDL and learning styles in a language class with learners who showed significant improvement after the guided DDL induction instruction. The results found weak correlations between the DDL task value and the inductive–deductive learning style continuum, and there was no magnitude differences found after an examination of the confidence interval of the two correlations.

Taken together, these results suggest that the DDL instruction in the current study could be beneficial for both deductive and inductive learners irrespective of their learning styles. Thus, the results do not support the view that DDL is suitable only for inductive learners; rather, a guided DDL induction such as the instruction used in this study could be used to cater for learners with different learning styles. This is therefore further support for the claim that “DDL should be accessible to learners with a variety of different preferences” (Boulton, 2009a, p. 14).

The findings in this study have two important implications for DDL research and practice. First, guided DDL induction, which in the case of this study was a mixture of inductive and deductive grammar instruction, has the potential to be employed more proactively as a teaching methodology with the understanding that (a) it may be better than conventional teaching approaches and (b) it does not favor learners with specific learning styles (i.e., inductive or deductive), so it could be effective for all learners. Since the purpose of a guided DDL induction approach is to assist learners become autonomous in their foreign language learning in the same manner as explicit dictionary training (Boulton, 2009b), guided induction could be seen as a promising methodological alternative.

Second, as argued in this study, the type of DDL activities should be carefully defined in DDL research as DDL has different conceptual meanings for different people. Simplified claims such as “DDL is an inductive approach” or “there is a strong relationship between DDL and a certain individual factor” are thus not tenable and possibly can be misinterpreted. It is therefore necessary to state the DDL types (i.e., corpus, concordancer, task, and instruction) and the learner characteristics (i.e., proficiency and individual differences) in detail before making generalizable claims.

This study has one limitation. Only the relationship between the guided DDL induction and learning styles on an inductive–deductive continuum was examined, which was intentional so as to focus on the specific topic and research questions that had been highlighted in previous DDL research. However, as pointed out by Boulton (2009a), learning styles are not limited to the inductive–deductive continuum, and including a wider range such as field dependent and field independent (Flowerdew, 2012) in future study designs could examine the relationship between a certain DDL type and other learning styles in more detail.

The appropriate combination of these factors to maximize DDL use requires further empirical investigation. At the same time, the learning style constructs may change in the near future due to a paradigm shift in individual differences research (see Dörnyei & Ryan, 2015, for details), which regards learning styles as complex and dynamic within certain contexts. Along with the development of this new paradigm and the alternative conceptual lens, future studies may provide a clearer picture of the dynamic interaction between DDL and learner characteristics.

Finally, it should be noted that some researchers, based on recent brain-based studies, claim that the idea that matching instruction to a learner’s preferred “sensory” learning style improves learning is a myth (Lethaby & Harries, 2016, p. 16). If this argument also holds true for “cognitive” learning styles (e.g., deductive and inductive), it may not be the learning styles but other learner characteristics that we need to pursue their relationships with DDL. Only further studies will confirm or refute this claim.

6. Conclusion

In spite of the alleged claims that inductive learners benefit more from a DDL approach than deductive learners, there has been little empirical research investigating this relationship. As a result, despite an increasing number of DDL studies, researchers have continued to wonder whether certain learning or personal styles are favored or disfavored (Cobb & Boulton, 2015, p. 497). As DDL instructional practices have evolved and diversified, this study focused on the relationship between a successful guided DDL induction and inductive–deductive learning styles. Low correlations were found between these two variables and no magnitude differences were found, which suggested that this type of DDL practice could provide both inductive and deductive learners with a powerful tool to develop language learning autonomy.

As a number of DDL studies have demonstrated, DDL can take many forms to meet the needs and proficiency of learners, and may work better than conventional teaching methods. Similar studies should be conducted to examine how DDL works for different types of learners, which could encourage language teachers to adopt DDL as a promising teaching methodology in the 21st century.

