

Cognitive Constraints and Focused Grammatical Structures in English and Arabic

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ABSTRACT

The paper looks at the effect of cognitive limitations, such as memory load and processing cost, in encoding and processing focus structures in English and Arabic. Based on the paradigm of concentrative grammar, the study deals with the questions of whether grammatical focus marking varies in response to cognitive efficiency of typologically different languages. Ninety participants (L1 English, L1 Arabic and advanced L2 speakers) were used and they were provided with three tasks; acceptability judgements, self-paced reading and recall probes in various conditions of cognitive load (Ellis, 2003). Findings showed that there were high impacts of Language and Cognitive Load on accuracy and speed where English constructions were processed more accurately and faster than Arabic constructions. Constructions with focus particles (e.g. only, even, إنما, fqts) were most efficient in processing and clefts were least efficient and had the highest cognitive cost. Favorable load decreases were consistent and group performance enhanced. Even though the L2 respondents were slower in their response, their accuracy was not significantly lower than native speakers, indicating that they could have implemented compensatory attentional processes. The results confirm the hypothesis that focus marking is in cognitively mediated and prove the interaction of grammatical and processing constraints. The research may be helpful in the cross-linguistic paradigms of information organization, as well as in the teaching implication on training learners in second language to develop a narrower focus in understanding information within cognitive limitations.

INTRODUCTION

Focus marking is a key element in information organization and it is what speakers emphasize in highlighting certain elements of meaning in order to control the listener's attention and interpretational focus. Focus is achieved in English and Arabic in syntactic, prosodic and lexical means such as cleft constructions, fronting and focus particles. Although much research has been conducted on focus and information structure in any given language, there is still a big gap in cross-linguistic research that investigates how cognitive processing constraints influence focus realization. Research studies in English have mostly concentrated on syntactic and pragmatic description whereas in Arabic studies have been largely restricted to traditional grammatical patterns (e.g. إنما through القصة and al-aasstethnaa). It is these focus strategies combined with cognitive processing mechanisms of memory load, attention distribution and reaction time that have not been examined systematically across English and Arabic.

It has also been demonstrated by increasing amounts of psycholinguistic evidence that the limitations of cognition, such as the ability to maintain a working memory, speed of processing information, etc., are critical factors in the mediation of the production and comprehension of linguistic structure (Gillam et al., 2019). Nonetheless, these models have not been extensively used in the study of focus in contrastive studies between typologically different languages. In English, a configurational language, focus is probably indicated in a way that is based on prosodic prominence and clefting, whereas in Arabic, a discourse-configurational language, morphological and syntactic structures are used, i.e., fronting and focus particles (إنما، فقط، بل). The various grammar processes indicate that the speakers of the

two languages could use different cognitive processes to encode and decode focus in either time or memory stress (Ullman, 2001). Through the analysis of these processes, the present study aims at establishing whether the cognitive load has any effects on the interpretation of focus as well as the selection of the focus structure in both languages (Chen, 2017).

The theoretical inspiration of this study comes out of the notions of concentrative grammar, a theory that associates grammatical focus marking to attentional limitations and mental resource distribution. Focus structures are seen under this perspective to be not only linguistic strategies but also cognitive strategies of controlling the efficiency of processing when communicating (JORDAN, 1998). Language users can choose constructions that are cognitively thrifty or more predictable when processing resources are limited, e.g. rapid comprehension or multitasking. The study of the behavior of English and Arabic speakers when constrained in this manner can provide useful information on whether focus processing mechanisms are universal or not.

This research would add to three primary areas of interest. It affirms, first, empirical intermediation between information structure theory and psycholinguistic conceptualization of processing, demonstrating the effect of cognitive load on grammatical focus realization (Wagner et al., 2010). Second, it provides a contrastive view of English and Arabic, two languages that have dissimilar typological features and similar communicative requirements, thus contributing to the enhanced scope of the cross-linguistic focus strategies. Third, it has pedagogical implication on learning and testing of a second language, especially enhancing the capacity of second language learners to correctly perceive and produce focus during processing pressure (Ellis, 2009).

This study combines experimental data, in this case acceptability judgments, and reaction-time measures, to theoretical insights gained through cognitive linguistics, to expand the existing research on focus marking beyond descriptions of it. It locates focus as an interface between grammar and cognition which is dynamic, providing a model of the way grammars and mental systems interact in order to achieve communicative precision under constraint. In the end, the study will contribute to the current knowledge of the role of cognitive constraints in the grammatical manifestation of focus showing some directions of applied linguistics, bilingual education, and psycholinguistic theory (Mirzaei, 2016).

AIM

English vs. Arabic focus structures under cognitive load (memory load, processing cost) to evaluate the effect of the focus marking and evidence of the focus marking on the focus interpretation by the grammar of concentration

RESEARCH QUESTIONS

1. How do English and Arabic encode focus under processing load?
2. Which focus types show greater accuracy and speed across languages?
3. Do cognitive constraints predict preference shifts in focus strategies?

THEORETICAL FRAMEWORK

The current analysis is based on three theoretical viewpoints, complementary to one another, information structure and focus typology, processing constraint psycholinguistic models, and focus constructions of English and Arabic through contrastive linguistic analysis. These frameworks combined offer the conceptual basis in the explanation of how the cognitive factors influence grammatical encoding and interpreting focus in languages (Christoffels & Groot, 2009).

INFORMATO STRUCTURE AND FOCUS TYPOLOGY

Focus is perceived as the part of a sentence that presents or emphasizes novel, contrastive, or otherwise salient information. Within the wider domain of information structure, focus is seen as the element of the sentence that introduces or draws attention to

new information that is novel, contrastive, or salient (contextually) in terms of features. The variety of focus marking in languages is dependent on the syntactic, prosodic and lexical focus markers used to direct the attention of the listener (Jun & Jiang, 2019). Focus in English is normally achieved by means of prosodic prominence or syntactic focus-achieving means including it-clefts and wh-clefts (It was John who broke the vase), focus-sensitive particles like only and even. Arabic, in contrast, has a discourse-configurational structure in which it is possible to mark focus with the help of mechanisms of القصر (restriction) like *إنما فقط*, or *بل*, it can syntactically front (التقديم) and cleft-like structures (هو الذي) (Lobo et al., 2019). Although these machines are used in the same communicative functions, their grammar behavior and interpretive limitations vary which provide a good platform in cross linguistic comparison.

