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Original Research

The role of language transfer in Arabic-speaking EFL learners' comprehension of scope ambiguity in doubly quantified sentences

by Dana Makhlouf[1], Aseel Zibin[1,2] and Abdel Rahman Mitib Altakhaineh[1]

[1]The University of Jordan, Amman, Jordan
[2]Applied Science Private University, Amman, Jordan

This study examines the influence of language transfer on Arabic-speaking EFL learners' understanding of quantifier scope ambiguity and the impact of their first language on resolving three types of doubly quantified sentences. Fifty English literature and applied English students from the University of Jordan participated, split into two groups: 25 with medium proficiency and 25 with advanced proficiency. A 14-item test with doubly quantified sentences and static pictures assessed how English proficiency influences comprehension of scope ambiguity across three patterns: numerical, universal, and existential quantifier sentences. Results indicated that higher proficiency participants better understood existential quantifier sentences, which are more complex. However, proficiency did not significantly affect comprehension of universal or numerical sentences. Numerical sentences were the most challenging due to ambiguity in linking numbers and objects, while universal sentences were easier due to their predictable meaning. In line with language transfer theory, the data analysis suggests that L1 syntactic structures influence the processing of doubly quantified sentences, with participants exhibiting tendencies to favour interpretations aligning with familiar L1 patterns. The study concludes that language transfer plays an important role in the accurate identification of scope ambiguity interpretations, particularly when L2 structures diverge from L1 norms, and provides recommendations for future research.

KEYWORDS: *psycholinguistics, scope ambiguity, doubly quantified sentences, Arabic-speaking EFL learners, language transfer*

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1. INTRODUCTION

Quantifier scope refers to the extent to which a quantifier (such as *all, some, none,* or *every*) applies within a sentence (Scontras et al., 2017). In sentences with multiple quantifiers, their interactions can lead to different interpretations (May, 1977). Quantifier scope ambiguity occurs when a quantifier's influence within a sentence is unclear, affecting which parts it applies to (Marsden, 2024). This is important for processing and

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'Several factors contribute to the difficulty of comprehending quantifier scope ambiguity for EFL learners. Variations in grammatical structures and the lack of exposure to ambiguous sentences in English affect the development of strategies necessary to understand such ambiguities. Furthermore, proficiency in English grammar also plays a role, as learners may find it difficult to recognise grammatical signals indicating quantifier scope'

interpreting sentences with complex quantificational structures. Doubly quantified sentences use two quantifiers (e.g., *every* and *a*, or *three* and *five*) to clarify the scope and relationships between elements. This ambiguity is challenging for English as a Foreign Language (EFL) learners, especially those whose native languages differ structurally from English (Zibin et al., 2024). It leads to different interpretations arising from various potential arrangements of quantifiers, possibly influenced by their first language (L1).

An example of a sentence containing two quantifiers is *Every student has a favourite subject*. This clause can be interpreted in two different ways. On the surface reading, it means that each student has some subject they enjoy, though these subjects may differ from one student to another, which corresponds to the distributive interpretation. On the inverse reading, it means that there exists one particular subject that every student is passionate about, which corresponds to the collective interpretation.

Doubly quantified scope ambiguity arises when the order of two quantifiers (e.g., universal and existential) can lead to different interpretations. The surface reading is the one where the quantifiers are interpreted in the order they appear in the sentence. The inverse reading is the one where the quantifiers are interpreted in the reverse order (Scontras et al., 2017). According to the first interpretation, all students have a favourite subject because the quantifier *every* has a wider range and applies to the entire sentence. Thus, every student has a subject they are passionate about, and that subject may not necessarily be the same. In the second reading, the quantifier *some* takes precedence and suggests that all students are passionate about one subject in particular.

Several factors contribute to the difficulty of comprehending quantifier scope ambiguity for EFL learners. Variations in grammatical structures and the lack of exposure to ambiguous sentences in English affect the development of strategies necessary to understand such ambiguities. Furthermore, proficiency in English grammar also plays a role, as learners may find it difficult to recognise grammatical signals indicating quantifier scope (Saba & Corriveau, 2001). However, an important factor which should be explored is the influence of language transfer (Odlin, 2022). The syntactic structures and quantifier usage patterns of a learner's L1 can affect their interpretation of quantifier scope ambiguity in English. Research has explored general difficulties in L2 quantifier scope comprehension (Chung & Shin, 2023), but there is a gap in understanding how specific L1 structures interact with English to create unique challenges for learners from different linguistic backgrounds. Thus, this study explores the ability of Arabic-speaking EFL learners to comprehend doubly quantified sentences and examines the impact of their first language on this comprehension. It aims to answer the following questions:

1. To what extent can Arabic-speaking EFL learners comprehend three patterns of doubly quantified sentences (i.e., universal quantifier sentences, existential quantifier sentences and numerical sentences)?

2. To what extent does the participants' English proficiency level affect their ability to comprehend these sentences?

3. In the light of language transfer (Odlin, 2022), to what extent does the participants' first language affect their comprehension of the three patterns of doubly quantified sentences in English?

2. THEORETICAL BACKGROUND

2.1. Language transfer effects

Language transfer, also known as language interference, describes the different ways in which a learner's L1 influences their acquisition and use of L2 (Dangzeng, 2021). This influence, as Lado (1957) theorised, can be either beneficial, accelerating learning when L1 and L2 structures align (positive transfer), or detrimental, leading to errors when they diverge (negative transfer) (Yang, 2019; Puig-Mayenco et al., 2020; Liang, 2024). The extent and nature of language transfer are governed by several factors, including the structural relationships between the languages themselves, the learner's proficiency, and their cognitive and developmental stage.

The transferability of linguistic features is a key principle. Positive transfer is facilitated by structural similarities. For example, Spanish speakers often benefit from cognates when learning English vocabulary (Kelley & Kohnert, 2012). Conversely, negative transfer often arises from structural differences, such as the tendency for Spanish speakers to omit subject pronouns in English due to the pro-drop nature of Spanish (Liceras & Díaz, 1999). Intralingual transfer, where learners misapply L2 rules, such as overgeneralising past tense forms (Pitkäranta, 2024), also contributes to the complexity of L2 learning. As Sasson et al. (2024) point out, this process involves a comparison of L1 and L2 knowledge, consciously or unconsciously adapting strategies and selectively transferring relevant L1 aspects to L2. In line with this, Zibin et al. (2024) noted that learners transfer could be restricted only to transfer relevant aspects of L1.