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References

- Aijmer, K. (Ed.). (2009). *Corpora and language teaching*. Amsterdam/Philadelphia: John Benjamins.
- Allan, R. (2008). Can a graded reader corpus provide “authentic” input? *ELT Journal*, 63, 23–32. doi:10.1093/elt/ccn011
- Aston, G. (Ed.). (2001). *Learning with corpora*. Houston, TX: Athelstan.
- Azzaro, G. (2012). Phrasal verbs through DDL. *Journal of Theories and Research in Education*, 7, 1–24.
- Bååth, R. (2014). Bayesian first aid: A package that implements bayesian alternatives to the classical *.test functions in R. In *UseR! 2014 - the International R User Conference*. Retrieved from http://sumsar.net/files/academia/baath_user14_abstract.pdf
- Baguley, T. (2012). *Serious stats: A guide to advanced statistics for the behavioral sciences*. Basingstoke, England: Palgrave Macmillan.
- Bernardini, S. (2004). Corpora in the classroom: An overview and some reflections on future developments. In J. M. Sinclair (Ed.), *How to use corpora in language teaching* (pp. 15–36). Amsterdam/Philadelphia: John Benjamins.
- Biber, D., Conrad, S., & Reppen, R. (1998). *Corpus linguistics: Investigating language structure and use*. Cambridge: Cambridge University Press.
- Boulton, A. (2009a). Corpora for all? Learning styles and data-driven learning. In M. Mahlberg, V. González-Díaz, & C. Smith (Eds.), *Proceedings of 5th Corpus Linguistics Conference*. Retrieved from http://ucrel.lancs.ac.uk/publications/cl2009/150_FullPaper.doc
- Boulton, A. (2009b). Testing the limits of data-driven learning: Language proficiency and training. *ReCALL*, 21, 37–54. doi:10.1017/S0958344009000068

- Boulton, A. (2010). Data-driven learning: Taking the computer out of the equation. *Language Learning*, 60, 534–572. doi:10.1111/j.1467-9922.2010.00566.x
- Boulton, A. (2011). Data-driven learning: The perpetual enigma. In S. Goźdz-Roszkowski (Ed.), *Explorations across languages and corpora* (pp. 563–580). Frankfurt, Germany: Peter Lang.
- Boulton, A. (2012a). Beyond concordancing: Multiple affordances of corpora in university language degrees. *Procedia - Social and Behavioral Sciences*, 34, 33–38.
doi:10.1016/j.sbspro.2012.02.008
- Boulton, A. (2012b). What data for data-driven learning? In *The EUROCALL Review: Proceedings of the EUROCALL 2011 Conference* (pp. 23–27). Retrieved from [http://eurocall.webs.upv.es/documentos/newsletter/papers_20\(1\)/07_boulton.pdf](http://eurocall.webs.upv.es/documentos/newsletter/papers_20(1)/07_boulton.pdf)
- Chambers, A. (2005). Integrating corpus consultation in language studies. *Language Learning & Technology*, 9, 111–125.
- Chambers, A., & O'Sullivan, I. (2004). Corpus consultation and advanced learners' writing skills in french. *ReCALL*, 16, 158–172. doi:10.1017/S0958344004001211
- Chan, T., & Liou, H.-C. (2005). Effects of web-based concordancing instruction on EFL students' learning of verb–noun collocations. *Computer Assisted Language Learning*, 18, 231–251. doi:10.1080/09588220500185769
- Chang, J.-Y. (2014). The use of general and specialized corpora as reference sources for academic english writing: A case study. *ReCALL*, 26, 243–259.
doi:10.1017/S0958344014000056
- Chang, W.-L., & Sun, Y.-C. (2009). Scaffolding and web concordancers as support for language learning. *Computer Assisted Language Learning*, 22, 283–302.
doi:10.1080/09588220903184518