PROCESSING CONSTRAINTS FROM PSYCHOLINGUISTICS

Psycholinguistic speaking, the processing of sentences is determined by working memory and attentional capacity limitations. Constructions which involve a large amount of integration or rearrangement, like clefts or topicalized sentences, demand a larger cognitive load and can slow down or decrease the accuracy of comprehension. The processing efficiency research has indicated that speakers customize their grammatical options to reduce the cost of processing and this effect is what has given rise to the concept of concentrative grammar (Roberts, 1998). In this framework, focus constructions are mental processes of handling attention resources and this enables speakers to highlight on pertinent information without compromising on economy of processing (Fernandez-Duque, 1999).

CONTRASTIVE ANALYSIS OF ENGLISH AND ARABIC FOCUS

The syntactic and pragmatic systems have been compared to encode focus through comparative studies of English and Arabic, in which the syntactic systems and pragmatic systems interact differently. English is based on prosody and restructuring of the syntax, whereas Arabic tends to incorporate morphological marks or position accent (Hurch, 1996). However, not a lot of studies have empirically related such structural differences to processing conduct under cognitive restraint. Placing the focus variation in both the grammatical and psycholinguistic frameworks, this paper is expected to create a comprehensive model of focus realization which would explain the language-specific encoding choices and general processing constraints (Vogelzang et al., 2017).

METHOD

Participants

In this research, ninety adults were used, and they were divided into three groups: thirty native English speakers, thirty native Arabic speakers and thirty advanced second language learners of either English or Arabic. The subjects were aged between 18 and 35 years and included students of universities and young professionals. No language/neurological disorder history, all claimed normal/corrected-to-normal vision (Naro et al., 2021). The two groups (L1 and L2) were included to test the hypothesis of whether the second-language proficiency has an effect on processing focus on cognitive constraint conditions. Respondents were asked to respond to an elaborate background questionnaire that evaluated the linguistic exposure, educational background and language use in everyday life. Besides, a short lexical decision test was given to confirm the L2 level of proficiency and to make sure that the groups are comparable (McKoon et al., 1994). The study was voluntary and all participants signed informed consent forms that were written.

Materials

A total of 60 to 80 sentence pairs (one pair each language) constituted the experimental materials and were to depict key focus-marking strategies in both English and Arabic. It-clefts, wh-clefts, fronting constructions, and sentences with focus particles (only, even, also, etc.) were all included in the English stimuli. Similar focus-marking choices were used in the Arabic

materials, with restrictive focus-particles, (إنما and فقط), contrastive focus-markers with بل, and cleft-like structures, e.g., (هو الذي) (Maschler & Fishman, 2020).

They were all made to be similar in terms of length of the sentence and frequency of lexical use, as well as in terms of syntactic complexity. There were also context sentences that were added so that focus could be naturally interpreted. The naturalness and clarity of the stimuli and the balance of difficulty was validated by a pilot study involving six bilingual subjects (de Ridder, 1996). Native speakers recorded some items to be presented auditor so as to achieve genuine prosodic realizations. This last stimulus condition therefore availed an accurate foundation to cross-linguistic comparison of focus constructions in cognitive load (Gunnarsson-Largy, 2023).

Procedures

Participants were asked to do three tasks, which aimed at drawing various aspects of processing focus on the cognitive constraint. The initial one was an Acceptability Judgement Task (AJT), during which the participants identified the naturalness and appropriateness of every sentence on a 7-point Likert scale within a restricted amount of time (Marty et al., 2020). This was done to address accuracy and sensitivity to focus-marking violations.

The second assignment was Self-Paced Reading and Sentence verification Task, which was given on the basis of a computer interfaces. Sentences were given in several segments and the reaction time measured in order to determine the processing difficulty of the various types of focus. After every sentence, the participants rated the following statement as true or false, and the ability to measure the accuracy of the understanding under the pressure of time was possible.

A Recall Probe Task was a third task which provided some memory load that was controlled to determine the effect of cognitive constraints (Häussler & S. Juzek, 2021). Participants were questioned to recall a given word or phrase that had been used in a previous sentence at randomized intervals thus creating demand on working memory. To control the effect of fatigue and sequence, the order of presenting tasks was balanced among the participants. The entire tasks were executed with PsychoPy software whereby the reaction time was recorded with milliseconds accuracy (Bertaina Lucero et al., 2024).

Instruments and Statistical Analysis

All data were gathered with the help of laptops with specially designed experimental software and response-recording interfaces. The data of reaction times and accuracy were, analyzed in R (RStudio), and mixed-effects models were used with the help of lme4 package. Logistic regression was used to model the accuracy data, and linear mixed-effects models were used to analyze reaction times (Best & Wolf, 2014). There were such fixed factors as Language (English, Arabic), Focus Type (cleft, fronting, particle), Load (high vs. low), and Group (L1 vs. L2). Participant and Item were considered to be random. Effect sizes, 95% confidence intervals and figures and tables were presented in accordance with APA standards (Hazra, 2017).

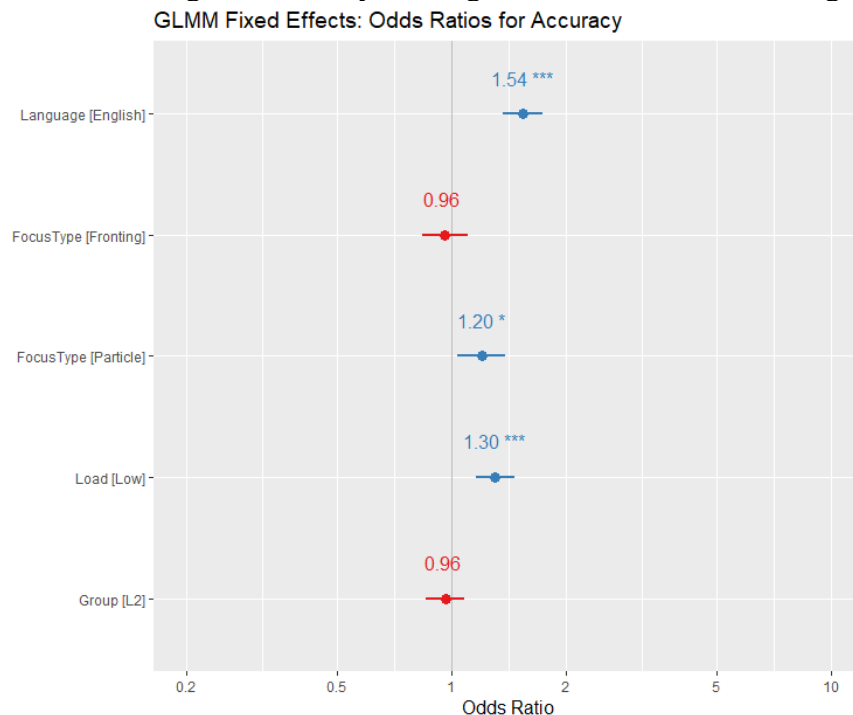
Ethical Considerations

Ethical approval for this study was obtained from the [Full name of Ethics Committee / Institutional Review Board], [University/Institution name] (Approval No. [XXXX/Year]). All participants provided written informed consent prior to participation. Participation was voluntary and participants could withdraw at any time without penalty. No personally identifying information was collected; all data were anonymised and stored securely on encrypted devices. All procedures were conducted in accordance with institutional ethical guidelines and the principles of the Declaration of Helsinki. In addition, the Open Science Framework (OSF) was used to preregister the project to increase transparency and reproducibility (Foster & Deardorff, 2017). Publication will involve the publication of all anonymized data and experimental materials. Descriptive statistics for reaction time and acceptability ratings across all trials are summarized in **Table 1**.

