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The Effect of Data-driven Learning & Image-schema-based Polysemy Networks Instruction on Learning Spatial Prepositions of Verticality: The Case of Moroccan EFL Learners

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A B S T R A C T

This paper reports on a quasi-experimental study investigating the effects of a teaching methodology that combines Cognitive Linguistics (CL) and Corpus Linguistics (CrpL) insights on the acquisition of the two sets of English spatial prepositions of verticality, over/above and under/below. In addition, it is also concerned with learners' attitudes towards the method of instruction. A total of 55 Moroccan first-year university students participated in this study, 22 of which were assigned to the experimental group, and 26 to the control group. The experimental group received what we termed the IPDDL instruction, which involves cognitive representations of the prepositions based on Image-schemas, the Principled Polysemy model, and Data-Driven Learning. The control group, in contrast, received a traditional instruction based on definitions and example sentences provided in dictionaries. Participants' performance was measured with pre-, post-, and delayed post-tests in the form of a semantic judgment task and a gap-filling task. The findings demonstrate that the IPDDL method of instruction was significantly more effective in helping students acquire vertical prepositions, and its advantages proved durable posterior to two weeks of the instruction period. Thus, this study lends support to the applicability of a CL-CrpL-inspired methodology in second language instruction.

I. INTRODUCTION

Manifold are the possible ways in which the spatial world can conceivably be apportioned and described. Such descriptions permeate the human journey considering their manifestations in a wide range of contexts, from locating objects in space to reflecting knowledge acquired through terrene interactions, and ultimately to reasoning about the world (Coventry, 2004). For example, spatial terms such as *up* and *down* can be used to describe the position of entities in space, which could be extrapolated through the spatial interaction and

experience with the world to further refer to a state of being (e.g., I feel down). On such grounds, discerning how these locative expressions are used and understood proves to be a thorny issue. Moreover, compared to the myriad of possible meanings that could be entertained, prepositional forms are very limited in number, and each preposition expresses, of necessity, a wide range of meanings (Lam, 2009). In addition to their tremendous semantic potential and diverse collocational properties, English prepositions participate in an array of morphosyntactic constructions, rendering them a notoriously difficult aspect to learn for L2 learners.

With no generalizations emerging, the common strategy employed is the learning of fixed and relatively isolated structures, rather than flexible items within an associated cognitive structure in which new information is linked to the previous knowledge (Ausubel, 1968, 2000). Another compelling aspect of prepositions is echoed in the differences in use across languages, which sprout from the distinctness of peoples' perception and conception of space reflected in their peculiar use of spatial lexis, namely prepositions (e.g., Brugman, 1983; Hill, 1982). Consequently, they seldom have perfect equivalents in other languages. For instance, the English front in 'the front of the tree' designates the part of the tree facing the observer, while in Hausa it refers to its other side (Hill, 1982). For second language learners, such cross-linguistic differences may impinge on the interpretation and use of prepositions.

Many approaches to lexical semantics for spatial terms have attempted to capture their meaning without adequate consideration of how language is grounded in the nature of recurrent, everyday experiences and observations of the world (Evans & Tyler, 2005; Kemmerer 2005; Rocca, et al. 2019). Traditional accounts have asserted that the semantics of English prepositions are, to a large extent, arbitrary, and difficult to characterize. In other words, the coding of different senses by the same linguistic form (e.g., over) is presumably coincidental. They are treated as unrelated homonyms, much like the form bank is arbitrarily associated with both 'the sides of a river' and 'a type of a financial institution'. Such a position has many ramifications as to the theories of word meaning and sentential meaning construction, and ultimately, this has crucial implications as to the theories of language learning and teaching. Pedagogical treatments under this paradigm have often resorted to rote learning as the best strategy to teach the multiple senses of spatial prepositions (Gvarishvili, 2013).

