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Research Paper

The Role of Linguistic Knowledge and Cognitive Processing in Foreign Language Fluency

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Abstract
Fluency is a key element in the development of foreign language and assesses the learner's proficiency and competence in speech. One way to examine this is through utterance and cognitive fluency, aspects personal to the speaker. Utterance fluency pertains to the timing, pauses, and correction features of spoken utterances, whereas cognitive fluency relates to the speaker's ability to engage the fundamental cognitive processes needed for smooth speech production. The main goal of the current mixed method study is to investigate the relationship between cognitive and utterance fluency and how grammatical knowledge and proficiency affect a particular area of linguistic knowledge. Drawing on Albino's (2017) framework, a quasi-experimental design was employed using video clips and semi-structured interviews. The study recruited 42 Iranian learners of English who were at the higher-intermediate level of language learning. The intervention took place over eight weeks, with the students attending 2 x 40-minute sessions per week. After approving the normal distribution of the collected data, t-test and Pearson correlation were used to analyze the data. The analysis identified several statistically significant relationships between fluency processing, syntactical knowledge, and cognitive processing. The analysis also revealed that cognitive processing impacted utterance fluency, and processing skills impacted syntactical structure knowledge. The research supports Kahng's

(2014, 2020) perspectives, demonstrating that grammatical knowledge and proficiency significantly impact linguistic knowledge. Further, the results suggest value in providing learners with exposure to real-world scenarios, which was viewed as effective in supporting fluency.

***Keywords**:* Fluency, Utterance, Cognition, Syntactical structure knowledge, L2
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1. Introduction

One of the most important components of foreign language acquisition (FLA) is fluency, a sign of communicative competence and target language proficiency (Kahng, 2020). The ability of a speaker to express ideas and thoughts clearly through speech is reflected in their utterance fluency, which is defined as their ability to speak coherently and smoothly. Despite its acknowledged significance, the scholarly community continues to debate the definition and measurement of fluency in foreign language acquisition. Modern research recognizes the multidimensional nature of fluency, encompassing cognitive, linguistic, and perceptual components, in contrast to traditional conceptions of fluency, which frequently concentrate on surface-level characteristics like speech rate and smoothness of delivery (Segalowitz, 2010).

Fluency in SLA can be analyzed into two distinct aspects: Utterance and cognitive fluency. These aspects each provide insight into a different facet of language production and processing (Magne et al., 2019). Utterance fluency refers to "the temporal, pausing, and repair characteristics of utterances" (Kahng, 2020, p. 458) while cognitive fluency is "about the speaker's capacity to utilize the underlying cognitive processes responsible for fluent speech production" (Kahng, 2020, p. 458). The ability of a speaker to express

ideas and thoughts clearly through speech is reflected in their utterance fluency, which is defined as their ability to speak coherently and smoothly. Conversely, cognitive fluency explores the fundamental cognitive processes—such as lexical retrieval and syntactic processing—that underlie language production. Lexical retrieval refers to the process of selecting a word from the lexicon that most accurately represents a specific concept and syntactic processing involves the cognitive mechanism through which individuals formulate the structural framework of a sentence in accordance with the grammatical conventions of a language (Zhang et al., 2025). Deciphering how these fluency dimensions interact is crucial to understanding the complexities of foreign language acquisition and developing instructional strategies that support language learners' development of fluency.

Segalowitz (2010) proposed a triadic model of fluency—cognitive, utterance, and perceived fluency—emphasizing fluency as a multidimensional construct. Kormos (2006) similarly highlighted the psycholinguistic processes underlying L2 speech production, such as conceptualization, formulation, and articulation, within a broader speech processing model. Recent perspectives, including Suzuki and Kormos (2023), further underscore that cognitive fluency is not unitary but composed of distinct sub-components such as lexical access speed, syntactic processing efficiency, and executive control. This study aligns with these conceptualizations by examining the intersection of these processes in relation to grammatical knowledge and L2 utterance fluency.

Despite numerous studies investigating various facets of fluency, significant gaps persist in understanding the underlying mechanisms that contribute to L2 fluency. Specifically, research has yet to fully elucidate how

grammatical knowledge and proficiency impact specific areas of linguistic competence, such as syntactical structure knowledge, and their subsequent influence on cognitive and utterance fluency (Magne et al., 2019). Furthermore, the exploration of these dynamics still needs to be explored among learners whose L1 differs significantly from the target language, such as Persian speakers acquiring English (Olkkonen & Mutta, 2019).

The current study seeks to bridge this gap by investigating how linguistic knowledge and processing skills influence cognitive and utterance fluency in the context of foreign language acquisition. Through an analysis of the relationship between fluency processing and knowledge of syntactical structure and processing abilities, this study aims to examine how linguistic knowledge and processing skills influence cognitive and utterance fluency among Iranian English language learners. The significance of this research stems from its ability to provide fresh perspectives to the theoretical and applied fields of foreign language learning.

2. Literature Review

Early foundational work by Lennon (2000) established distinctions between narrow and broad fluency, framing fluency as both measurable and perception-based. Subsequent studies, such as Kahng (2020), have built on this by empirically validating how different subcomponents of fluency (e.g., cognitive vs. utterance) contribute uniquely to L2 proficiency. The present review is structured thematically by distinguishing between utterance fluency, cognitive fluency, and their interactions, enabling a more critical synthesis of the literature rather than a chronological summary.

2.1 Utterance Fluency

The temporal values of speech that represent how a fundamental cognitive process functions are referred to as utterance fluency (Segalowitz, 2010). This is especially crucial when considering the idea of perceived fluency,

which refers to the fact that learners base their conclusions about a speaker's cognitive fluency on how smoothly they perceive the speaker's utterance (Segalowitz, 2010). The relationship between utterance and perceived fluency was examined by Préfontaine (2010), who pointed out that temporal variables can be extracted and compared with holistic ratings across tasks to achieve the intricacy of these dynamics.