- Chen, H.-J. H. (2011). Developing and evaluating a web-based collocation retrieval tool for EFL students and teachers. *Computer Assisted Language Learning*, 24, 59–76.
doi:10.1080/09588221.2010.526945
- Cheng, W. (2010). What can a corpus tell us about language teaching? In A. O’Keeffe & M. McCarthy (Eds.), *The Routledge handbook of corpus linguistics* (pp. 319–332). London: Routledge.
- Chujo, K., Anthony, L., & Oghigian, K. (2009). DDL for the EFL classroom: Effective uses of a Japanese-English parallel corpus and the development of a learner-friendly, online parallel concordancer. In M. Mahlberg, V. González-Díaz, & C. Smith (Eds.), *Proceedings of 5th Corpus Linguistics Conference 2009, University of Liverpool, UK*. Retrieved from <http://ucrel.lancs.ac.uk/publications/cl2009/>
- Chujo, K., Anthony, L., Oghigian, K., & Uchibori, A. (2012). Paper-Based, Computer-Based, and Combined Data-Driven Learning Using a Web-Based Concordancer1. *Language Education in Asia*, 3, 132–145. Retrieved from http://hanamizuki2010.sakura.ne.jp/public_html/data/LEiA_V3_I2_02_Chujo_et_al_Paper_Computer_and_Combined_DDL.pdf
- Chujo, K., & Oghigian, K. (2008). A DDL approach to learning noun and verb phrases in the beginner level EFL classroom. In A. Frankenberg-Garcia (Ed.), *Proceedings of the 8th Teaching and Language Corpora Conference* (pp. 65–71). Lisbon, Portugal: Associação de Estudos e de Investigação Científica do ISLA-Lisbo Fichier.
- Chujo, K., Oghigian, K., & Akasegawa, S. (2015). A corpus and grammatical browsing system for remedial EFL learners. In A. Leńko-Szymańska & A. Boulton (Eds.), *Multiple*

Affordances of Language Corpora for Data-driven Learning (pp. 109–128).

doi:10.1075/scl.69.06chu

Cobb, T., & Boulton, A. (2015). Classroom applications of corpus analysis. In D. Biber & R.

Reppen (Eds.), *The Cambridge handbook of corpus linguistics*. Cambridge (pp. 478–497).

Cambridge: Cambridge University Press.

Cohen, A. D., Oxford, R. L., & Chi, J. C. (2006). Learning style survey: Assessing your learning

styles. In A. D. Cohen & S. J. Weaver (Eds.), *Styles and strategies-based instruction: A*

teachers' guide (pp. 15–21). Minneapolis, MN: Center for Advanced Research on Language

Acquisition, University of Minnesota.

Cresswell, A. (2007). Getting to “know” connectors? evaluating data-driven learning in a writing

skills course. *Language and Computers*, 61, 267–287. Retrieved from

<http://core.kmi.open.ac.uk/download/pdf/11070142.pdf>

Cronbach, L. J., & Snow, R. E. (1977). *Aptitudes and instructional methods*. New York, NY:

Irvington.

Daskalovska, N. (2015). Corpus-based versus traditional learning of collocations. *Computer*

Assisted Language Learning, 28, 130–144. doi:10.1080/09588221.2013.803982

Dimitrov, D. M., & Rumrill, P. D. (2003). Pretest-posttest designs and measurement of change.

Work (Reading, Mass.), 20, 159–65. Retrieved from

<http://www.ncbi.nlm.nih.gov/pubmed/12671209>

Dörnyei, Z. (2007). *Research methods in applied linguistics: Quantitative, qualitative, and mixed*

methodologies. Oxford University Press.

Dörnyei, Z., & Ryan, S. (2015). *The psychology of the language learner revisited*. New York,

NY: Routledge.