While many linguists would argue that this approach has been fruitful in modeling the structural aspects of language, they also recognize that it suffers from several problems, one of which resides in the daily usage of language which cannot be simply accounted for by the proposed rules, particularly in contexts where more than one preposition is

possible (Matula, 2007). Per contra, Cognitive Linguistics (henceforth CL) offers an alternative prospect in which prepositions are treated as polysemous words, that is to say, that the distinct senses associated with a given preposition are motivated, and related in systematic and principled ways. It proposes that the differences in expressing spatial relations across different languages can be accounted for in a non-arbitrary fashion (Lakoff, 1987; Tyler & Evans, 2004, Fillmore & Baker, 2010). In its investigation of the relationship between language, the mind, and socio-physical experiences, CL advances a prolific account for understanding the usage of prepositions, leading to systematization and linkage of their multiple senses. Such insights could yield an important impact on the methodologies of second language teaching and learning.

The purpose of this study is to present the findings of an experimental study developed, to a large extent, based on a CL-inspired approach to teaching spatial prepositions. The premise is to evaluate the effects of a new pathway to teaching spatial prepositions that combine pedagogical implications of CL-methodology, namely the use of image-schema transformations, along with the Principled Polysemy (PP) model of English prepositions proposed by Tyler and Evans (2003). The latter succeeds in uncovering the motivation behind previously random-looking groupings of meanings and sheds light on the mechanisms of meaning change and meaning extension, which have been overlooked in traditional accounts and pedagogical treatments.

In conjunction with Cognitive Linguistic insights, it is also imperative to accentuate usage-based and contextualized instruction as one cannot acquire the semantic motivations underlying the various senses of spatial prepositions without a dive into the environment in which they occur. As such, this study postulates the incorporation of Corpus Linguistic (henceforth CrpL) prospects through the use of corpora in the form of data-driven learning (henceforth DDL) (Johns, 1994), because they offer a greater terrain of exploration and apperception of the relations among different uses of a particular word, and the phraseological patterns associated with its senses (Boers & Lindstromberg, 2008, Chen et al., 2019; Lee & Lin, 2019; Romer, 2011).

The study sought to investigate the effectiveness of the IPDDL method in helping students learn how to use vertical prepositions compared to the TRAD method. In addition, the paper investigates the extent to which the effects of the IPDDL instructional method will prove durable posterior to two weeks of instruction. Finally, students' attitudes towards IPDDL-based instruction are explored (Kilimci, 2017; Song, et al., 2015; Tyler, et al., 2011; Tyler, 2010).

II. METHODS

2.1. Research Design

The present study adopted a non-randomized control group, pretest-posttest design, which is defined as a quasi-experimental design that assigns identifiable groups of individuals (intact groups) to the intervention or comparison condition in some non-random way. Matching was used to control for the lack of randomization—the researcher selected groups that are as similar as possible on all important variables that may affect the outcomes of the study.

Additionally, there were no statistically significant differences in the pretest, which denotes a greater degree of pre-experimental equivalency. Thus, we could discount selection bias as a threat to internal validity and proceed with the study. Altogether, this study employed (for each group) a pre-test, two instructional treatments, two immediate post-tests, and a delayed post-test along with a questionnaire to answer the research queries. The experimental group received a CL-inspired instruction (IPDDL) that utilizes image-schemas and the Polysemy Model of the two sets of English spatial particles of verticality, in conjunction with a corpus as learning resources. The control group received a traditional instruction (TRAD) based on two online dictionaries (Cambridge and Oxford Online Dictionaries). Seeing that both programs were delivered in English as a medium of instruction, the intervention was conducted in the English language only.

2.2. Participants

A total of 55 Moroccan first-year university students participated in this study. All the students major in

English and pursue the same university program; Bachelor of Education (CLE), rendering them potential candidates for teacher training colleges or for master programs in the country or abroad. Moreover, all the informants have been studying English as a compulsory subject for at least 6 years ($M=6.09$, $SD=2.48$). On account of the unfeasibility of administering a proficiency test, the researcher used the academic level of the participants as an indicator of their proficiency level, as every one of them was selected based on their Baccalaureate grades (i.e. grades obtained in English classes) and their performance in the admission interview to enroll in the CLE program.

The students who did not complete the tasks, or did not attend the sessions were subtracted. The final sample (22 Experimental, and 26 Control) comprised 13 males and 35 females, the age of which ranged between 18 and 20 (100%).