The relationship between the languages, often described as linguistic distance, is a critical determinant of transfer effects. Abdullaev (2021) observed that positive transfer is more likely when L1 and L2 share syntactic, phonological, or lexical properties, while negative transfer tends to arise from significant structural distance. Learner characteristics also play a crucial role.

'Importantly, language transfer is not unidirectional. Bidirectionality demonstrates that transfer can affect both L2 learning and L1 use, potentially leading to L1 attrition. Recognising the potential impact of language transfer in the theories of second language is essential. Understanding these effects can enhance language teaching by anticipating learner challenges, as well as informing how to address challenges stemming from language transfer'

Less proficient L2 learners tend to rely more heavily on their L1, leading to higher transfer rates and more frequent errors (Heydari & Bagheri, 2012). As proficiency increases, learners become more selective in their transfer, applying L1 features only when they align with L2 norms (Zibin et al., 2024). Age and cognitive development further influence these processes (Dey et al., 2024). Marinova-Todd et al. (2000, p. 26) suggest that *'older learners are more likely to maintain their L1 at a high level, whereas younger learners are more likely to switch to dominance or even monolingualism in the L2'.*

Importantly, language transfer is not unidirectional. Bidirectionality demonstrates that transfer can affect both L2 learning and L1 use, potentially leading to L1 attrition (Pavlenko & Jarvis, 2002). Recognising the potential impact of language transfer in the theories of second language is essential. Understanding these effects can enhance language teaching by anticipating learner challenges, as well as informing how to address challenges stemming from language transfer (Zibin et al., 2024).

Finally, transfer is not limited to grammatical structure or scope. Syntactic transfer manifests as L1 sentence structures influencing L2 syntax. Lexical transfer involves L1 vocabulary influencing L2 (Löhr, 2022); while cognates can aid learning, false cognates can lead to confusion (Otwinowska & Szewczyk, 2019). Pragmatic transfer occurs when L1 cultural norms impact L2 communication, such as Arabic-speaking learners inappropriately overusing formal expressions in informal settings (Žegarac & Pennington, 2000).

Drawing on the above, the present study adopts language transfer theory to investigate how EFL learners process and interpret sentences with scope ambiguity arising from the interaction of multiple quantifiers. Taking into account that L1 syntactic structures can influence L2 sentence processing, as argued by prior research (Zibin et al., 2024), this study explores whether learners' native language patterns affect their ability to identify the intended meanings of doubly quantified sentences, particularly when L2 surface structures are different from L1 norms.

2.2. Previous studies

Fortuny and Payrató (2023) emphasise that linguistic ambiguity arises when an expression can be analysed in multiple ways at a given level of linguistic representation, referencing key works in the field. The study also explores the interaction between ambiguity and related phenomena such as vagueness, reference transfer, and generality of sense, using examples to clarify these distinctions. The two researchers highlight the importance of empirical research in understanding how people process ambiguous sentences. In a recent study, Chung and Shin (2023) studied how L2 learners and L1 speakers interpret ambiguous sentences, especially those with negation and *every*. Both preferred less mentally taxing interpretations, with L2 learners favouring surface scope and L1 speakers considering context more. This suggests the need for personalised linguistic education and raises questions about cognitive processes in scope interpretation.

Scontras and Pearl (2021) investigated how children and adults resolve scope ambiguities, focusing on sentences where the meaning hinges on the order of quantifier and negation interpretations. Through computational cognitive modelling, the authors analyse truth-value judgment tasks to explore the interaction of grammatical processing and pragmatic factors. Their main finding is that pragmatic factors could be more influential than grammatical processing in explaining children's non-adult-like behaviour in resolving these ambiguities. Interestingly, the model suggests a qualitative similarity between child and adult ambiguity resolution, supporting a continuous developmental model where children do not mainly change their ambiguity resolution strategies but rather refine their application of pragmatic cues to achieve adult-like comprehension.

Furthermore, Apresjan's (2019) study focused on pragmatic factors in interpreting negation and quantifiers, revealing that both Russian and English speakers employ similar disambiguation strategies despite different syntactic structures. Lexical cues are crucial, with distinctions between verb-negated and quantifier-negated readings. In addition, Scontras et al. (2017) experimentally examine how speakers of English and Mandarin Chinese interpret doubly quantified sentences, which exhibit scope ambiguity in English but are claimed to be unambiguous in Mandarin. The study also investigates English-dominant heritage speakers of Mandarin to see how their interpretation of such sentences is affected in both languages. The authors use an acceptability-rating task with visual scenarios to assess the availability of inverse scope interpretations. They confirm that native English speakers generally allow inverse scope, while native Mandarin speakers resist it. They also found that heritage Mandarin speakers also resist inverse scope in Mandarin, suggesting a robustness to the prohibition on inverse scope, even when English is the dominant language. However, these heritage speakers show higher ratings for inverse scope compared to native Mandarin speakers. Interestingly, the English of these heritage Mandarin speakers also shows a resistance to inverse scope, leading the authors to suggest that heritage speakers may adopt a simpler, less ambiguous system for scope calculation. This study suggests that linguistic background influences ambiguity resolution (Kurtzman, & MacDonald, 1993).

Setiawan's (2014) research on ambiguity in EFL writing among 66 students showed that ambiguity leads to misunderstandings, advocating for educational strategies to enhance

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clarity. Kim's (2010) study on Korean EFL learners and native English speakers interpreting scope ambiguity showed that native speakers varied in interpretations, while EFL learners favoured broader scope readings, highlighting L1 transfer's influence on comprehension. In similar vein, Lee (2009) examined how native Korean speakers, native English speakers, and Korean-speaking L2 learners comprehend scope ambiguity. Results indicated that native Koreans negated the entire set, while English speakers' preferences varied, emphasising the role of language proficiency in comprehension.