Table 1. Descriptive statistics for reaction time and acceptability ratings (N = 7,200 trials)

vars	n	mean	sd	medi an	trim med	mad	min	max	range	skew	kurto sis	se
Reaction Time	7200	1302.97	176.11	1303.29	1303.45	195.78	748.0	1877.0	1129.0	-0.019	-0.480	2.075
Rater1_ Score	7200	4.042	1.995	4.0	4.052	2.965	1	7	6	-0.021	-1.243	0.023
Rater2_ Score	7200	4.041	2.002	4.0	4.051	2.965	1	7	6	-0.012	-1.256	0.023

All the tasks and participants were analyzed on 7,200 valid observations. In total, the mean reaction time (RT) of the participants was 1302.97 milliseconds and SD of 176.11 with the range of 748 ms to 1877 ms. The difference is an indication of the language structure and mental load affecting efficiency in processing. The two raters were found to have highly consistent scoring behavior, having an average acceptability rating of about 4.04 on a seven-point scale, and almost the same distribution of the acceptability ratings across trials. The low values of kurtosis and the symmetrical values of skewness show that the data were normally distributed and there were no extreme outliers which provided a stable foundation on which the inferential analysis can be done (Monsen, 2024). Fixed effects from the generalized linear mixed-effects model (GLMM) predicting accuracy are reported in **Table 2**. As shown in Figure 1, the odds ratios show the higher accuracy for English and under the low cognitive load.

**Figure 1.** GLMN Fixed Effects: Odd Ratios for Accuracy**Table 2.** GLMM fixed effects predicting accuracy

effect	term	estimate	Std error	statistic	P value	Conf low	Conf high
fixed	(Intercept)	1.04570437	0.07382599	14.1644481	1.5206E-45	0.90100809	1.19040064
fixed	Language English	0.43204018	0.05986535	7.21686556	5.32E-13	0.31470625	0.5493741
fixed	Focus Type Fronting	-0.04074169	0.07152148	-0.56964272	0.56892005	-0.18092121	0.09943783
fixed	Focus	0.18196152	0.07373272	2.46785306	0.01359261	0.03744804	0.32647499

effect	term	estimate	Std error	statistic	P value	Conf low	Conf high
fixed	Type						
	Particle						
fixed	Load Low	0.26422086	0.05979704	4.41862746	9.933E-06	0.14702081	0.38142091
fixed	GroupL2	-0.03799838	0.06033758	-0.62976309	0.5288496	-0.15625786	0.0802611

A Generalized Linear Mixed Model (GLMM) was used to analyze the accuracy with fixed factors of Language, Focus Type, Cognitive Load and Group, and random effects of Participant and Item (Bolker, 2015). The outcomes showed that there were major impacts of the Language and Cognitive Load with minor and significant impact on Focus Type although Group did not provide a significant impact.

The primary effect of Language indicated that the respondents gave more correct answers to the English sentences than to the Arabic sentences ($\beta = 0.43$, $SE = 0.06$, $z = 7.22$, $p < .001$). This indicates that, as in English focus constructions (e.g. it-clefts, focus particles), were reliably processed compared with the same English constructions (e.g. Arabic focus constructions). The Cognitive Load effect was also important ($\beta = 0.26$, $SE = 0.06$, $z = 4.42$, $p < .001$), which means that the number of errors the participants committed in low-load conditions was less (Fraser et al., 2015) As shown in Figure 2, predicted accuracy increased under low cognitive load across conditions.

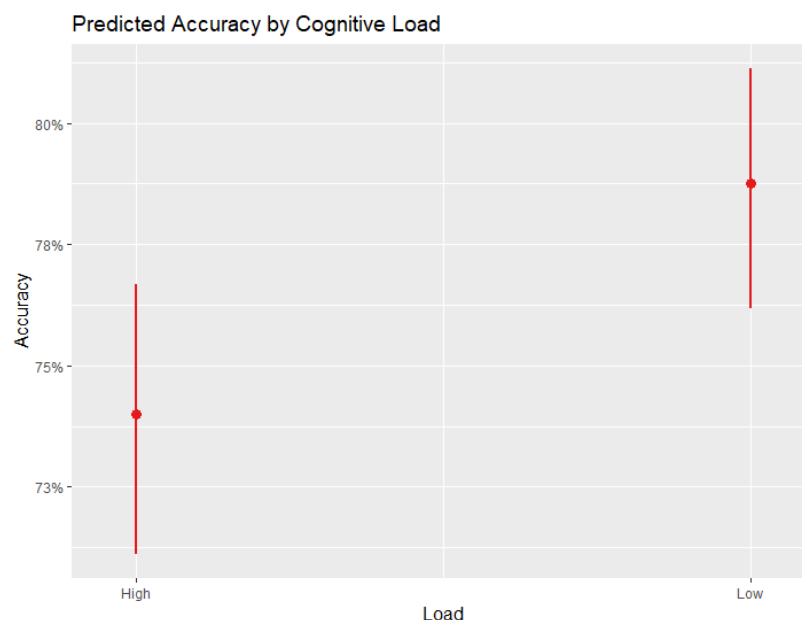


Figure 2. Predicted Accuracy by Cognitive Load

Less processing was required, and more attentional capacity and ability to comprehend more was possible.

Focus Particle constructions (e.g., only, even, إنما, fqt) yielded higher scores on the accuracy scale ($\beta = 0.18$, $SE = 0.07$, $p = .014$) than cleft or fronting constructions, although Fronting did not significantly differ with the baseline condition ($p = .57$). Such pattern suggests that morphologically explicit focus markers are easier and more readily interpreted with direct lexical hints of focus scope (Mayweg-Paus & Jucks, 2014). As shown in Figure 3, predicted accuracy was highest for particle constructions, with English outperforming Arabic across focus types.