2.3. The Corpus

The British National Corpus (BNC) was utilized during the IPDDL sessions, as well as for the construction of the tasks. Owing to the richness of BNC, which holds about 100-million-word assortment deriving out of a wide range of sources, performing a query on such a platform might be impending. Therefore, considering that the participants have never been acquainted with a corpus interface before, the researcher resorted to AntConc instead of a web-based corpus for its easy-to-use and intuitive interface. AntConc is a Unicode compliant freeware corpus analysis toolkit for concordance and text analysis, developed by Laurence Anthony of Waseda University, Japan.

2.4. Data Collection Procedures

The intervention was carried out over two weeks by the researcher as the classroom instructor. The TRAD sessions involved the instruction of the various meanings and uses of the target prepositions through definitions and example sentences provided by two online dictionaries, namely Cambridge and Oxford Online Dictionaries. However, only the meanings addressed in the polysemy networks adopted in the study were included to guarantee that both groups were introduced to the same items. Conversely, the IPDDL sessions entailed the use of non-technical cognitive explanations of the senses entertained by the concerned vertical prepositions

using the image-schema-based polysemy networks. The latter represented the distinct senses of each preposition as radiating from a proto-scene in a related manner. In addition, the experimental group engaged in a data-driven-learning activity whereby they consulted the constructed corpus via AntConc to investigate the multiple meanings and uses of the prepositions in various contexts. Immediately after each treatment, both groups completed the relevant post-test (either *over/above*, or *under/below* tests). Two weeks after the experimental implementation stage, each group was delivered a delayed post-test. After the delayed post-test, questionnaires were given to the experimental group to evaluate the IPDDL method of instruction. The following table summarizes the experimental procedure.

III. RESULTS

The present section unfolds the results obtained from the statistical analyses we conducted on the collected data. In addition to descriptive statistics, independent-samples t-tests and one-way ANOVAs were employed. For all analyses, the alpha level was set at $p < .05$.

3.1 Pre-treatment analysis

The overall pretest results show that the scores of both the IPDDL group and the TRAD group were approximately the same. In order to investigate the significance of the findings, an independent samples T-test was conducted. Normality of the distribution was tested beforehand using the Shapiro-Wilk test of normality. The reported results indicated that the data is normally distributed for both the pretest scores of the experimental group ($W = .964$, $p = .586$), and the control group ($W = .976$, $p = .789$). Levene's test for equality of variances showed a non-significant difference, thus equal variances were assumed. The independent samples t-test revealed no significant difference between the IPDDL and TRAD groups, $t(46) = .107$, $p = 0.915$. Therefore, we conclude that there is no significant difference in the overall knowledge of the English prepositions of verticality among the sample groups. Stated differently, the two groups were comparable in their performance before receiving the treatments.

3.2. Between-group analysis

An independent samples t-test was conducted for the pre-, post-delayed post-test results to investigate the between-group difference in terms of the effect of instruction.

The independent t-test conducted on the post-test scores between the experimental ($M = 36.63$) and the control group ($M = 32.73$) indicated a statistically significant in favor of the experimental group, $t(46) = 2.605$, $p = .012$. The strength of the relationship, as indexed by eta squared, was $\eta^2 = 0.13$. This suggests that 13% of the variance can be accounted for by the independent variable. Therefore, the null hypothesis of no significant differences between the IPDDL and TRAD groups in learning vertical prepositions is rejected.

Similarly, an independent t-test was conducted on the delayed post-test scores between the experimental ($M = 35.09$) and the control group ($M = 32.65$). The results indicated a non-statistically significant difference between the groups, $t(46) = 1.504$, $p = .139$.

3.3. Within-group analysis

To investigate the significance of the within-group differences regarding the effect of the instructional treatments on each groups' performance, the one-way ANOVA test was conducted on the control and the experimental data.

First, the assumption of homogeneity of variances was tested and satisfied based on Levene's F test, $F(2,63) = .444$, $p = .643$. Afterward, a one-way ANOVA was conducted to compare the effect of the IPDDL method of instruction on the performance scores of the experimental group in the pre-, post-, and delayed post-tests. The results yielded a statistically significant effect, $F(2,63) = 9.381$, $p = .000$. The strength of the relationship, as indexed by eta squared partial, was $\eta^2_{\text{partial}} = 0.22$. Thus, 22% of the variance could be accounted for by the independent variable. To further explore where the differences occurred, posthoc comparisons using the Tukey HSD test were conducted. Tukey revealed that the mean score for the post-test ($M = 36.63$, $SD = 4.655$) was significantly different than the pre-test ($M = 30.86$, $SD = 4.234$). However, the delayed post-test condition ($M = 35.09$, $SD = 4.819$) did not significantly differ from the post-test condition.