- Educational Testing Service. (2013). Mapping the TOEIC and TOEIC Bridge tests on the common european framework of reference for languages. Retrieved from http://www.ets.org/s/toEIC/pdf/toEIC_cef_mapping_flyer.pdf
- Flowerdew, J. (1996). Concordancing in language learning. In M. Pennington (Ed.), *The power of CALL* (pp. 97–113). Houston, TX: Athelstan.
- Flowerdew, L. (2008). Corpus linguistics for academic literacies mediated through discussion activities. In D. Belcher & A. Hirvela (Eds.), *The oral-literate connection: Perspectives on L2 speaking, writing and other media interactions* (pp. 268–287). Ann Arbor, MI: University of Michigan Press.
- Flowerdew, L. (2009). Applying corpus linguistics to pedagogy: A critical evaluation. *International Journal of Corpus Linguistics*, 14, 393–417. doi:10.1075/ijcl.14.3.05flo
- Flowerdew, L. (2012). *Corpora and language education*. Basingstoke, England: Palgrave Macmillan.
- Gabrielatos, C. (2005). Corpora and language teaching: Just a fling or wedding bells. *TESL-EJ*, 8, 1–35.
- Gaskell, D., & Cobb, T. (2004). Can learners use concordance feedback for writing errors? *System*, 32, 301–319. doi:10.1016/j.system.2004.04.001
- Gilquin, G., & Granger, S. (2010). How can DDL be used in language teaching? In A. O’Keeffe & M. McCarthy (Eds.), *The Routledge handbook of corpus linguistics* (pp. 359–369). London, England: Routledge.
- Huang, Z. (2014). The effects of paper-based DDL on the acquisition of lexico-grammatical patterns in L2 writing. *ReCALL*, 26, 163–183. doi:10.1017/S0958344014000020

- Hwu, F., & Sun, S. (2012). The aptitude-treatment interaction effects on the learning of grammar rules. *System*, *40*, 505–521. doi:10.1016/j.system.2012.10.009
- Johns, T. (1991). From print out to handout: Grammar and vocabulary teaching in the context of data-driven learning. In T. Johns & P. King (Eds.), *ELR Journal 4: Classroom Concordancing* (pp. 27–46). Birmingham: University of Birmingham.
- Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). New York, NY: Guilford.
- Larson-Hall, J. (2016). *A guide to doing statistics in second language research using SPSS and R* (2nd ed.). New York, NY: Routledge.
- Larson-Hall, J., & Plonsky, L. (2015). Reporting and interpreting quantitative research findings: What gets reported and recommendations for the field. *Language Learning*, *65*, 127–159. doi:10.1111/lang.12115
- Lee, B. (2015). EFL learners' perspectives on ELT materials evaluation relative to learning styles. *RELC Journal*, *46*, 147–163. doi:10.1177/0033688214564177
- Lee, C., Yeung, A. S., & Ip, T. (2016). Use of computer technology for english language learning: Do learning styles, gender, and age matter? *Computer Assisted Language Learning*. doi:10.1080/09588221.2016.1140655
- Lee, C.-Y., & Liou, H.-C. (2003). A study of using web concordancing for English vocabulary learning in a Taiwanese high school context. *English Teaching and Learning*, *27*, 35–56.
- Lethaby, C., & Harries, P. (2016). Learning styles and teacher training: Are we perpetuating neuromyths? *ELT Journal*, *70*, 16–27. doi:10.1093/elt/ccv051
- Lewis, J. (2006). Connecting corpora to learner style: To what extent is the effectiveness of an online corpus-based approach to grammar learning dependent on whether students prefer to

- learn grammar deductively or inductively? *Unpublished Master's Dissertation*. Retrieved from http://www.fc.up.pt/fcup/contactos/teses/t_020370029.pdf
- Lin, M. H., & Lee, J.-Y. (2015). Data-driven learning: Changing the teaching of grammar in EFL classes. *ELT Journal*. doi:10.1093/elt/ccv010
- Marsden, E., Mackey, A., & Plonsky, L. (2016). The IRIS repository: Advancing research practice and methodology. In A. Mackey & E. Marsden (Eds.), *Advancing methodology and practice: The IRIS repository of instruments for research into second languages* (pp. 1–21). New York, NY: Routledge.
- Mizumoto, A., Chujo, K., & Yokota, K. (2016). Development of a scale to measure learners' perceived preferences and benefits of data-driven learning. *ReCALL*, 28, 227–246. doi:10.1017/S0958344015000208
- O'Keeffe, A., McCarthy, M., & Carter, R. (2007). *From corpus to classroom: Language use and language teaching*. Cambridge University Press.
- O'Sullivan, Í. (2007). Enhancing a process-oriented approach to literacy and language learning: The role of corpus consultation literacy. *ReCALL*, 19, 269. doi:10.1017/S095834400700033X
- Oxford, R. L., & Lee, K. R. (2007). L2 grammar strategies: The second cinderella and beyond. In A. D. Cohen & E. Macaro (Eds.), *Language learner strategies: 30 years of research and practice* (pp. 117–139). Oxford, England: Oxford University Press.
- Pintrich, P. R., Smith, D. A. F., Garcia, T., & Mckeachie, W. J. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement*, 53, 801–813. doi:10.1177/0013164493053003024