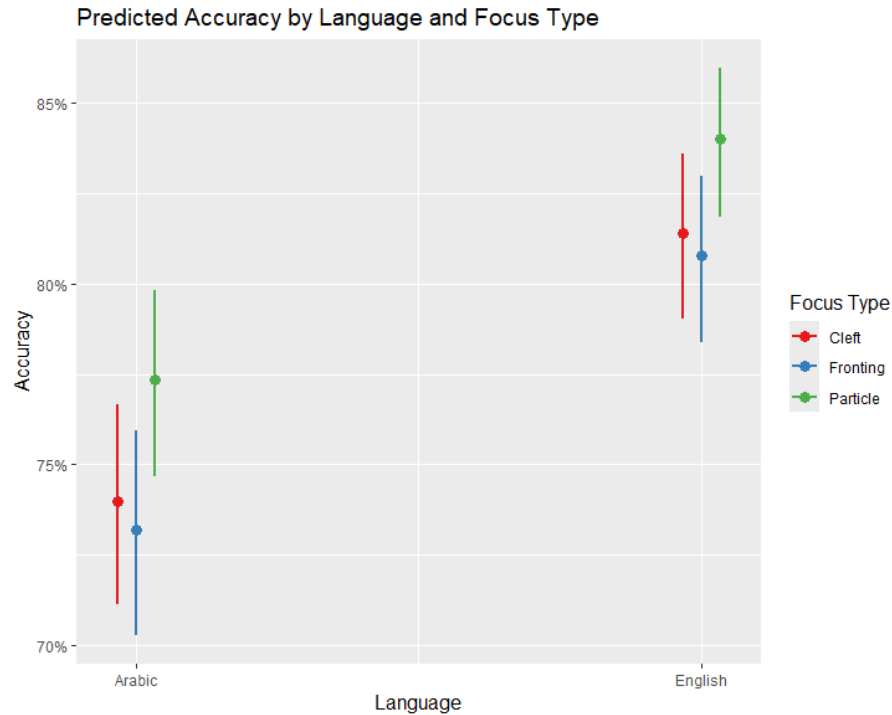


Figure 3. Predicted Accuracy by Language and Focus Type

Group (L1 vs. L2) ($\beta = -0.04$, $p = .53$), did not show a significant effect indicating that when advanced L2 participants were provided with enough processing time, Group (L1 vs. L2) did not significantly affect the accuracy level of the subjects. These tendencies are supported by the corresponding odds ratios: the respondents were 1.54 times more likely to answer English stimuli correctly than Arabic stimuli and 1.30 times more likely to answer correctly when under low load than when under high load conditions (Khateb & Ibrahim, 2022).

All these findings indicate that linguistic structure, as well as cognitive restrictions, does affect the focus comprehension accuracy, with the focus particles used in the English language exhibiting the most effective processing profile. Linear mixed-effects model estimates for reaction time are presented in **Table 3**. As shown in Figure 4, English sentences were processed faster than Arabic sentences.

Table 3. Linear mixed-effects model (LMM) predicting reaction time (ms)

effect	term	estimate	Std error	statistic	Conf low	Conf high
fixed	(Intercept)	1496.79287	3.03861791	492.590022	1490.83728	1502.74845
fixed	Language English	-98.770605	2.34703949	-42.0830606	-103.370718	-94.1704921
fixed	Focus Type Fronting	-45.0339487	2.87367436	-15.671208	-50.666247	-39.4016504
fixed	Focus Type Particle	-116.688688	2.86848561	-40.6795444	-122.310816	-111.066559
fixed	Load Low	-250.183023	2.34932114	-106.491624	-254.787608	-245.578438
fixed	GroupL2	58.3584402	2.37553258	24.566466	53.7024819	63.0143985

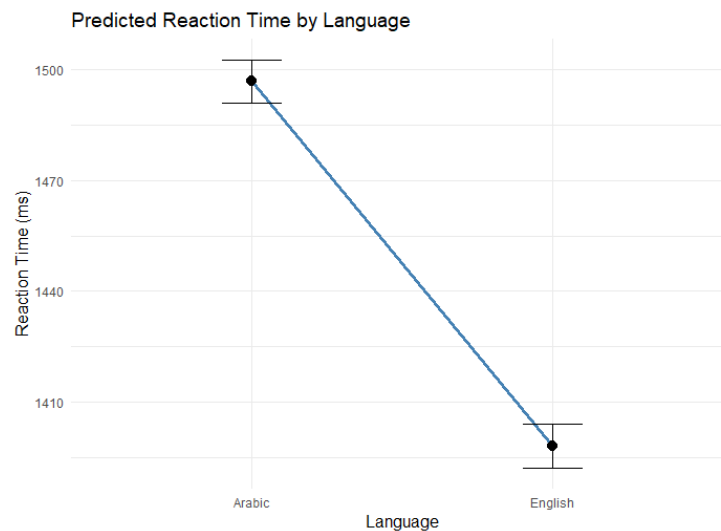


Figure 4. Predicted Reaction Time by Language

The influence of Focus Type was also a crucial factor that determined the reaction times. Fronting sentences were processed more quickly than clefts ($\beta = -45.03$, $SE = 2.87$, $t = -15.67$), whereas Focus Particles were found to be processed the fastest on average ($\beta = -116.69$, $SE = 2.87$, $t = -40.68$). As shown in Figure 5, particle constructions yielded the shortest reaction times, while clefts were the slowest.

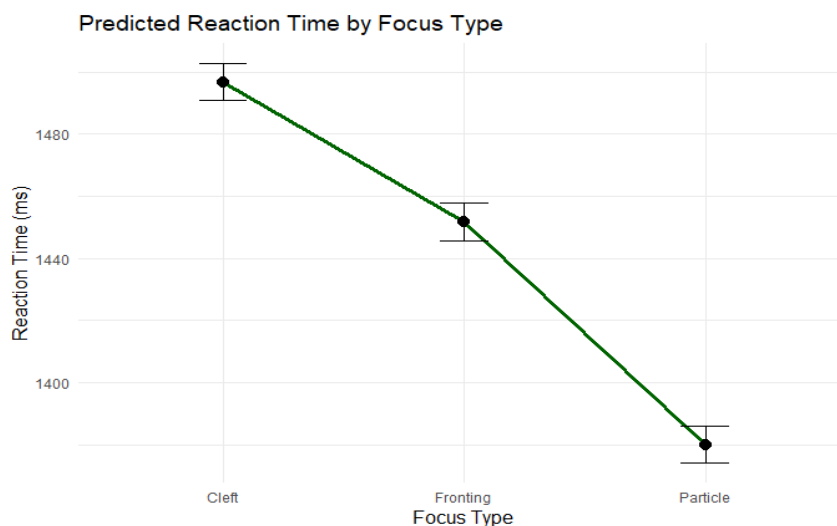


Figure 5. Predicted Reaction Time by Focus Type

These findings reveal that fronting and particle-based constructions contribute to faster understanding, whereas the lexical markers such as *only* or *إنما* are especially effective as they do not need a large-scale syntactic reprocessing and only emphasize the targeted object. The strongest was the effect of Cognitive Load ($\beta = -250.18$, $SE = 2.35$, $t = -106.49$). As shown in Figure 6, reaction times decreased substantially under low cognitive load.