Zhou (2008) criticised conventional methods on semantic scope, advocating for a broader understanding that includes all plausible interpretations. Using corpus analysis on negation-quantifier scope ambiguity, the study revealed more interpretations than expected and a significant correlation between common out-of-context phrases and corpus data prevalence. These findings stress the importance of acknowledging ambiguity and interpretation variability in semantic analyses, providing insights for language processing and theoretical linguistics.

Paterson et al. (2008) examined processing quantifier scope ambiguity, like in *Kelly showed a photo to each critic*, using eye-tracking technology to assess how grammatical roles, phrase order, and lexical features influence comprehension. Results demonstrated that these factors interact complexly, complicating sentence understanding. This research contributes to theories about processing difficulties and enhances our understanding of cognitive processes and language comprehension models.

Westerståhl's (2007) study questions the notion that scope ambiguities arise solely from structural ambiguities in language, suggesting they may stem from the sentences' inherent structures. Through examining quantifier scope, he explores meaning understanding and the principle of compositionality, which posits that complex meanings derive from simpler components (Altakhaineh, 2022). Westerståhl (2007) introduces 'relational semantics', acknowledging multiple meanings for phrases and words, aiming to refine compositionality while preserving its strengths. His findings promote a nuanced view of linguistic meaning that embraces complexity.

Villalta (2003) examines real-time resolution of quantifier scope ambiguities in *how many* questions with universally quantified subjects in English and French. Using self-paced reading tests and questionnaires, the study reveals that participants' scope preferences often contradict economy-based models due to contextual influences. It shows that context can delay the resolution of structural ambiguities, and comparisons between English and French demonstrate cross-linguistic processing variations, enhancing our understanding of semantic mechanisms and the role of context in semantic processing.

The current study on Arabic-speaking EFL learners' understanding of scope ambiguity in doubly quantified phrases differs from past research. Earlier studies examined types of ambiguity across various contexts and demographics, but this research specifically addresses how Arabic-speaking EFL learners comprehend quantifier scope ambiguity in English. Unlike previous studies that focused on written texts (Setiawan, 2014) or compared different language groups (Kim, 2010; Scontras et al., 2017), this study targets a specific learner community facing unique linguistic challenges. It uses visual stimuli to explore learners' understanding of three types of scope ambiguity and their difficulties in distinguishing between surface and inverse readings. Additionally, while other research has looked at L1 transfer's role in resolving ambiguities (Kim, 2010; Zibin et al., 2024), this study considers L1 effects in a foreign language context and offers insights for language education which are specific for Arabic-speaking EFL learners, contrasting with studies that only address theoretical implications (Westerståhl, 2007; Zhou, 2008).

3. MATERIAL AND METHODS

3.1. Participants

The study's participants were chosen purposively from among University of Jordan students, with a focus on those enrolled in programmes in English Literature and Applied English (Altakhaineh et al., 2024). We ensured that none of the participants is a native speaker of English, has a native speaker parent or lived in an English-speaking country for more than 6 months. The sample consist of 50 students (native speakers of Jordanian Arabic) in total, who were split into two groups according to their levels of English proficiency: 25 students with medium proficiency (GPA 3-3.5) and 25 students with advanced proficiency (GPA 3.6-4).

For the purposes of this study, English proficiency was determined based on Grade Point Average (GPA): 25 students with medium proficiency (GPA 3.0-3.5) and 25 students with advanced proficiency (GPA 3.6-4.0). We recognise that GPA, although it is available and indicative of overall academic success within English-related programmes at the University of Jordan, is not a direct or comprehensive measure of specific language skills such as grammar, speaking, reading, or listening. Ideally, standardised language proficiency tests like TOEFL, IELTS, or assessments in line with the Common European Framework of Reference (CEFR) provide more validated measures. However, using such tests would have increased the complexity of this initial investigation. Therefore, GPA was used as a practical and accessible proxy for overall English language competence within the context of the University's academic framework. We still acknowledge that this is as a limitation.

Since the nature of quantifier scope ambiguity necessitates a comprehension of English grammar to generate meaningful results, students with lesser levels of English proficiency were excluded from the study (Zibin, 2016). All participants were informed of the study's general goals and methods, and participation was entirely voluntary. This research project was approved by the Graduate Studies and Research Committee at the Department of English Language and Literature, the University of Jordan on 4/12/2024 Each participant gave their informed consent after being made fully aware of their rights, which included the freedom to discontinue participation at any time without

facing any repercussions. All data was collected and kept private in accordance with ethical guidelines. All publications and reports contained anonymised identifiable information. This strategy made sure that the participants' rights and privacy were respected, adhering to the ethical standards set forth for studies involving human participants.

3.2. Materials and procedures

The test comprised 14 items aimed at investigating participants' understanding of scope ambiguity. These items were categorised as follows: 4 items featuring the existential quantifier sentences where *every* positioned in the middle of the sentence, 4 items with the universal quantifier located at the beginning of the sentence, 4 items involving numerical expressions, and 2 distractor items. The inclusion of distractors was to enhance the validity of the assessment. See Table 1 which presents the three types of scope ambiguity used in this study together with their two readings. This approach ensured that participants' responses reflected genuine understanding rather than random guessing.

Most static images for the test items were sourced from established linguistic resources, including The Scope Fieldwork Project (2008). Additionally, the researchers personally designed the images representing numerical sentences and distractors to ensure alignment with the specific goals of the study. The entire test, including all items and corresponding images, is included in the appendices for reference and replication purposes.

Table 1
The three types of scope ambiguity used in this study together with their two readings

SENTENCE PATTERN	QUANTIFIER TYPE	EXAMPLE SENTENCE	SURFACE READING	INVERSE READING
Universal Quantifier Sentences	A universal quantifier followed by an existential quantifier	Every man is sitting against a barrel	Each man is sitting against a specific barrel (distributive)	There exists a barrel such that all men are sitting against it (collective)
Existential Quantifier Sentences	An existential quantifier is followed by a universal quantifier	A shark attacked every pirate	There is one specific shark that attacked all the pirates (collective)	For every pirate, there was a (possibly different) shark that attacked them (distributive)
Numerical Sentence	Numerical (two)	Two architects built three houses	Two architects collectively built three houses (collective)	Two architects each built three different houses (distributive)

The examples illustrate that the most direct, or surface, interpretation follows the order in which the quantifiers appear in the sentence (Scontras et al., 2017). In sentences beginning with *every*, this often results in a distributive reading, where the universal quantifier applies to each individual element. In sentences where *a/an/one* precedes *every*, the surface reading, following the order of quantifiers, typically results in a collective interpretation, suggesting a single entity acting upon or related to all members of a group (e.g., *A shark attacked every pirate* implies one shark attacked all pirates). In sentences using numerical quantifiers, the surface reading frequently leads to a collective interpretation, where the numbers refer to a group acting as a whole. The inverse reading then offers an alternative interpretation where the scope relationships between the quantifiers are reversed, leading to a different understanding of the sentence's meaning (Philipp & Zimmermann, 2020).