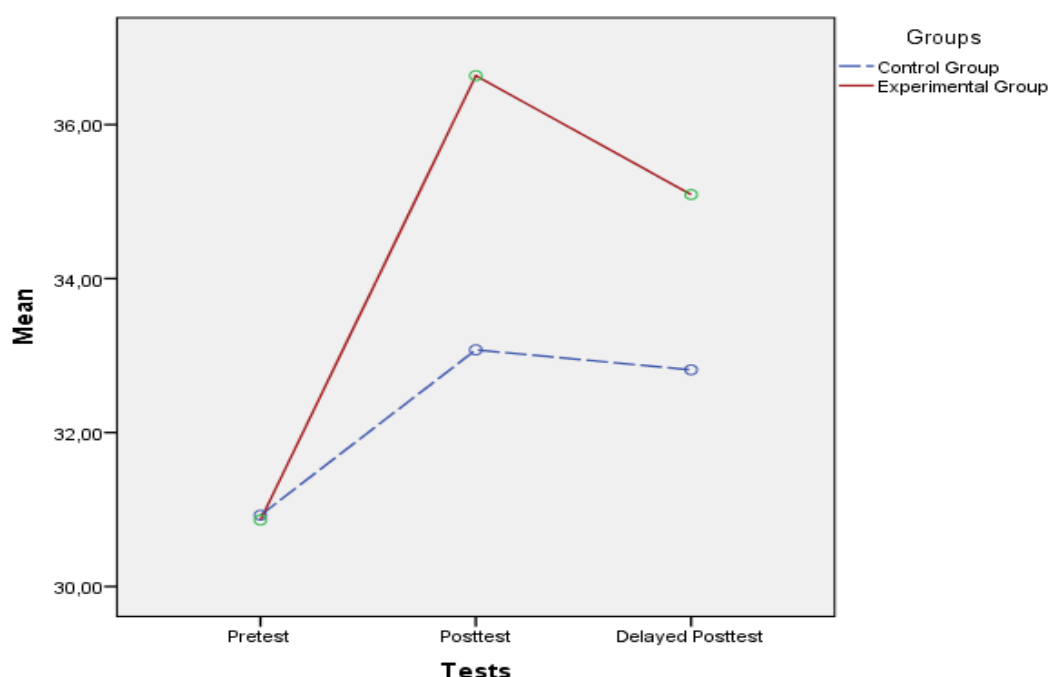


Fig.1. Comparison of group performance by pre-test, post-test, and delayed post-test.

This suggests that the positive trajectory is sustained to the delayed post-test stage, though a slight decrease in overall scores is evident. Therefore, the null hypothesis of no effect of the method on the retention of the target prepositions for two weeks is rejected.

Similarly, the assumption of homogeneity of variances was tested for the control group results and satisfied based on Levene's F test, $F(2,75) = .951$, $p = .391$. Furthermore, a one-way ANOVA was conducted to compare the effect of the TRAD method of instruction on the performance scores of the experimental group in the pre-, post-, and delayed post-tests. The results indicated a non-statistically significant effect, $F(2,75) = 1.140$, $p = .325$. Thus, no observable change in group performance was evident for the control group throughout the study period.

The results from the two different instructional interventions (TRAD versus IPDDL) indicated that IPDDL instruction was effective, as evidenced by the statistically significant improvement in students' scores over time. In addition, the effects of the IPDDL method on the acquisition of the target prepositions proved durable posterior to two weeks of the instruction period.

3.3. Questionnaire results

The follow-up survey addressed four aspects of students' attitudes towards the IPDDL method of instruction: (a) the perceived effects of polysemy networks on prepositions learning; (b) perceived effects of image-schemas on prepositions learning; (c) perceived effects of DDL on prepositions learning; and (d) perceived problems in using DDL activities.