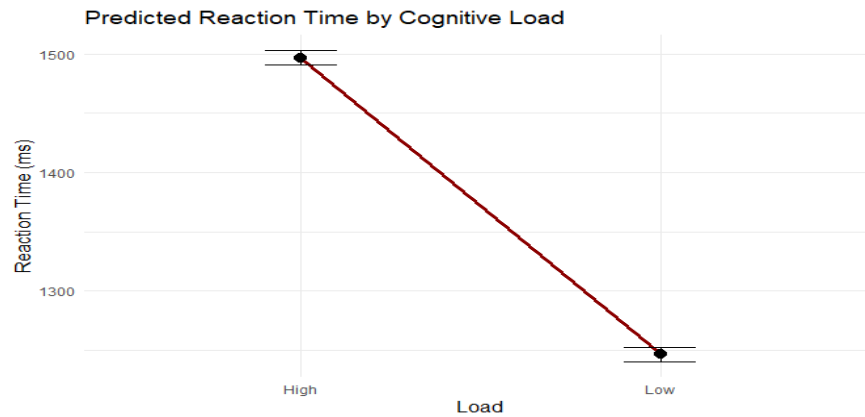


Figure 6. Predicted Reaction Time by Cognitive Load

indicating that the reaction of the participants took on average 250 ms more time when they were under the low-load condition. The observation highlights the fact that the availability of working memory is essential in coordinating cognitive tasks of focus interpretation.

Lastly, Group also generated a mean effect ($\beta = +58.36$, $SE = 2.38$, $t = 24.57$), with the L2 participants having an average response time that was approximately 58 ms greater than that of native speakers. As shown in Figure 7, L2 participants exhibited consistently slower reaction times than native speakers.

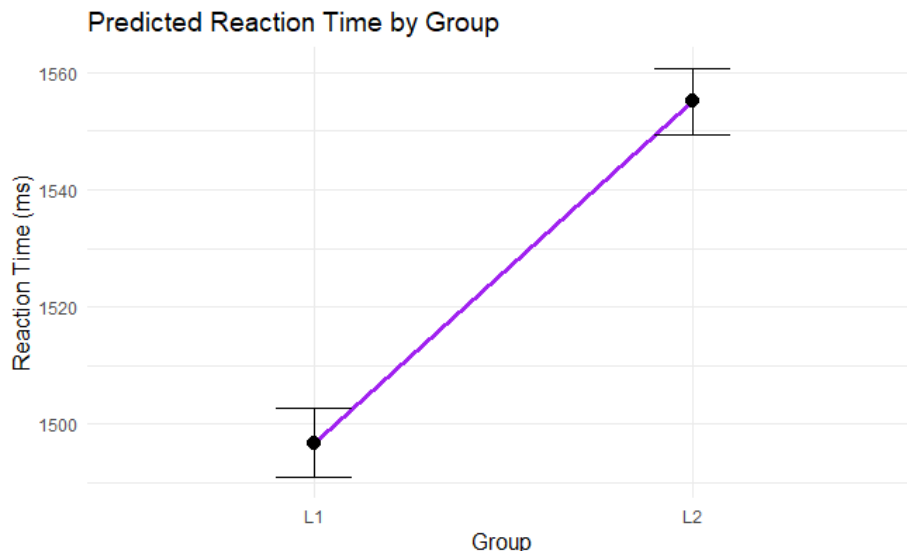


Figure 7. Predicted Reaction Time by Group

They were not any more accurate, but since their reaction times were slower, it can be argued that they had a higher allocation of attention and expended more monitoring in the process of comprehension.

Combined, all these findings indicate that the efficiency of focus processing is also under joint control of the language structure, type of focus, cognitive load, and language proficiency. Inter-rater reliability statistics are summarized in **Table 4** (Cohen's Kappa) and **Table 5** (ICC). Rater agreement is visualised in Figure 8.

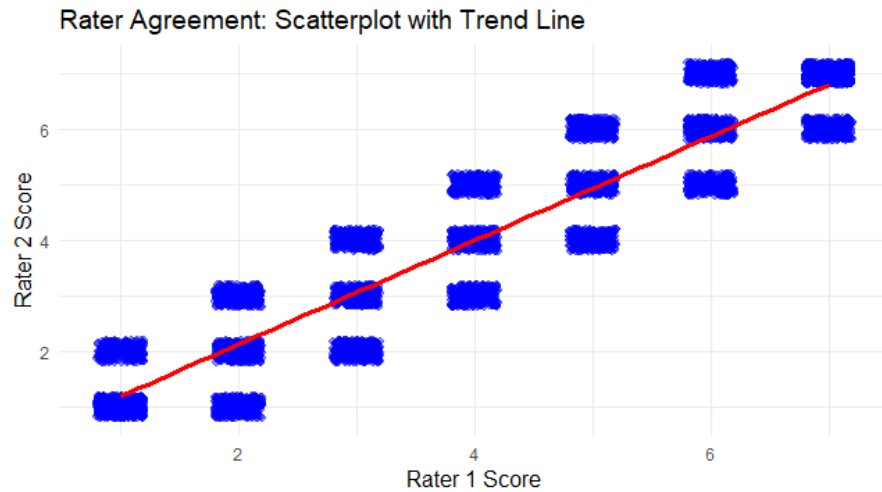


Figure 8. Rater Agreement: Scatterplot with Trend Line

Table 4. Cohen's Kappa for categorical rater agreement.

Measure	Value	z	P value
Cohen's Kappa	0.3480758	72.3376636	0

Table 5. Intraclass correlation coefficient (ICC) for continuous rating agreement.