Multiple studies established that the quality of speech delivery shows a strong connection with the mental processing speed (Kahng, 2020; Pérez Castillejo, 2019). The study of L2-specific features along with L2 speech production cognitive processes represents a crucial foundation, according to Derwing (2017). The current research examines solely the impact of linguistic knowledge along with processing skills on L2 acquisition instead of investigating L1 cognitive processes and L2 fluency interactions according to Duran-Karaoz and Tavakoli (2020). While utterance fluency reflects a speaker's ability to produce smooth and coherent speech, it is closely linked to cognitive fluency, which involves the underlying mental processes that facilitate language production. The following section explores how these two aspects of fluency interact and influence L2 learning outcomes. Whereas speech rate may indicate general language processing efficiency (De Jong et al., 2015), repair-based measures provide insight into breakdowns in lexical or syntactic planning, often driven by working memory limitations (Kormos, 2006). This distinction supports a multi-component view of fluency (Suzuki & Kormos, 2023).

2.1.1 The Role of Linguistic Knowledge and Cognitive Processing in L2 Fluency Development

It is crucial to define L2 fluency, comprehend the connection between utterance and cognitive fluency, and acknowledging the influence of specialized language knowledge is crucial. In this context, linguistic

knowledge is the unconscious grammar knowledge that enables a speaker to use and understand a new language effectively (Asmari & Javid, 2018). The term is sometimes used interchangeably with grammatical competence. However, it should be recognized that at its core, linguistic knowledge refers to innate understanding and processes that support the ability, at a subconscious level, to match sounds, meanings, and overall utterances to achieve comprehension for both the speaker and listener (Anckar & Veivo, 2019; Lintunen et al., 2020). One theory, usage-based language acquisition, suggests that experiential communication exchanges lead to embedding cognitive processes and, thus, linguistic knowledge, which can then be used for interaction. A second theory is based on psychological disciplines and suggests that the retrieval of linguistic knowledge occurs when the same conditions exist as those experienced during learning.

Regarding a theoretical understanding of cognitive and utterance fluency, the general perspective is that embedded linguistic knowledge engages the cognitive processes necessary for retrieving knowledge and, thus, achieving fluency in L2. At a practical and real-world level, however, there is an indication of the role of social interaction during learning, meaning that achievement of fluency is dynamic and ongoing. Therefore, this indicates that L2 utterance fluency and, by association, cognitive fluency relies on linguistic knowledge and the cognitive processes that allow for the retrieval of this knowledge. As such, during learning, the cognitive processes and linguistic knowledge of the L1, which will be more firmly embedded in the learner's mechanisms and processes, are likely to impact their utterances in L2, leading to errors or errors or failures in adequate fluency.

2.2 Fluency Classification and its Role in Second/Foreign Language Processing

According to Skehan et al. (2016), clause level, speed, and discourse should be separated when classifying different aspects of fluency in utterances. According to this viewpoint, pausing and clause processing are related to the lexical decisions made for a clause. On the other hand, discourse-level processing is at a higher level. It relates to the challenges of joining linguistic units, which means that any dysfluency is the result of issues in planning at the formulation level. While Skehan et al.'s (2016) work offers some interesting conceptual notions of how to evaluate fluency, it is, at this stage, not thoroughly tested. In the current study, utterance fluency will be examined from the standpoint of Segalowitz (2010), who classified it into three categories: breakdown, speed, and repair. In other words, the flow of speech (breakdown), the number of syllables per second (speech) and the number of false starts, repetitions, or corrections (repair). At the same time, consideration will be given to pure fluency, which is focused on the underlying processes of speech (Huensch & Tracy-Ventura, 2017) rather than composite measures (De Jong et al., 2015). This is because these are more perceptual, judged by human factors, and influenced by individual speaking styles.

The work of Tilsen (2018) provides the foundation for understanding fluency. It posits that speakers go through three stages: articulation, formulation, and conceptualization. First, the speaker creates a pre-verbal message, which they formulate internally by encoding grammatical and phonological processes before converting to articulation. In L2 fluency, Kormos (2006) suggests similar processes at work but emphasizes that cross-linguistic influences impact these factors and that L2 processing is not generally automatic in learners. This means that a new "lexical store" may be

necessary to act as a place to process knowledge of phonological and syntactical rules to conceptualize, formulate and articulate the desired utterance fluently and correctly.

Automatic generation of speech is vital to understanding the role of linguistic knowledge and its connection to cognitive and utterance fluency in L2. Tavakoli (2019) indicates that the differences in automatic production are vital for variations in L1 and L2 fluency. Therefore, understanding how L2 speech is conceptualized at a cognitive level and then formulated and articulated requires knowledge of the L1 and L2 relationship, the impact of individual differences, and overall proficiency. Studies in this area (De Jong et al., 2015; Derwing et al., 2009; Huensch & Tracy-Ventura, 2017; Towell & Dewaele, 2005) suggest that pausing reduces as proficiency increases, indicating an improvement in automaticity. In addition, in the early learning stages, levels of fluency are not impacted by the closeness of the L2 to L1. However, as proficiency increases, the differences can be reduced more effectively than where there are significant variations. This can also lead to greater exposure to L2. This could have considerable relevance in the present study, which focused on Iranian learners of English, given the considerable variations between Persian and English (Ebadi & Asakereh, 2017; Ghasemi & Hashemian, 2016; Heidarian & Heydon, 2025; Khani & Behruz Lotfi Gaskaree, 2023).

Specifically, it has been noted by De Jong et al. (2015) and Huensch and Tracy-Ventura (2017) that identifying unique L1 speaking styles is crucial before evaluating L2 fluency. Both works reported that the types of L2 fluency errors, accounting for language proficiency levels, particularly concerning pausing and speed rate of speech, were significantly correlated with L1 fluency behaviors. In the present study, this means that L1 fluency styles were controlled when evaluating the relationships between linguistic

knowledge and cognitive and utterance fluency, as this allowed for the measurement of proficiency in L2 specifically and limited the potential of L1 to influence production.