The purpose of the study's test is to evaluate how well Arabic-speaking EFL students understand quantifier scope ambiguity in English. Quantifiers like *every* and numerical terms, which are known to generate scope issues, are used in a variety of sentence constructions. Depending on how the quantifiers are processed, each sentence is built to allow for both surface and inverse readings. For instance, universal quantifier sentences and existential quantifier sentences are designed to test participants' comprehension of the surface interpretation or the inverse reading. Numerical quantifier sentences, such as *two students read three books*, allow for the evaluation of participants' capacity to differentiate between interpretations that attribute the number to the books or the students.

3.3. Test Implementation

Participants took the test at the University of Jordan after receiving explicit instructions before starting. In order to make it visually appealing and easy to use, it was printed on coloured paper, which may help participants stay focused. The students participated in the test across two separate sessions to ensure focus and manageability. Each session was designed to last 30-45 minutes, providing sufficient time for students to complete the test. This structure allowed for a comprehensive assessment while maintaining a good testing environment.

To test students' ability to resolve scope ambiguity, study participants were provided with a test that includes sentence-picture pairings and three illustrations and one *I don't know* option: the first illustration matches the inverse reading

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(distributive), the second matches the surface interpretation of the sentence, and the third is an illustration that matches none of the readings. The students had to choose the two illustrations that represented the surface and inverse readings of the sentence containing the scope ambiguity, which were shuffled in the test (Figure 1).

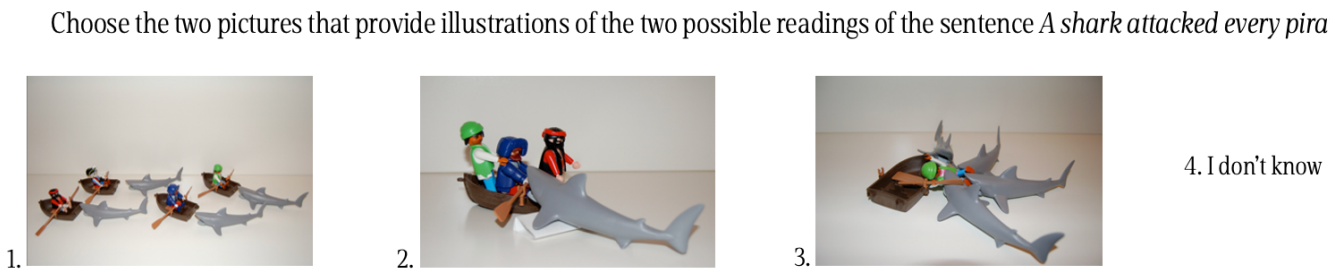

Figure 1. An example of a test item

The two illustrations correspond to the two possible readings. Under the inverse reading, the sentence is understood as *for every pirate, there is a shark that attacked them*, which allows for the possibility that each pirate was attacked by a different shark. Under the surface reading, the meaning is *there is one specific shark that attacked all of the pirates*, reflecting the syntactic order of *a* before *every* (Scontras et al., 2017, p. 1). A third illustration represents a scenario that does not match either of these readings. In addition, a fourth option is included in order to reduce the likelihood of an incorrect choice by 25% (Zibin, 2016).

Prior to administering the entire test, a pilot test that included 5 participants (different from the ones who actually took the test at the end) was carried out. Some elements were changed in response to the feedback in order to make instructions more explicit and guarantee that the pictures accurately matched the surface and inverse readings without any further ambiguity. This pilot stage made that the final test measured the things it was supposed to measure.

3.4. Data analysis

With an emphasis on sentence types and competence levels, the data analysis sought to evaluate Arabic-speaking EFL learners' understanding of quantifier scope ambiguity in English. Using SPSS, statistical analyses were performed to assess test reliability, item discrimination and difficulty, and significant differences across proficiency groups as described in Table 2.

Table 2
Test aspects and statistical measurements

TEST ASPECT	STATISTICAL MEASUREMENT
Reliability	Cronbach's Alpha
Item Difficulty	Difficulty Index (percentage of correct responses)
Item Discrimination	Discrimination Index
Comparative Analysis	Independent Samples t-test
Quantifier Type Analysis	Analysis of Variance (ANOVA) (if applicable)
Descriptive Statistics	Mean, Standard Deviation

The test consisted of 28 marks, with each question worth a maximum of 2 marks. A mark was awarded for selecting the correct answer reflecting the inverse reading and another for identifying the surface reading. Students who correctly identified both received full marks.

Participants' responses were categorised in an Excel sheet based on their comprehension of the target quantifier scope as inverse or literal. Inverse readings scored 1, and literal readings scored 0; distractor options were excluded. Data analysis was performed using SPSS version 21, focusing on key factors outlined in Table 2.

The first phase involved calculating internal consistency values using Cronbach's Alpha to evaluate the test's reliability, with a score above 0.7 considered good. The second phase assessed item difficulty, calculated as the number of correct answers divided by total responses, yielding scores from 0% to

100%. Approximately half of the participants correctly answered items with a 50% difficulty score. Scores near 100% indicate ease, while scores close to zero suggest high difficulty. The discrimination index was computed to evaluate each item's ability to distinguish between high and low performers. Negative values indicate potential bias, while positive values suggest successful differentiation, with values near 0 indicating poor differentiation. The final analysis stage used an independent samples t-test to assess significant differences in participants' interpretations of quantifier scope based on proficiency levels. The t-test examined comprehension differences across proficiency groups for each sentence type.