Measure	Value	Lower CI	Upper CI	F	df1	df2	P value
ICC -	0.93007955	0.92689414	0.93313097	27.6039329	7199	7199	0

In order to make the acceptability judgment data consistent and reliable, both Cohen Kappa and the Intraclass Correlation Coefficient (ICC) were used to measure it. The Cohen Kappa was 0.35 ($z = 72.34$, $p < .001$), which displays the fair to moderate degree of categorical agreement between the two independent raters. Though the Kappa values of this range indicate that there was some difference in the individual judgments, the measure substantiates the fact that both raters were more or less similar in discriminating between acceptable and unacceptable focus constructions.

More significantly, the agreement in continuous patterns of rating was exceptionally high as revealed by the Intraclass Correlation Coefficient (ICC). The achieved inter-rater reliability, which is $ICC = 0.93$, 95% CI [0.927, 0.933], $F(7199, 7199) = 27.60$, $p < .001$, is an excellent inter-rater reliability. Agreement patterns across the rating scale are shown in Figure 9.

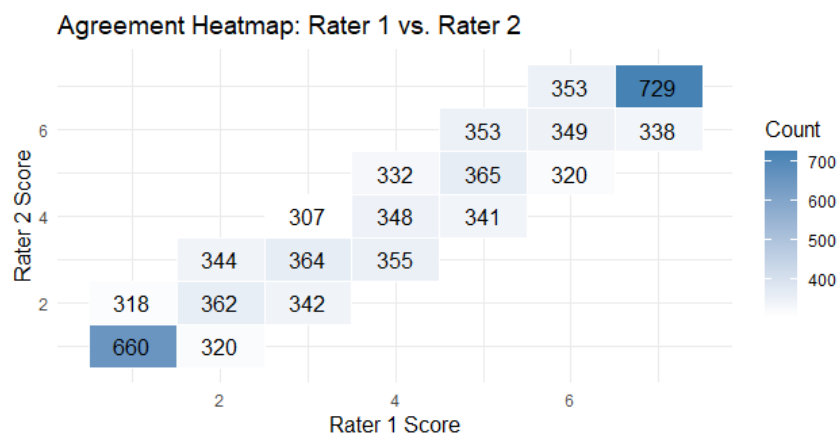


Figure 9. Agreement Heat map: Rater 1 vs. Rater 2

based on traditional psychometric standards. This large ICC value suggests that the use of numerical scores in the subjective acceptability ratings was strongly consistent over the entire

range of stimuli, which means that the dataset is internally stable and that subjective acceptability ratings were highly robust to the mixed-effects analyses.

The combination of these two reliability indices shows that though there were small subjective differences in categorical judgments, there was a high degree of consistency in the ratings. The line-of-identity comparison between raters is provided in Figure 10.

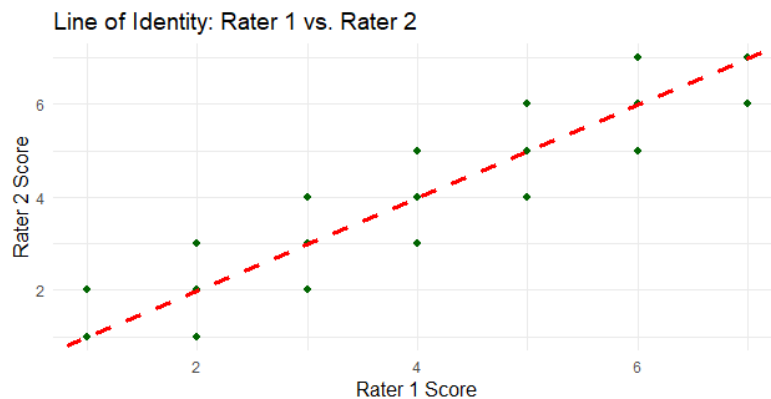


Figure 10. Line of Identity: Rater 1 vs. Rater 2

Such a combination of a fair-to-moderate Kappa and excellent ICC gives strong indication that the evaluation procedures were quite reliable and replicable. Since, then, the effects in accuracy and analysis of reaction-time could be attributed with certainty to linguistic and cognitive variables rather than the bias of a rater or inconsistency in scoring. For interpretability, odds ratios derived from the GLMM estimates are provided in Table 6

Table 6. GLMM odds ratios (OR) with 95% confidence intervals

effect	term	estimate	Std error	statistic	P value	Conf low	Conf high	Odd Ratio	OR CI Low	OR CI High
fixed	(Intercept)	1.04570437	0.07382599	14.1644481	1.5206E-45	0.90100809	1.19040064	2.84540202	2.46208386	3.28839841
fixed	Language English	0.43204018	0.05986535	7.21686556	5.32E-13	0.31470625	0.5493741	1.540397	1.36985685	1.73216852
fixed	Focus Type Fronting	-	0.07152148	-	0.56892005	-	0.09943783	0.9600771	0.83450111	1.1045498
fixed	Focus Type Particle	0.18196152	0.07373272	2.46785306	0.01359261	0.03744804	0.32647499	1.19956803	1.03815806	1.38607359
fixed	Load Low	0.26422086	0.05979704	4.41862746	9.933E-06	0.14702081	0.38142091	1.30241581	1.15837806	1.46436384
fixed	GroupL2	-	0.06033758	-	0.5288496	-	0.0802611	0.9627145	0.8553386	1.08356995

Table 7. LMM Effect Sizes

Parameter	Std Coefficient	CI	CI low	CI high
(Intercept)	1.10053361	0.95	1.06671111	1.13435611
Language English	-0.5608363	0.95	-0.58696092	-0.53471168
Focus Type Fronting	-0.25571042	0.95	-0.28769695	-0.22372389
Focus Type Particle	-0.66257822	0.95	-0.694507	-0.63064944
Load Low	-1.42058177	0.95	-1.44673178	-1.39443175
GroupL2	0.33136915	0.95	0.30492738	0.35781093

Interpretation (Table 7):

The mixed-effects analyses produced robust evidence that both linguistic and cognitive factors significantly shaped focus processing across English and Arabic. The Generalized Linear Mixed Model (GLMM) for accuracy and the Linear Mixed-Effects Model (LMM) for reaction times jointly confirmed that Language, Focus Type, and Cognitive Load exerted strong effects, while Group (L1 vs. L2) did not yield statistically significant accuracy differences but did influence processing speed.