2.2.1 Conceptual Fluency Theory

The ability to use and comprehend a language's concepts, or linguistic knowledge, is referred to as conceptual fluency. In this respect, conceptual fluency is related to the ability to automatically encode at the pre-verbal and formulation stages of utterance. According to (Boussaid, 2023) who first introduced conceptual fluency, learners need to understand and learn how the L2 encodes based on metaphorical reasoning, which, like grammatical and lexical knowledge, is automatic in the L1. However, developing this ability in L2 requires either immersion or contact with native speakers, so there are frequent errors in L2 learners' productions who have not yet developed the ability to encode the L2 fluently (Graf et al., 2018). Indeed, research results suggest that L2 learners develop a common underlying conceptual base in the learning process and not two grammars for the different languages (He & Chen, 2025; Ustinova et al., 2023). Accessing the correct information from this conceptual base leads to their overall fluency levels. This aligns with Boussaid's metaphorical basis of conceptual fluency (2023) and again highlights the essential connections between cognitive and utterance fluency and the impact of the L1 processing or automatic understanding reflective of fluency in the L1.

Processing skills in this study are operationalized following Segalowitz's (2010) framework as cognitive mechanisms underpinning fluency, specifically lexical retrieval speed, syntactic parsing, and working memory. These correspond to Levelt's (1989) model of speech production, where conceptualization, formulation, and articulation stages are supported by real-time cognitive processing. Furthermore, Skehan (2009) highlights how

fluency arises from task performance factors, including attention allocation, processing efficiency, and linguistic repertoire, which we interpret as integral to utterance fluency.

2.3 Purpose of the Study

This study's primary goal was to investigate, as proposed by Kahng (2014, 2020), the effects of grammatical knowledge and proficiency on cognitive and utterance fluency in foreign language learning and how these factors influence the connection between utterance and cognitive fluency. The present study examined and identified how grammatical knowledge levels impact learners' overall fluency in L2. At the same time, the work recognized the influence of L1 fluency factors on L2 fluency performance, particularly concerning the creation of a common conceptual base and how this impacts the ability to conceptualize and formulate fluent utterances accurately.

Initial findings suggest that as learners focus on grammatical accuracy and syntactical complexity, their utterance fluency may decrease due to increased cognitive effort in structuring sentences correctly (Brown et al., 2019; Felker et al., 2019; Heller et al., 2017). However, there is a gap in understanding how this can be addressed, particularly with learners whose L1 is very different from English (Olkkonen & Mutta, 2019), for example, Persian speakers Research Questions

The main questions for the present research include:

1.Does cognitive processing (complexity of structure) impact utterance fluency for L2?

2.What is the impact of processing skills such as lexical retrieval, syntactic parsing, and working memory on the syntactical structure knowledge in L2?

3.Is there a relationship between cognitive processing and syntactical knowledge in L2?

4.Is there a relationship between fluency processing and syntactical knowledge in L2?

3. Method

A case study design was adopted, based on the study by Albino (2017), with the research instruments being video clips and interviews recorded with the participants. During the intervention, the participants were asked to watch some videos on English cultural situations to encourage conceptualization in the L2 (Saeedi Talab & Salehabadi, 2019) rather than L1 and identify whether the learner's fluency improved through discussion and debate about the descriptions. This study received ethical approval, ensuring compliance with research ethics guidelines. Participation was strictly voluntary, and all participants provided informed consent after being fully briefed on the study's aims, procedures, and duration. Anonymity and confidentiality were maintained by assigning coded identifiers instead of personal details. Data collection lasted 8 weeks, with participants having the right to withdraw at any stage without consequences.

3.1 Participants

Using convenience sampling, data were gathered from 42 Persian students in a secondary school who were classified as upper-intermediate English learners based on their performance on a standardized TOEFL-PBT test. The rationale for choosing this group was that they would understand everyday language at the textbook level with minimal grammar or vocabulary errors and could easily produce utterances. At the same time, it was considered that their level of conceptual fluency would not be advanced. The overall number

of students enrolled at the upper-intermediate level was 45 and three of the students did not sign the written consent form from the onset of the study. Therefore, the study was conducted with 42 participants based on Krejcie and Morgan's (1970) sample size formula.

The participants were all females aged 20–27 (M=23.48, SD= 1.71) studying English as a foreign language. None of them had ever visited or resided in an English-speaking country to avoid the influence of these factors and had been studying English for 6-10 years. They were learning the language at a higher-intermediate level. A sample TOEFL-PBT (Test of English as a Foreign Language – Paper-Based Test) from ETS (Educational Testing Service) was used to assess the participants' level of language proficiency at the beginning of the study

3.2 Data Collection

The students participated in two 40-minute weekly sessions for the intervention, which lasted eight weeks. The students were shown video images depicting English-language cultural communication scenarios during the sessions, and they were then asked to discuss the events in the image for two to three minutes on their own. The sessions were videotaped with consent and then transcribed and analyzed. Utterance fluency was assessed using three subdimensions following Segalowitz (2010): speed (measured as syllables per second), breakdown (number and duration of pauses, with >250ms used as the threshold for meaningful pauses), and repair (frequency of repetitions, false starts, and self-corrections). These metrics were selected to align with recent practices in fluency measurement (e.g., Tavakoli & Uchihara, 2020). The LLAMA tests and working memory span tasks were selected for their established validity in assessing linguistic aptitude and

executive functioning in SLA contexts (Meara, 2005; Miyake & Friedman, 1998).

Before the intervention, all the students were given oral texts based on the multiple-choice grammatical tests, which have increasing complexity and were designed to identify their current level of linguistic knowledge to deliver a baseline. This grammar test was developed from a TOFEL-PBT test. The tests were given orally to assess students' ability to draw on their cognitive knowledge to deliver fluent answers. The students were also instructed to speak in Persian for 5 minutes on any topic they felt comfortable discussing at that time. This provided a control baseline for individual speech factors in L1, such as speech rate, hesitancy and pausing behavior. The intent of this additional assessment in L1 was based on the work of Kahng (2020), who recognized the impact of L1 speech behaviors on L2 fluency levels.

Fluency measures came from Segalowitz's (2010) work, and so breakdown, speed, and repair were measured individually for the participants. The tests were repeated at the four-week stage and post-intervention to provide comparisons. Following the intervention, the respondents were then interviewed for their comments on the process and whether they felt their understanding of achieving more native fluency had improved. In summary, the test instruments were as follows (Table 1):

Table 1.