Five key elements were necessary to calculate the t-value: Significance Level ($\alpha = 0.05$), Degrees of Freedom ($df = n_1 + n_2 - 2$), Standard Error (SE), and the Null Hypothesis (H0), which posits no significant comprehension difference between groups for each quantifier scope. The t-value was determined by dividing the mean difference by the standard error and comparing it to the critical value from the t-distribution table for a two-tailed test.

3.4.1. Reliability analysis

Table 3 displays the Cronbach's Alpha values for each type of sentence as well as the total values.

Table 3
Reliability results

SENTENCE TYPE	CRONBACH'S ALPHA
Universal quantifier sentences	0.74
Existential quantifier sentences	0.71
Numerical Sentences	0.69
Overall Reliability	0.71

Participants' interpretation of phrases with quantifiers at the beginning has a moderate to high internal consistency, with an Alpha value of 0.74. Comparable degrees of consistency are also shown by the Alpha rating of 0.71 for sentences containing quantifiers in the middle. Although participants found numerical sentences difficult (0.69), their answers were generally consistent across questions, as indicated by the somewhat lower but still acceptable Cronbach's Alpha for these sentences. With a Cronbach's Alpha of 0.71, the test's overall reliability shows that participants consistently understood the scope of quantifiers in a variety of phrase patterns, with a high degree of consistency in universal quantifier sentences.

These results imply that the test successfully assessed participants' understanding of quantifier scope ambiguity, especially universal quantifier sentences, which is consistent with participants' propensity to find this structure easier to understand.

3.4.2. Difficulty analysis

With values ranging from 0% to 100%, difficulty was determined by dividing the number of right answers by the total number of questions for each type of text. Moderate difficulty is indicated by a value close to 50%, severe difficulty by a value close to zero, and simpler comprehension by a value close to 100% as shown in Table 4.

Table 4
The test difficulty and discrimination results

SENTENCE TYPE	DIFFICULTY (MEAN SCORES)	DISCRIMINATION INDEX
Existential quantifier sentences	1.50 – 1.64	Moderate
Universal quantifier sentences	1.72 – 1.90	High
Numerical Sentences	1.32 – 1.50	Low

Table 4 reveals the difficulty test value, indicating the percentage of participants who correctly answered each item varied by text type. The difficulty and discrimination results are: *Mean Score 1.32-1.50 (Numerical Sentences)*. Moderate to High Difficulty, with an estimated accuracy range of 32%-50%. *Mean Score 1.50-1.64 (Existential quantifier sentences)*. Moderate Difficulty, with an estimated accuracy range of 50%-64%. *Mean Score 1.72-1.90 (Universal quantifier sentences)*. Low Difficulty (relatively easy), with an estimated accuracy range of 72%-90%.

Comprehension varied by sentence type, with difficulty scores from 1.32 to 1.90. Universal quantifier sentences were easier, scoring 1.72 to 1.90, likely due to their predictability. Conversely, numerical sentences had the lowest mean difficulty scores (1.32 to 1.50) due to their higher cognitive demands.

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Existential quantifier sentences showed moderate discrimination (1.50–1.64), distinguishing between high- and low-performing groups. Those proficient in the language comprehended universal quantifier sentences better, while even skilled participants struggled with numerical sentences, likely due to complex quantifier interactions. In numerical contexts, the surface reading reflects a collective interpretation, contrasting with the distributive opposite seen in sentences with the universal quantifier.

4. RESULTS AND DISCUSSION

4.1. Comprehending the three types of sentence patterns in scope ambiguity

This section aims to provide answers to the first research question which is concerned with the extent to which Arabic-speaking EFL learners can comprehend three patterns of doubly quantified sentences. Starting with descriptive analysis, Table 5 presents the means and standard deviation for participants' responses across the three types of scope ambiguity.

Table 5
Descriptive statistics for participants' responses across three types of scope ambiguity

SCOPE AMBIGUITY TYPES	MEAN		STD. DEVIATION
	STATISTIC	STD. ERROR	STATISTIC
A) Existential quantifier sentence. Qa1	1.52	0.08	0.58
A) Existential quantifier sentence. Qa2	1.64	0.08	0.56
A) Existential quantifier sentence. Qa3	1.50	0.08	0.54
A) Existential quantifier sentence. Qa4	1.50	0.08	0.58
B) Universal quantifier sentence. Qb1	1.72	0.06	0.45
B) Universal quantifier sentence. Qb2	1.90	0.05	0.36
B) Universal quantifier sentence. Qb3	1.86	0.06	0.41
B) Universal quantifier sentence. Qb4	1.78	0.07	0.47
C) Numerical sentence Q c1	1.42	0.07	0.50
C) Numerical sentence Q c2	1.50	0.07	0.51
C) Numerical sentence Q c3	1.32	0.07	0.51
C) Numerical sentence Q c4	1.50	0.07	0.51
total_a	6.16	0.16	1.13
total_b	7.26	0.16	1.14
total_c	5.74	0.23	1.61
Total	19.16	0.34	2.38

The descriptive statistics in Table 5 shows that the lowest mean scores were obtained on numerical sentences (total_c) with a mean of 5.74, followed by existential quantifier sentences (m=6.16), and finally universal quantifier sentences (m=7.26). This suggests the numerical sentences were the most challenging for the participants, while those containing *every* initially were the least challenging, which provides an answer to the first research question. This highlights the challenges associated with comprehending different types of sentences containing scope ambiguity.

4.2. The effect of English proficiency level on comprehending scope ambiguity

To determine whether the participants' English proficiency level affected their comprehension of the three types of scope ambiguity and whether the differences between the participants' answers on the three types were statistically significant, a t-test was used (second research question). Table 6 displays the means, standard deviations, and t-test results comparing participants with medium proficiency (M) and high proficiency (H) in English for different sentence types (total_a for existential

quantifier sentences, total_b for universal quantifier sentences, and total_c for numerical sentences). Table 6 shows that the differences between participants answers with medium and high proficiency levels on existential quantifier sentences are statistically significant in favour of those with high proficiency levels (p value=0.000). However, the differences between the participants' answers with H and M proficiency levels on universal quantifier sentences (total-b) and numerical sentences (total-c) are not statistically significant (p values=0.356 and 0.699), respectively.