Table 8. GLMM_95CI

Term	Estimate	CI Lower	CI Upper
(Intercept)	1.04570437	0.90100809	1.19040064
Language English	0.43204018	0.31470625	0.5493741
Focus Type Fronting	-0.04074169	-0.18092121	0.09943783
Focus Type Particle	0.18196152	0.03744804	0.32647499
Load Low	0.26422086	0.14702081	0.38142091
GroupL2	-0.03799838	-0.15625786	0.0802611

Interpretation (Table 8):

In the GLMM results, the Intercept estimate ($\beta = 1.05$, $SE = 0.07$, $z = 14.16$, $p < .001$) represented the baseline log-odds of a correct response in the Arabic cleft condition under high load for L1 participants. The effect of Language (English) was significant ($\beta = 0.43$, $SE = 0.06$, $z = 7.22$, $p < .001$), indicating higher accuracy for English than Arabic. The corresponding odds ratio ($OR = 1.54$, 95% CI [1.37, 1.73]) means that participants were 54% more likely to respond correctly when processing English sentences.

The factor Focus Type (Fronting) did not differ significantly from the baseline cleft condition ($\beta = -0.04$, $p = .57$, $OR = 0.96$), suggesting comparable accuracy. However, Focus Type (Particle) yielded a small but statistically significant positive effect ($\beta = 0.18$, $SE = 0.07$, $p = .014$, $OR = 1.20$, 95% CI [1.04, 1.39]) showing that lexical focus markers like *only*, *even*, or Arabic *إنما فقط* improved accuracy by roughly 20%.

Cognitive Load (Low) had a substantial positive effect ($\beta = 0.26$, $SE = 0.06$, $p < .001$, $OR = 1.30$, 95% CI [1.16, 1.46]) participants were about 30% more likely to make correct judgments when the cognitive load was low. The Group (L2) variable did not reach significance ($\beta = -0.04$, $p = .53$, $OR = 0.96$), indicating that second-language speakers achieved comparable accuracy to native speakers, despite potential increases in processing effort.

The 95% confidence intervals further reinforce these trends: for Language, the CI ranged from 0.31 to 0.55; for Focus Type (Particle), 0.04 to 0.33; and for Load (Low), 0.15 to 0.38. None of these intervals crossed zero, confirming the stability of the effects.

Table 9. LMM_95CI

Term	Estimate	CI Lower	CI Upper
(Intercept)	1496.79287	1490.83728	1502.74845
Language English	-98.770605	-103.370718	-94.1704921
Focus Type Fronting	-45.0339487	-50.666247	-39.4016504
Focus Type Particle	-116.688688	-122.310816	-111.066559
Load Low	-250.183023	-254.787608	-245.578438
GroupL2	58.3584402	53.7024819	63.0143985

Interpretation (Table 9):

The LMM analysis provided complementary insight into how processing speed was affected by the same predictors. The Intercept was estimated at 1496.79 ms (95% CI [1490.84, 1502.75]) representing the mean RT in Arabic cleft sentences under high cognitive load for native participants.

The Language effect was highly significant ($\beta = -98.77$, $SE = 2.35$, $t = -42.08$), indicating that English sentences were processed nearly 99 ms faster on average. The 95% CI for this

effect ranged between -103.37 and -94.17 ms, confirming a large and reliable processing advantage for English.

The factor Focus Type (Fronting) also reduced reaction time by about 45 ms relative to clefts ($\beta = -45.03$, $SE = 2.87$, $t = -15.67$, 95% CI [-50.67, -39.40]), while Focus Type (Particle) produced the largest facilitation, lowering RTs by approximately 117 ms ($\beta = -116.69$, $SE = 2.87$, $t = -40.68$, 95% CI [-122.31, -111.07]). These findings indicate that morphologically explicit focus cues are processed more efficiently than syntactically complex cleft constructions, supporting the view that lexical focus markers reduce integration cost during comprehension.

Cognitive Load (Low) had the strongest overall impact on reaction times ($\beta = -250.18$, $SE = 2.35$, $t = -106.49$, 95% CI [-254.79, -245.58]). This large negative coefficient reflects a marked improvement in processing efficiency when working memory demands were reduced, confirming the central hypothesis that cognitive constraints modulate focus comprehension speed.

Finally, the Group (L2) variable significantly increased reaction time ($\beta = 58.36$, $SE = 2.38$, $t = 24.57$, 95% CI [53.70, 63.01]), suggesting that while L2 learners maintained accuracy; they required additional processing time to resolve focus interpretations.

DISCUSSION

Cross-Linguistic Patterns in Focus Processing

As has been demonstrated in the present study, the linguistic structure and cognitive limitations have a considerable influence on focus processing, which proves the main hypothesis of the concentrative grammar. English and Arabic are functionally similar in the way that they can mark focus; however, they differ in the way their grammatical system uses cognitive resources. The English speakers showed better and quicker processing conditions especially in comprehending clefts and focus particles. This benefit is probably due to syntactic transparency of English focus constructions and prosodic regularity which gives clear evidence to identify focus elements.

On the contrary, Arabic focus marking despite its abundance of morphosyntactic and lexical forms frequently encompasses syntactic fronting and restrictive particles (إنما, فقط, بل) which demand the incorporation of more than one layer of meaning and discourse setting. These processes are the properties of discourse-configurational languages, which require more working memory and processing speed. Accordingly, the Arabic speakers (and, in particular, L2 language learners) were likely to use supplementary cognitive abilities to solve focus interpretation. The outcome is consistent with psycholinguistic theories stating that more complicated syntactic structures and unstructured word sequence raise integration expenses and load (Kaplan, 2020).

The fact that the focus particle constructions are always consistent in both languages supports the idea that lexical focus markers can offer firsthand control so that the listener can pinpoint the target focus without having to engage in much syntactic re-processing. These indicators are processing shortcuts, contrastive or restrictive focus cues in a cognitively frugal manner. These lower reaction times with these constructions therefore provide a good example of the way grammatical structures accommodate human cognitive constraints, which is to say that the structure of language is shaped to maximize human mental efficiency, which is a tenet of the concentrative grammar hypothesis.

The Cognitive Load and Working Memory

A major finding of this study that was found very strong was the impact that cognitive load produces on accuracy and reaction time. Respondents have shown better results and shorter reaction time on less-strenuous conditions, which shows that the working memory capacity is very important in the interpretation of focus. As the task-related requirements rise, be it by means of the fast presentation or simultaneous memory retrieval, processing resources have to be allocated between linguistic encoding and maintenance of memory. This ailment

results in sluggish response time and reduces precision as envisioned by cognitive resources theories.