Test instrument details

Test	Timing	Data received and rationale
MCQ Grammar Tests	Pre and post-test	Quantitative to identify underlying linguistic (grammatical knowledge)
Utterance Fluency Assessment of L1 speed, repair rate and pausing behavior	Pre-intervention	To provide a baseline indication of individual fluency style for comparison with L2.
Oral discussion	During intervention and post-intervention	Qualitative overview and quantitative data on utterance fluency measure speed, repair rate and pausing

		behavior. Quantitative data on time taken to answer to reflect cognitive utterance levels.
Interview	Post-intervention	Qualitative to evaluate overall learner perceptions.

Following the intervention, participants also engaged in a post-intervention interview to detail their experiences within the sessions. This provided an opportunity to gain insight into the benefits and challenges of the intervention and determine if participants perceived their participation as beneficial or if they believed they had improved. This process was supported by creating an interview guide that formulated discussions and questions to be probed where necessary. Semi-structured interviews were employed in the study because of their commendable adaptability, flexibility, and capacity to yield rich data (Brinkmann, 2014; Newcomer et al., 2015). Every interview took place face-to-face and lasted between 15 and 25 minutes for each subject. Through this approach, more dialogue could be generated by including follow-up and focused questions to gain a brief understanding from the participant, allowing an opportunity to inform the research outcomes more thoroughly (Kendall, 2014).

An interview guide was developed to provide some structure to support the interviews (Emans, 2019; Xerri, 2018). The guide provided four main questions which participants were asked:

1.How did you find the language sessions?
2.Do you feel your English language skills improved during these sessions?
3.What do you think was good about these sessions?
4.What did you find challenging during these sessions?

Four participants were selected from outside of the intervention for a pilot study to test the effectiveness of these questions in providing relevant data to inform the research questions. A think-aloud protocol (Dornyei, 2007) was used to ensure the interview questions were both lexically and syntactically as unambiguous as possible (Chenail, 2011; Majid et al., 2017). After the pilot interviews, the transcripts were subjected to thematic analysis, demonstrating that the questions had been carefully crafted.

3.3 Procedures

Research data collection occurred on a unified day for the participants to access TOEFL-PBT test (Modarresi & Alavi, 2014) and proficiency evaluations in classroom session. The eight-week training employed minimally two sessions of forty minutes each week for all students. Semi-structured interviews which lasted 15-25 minutes, collected their insights about their learning experience after the intervention process. Before initiating the intervention, each participant completed the PBT TOEFL test from the ETS to determine the participant's language proficiency (Destiyanti et al., 2021). The most popular and widely used English proficiency exam is the TOEFL. It is widely used to determine the appropriateness of admission to educational establishments or to determine the ability of an individual to engage in higher education actively (Hastuti & Kalim, 2019). Individual appointment times were given to the participants, inviting them to participate in the study. The time and date of the interview was set based on the participant’s schedules in order to provide a better opportunity for participants to present their best performance. Four video clips on age-appropriate English cultural communication scenarios were shown to them. This covered subjects like texting among the younger generation, everyday interactions, and self-confidence. Native speakers were featured in every

video. The participants were given sufficient time to view each video. After viewing each video, the participants were asked to explain what they had taken away. A flash digital recorder with a microphone captured the speech at a sampling frequency of 48,000 Hz. For every video, there were four to five minutes of description presented by the participant. The voices of the participants were transcribed after being recorded. The number of repairs, accuracy, complexity, and length of pauses per 100 words were all calculated using the transcriptions. Information about the study's objectives and purpose was given to each participant in their mother tongue. The transcriptions were analyzed by two expert raters with a background of over 15 years in performing placement tests at language institutes and to ensure more objective scoring, inter-rater reliability was used. Cohen's Kappa results revealed 87% which indicates an almost perfect agreement.

3.4 Data Analysis

Researchers performed the quantitative analysis through SPSS version 27. Statistical analysis focused on multiple-choice grammar test scores and utterance fluency measures with speech rate, breakdowns, and repairs as well as syntactical structure knowledge assessments using descriptive statistics and paired-samples t-tests along with Pearson's correlation to study the connections between cognitive processing and grammatical proficiency and fluency. The data was first checked to see if they had a normal distribution using the Kolmogorov-Smirnov test. The association between cognitive and utterance fluency measures was ascertained through Pearson's Product-Moment correlations, with cognitive fluency elicited via response time and accuracy in structured grammar tasks, and utterance fluency measured through speech rate, pauses, and repairs in recorded spoken tasks. This allowed assessing if significant correlations were prevalent as the

intervention progressed and improved. Second, to determine whether there was a significant difference between the pre-and post-test results from the MCQ Grammar test, a series of paired samples t-tests were carried out. Ultimately, the correlations pertaining to utterance fluency were assessed and classified into three subcategories: duration of pauses, quantity of repairs, and percentage of error-free clauses. Additionally, the participants' gain score in syntactical structure knowledge was considered.

Two experts in SLA writing measured and analyzed the collected transcribed data. Cohen's Kappa was used to calculate the interrater reliability between raters. The overall result was 0.89, which shows an "almost perfect agreement" (Landis & Koch, 1977).

Each interview was transcribed and prepared for thematic analysis. Following Dale's (1996, p. 315) recommendations, each transcript was reviewed multiple times to gain a "sense of the whole" from the participant's experiences. This allowed the researcher to comprehend the participant's viewpoints more thoroughly. Once the interviews were transcribed, they were read on four occasions, as this was deemed the point of data saturation for the researcher, where no new information could be derived from the transcript.

Interview transcripts underwent thematic analysis following Braun et al.'s (2016) six-step process—familiarization, generating initial codes, searching for themes, reviewing themes, defining and labelling themes, and producing a report. Transcripts were reviewed multiple times to ensure data saturation and thematic clarity. This approach provided rich insights into participants' experiences (Mcardle et al., 2012) and perceptions of fluency development and also could provide pertinent themes that emerged from the transcripts (Brinkmann, 2014; Galletta, 2013).

4. Results

This section's main goal is to give readers an understanding of the research measures' findings regarding the effects of grammatical knowledge and proficiency on a particular domain of language knowledge and the connection between utterance fluency and cognitive ability. We will begin by presenting the descriptive statistics and then follow with presenting each research question and results pertaining to it, and finally finish with elaborating on the interview data results.