Table 6
Impact of English proficiency level on comprehension of scope ambiguity

GP	N	MEAN	STD. DEVIATION	STD. ERROR MEAN	T-VALUE	P-VALUE
total_a M	26	5.62	1.023	0.201	-4.066	0.000
total_a H	24	6.75	0.944	0.193		
total_b M	26	7.12	1.306	0.256	-0.933	0.356
total_b H	24	7.42	0.929	0.190		
total_c M	26	5.65	1.495	0.293	-0.389	0.699
total_c H	24	5.83	1.761	0.359		

Existential quantifier sentences were more challenging, particularly for medium-proficiency participants, as reflected in the significant difference in scores between the two groups (p = 0.000). The syntactic complexity and ambiguity inherent in these structures likely require a higher level of English proficiency to resolve effectively. However, interestingly, inverse readings – where each individual entity is considered separately – may be relatively easier for medium-proficiency learners than surface readings. This is because the inverse reading in existential quantifier sentences follows their L1 processing patterns and is supported by clearer, distributive cues in the sentence structure and pictures. For example, an existential quantifier sentence from the test, with both surface and inverse interpretations, is shown below alongside the associated pictures.

Surface reading: *A bird is perched in every tree*. There exists a single bird such that it is perched in every tree/branch of the same tree. This interpretation follows the order in which the quantifiers appear in the sentence, where *a bird* is considered as a single entity that somehow relates to all the trees. As shown in Figure 2, this reading depicts one bird present in all trees, requiring the listener to imagine a scenario where one bird can be in multiple locations.

This appears to be straightforward, but this reading might be less intuitive for Arabic speakers because it does not directly map onto common sentence structures. In Arabic, expressing this collective meaning might require a more complex construction, rather than a simple sentence beginning with an indefinite noun.

Figure 2. A test item showing the surface reading of an existential quantifier sentence: *A bird is perched in every tree*

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Inverse reading: *A bird is perched in every tree*. Each tree has a unique bird perched on it (Figure 3). This reinterpretation requires participants to understand that a new bird is introduced for each tree shown, reversing the scope of the existential quantifier. This distributive reading can be in line with some possible Arabic translations, such as 'طائر يقف على كل شجرة' or the Jordanian Arabic equivalent 'عصفور واقف على كل شجرة', which directly translates to *a bird stands on every tree*. However, even with this direct correspondence at face value, the interpretation can still be influenced by how quantifiers and scope are processed in Arabic, where other sentence constructions or contextual cues might be preferred to convey this meaning unambiguously. This challenges medium-proficiency learners, due to the potential influence of L1 processing habits (Wu & Ionin, 2022).

Figure 3. A test item showing the inverse reading of an existential quantifier sentence: *A bird is perched in every tree*

An existential quantifier sentence introduces ambiguity by complicating the relationship between the subject and object, demanding syntactic flexibility that is more pronounced in high-proficiency participants.

For sentences in total_b, universal quantifier sentences, the mean score for participants with medium proficiency was 7.12, compared to 7.42 for those with high proficiency. Although the mean for high proficiency participants was slightly higher, this difference was not statistically significant, as indicated by the p-value of 0.356. This suggests that both proficiency levels were similarly effective in interpreting these types of sentences, likely due to the simpler structure when *every* appears initially, which reduces ambiguity and makes the sentences easier to process for participants across both groups. This suggests that structural simplicity reduced ambiguity, facilitating understanding for both groups (Wu & Ionin, 2022). An example of a sentence from the test with *every* initially with both surface and inverse readings with the pictures used on the test is provided below.

Surface reading: *Every man is sitting against a barrel*. The interpretation where each man sits against his own barrel agree with Arabic syntax, which typically presents quantifiers in a direct one-to-one relationship (e.g., 'كل رجل يجلس بجانب برميل') or in Jordanian Arabic 'كل زلمة قاعد جنب برميل'. This facilitates easier comprehension for Arabic-speaking learners, as shown in Figure 4

Figure 4. A test item showing the surface reading of a universal quantifier sentence: *Every man is sitting against a barrel*

Inverse reading: *All men are sitting against one barrel*. All men are sitting against the same barrel as shown in Figure 5. The broader scope of *every* requires syntactic restructuring, which is less intuitive in Arabic. While this kind of scenarios are rare in Arabic, learners could express this with explicit markers, e.g., 'كل الرجال يجلسون بجانب برميل واحد.' Or in Jordanian Arabic 'كل الزلام قاعدين جنب برميل واحد'. In general, it could be argued that the structural clarity of sentences with *every* at the beginning compared to existential quantifier sentences minimised L1 interference, making them more accessible to participants across proficiency levels. That is, a clear position for the quantifier, such as *every man is sitting against one barrel*, conveys the relationship between the subjects and objects. This clarity may help prevent learners from misinterpreting the sentence due to differences in quantifier usage or sentence structure in their native language (Julaika et al., 2025).

Figure 5. A test item showing the inverse reading of a universal quantifier sentence: *Every man is sitting against a barrel*

In the case of total_c (numerical sentences), the mean scores were 5.65 for medium proficiency and 5.83 for high proficiency. Again, participants with high proficiency scored slightly higher, but the difference was not significant statistically, with a p-value of 0.699. This indicates that proficiency did not play an important role in the comprehension of numerical sentences, suggesting that factors beyond linguistic proficiency may be at play. Further investigation could explore the specific cognitive challenges these sentence structures pose for L2 learners (Demir, 2020). An example of a sentence from the test with numbers with both surface and inverse readings with the pictures used on the test is provided below.

Surface reading: *Two architects built three houses*, interpreted as a collective action. Arabic's preference for explicit numerical relationships (e.g., 'مهندسان بنيا ثلاثة بيوت') or in Jordanian Arabic 'مهندسين بنوا ثلاث بيوت' supports this reading, as shown in Figure 6. As discussed previously, in these sentences, the surface reading is the collective one, while the inverse is the distributive one.

Figure 6. A test item showing the surface reading of a sentence containing numbers: *Two architects built three houses*

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Inverse reading: *Each architect built three houses*, involving separate pairs. Two architects each built three different houses. In Arabic, this might require explicit clarification (e.g., مهندسان بنى كل واحد منهما ثلاثة بيوت) or in Jordanian Arabic مهندسين بنى كل واحد منهم ثلاث بيوت, highlighting the difficulty in processing such distributions without clear linguistic cues, as shown in Figure 7. That is, without overt linguistic cues, understanding the distribution of actions can be challenging for learners, especially when the structures differ significantly between English and Arabic (Wu & Ionin, 2022).