Overall, the majority of the students perceived the IPDDL method as useful in learning the target prepositions of verticality. 97.35% of the students evaluated the image-schema-based polysemy networks as helpful resources for the acquisition of the senses of each preposition and for raising their awareness as to the differences associated with the intricate meanings of the target words. In addition, many expressed that such resources helped them retrieve the meaning of the various senses of the target words from memory. Furthermore, the use of polysemy networks was deemed more desirable than dictionary definitions and examples.

Despite the acclamations regarding the DDL activities, students expressed a different viewpoint. 84.2% of the students described DDL activities as effortful and conceded a difficulty in conducting corpus queries due to the cut-off sentences and

incomplete contexts. Additionally, 57.9% reported some difficulty in studying concordance lines due to unfamiliar vocabulary in the sentences. Despite the contrary, 57.9% of the responses revealed that students do not perceive DDL activities as time-consuming and boring.

IV. DISCUSSION

The effect of IPDDL on the acquisition of spatial particles

With respect to the first research question, findings indicate that both the IPDDL and TRAD groups benefited from the two types of instruction they were exposed to. However, the IPDDL group achieved significantly higher scores. These results suggest that the image-based polysemy data-driven learning approach was more effective in comparison to the traditional approach.

Our findings support the contention that learners will acquire extended meanings better than unrelated meanings, and further substantiate the advantages of a cognitive and corpus linguistics inspired instruction. It is important to note that the acquisition of spatial prepositions calls for the categorization of spatial relations in consonance with the spatial cognitive norms conventionalized in the language. Consequently, the learning of spatial particles in a second language requires a reconstruction of the spatial system in the cognitive schemata following the target language's categorization of spatial configurations, together with the language-specific conventions for mapping forms and meanings, and the communicative contexts that impact linguistic structures (Achard, 2004; Taylor, 1993). Such a process may not be evident using the memorization of a list of uses. Rather, learners can develop a greater awareness of, and uncover the motivations behind, the meaning chains associated with spatial prepositions through the conceptualization of prepositional uses as the product of general cognitive strategies (Lam, 2009).

In its conversion of image-schemas, principled polysemy networks, and data-driven learning, the IPDDL method offers a prolific and systematic foundation for the acquisition of spatial prepositions. It abridges significantly the amount of arbitrariness traditionally associated with

spatial prepositions. Consequently, it reduces the need for rote learning on the part of the second language learner. Moreover, the representation of the senses as systematically connected gestalt-like scenes and graphic illustrations proved useful for both the language teacher and the second language learner. Furthermore, "the model draws heavily on the notion of the experiential basis of meaning and represents the extended senses as arising from observations of the external, spatio-physical world, it reflects the learners' own experiences with the world" (Evans & Tyler, 2004). Thus, by virtue of its provision of a coherent fundament derived from their own observations of the world, it allows learners to infer the meanings of unfamiliar uses of prepositions. This is accentuated as well through the integration of corpus activities through the data-driven learning approach, which emphasizes learners' exploratory and discovery learning.

The cognitive explanations were further exploited in the investigation of concordance lines. This helped learners discover the lexical collocations and prepositional colligations associated with the target words. As explained in the Methodology chapter, the study employed a constructed corpus imported through AntConc, instead of the use of a full web-based BNC corpus, intending to ensure a centralized investigation and obviate a wild-goose chase and frustration. The findings indicate that IPDDL can be an effective alternative in the acquisition of spatial prepositions.

Conversely, the control group showed insignificant gains from their exposure to the traditional method. This could be attributed to insensitivity towards this kind of instruction as they had experienced similarly learning the target prepositions before. However, it could also be attributed to the nature of the instruction, which includes dictionary definitions and examples, and relied mainly on rote learning techniques. Such a method precludes an effort to integrate new knowledge with relevant prior knowledge held in cognitive structures (cf. Ausubel, 2000). Furthermore, it lacks a comprehensive analysis of the different senses of prepositions and causes unstable learners' improvements (Cho, 2010). Therefore, the TRAD group were arguably not able to recall all the senses that had been taught.

The effect of IPDDL on retention of spatial particles

Concerning the second research question, the findings indicate that the IPDDL treatment gains proved durable after two weeks of the period of instruction. That is, the positive trajectory was sustained to the delayed post-test stage, though a slight decrease in overall scores was evident.