4.1 Descriptive Statistics

The participants' ages (M=23.48, SD=1.71) ranged from 20 to 27. The pre-test multiple choice grammar test scores ranged from 20 to 33 out of 40 (28.21±3.2), which increased to an average of 32.81 (±4.7) on the post-test (test scores ranging from 22 to 39), with gain scores ranging from 0 to 9 points (4.3±2.6). The number of repairs per 100 words varied from 3.0 to 17.0 (8.7±4.5), while the length of pauses per 100 words (ms) varied from 9000 to 25,000 ms (15,650.0±4944.7 ms). The percentage of error-free clauses related to structure complexity ranged from 14.7 to 90.0 (59.6±29.0), while the accuracy scores ranged from 40.6 to 88 (65.8±18.8).

4.2 RQ1: Does cognitive processing (complexity of structure) impact utterance fluency for L2?

Firstly, a Kolmogorov-Smirnov test indicated that the Pre-test MCQ Grammar test score followed a normal distribution, W (41) 0.13412, p = 0.40147, as was also found for the post-test, W (41) = 0. 17476, p = 0.13629As a result, a paired-samples t-test was employed to ascertain whether there was a discernible significant difference between the pre-and post-test scores. This verified the necessity of using a parametric test. A significant large effect size using Cohen’s d (Dornyei, 2011) was found (d=1.281243) in the paired samples t-test between the pre-and post-test

results (M = 28.2, SD = 2.7 and M = 32.8, SD = 4.3), t (41) = -11.689, p < 0.001, showing that participants generally performed better on the post-test (4.20, 95% CI: -5.45, - 2.95).

4.3 RQ2: What is the impact of processing skills on the syntactical structure knowledge in L2?

In order to address RQ2, the relationship between the participant's gain score in their knowledge of syntactical structure and cognitive processing was ascertained using a Pearson Product Moment correlation (Table 2). The analysis revealed a strong positive relationship (Dornyei, 2011) between the variables, $r\,(42) = 0.78, p < 0.01$. This would suggest that the more syntactical structure knowledge the participants hold, the more complex their sentence production and cognitive fluency were. While a significant correlation was observed between processing speed and utterance fluency (r = .78, p < .01), it is important to note that causality cannot be definitively inferred from correlational analysis. The findings suggest a strong association, but further experimental or longitudinal research would be needed to establish causal pathways (Kahng, 2020).

Table 2.

Pearson Product Moment Correlation results between cognitive processing and the gain score

		Syntactical structure knowledge	Complexity in structures percentage of error-free clauses
Syntactical structure knowledge	Pearson Correlation	1	.783**
	Sig. (2-tailed)		.000
	N	42	42
Complexity in structures percentage of error-free clauses	Pearson Correlation	.783**	1
	Sig. (2-tailed)	.000	

	N	42	42

**. Correlation is significant at the 0.01 level (2-tailed).

4.4 RQ3: Is there a relationship between cognitive processing and syntactical knowledge in L2?

The participants' knowledge of syntactical structure and utterance fluency were compared using the Pearson Product Moment correlation to see if there was any correlation. The correlation between the utterance fluency subcategories—such as the length of pauses, the number of repairs, the percentage of error-free clauses, and the gain score in the participants' syntactical structure knowledge—was calculated to accomplish this goal. All correlations appeared statistically significant based on the results shown in Table 3 (Dornyei, 2011).

Table 3.

Pearson Product Moment Correlation results between cognitive processing and syntactical knowledge

		Number of repairs per 100 words	Percentage of error-free clauses	Length of pauses per 100 words in milliseconds	syntactical structure knowledge
Number of repairs per 100 words	Pearson Correlation	1	-.934**	.856**	-.776**
	Sig. (2-tailed)		.000	.000	.000
	N	42	42	42	42
Percentage of error-free clauses	Pearson Correlation	-.934**	1	-.918**	.806**
	Sig. (2-	.000		.000	.000

	tailed)				
	N	42	42	42	42
Length of pauses per 100 words in milliseconds	Pearson Correlation	.856**	-.918**	1	-.795**
	Sig. (2-tailed)	.000	.000		.000
	N	42	42	42	42
syntactical structure knowledge	Pearson Correlation	-.776**	.806**	-.795**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	42	42	42	42

**. Correlation is significant at the 0.01 level (2-tailed).

First, as seen in Table 2, there was a significant negative correlation ($r = -0.93$, $p < 0.01$) between the number of repairs and the percentage of error-free clauses, indicating that participants made fewer repairs with a higher percentage of error-free clauses. Second, there was a significant negative correlation ($r = -0.91$, $p < 0.01$) between the number of error-free clauses and the length of pauses. This suggests that learners who pause more frequently during speech are more likely to have a lower percentage of error-free clauses. Ultimately, a significant inverse correlation was found between the duration of pauses and the knowledge of syntactical structure ($r = -0.79$, $p < 0.01$), indicating that individuals with greater grammatical knowledge generated fewer pauses while speaking.

Thirdly, the analysis showed a significant positive correlation ($r = 0.85$, $p < 0.01$) between the number of repairs and the length of pauses, indicating

that a higher number of repairs results in longer pauses during speech. Lastly, a significant positive correlation was found ($r = 0.80$, $p < 0.01$) between the percentage of error-free clauses and syntactical structure knowledge, indicating that learners with higher grammatical knowledge generated more error-free clauses.

Fourth, the analysis showed a significant negative correlation ($r = - 0.77$, $p < 0.01$) between the learners' syntactic structure knowledge and the number of repairs. This indicates that learners with less grammatical knowledge are likelier to make repairs during speech.

4.5 RQ4: Is there a relationship between fluency processing and syntactical knowledge in L2?

An additional Pearson's Product Moment correlation was performed to evaluate the participants' knowledge of syntactical structure and utterance fluency to ascertain the relationship between syntactical knowledge and fluency processing in L2. To this end, the percentage of error-free clauses, number of repairs, length of pauses, and the correlation between the complexity of structure and utterance fluency subcategories were calculated. According to Table 4's findings, every correlation was significant (Dornyei, 2011).