- R Core Team. (2015). R: A language and environment for statistical computing [Computer Software]. Vienna, Austria. Retrieved from <http://www.r-project.org/>
- Reid, J. M. (1995). *Learning styles in the ESL/EFL classroom*. New York, NY: Heinle.
- Römer, U. (2011). Corpus research applications in second language teaching. *Annual Review of Applied Linguistics*, 31, 205–225. doi:doi:10.1017/S0267190511000055
- Rosseel, Y. (2012). Lavaan: an R package for structural equation modeling. *Journal of Statistical Software*, 48, 1–36. Retrieved from <http://www.jstatsoft.org/v48/i02/>
- Scott, M., & Tribble, C. (2006). *Textual patterns: Key words and corpus analysis in language education*. Amsterdam, the Netherlands: John Benjamins.
- Sha, G. (2010). Using Google as a super corpus to drive written language learning: A comparison with the British National Corpus. *Computer Assisted Language Learning*, 23, 377–393. doi:10.1080/09588221.2010.514576
- Sinclair, J. M. (Ed.). (2004). *How to use corpora in language teaching*. Amsterdam/Philadelphia: John Benjamins.
- Smart, J. (2014). The role of guided induction in paper-based data-driven learning. *ReCALL*, 26, 184–201. doi:10.1017/S0958344014000081
- Taylor, L., & Barker, F. (2008). Using corpora for language assessment. In E. Shohamy & N. H. Hornberger (Eds.), *Encyclopedia of language and education, Volume 7: Language testing and assessment* (2nd ed., pp. 241–2). New York, NY: Springer.
- Tono, Y., & Negishi, M. (2012). The CEFR-J: Adapting the CEFR for English language teaching in Japan. *Framework & Language Portfolio (FLP) SIG Newsletter*, 8, 5–12. Retrieved from http://www.tufs.ac.jp/ts/personal/tonolab/cefr-j/Tono%26Negishi2012forJALT_FLPSIG.pdf

- Tribble, C. (2015). Teaching and language corpora: Perspectives from a personal journey. In A. Leńko-Szymańska & A. Boulton (Eds.), *Multiple affordances of language corpora for data-driven learning* (pp. 37–62). Amsterdam, the Netherlands: John Benjamins.
- Utiyama, M., & Isahara, H. (2003). Reliable measures for aligning Japanese-English news articles and sentences. In *Proceedings of the 41st Annual Meeting of the Association for Computational Linguistics* (pp. 72–79). Sapporo, Japan: The Association for Computational Linguistics. Retrieved from <http://acl.ldc.upenn.edu/acl2003/main/index.html>
- Yoon, C. (2011). Concordancing in L2 writing class: An overview of research and issues. *Journal of English for Academic Purposes, 10*, 130–139. doi:10.1016/j.jeap.2011.03.003
- Yoon, H., & Jo, J. W. (2014). Direct and indirect access to corpora: An exploratory case study comparing students' error correction and learning strategy use in L2 writing. *Language Learning & Technology, 18*, 96–117. Retrieved from <http://llt.msu.edu/issues/february2014/yoonyjo.pdf>
- Zou, G. Y. (2007). Toward using confidence intervals to compare correlations. *Psychological Methods, 12*, 399–413. doi:10.1037/1082-989X.12.4.399