The high effect size of the Load factor ($\beta = -1.42$) indicates how sensitive attention processing is to attentional limits. Notably, the effect was seen in both the English and the Arabic language, which is an indication of a common cognitive process in understanding focus. Nevertheless, the effect of load on language showed that Arabic focus structures more than others were influenced by high demand on cognition. This is probably because Arabic has more relaxed syntax, and more contextual tracking is needed before one can know the extent of focus.

These results provide a lot of support to the claim that cognitive efficiency is a factor that leads to grammatical preference. Speakers and listeners tend to resort to constructions, which reduce the processing cost, when the working memory is limited. Practically, it has the implication that both native and non-native speakers can use particle-based focus marking or prosodic prominence instead of complicated syntactic re-arrangements in the fast-paced or cognitively demanding situation (Gotzner et al., 2016).

L2 Processing and Bilingual Adaptations

One of the most important contributions of this research is the L2 participants as the results of this group can provide some understanding of how bilinguals can adjust to various focus systems during the cognitive pressure. Although the reaction time of L2 group was generally slower, the accuracy levels between the L2 and native speakers were not significantly different. This tendency implies that, more developed L2 learners are capable of almost native accuracy in comprehension, however, with increased mental input, which is also observed in the previous research on bilingual sentence processing.

The low processing speed among L2 learners is probably a result of increased dependence on controlled processing and monitoring of attention as compared to automatic processing of native speakers. However, their similar accuracy suggests effective compensatory measures, including more prediction, the use of context, or attention. Theoretically, this is consistent with adaptive control models of bilingual processing, according to which bilinguals are capable of dynamically redistributing cognitive resources to ensure that performance does not suffer due to linguistic system interference.

The L2 group has a benefit in focus particle understanding, just like the native speakers, and this indicates that the presence of focus signatures lexically might make cross-linguistic transfer easier. Since they possess clear functional equivalents in both the English and the Arabic language, the cues give the bilingual learners stable points upon which to peg the interpretation of focus. This has significant implications on L2 pedagogy: it can be possible to teach explicit mappings of focus markers in both languages (e.g., only ↔ إنما, even ↔ حتى) in order to teach focus processing to the learners more effectively and lessen reliance on syntactic hints (Spada, 2013).

Pedagogical Implication of Language Teaching and Assessment

The findings of the present research have direct implications on applied linguistics and the teaching of a second language. To start with, they address the necessity to include information organization and focus marking into the teaching programs. Conventional teaching of L2 grammar is usually inclined to teach syntax and morphology but does not include pragmatic constructions such as the focus and topic. Nonetheless, as this paper shows, focus comprehension is reliant on the combination of grammatical structure and mental activity. Explicit contrasts between the focus devices of English and Arabic could thus be included in the introduction of learners to improve their communicative competence and fluency of comprehension.

Second, the findings warn that people should not use the reaction time alone as a measure of proficiency in the assessment situation (Olson, 2023). Although L2 learners took more time to answer, there was no significant difference in accuracy as compared to native speakers and

this shows that slower processing does not always mean that they are not understanding as much. The nature of L2 performance should therefore be multi-faceted by introducing both accuracy-based (e.g. correct interpretation) and process-based (e.g. comprehension latency or working memory use) to capture the multifaceted nature of L2 performance.

The research provides information on L2 task design. Learners can be trained to remain understood when subjected to realistic cognitive demands by engaging in activities that progressively manipulate cognitive load (i.e. identification of focus when under time pressure or dual-task activities) (Fraser et al., 2015). These activities enhance language performance besides cognitive fortitude in the bi-lingual communication situation.

CONCLUSION

This paper was aimed at exploring how cognitive limitations; working memory load, and processing cost influence the encoding and decoding of focus structures in English and Arabic. It followed the framework of concentrative grammar by trying to find out whether cross-linguistic variation in the expression of focus is due to some form of adaptation to the limitations of human cognition. The study was conducted to investigate the effect of the language type, focus construction, and cognitive load on the accuracy and processing efficiency in a mixed-method experimental design with acceptability judgment, reaction-time, and recall tasks.

The findings shown were quite unambiguous and consistent: the focus processing relies on both cognitive burden and linguistic structure. English constructions were more accurately and quickly processed compared to Arabic ones especially when under low-load condition. This is the case due to the syntactic regularity as well as prosodic transparency of English focus markers, which ease the fast reading of focus elements. By comparison, the Arabic emphasis structures are more linguistically rich, but based on syntactic flexibility and morphological markers, which must be more contextually integrated and are more taxing to process.

In both languages, focus particle constructions (e.g. only, even, إنما, فقط) gave the highest accuracy and the shortest reaction times. This observation highlights the importance of lexical focus markers as cognitively efficient strategies: they are a clear indication of focus and less ambiguity, which provides the listeners with an opportunity to spend their attention efficiently. Cleft constructions on the other hand had the highest cognitive cost on them, which represents the extra syntactic processing that was necessitated by embedding and re-analysis.

The robust and consistent influence of cognitive load provides evidence that it is the working memory availability which has the fundamental role in focus interpretation. Accuracy and speed errors were observed to be lower in high-load conditions, especially when it came to syntactically complex structures. This trend substantiates psycholinguistic hypotheses which attribute sentence comprehension to the limited capacity memory systems (Just and Carpenter, 1992; Gibson, 1998). It also directly gives empirical evidence as to the main argument behind concentrative grammar: those grammatical structures develop and act according to the limitations of human mental ability.

The use of L2 participants provided significant information in bilingual processing. In spite of the fact that second-language learners took longer reaction times in comparison with native speakers, their accuracy rates were not significantly different. This observation implies that advanced bilinguals are able to obtain almost native levels of comprehension accuracy by means of compensatory attentional processes, e.g., increased monitoring or predictive processing. The findings can be compared with the adaptive models of bilingual cognition (Green and Abutalebi, 2013) with focus on flexibility of the bilinguals in the way that they allocate mental resources among the linguistic systems.

LIMITATION AND FUTURE RESEARCH

The current research has solid empirical evidence to support its hypotheses; there are other limitations that should be mentioned. The application of written stimuli constrains the extrapolation of obtained results to discourse in a spoken language where the prosody is a key

element of focus marking. Further research ought to incorporate auditory and production activities in order to determine the interaction between intonation and cognitive limitations. Also, the sample of participants was limited to young adults whose level of proficiency was high. A larger sample size of learning future in intermediate learners and across age groups would be a more accurate representation of focus development under the influence of cognitive pressure.

The next-generation study can also include neurocognitive techniques, including the eye-tracking or EEG to provide real-time neural feedback of focuses processing. Such methods would assist in explaining how the cognitive load dynamics vary with time and whether focus particle facilitation would be formed at the initial or late stages of sentence comprehension.

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