Table 4.

Pearson Product Moment Correlation results between fluency processing and syntactical knowledge in L2

		Length of pauses per 100 words in milliseconds	Number of repairs per 100 words	Percentage of error-free clauses	Complexity in structures percentage of error-free clauses
Length of pauses per 100 words in	Pearson Correlation	1	.856**	-.918**	-.875**

milliseconds	Sig. (2-tailed)		.000	.000	.000
	N	42	42	42	42
Number of repairs per 100 words	Pearson Correlation	.856**	1	-.934**	-.919**
	Sig. (2-tailed)	.000		.000	.000
	N	42	42	42	42
Percentage of error-free clauses	Pearson Correlation	-.918**	-.934**	1	.912**
	Sig. (2-tailed)	.000	.000		.000
	N	42	42	42	42
Complexity in structures percentage of error-free clauses	Pearson Correlation	-.875**	-.919**	.912**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	42	42	42	42

**. Correlation is significant at the 0.01 level (2-tailed).

First, the analysis showed a significant positive correlation ($r = 0.85$, $p < 0.01$) between the number of repairs and the duration of pauses, indicating that the more repairs, the longer the pauses will be in the speech. The percentage of error-free clauses and structure complexity were found to have a very strong positive relationship ($r = 0.91$, $p < 0.01$), indicating that higher structure complexity was associated with lower percentages of error-free clauses in speech.

The number of pauses a learner makes during a speech was found to have a very strong negative relationship ($r = -0.91$, $p < 0.01$), with the percentage of error-free clauses recorded decreasing with the number of pauses. An

additional significant negative correlation was found between the number of repairs and the percentage of error-free clauses ($r = -0.93$, $p < 0.01$), indicating that a higher percentage of error-free clauses was recorded in relation to the fewer repairs that the learners made. Finally, a very strong negative correlation was found ($r = -0.91$, $p < 0.01$) between the number of repairs and the complexity of the structures, indicating that the more repairs, the less complex the speech structures were. There was a significant negative correlation ($r = -0.87$, $p < 0.01$) found between the length of pauses and structure complexity, indicating that more pauses in a speech led to less complex causes.

4.6 Interview Data

The themes that emerged from the interview process are depicted in the thematic structure (see Figure 1). The emerging themes of video use and challenges are exemplified by the structure. The themes, which include a number of sub-themes that are covered in more detail below, offer pertinent information regarding the research questions.

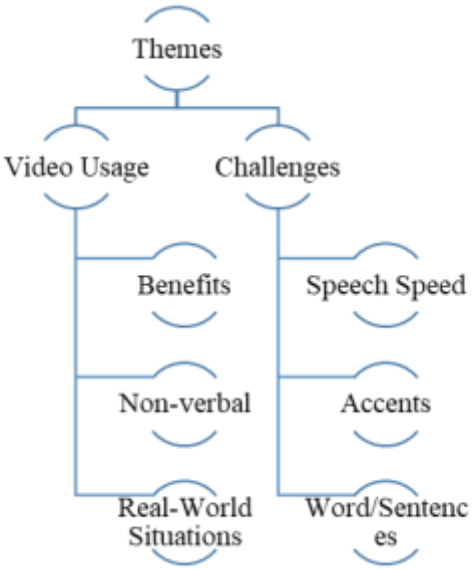

Figure 1.
The Thematic Structure Outlining the Themes Identified from the Interview Transcripts

4.6.1 Video Usage

In total, 37 comments were collected relating to video usage and its benefits, the provision of non-verbal communication and real-world situations. Therefore, it is vital to understand how the use of videos impacted the participant's experiences. Firstly, one of the prominent areas discussed was related to the beneficial nature of videos in providing real-world scenarios whereby the participants were able to learn about accents, speaking in sentences, and native gestures. The use of videos was well received by many participants, who found the videos to be "very helpful" due to the real-world examples they provided. One participant stated:

I liked the speaking patterns available (like how to apologize) in the videos (P004)

I learned new technical expressions and idioms from the videos (P019)

This highlights that giving the learners real-world examples where they are provided exposure to a range of speaking patterns was well-received and enhanced their learning. Such views were mirrored among the participants, who noted that while they enjoyed the videos and found these to be particularly "helpful", there were elements in the videos that supported their learning.

I feel more confident speaking about technology after watching the video (P028)

I think after watching videos four or five times, I speak more fluently (P009)

This shows that the participants felt that being provided with real-world examples allowed them to understand social situations better and how individuals utilized non-verbal communication when in a conversation. As one participant noted, they "liked the native speaker's gestures in the videos", suggesting that seeing native speakers having an everyday conversation allowed them to develop their understanding of how to use different forms of grammar and words to construct sentences to form a speech and dialogue. The participants noted that in addition to the benefit of learning more about these real-world interactions, the video supported their fluency, taught them new vocabulary, and improved their perceived ability to speak in sentences.

5. Discussion

This research contributes to existing knowledge by illustrating the intricate relationship among grammatical understanding, cognitive processing abilities, and different facets of fluency in foreign language (L2) learners. In particular, the findings suggest that it might be beneficial to increase students' awareness of their speech rate and the presence of pauses, especially in sentence structures. Using strategy-based exercises in the classroom could teach students how to control the way they produce speech. Some examples of these techniques include using filler words or deliberately pausing at clause boundaries to plan. The study found a strong correlation between syntactic knowledge and cognitive fluency ($r = .78$, $p < .01$), supporting Vafaee and Suzuki (2019), who highlighted the role of syntactic processing in L2 proficiency. However, unlike Koizumi and In'nami (2013), who found a weaker association, our study suggests that syntactic complexity plays a more substantial role in fluency for learners at the upper-intermediate level. According to earlier research (Lambert et al., 2017; Tavakoli et al., 2016), improving learner consciousness and providing strategy instruction are effective ways to improve fluency. Additionally, it has been shown that allocating time for pre-task planning and practice opportunities improves speaking speed and decreases pauses and hesitations (e.g., Lambert et al., 2017).