Figure 7. A test item showing the inverse reading of a sentence containing numbers: *Two architects built three houses*

Numerical sentences (Group C) could be challenging to learners due to the complex relationships between quantities and objects. The difficulty with inverse readings in numerical sentences potentially demonstrates the impact of linguistic distance on the interpretation of scope ambiguity in L2. It is possible that the logical demands of these sentences interact with L1 transfer effects, an area worthy of future research (Demir, 2020). These findings might support Westerståhl's (2007) assertion that scope ambiguity arises from sentence structure rather than grammatical rearrangement. For example, in inverse readings (e.g., *two architects built three houses*), participants must reconcile the relationships between quantities and objects. Arabic-speaking EFL learners may struggle with English's stricter syntactic cues, which require inferring relationships from fixed word order. This difficulty may contribute to the lower mean scores for numerical sentences compared to other types.

In contrast, universal quantifier sentences (Group B) had the highest mean score of 7.26, which may indicate easier processing. Their clarity is in agreement with participants' intuitive understanding, reducing the need for syntactic restructuring. This suggests structural simplicity minimises ambiguity, as participants may rely on certain L1 patterns in L2 (Zibin et al., 2024).

Existential quantifier sentences (Group A) achieved an intermediate mean score of 6.16, reflecting moderate complexity. These sentences require greater syntactic flexibility, particularly in surface readings (e.g., *A bird is perched in every tree*), necessitating reanalysis of the quantifier's scope. Higher proficiency participants performed better (as shown in Table 6), medium-proficiency participants faced challenges, highlighting the influence of linguistic distance on comprehension.

4.3. Discussion on the relationship between English proficiency and types of scope ambiguity

The study's findings indicate that English proficiency significantly influences comprehension of scope ambiguity, especially in sentences with mid-sentence embedded quantifiers like *every*. High-proficiency participants outperformed medium-proficiency ones. This supports the notion that greater syntactic familiarity aids in understanding complex structures. In simpler sentence types, such as universal quantifier sentences, no substantial differences emerged between proficiency groups. This suggests that advanced proficiency enhances comprehension of complex sentences, while gaps narrow in straightforward ones. The lack of variation in simpler sentences supports the idea that comprehension difficulty increases with structural complexity, demanding higher linguistic skills (Zibin et al., 2024).

No significant difference emerged between high and medium proficiency groups for universal quantifier sentences, likely due to the structural simplicity that reduces potential ambiguity. These observations align with Zhang's (2023) findings, which suggest that less complex structures are generally easier to process. Future research could investigate whether this ease of processing extends to sentences with clear scope structures. The meaning becomes clearer by positioning *every* first, so both medium and high proficiency participants found it easy. This sug-

gests straightforward syntactic patterns do not depend on advanced skills for comprehension, as the initial placement of *every* contributes to clarity. This supports Scontras et al. (2017), who noted that structural factors can lessen proficiency differences in scope ambiguity comprehension, particularly in predictable configurations.

In the case of numerical sentences, there was no difference in comprehension between medium and high proficiency groups. This supports language transfer theory, suggesting that when L1 and L2 lack relevant syntactic similarities, L2 proficiency has limited impact on comprehension. Numerical sentences often rely on logical reasoning rather than linguistic processing, which may be less influenced by language proficiency. According to Odlin (2022), complex syntactic structures can be difficult for L2 learners. Consequently, both groups exhibited similar performance outcomes in interpreting numerical relationships. This might suggest that the challenges posed by these structures are not easily overcome by increased proficiency alone, which highlights the influence of underlying L1 transfer effects, or other factors affecting the interpretation of complex sentences (Scontras et al., 2017).

Learners faced difficulties with sentences containing existential quantifiers (e.g., sentences using *a* at the beginning), possibly due to their intermediate level of syntactic complexity, as these structures involve relationships between different sentence elements. As Isurin (2021) notes, learners often struggle when L2 syntactic patterns differ from their L1. This interaction between syntactic transfer and linguistic distance can result in different difficulties in processing ambiguous structures, a phenomenon supported by second language acquisition theories. Furthermore, ambiguity itself can impede comprehension, as evidenced by Setiawan's (2014) finding that ambiguity in EFL writing led to misunderstanding. The finding that L1 affected comprehension of L2 scope ambiguity in sentences with *every* supports Kim's (2010) work, which noted that Korean EFL learners prefer broad-scope readings due to L1 influence, similar to Arabic-speaking EFL learners in this study.

4.4. Discussion related to L1 transfer

The challenges with inverse readings stem from syntactic transfer, where L1 structures impact L2 processing (Philipp & Zimmermann, 2020). For instance, in the case of *Every man is sitting against a barrel*, the surface reading – where each man has his own barrel – is more straightforward for Arabic speakers. These structures agree with Arabic constructs like 'كل رجل يجلس بجانب برميل' or the Jordanian 'كل زلمة قاعد جنب برميل', which depict a one-to-one relationship between the quantifier and individual subjects. This similarity makes the surface reading intuitive due to the structural similarity in Arabic, minimising the need for complex reinterpretation.

In contrast, for sentences involving existential quantifiers, Arabic speakers may find the inverse reading – where each tree has a unique bird perched on it – more natural, agreeing with common Arabic patterns. For instance, expressions like 'طائر يقف على كل شجرة' or the Jordanian 'عصفور واقف على كل شجرة' are often interpreted as implying a different bird per tree. In these cases, the inverse reading appears to match their typical processing of distributive relationships. The inverse reading in English – such as *All men are sitting against one barrel* – can require a syntactic restructuring, but this interpretation may be more intuitive for Arabic speakers in some contexts, because it reflects familiar semantic and pragmatic patterns in their L1. However, the broader scope of the inverse reading, especially in the context of *every tree*, involves more complex syntax in English that conflicts with Arabic's flexible word order and quantifier usage, leading to difficulties in accurate interpretation. The surface reading – *Every man is sitting against a barrel* – is simpler and more consistent with canonical English syntax, thus easier for learners to process and less prone to L1 interference. This disparity between the two interpretations illustrates how the type of sentence influences processing strategies, with tendencies favouring either the surface or inverse reading depending on their L1 habits. The reliance on familiar L1 patterns can lead to errors, especially when the English input diverges from those norms (Isurin, 2021; Odlin, 2022).