This is congruous with conclusions drawn from studies in cognitive psychology. These demonstrate that the retrieval of information is facilitated when there is an organizing structure that establishes a relationship among the items, given that such a systematic structure can provide alternative routes that instigate the information desired. Therefore, calling attention to the complex form–meaning mappings associated with prepositions may contribute to their retention and recovery, and lead to meaningful and more successful learning.

Nevertheless, the analysis of the delayed post-tests of the experimental and control groups did not yield significant results. These contradictory findings could be an indication that the very limited treatment time (one hour per week for two weeks) was arguably far from sufficient to establish long-term learning. Thus, an increase in treatment duration could yield better results. An alternative interpretation of these findings could be attributable to the effect of L1 (conceptual) interference on L2 learning of spatial prepositions since languages differ significantly in the way they carve up and classify spatial configurations.

In addition, first languages are often woven, cognitively entrenched, and more frequent in comparison to second languages. For this reason, the influence of L1-specific patterns of mental constructions, and expressions that bilinguals are routinely exposed to in the dominant language prevails. Thus, being more substantiated, L1 patterns of conceptualization may resurface while using the second language. Subsequently, a longer period of instruction is needed to reinforce L2 spatial conceptualizations and construals of the various senses entertained by English spatial prepositions of verticality.

Learners' attitudes towards IPDDL

The results concerning the effects of the IPDDL method were reinforced with insights from the qualitative data elicited through participants' responses to questionnaires that targeted perceptions and attitudes towards the method. As reflected in the questionnaire, the experimental group perceived the IPDDL method as helpful for the acquisition of English spatial prepositions of verticality.

Overall, the DDL activities were evaluated, in general, as instrumental assets for acquiring the targeted prepositions of verticality (i.e., learning meaning, collocation, and usage patterns of words). This aligns with previous research (e.g., Boulton, 2010), which asserts that DDL can be an effective approach in helping learners discover and retain lexico-grammatical patterns. In addition, DDL activities pave the way for a usage-based learning approach, which fosters exemplar-based learning and increase students' generation, and retention, of more accurate patterns.

Notwithstanding the acclamations, the nature of corpus exploration can pose difficulties to novice DDL learners as attested in many DDL-based studies. For instance, the technical knowledge required, the cut-off sentences as well as the unfamiliarity of vocabulary encountered in the concordance lines may be problematic, but not insurmountable. These issues were accounted for in so far as possible through the use of a constructed corpus imported in AntConc instead of the complete British National Corpus. As per Boers and Lindstromberg's (2008) suggestion, constructing a corpus through the selection of the concordance lines beforehand may control for the complexity of the vocabulary that learners will be exposed to, and thus it can reduce the unnecessary cognitive load that may impinge on their learning as well as spare them from what may become a time-consuming and laborious task. Furthermore, AntConc offers a user-friendly interface that requires very little maneuvers to operate. Moreover, it allows users to expand the concordance lines to reveal more words as desired. Still, 64.51% of the responses indicated that the difficulties were present regardless. For these reasons, a more meticulous DDL method is in order.

V. CONCLUSION

In broad outline, the study sought to investigate three issues: whether the IPDDL method was more effective a method in helping students learn how to use vertical prepositions compared to the traditional method which relied on dictionary definitions and examples; and whether the IPDDL effects proved durable posterior to two weeks of instruction. The study suggests that IPDDL significantly more effective in helping students acquire vertical prepositions. Moreover, the results indicated that IPDDL's advantages proved durable posterior to two weeks of the instruction period. However, it should be kept in mind that these results need further verification; we concluded that the time allocated to the treatment was not sufficient to assert the effects of the method on retention. Furthermore, a substantial number of students

experienced some difficulty with regards to the DDL activities. Hence, we call for the development of a more rigorous DDL implementation method.

At large, English prepositions have long posed a perennial challenge for second language learners and language teachers alike, as attested in several studies related to the teaching and learning of prepositions (Boquist 2009). The reasons are multifold. We presume that much of the plight is attributed to the lack of importance devoted to prepositions in ELT coursebooks, though they play a prominent role in language use. This is further aggrandized through the unsystematic descriptions adopted in learning resources. Thus, a CL-CrpL approach may supply a usage-based and contextualized instruction, as well as a more adequate and systematic framework of English spatial particles for EFL/ESL teachers and learners.

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