While previous research (e.g., Skehan & Foster, 2012) suggested that L1 fluency significantly influences L2 fluency, the current findings indicate that the impact of L1 fluency was minimal in this study. This may be due to differences in instructional background, as participants had formal EFL education but no immersion experience. Furthermore, research indicates that teaching collocations and fixed expressions are essential to a comprehensive vocabulary instruction program because people who are well-versed in

idiomatic phrases tend to pause less frequently in sentences (Tavakoli & Uchihara, 2020). Finally, studies show that performing a task repeatedly can improve speech fluency and reduce the frequency of pauses within sentences (Lambert et al., 2017).

5.1 Does cognitive processing (complexity of structure) impact utterance fluency for L2?

Based on the post-test results, there was a noticeable improvement of 4.2 points, indicating a moderate impact, according to the current study's findings. Such findings align with the previous belief that focusing on L2 specifics of fluency allows the underlying cognitive processes associated with L2 to be correctly considered, thus leading to fluency improvements (Duran-Karaoz & Tavakoli, 2020). However, the intervention approach, which provides practical and real-world examples of social interactions, allowed the learners to develop meaning while achieving fluency The results of De Jong (2015), who observed that when learners participate in an L2 conversation, they can follow the main points of the conversation and know what they want to say, are probably related to these improvements. Accordingly, L2 learners can acquire cognitive processing abilities unique to L2 (Segalowitz, 2016). The correlations among lexical retrieval speed, utterance fluency measures, and syntactic coding speed explain this (Kahng, 2020). While prior research has examined the correlation between the use of video resources and improvements in utterance fluency, this study extends the investigation by analyzing not only utterance fluency, but also the relationship between cognitive fluency, grammatical knowledge, and processing skills in L2 learners. (García-Amaya, 2017). As it offers chances to grow in competence and confidence and has a significant influence on conversational fluency, this can boost the learner's confidence (MacIntyre & Doucette, 2010; Song & Li, 2020).

5.2 What is the impact of processing skills on the syntactical structure knowledge in L2?

The results of the current study showed a significant positive correlation between learners' cognitive processing and their gain score in syntactical structure knowledge, indicating that learners' cognitive fluency and utterance with their level of syntactical structure knowledge. These opinions are consistent with earlier research that demonstrated the mediating role that processing abilities play in the development of cognitive and utterance fluency (Magne et al., 2019). As a result, the current study highlights that after the intervention, students with higher cognitive processing abilities significantly increased their understanding of syntactic structure. The opinions of Koizumi and In'nami (2013) support such views. They emphasized the importance of vocabulary knowledge in speaking fluency by arguing that size, depth, speed, and vocabulary knowledge can all be used to explain variations in learners' speaking proficiency. Additionally, while the results support the theories of Vafaee and Suzuki (2019), who emphasized the significance of syntactic knowledge in L2 abilities and the influence of learners' processing abilities, this study extends their findings by examining the interaction between syntactic knowledge, cognitive fluency, and utterance fluency in a quasi-experimental setting.

5.3 Is there a relationship between cognitive processing and syntactical knowledge in L2?

The results identified relationships with the number of repairs, length of pauses, and syntactical structure when focusing on error-free clauses. The learners produced a higher percentage of error-free clauses, as indicated by the first relationship between the number of repairs and the number of repairs required. In this sense, learners who made fewer repairs were able to complete a speech with more error-free clauses and thus demonstrated a

greater level of consistency in their fluency. This would imply that enhanced fluency can be highlighted by using Segalowitz's (2010) definition of utterance fluency, which takes into account speech flow, the number of syllables per second, and the number of repairs needed. These findings align with Levelt's speech production model (Tilsen, 2018), which posits that fluent speech depends on efficient grammatical encoding. The observed fluency improvements after structured exposure suggest that cognitive processing skills can be enhanced through targeted instruction, reinforcing the role of experience in fluency development (Tavakoli, 2019). Moreover, it can be contended that students exhibiting superior syntactical knowledge were able to exhibit more complex, accurate, and fluent speech performance. Such results align with the usage-based language acquisition theory, which suggests that experiential communication exchanges lead to the embedding of cognitive processes and linguistic knowledge, which can be used for interaction. This emphasizes the role of providing real-world scenarios to the learners to create a pattern of cognitive understanding to enhance linguistic knowledge.

In the second relationship, it was found that learners who utilize a greater number of pauses during a speech are more likely to have a lower percentage of error-free clauses. The number of pauses taken during a speech is an aspect of fluency alongside speed and repair, and these factors can have significant implications for speech performance (Michel, 2017). The results indicated that speaking with more pauses during a speech resulted in lower accuracy, which is consistent with findings from other studies that longer clauses had a lower likelihood of being error-free. Ferrari (2012), for instance, proposed a trade-off between complexity and accuracy when the lengthening of utterances over time is not taken into account. This is disputed, though, since it has been shown that accounting for clause length

and complexity does not always bolster the idea that trade-offs are occurring (Skehan & Foster, 2005; Vercelloti, 2017). The results of this study indicate that there might be a trade-off because there are fewer error-free clauses, but more research in the literature is needed to confirm this.

According to the third relationship, students who knew more grammar produced more error-free clauses. These opinions are consistent with earlier research that found a link between error-free clauses and L2 grammatical accuracy (Long & Watanabe, 2021; Nasim Valizadeh et al., 2018). As expected, those learners who have a greater understanding of how to apply and speak a language are more likely to produce fewer errors in speech, thus demonstrating improved fluency. This was also evident in the findings relating to the relationships between syntactical structure knowledge and the number of repairs when focusing on the length of pauses. As seen in the current study, this leads to improved speech performance, but this has not always been supported in the literature. When comparing grammatical knowledge and pragmatic competence in intermediate-level learners, learner performance did not significantly differ from learners' abilities, according to a study by Ashoorpour et al. (2014) that contrasted the current study findings. The results of this study, however, add to the discussion about the value of using approach methods to increase learners' knowledge and how this can be done successfully because they imply that gains in knowledge have a major impact on learners' speech performances. Similarly, it is noted that learners who made more repairs typically had longer pauses in their speech and had lower grammatical knowledge. Therefore, improved knowledge is suggested to lead to improved speech performance and the learner's improved ability to demonstrate fluency and accuracy in their performance.