Inverse readings require learners to reinterpret English syntax, conflicting with Arabic's default, more flexible word order and quantifier usage. As suggested by Adam (2024), the SVO structure of English contrasts with Arabic's flexible syntax, which can often cause learners to rely on their L1 strategies – particularly when the L2 structure deviates from familiar patterns. This reliance on L1 strategies can complicate the comprehension of inverse scope, especially in sentences involving complex scope ambiguities (Philipp & Zimmermann, 2020).

On the other hand, surface readings generally follow canonical, straightforward syntactic patterns, which are in line with principles of syntactic simplicity in psycholinguistics (Scontras et al., 2017). Such structures, like the explicit *every* at the beginning of a sentence, reduce ambiguity and likely minimise L1 interference, enabling participants to process these sentences more easily. This phenomenon is in line with the concept of positive transfer, where L1 structures consistent with L2 norms support better comprehension. Zibin et al.'s (2024) findings that higher proficiency learners can adapt their syntactic processing to better align with L2 norms further support this view.

Participant proficiency levels influence their ability to interpret both surface and inverse readings. Less proficient learners tend to rely more heavily on their L1, which increases transfer effects and ambiguity, while higher proficiency learners are better able to adapt to the syntactic norms of L2. Nonetheless, even advanced learners sometimes struggle with inverse readings, reflecting their inherent complexity and the divergence from common syntactic patterns (Philipp & Zimmermann, 2020).

In summary, these findings support the theory of language transfer, demonstrating that L1 influence is strongest when L2 structures differ from L1 norms. The comparative ease with surface readings illustrates how clarity in sentence structure can

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facilitate comprehension across proficiency levels. Moreover, as Zibin et al. (2024) suggest, increased exposure to L2-specific patterns diminishes transfer effects, leading to improved understanding of complex sentences in L2.

5. CONCLUSION

This study examined how English proficiency influences the comprehension of doubly quantified sentences and the distinction between surface and inverted readings in three sentence types: numerical sentences, existential quantifier sentences and universal quantifier sentences. Results indicated that higher proficiency significantly improved understanding of existential quantifier sentences. This suggests that advanced learners' grammatical knowledge allows them to correctly parse the sentence structure and determine the scope relations between the quantifiers in these sentences. In contrast, proficiency did not significantly affect comprehension of numerical statements or universal quantifier sentences, indicating that the latter are simpler and require less proficiency.

The study found that all participants faced the greatest challenges with numerical statements due to the mental effort required to connect numbers and sentence objects, resulting in lower mean scores. Similarly, existential quantifier sentences were challenging due to complex syntactic links between the quantifiers. Conversely, universal quantifier sentences received higher mean scores, likely because their scope is more predictable.

Surface readings in existential quantifier sentences could have been more difficult to comprehend. In the context of existential quantifiers, the inverse reading appears to be more in line with Arabic expressions, which emphasise collective relationships. The more English based thinking of the one-to-one relationships with surface reading could have been a hindrance. Future research is needed to investigate this potential influence of L1 on the interpretation of existential quantifiers, while also considering the role of individual differences and task-related factors.

Inverse readings in universal and numerical quantifier sentences that involved reinterpretation of the relationship between numbers and objects were associated with a higher error rate in participant responses, suggesting potential difficulties with that type of sentence interpretation. The added complexity of changing the number's scope makes inverse readings more challenging to grasp compared to surface readings in certain cases, possibly due to the greater deviation from the sentence's surface structure that is required to arrive at that interpretation. The results support the theory of language transfer, showing that learners' L1 influences their processing of L2 structures. Arabic-speaking learners often relied on L1 patterns, leading to challenges in interpreting scope ambiguity in English. This may also explain their better performance with surface readings in universal and numerical quantifier sentences, which aligned more closely with their intuitive processing.

Further research should explore how different levels of linguistic exposure impact the understanding of scope ambiguity, including factors like multilingualism and the frequency of complex syntactic patterns in daily interactions. Although the study focused on English proficiency, participants' understanding of numerical sentences could be influenced by cognitive factors such as logical reasoning and working memory capacity. Future research should investigate the relationship between these cognitive traits and sentence comprehension, particularly for sentences with quantifiers like *every*. Future research should also focus on the cognitive processes involved in inverse reading comprehension, as these readings were consistently challenging in universal and numerical quantifier sentences. Neuroimaging or eye-tracking methods could help understand how participants mentally rearrange sentences in real time. Given that participants struggled with numerical sentences, further research is needed to explore whether specific instructional strategies can improve students' grasp of scope ambiguity in mathematical and logical contexts. Such studies may influence curriculum development and language instruction in areas requiring cognitive and linguistic reasoning.

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ABOUT THE AUTHORS

Dana Makhlouf
MA in Linguistics
English Language and Literature Department, School of Foreign Languages, The University of Jordan, Amman, Jordan
Postal address: 11942, Amman, Jordan, Queen Rania St.
Email: danamakhlouf344@icloud.com
ORCID: https://orcid.org/0009-0009-0888-0712

Aseel Zibin
PhD in Linguistics and English Language, Associate Professor
English Language and Literature Department, School of Foreign Languages, The University of Jordan
Postal address: 11942, Amman, Jordan, Queen Rania St.
Applied Science Private University, Amman, Jordan
Postal address: 11937, Amman, Jordan, Al Arab St. 21.
Email: a.zabin@ju.edu.jo
ORCID: https://orcid.org/0000-0003-2509-064X

Abdel Rahman Mitib Altakhaineh
PhD in Linguistics and English Language, Associate Professor
English Language and Literature Department, School of Foreign Languages, The University of Jordan, Amman, Jordan
Postal address: 11942, Amman, Jordan, Queen Rania St.
Email: a.altakhaineh@ju.edu.jo
ORCID: https://orcid.org/0000-0001-7605-2497