5.4 Is there a relationship between fluency processing and syntactical knowledge in L2?

The findings indicate the existence of relationships, but it is thought to be crucial to specify the locations of these relationships' identification. The percentage of error-free clauses and length of pauses, the number of repairs and percentage of error-free clauses, and the length of pauses and the number of repairs all showed relationships, as was discovered in RQ3. As a result, the relationship between these variables and the structure's complexity will receive more attention in this section. The findings identified three relationships.

First, the findings indicated a substantial positive correlation between the proportion of error-free clauses and structure complexity, indicating that speech with lower percentages of error-free clauses generally had more complex structures. According to Skehan and Foster's (2012) model, accuracy and fluency development are greatly impacted by complexity. It may affect how the learner's linguistic system develops. According to earlier research, various characteristics can greatly influence language production and add to the complexity of cognitive tasks (Ferrari, 2012). The current study's findings are consistent with the theory that errors are more likely to occur in structures with greater complexity. When considering the learners' perspectives on the intervention, it is possible to understand some factors that could have impacted these outcomes, including accents, gestures, and speed of speech. Studies have shown that minor deviations in accent and intonation can impact a learner's ability to understand and demonstrate their understanding of what is being discussed and to provide appropriate responses (Kuiken & Vedder, 2012). Such views further support the second relationship identified between the number of repairs and structure complexity, suggesting that the greater the number of repairs the learner

makes, the less complex the structures produced in speech. Further, a final relationship was identified between the length of pauses and structure complexity, suggesting that the greater number of pauses in a speech led to less complex causes. Therefore, this would suggest that learners with lower syntactical knowledge have reduced fluency processing -which refers to the cognitive and linguistic mechanisms that enable smooth and efficient speech production in a foreign language- and can demonstrate less speech fluency.

From the student's perspectives, the intervention led to a clear and great improvement in their fluency, which suggests that a direct focus on fluency in the classroom, whereby they are provided with exposure to real-world contexts, is beneficial to enhancing knowledge. Furthermore, from the interviews, it was evident that the participants found the use of videos of native speakers helpful as it led to improved fluency and understanding of conversational topics.

Although the findings support a relationship between syntactic knowledge and utterance fluency, the triadic nature of fluency (Segalowitz, 2010)—encompassing cognitive, utterance, and perceived fluency—warrants further separation in interpretation. The current study does not isolate perceived fluency, which may be influenced by prosody, intonation, or other suprasegmental features (Préfontaine, 2010). Furthermore, the lack of a strong effect for working memory may reflect task-specific demands that favored syntactic over executive control processes, as discussed in recent meta-analytic reviews (Bulté & Housen, 2020; Kahng, 2020).

6. Conclusion and Implications

The research supports Kahng's (2014, 2020) perspectives, demonstrating that grammatical knowledge and proficiency significantly impact linguistic

knowledge. Further, the results demonstrate that there is real value in providing learners with exposure to real-world scenarios, which allows an opportunity to gain more experience with conversational discussions, gestures and accents, effectively supporting fluency. This acknowledged the impact of L1 fluency factors on L2 fluency performance, especially concerning establishing a shared conceptual framework and how this affects the capacity to accurately conceptualize and formulate fluent utterances, as the current study further demonstrates.

The results revealed that cognitive processing impacted utterance fluency following improvements in gain scores following the intervention compared to baseline. At this stage of the operation, there are several opportunities for improving fluency, which is open to various pedagogical approaches to enhance learners' knowledge and understanding of language. This suggests that focusing on L2 specifics of fluency allows the underlying cognitive processes associated with L2 to be correctly considered, thus improving fluency. Further, the study noted the association between cognitive processing and syntactical structure knowledge, emphasizing that focusing on developing students' knowledge and understanding significantly improves speech performance. This suggested that learners with a larger cognitive processing ability could significantly improve their syntactic structure knowledge following the intervention. The findings suggest several practical applications for L2 instruction. Given the strong relationship between grammatical knowledge and fluency, educators should integrate explicit grammar instruction with fluency-building activities, such as timed speech tasks and structured conversation exercises. Additionally, video-based learning should be incorporated to expose learners to authentic speech patterns, aiding both cognitive and utterance fluency. To enhance processing skills, teachers can implement retrieval-based exercises (e.g., rapid lexical

recall drills) and task repetition techniques, which have been shown to improve automaticity in speech production. Finally, curriculum designers should consider sequencing lessons that progressively increase syntactic complexity, ensuring learners develop both accuracy and fluency in tandem. The results from the current research show that improvements in the learner's knowledge significantly impact their speech performance and, therefore, add to the debate on the importance of utilizing approach methods to improve their knowledge and how this can be effectively achieved. The study results have significant implications for teaching practice and how to construct and focus future research on supporting improvements to fluency development and its promotion.

While drawing these conclusions, it is essential to highlight some limitations within the work. While the current study effectively provided insights into the role of linguistic knowledge and processing skills in L2, with specific reference to cognitive and utterance fluency, some limitations were present. Firstly, the study results are not generalizable to the rest of the population as a single group was used, and therefore, the findings are relatable to this population only. Future research endeavors ought to be cautious of these constraints and, as a result, should strive to enhance the size of the study and the sample size enlisted. This can advance knowledge of the significance of linguistic expertise and processing abilities in L2 and help offer a deeper understanding of how the intervention affected the participants. Secondly, the study utilized several Pearson product-moment correlations, which allowed an understanding of the current relationship. However, this approach does not consider if a variable has been classified as dependent or independent. This approach cannot also suggest if the improvements resulted from the intervention as this approach does not allow for a cause-effect relationship to be distinguished.

Future research should explore the long-term effects of grammatical knowledge and processing skills on L2 fluency using longitudinal studies to track fluency development over time. Additionally, experimental designs with control and treatment groups could further isolate the effects of targeted fluency interventions. Investigating different L1 backgrounds and their influence on cognitive and utterance fluency would provide comparative insights, particularly between learners of typologically similar and dissimilar languages. Moreover, future studies could incorporate neurolinguistic measures (e.g., EEG or fMRI) to examine real-time language processing and its impact on fluency outcomes.

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