JOLLT Journal of Languages and Language Teaching
https://e-journal.undikma.ac.id/index.php/jollt
Email: jollt@undikma.ac.id
DOI: https://doi.org/10.33394/jollt.v14i3.17283

July 2026. Vol. 14, No. 3
p-ISSN: 2338-0810
e-ISSN: 2621-1378
pp. 848-863

A MULTI-PHASE STUDY OF PROCESSING DEPTH: ATTENTIONAL MECHANISMS UNDERLYING EFFECTIVE VOCABULARY CONSOLIDATION

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Article Info
Article History
Received: Agustus 2025
Revised: December 2026
Accepted: June 2026
Published: July 2026
Keywords
Processing depth;
Attentional principles;
Cognitive mechanisms;
Affective mechanisms;
Vocabulary consolidation;

Abstract

Processing depth is multidimensional; its definition must not overlook the complex cognitive and affective processes involved and their influence in operating memory performance. A clarified account of the mechanisms driving processing depth is needed to extend its application in cognition and language learning. This understanding could provide insights into the effectiveness of language teaching materials and vocabulary learning strategies over others. To serve this purpose, this study investigated the effect of different types of processing depth on vocabulary consolidation, both structural and semantic. Specifically, this study used a mixed-methods approach with a sample of 167 students and progressed through three phases, each building on insights gained from the previous one. The first within-subjects experiment investigated the effect of structural processing and two types of semantic processing on vocabulary consolidation among participants, while semantic outputs produced during the different types of processing were examined to understand the governing principles behind each type. It was revealed that semantic processing was more effective, with distinctiveness particularly associated with improved performance. Building on these findings, the second between-subjects experiment was designed to examine strategy training using vocabulary consolidation strategies reflecting different processing types, complemented by post-training feedback. The third phase focused on model building, developing the Attentive Depth of Processing Model; it posits that attention serves as a pivotal axis around which depth orbits, governed by attentional principles that support long-term consolidation. Overall, this study seeks to understand deep processing principles and provide a basis to improve vocabulary acquisition.

How to cite: Laaribi, M. (2026). A Multi-Phase Study of Processing Depth: Attentional Mechanisms Underlying Effective Vocabulary Consolidation. *JOLLT Journal of Languages and Language Teaching,* 14(3), 848-863. Doi: https://doi.org/10.33394/jollt.v14i3.17283

INTRODUCTION

If vocabulary acquisition is seen as the architecture of language learning, then depth of processing may be described as the quality of its foundation: the cognitive cement that can help to determine whether words remain blueprints or take root as permanent structures in memory. The present study draws upon foundational principles of cognitive psychology, particularly the concept of depth of processing, to examine its application in vocabulary acquisition. Understanding the way vocabulary is consolidated is central to both cognitive psychology and language learning. Vocabulary acquisition is essentially within the field of applied linguistics, but is also deeply rooted in memory, attention, and cognitive processing. These underlying

processes, particularly those associated with processing depth, have been at the heart of long-standing theoretical claims about cognition and learning. According to the Levels of Processing framework (Craik & Lockhart, 1972), deeper, semantically-oriented processing leads to more robust memory traces than its shallower surface-leveled counterpart. This dichotomy of deep versus shallow processing has shaped various aspects of the literature on memory and retention. However, despite its widespread acceptance, the concept of depth remains theoretically underspecified and methodologically underexplored in applied contexts of language learning.

The prevailing assumption that deep processing is synonymous with semantic encoding has been widely adopted but insufficiently questioned. In language learning, particularly in vocabulary instruction, recommendations of deep processing to reinforce learning may be vague and rest on unexamined premises in similar contexts. Although research tends to reinforce the semantic and structural dichotomy, often using familiar vocabulary or non-linguistic stimuli, it rarely examines what actually makes certain types of processing more effective. As for studies that incorporate the effectiveness of vocabulary acquisition strategies, strategy-based research has examined the effectiveness of various vocabulary learning techniques but rarely addressed the underlying cognitive and affective principles that govern this effectiveness. As such, both the conceptual clarity and practical applicability of deep processing remain open to investigation.

Existing research also often relies on artificial stimuli and controlled laboratory settings, which questions the ecological validity and applicability of findings in real-world educational environments. An underemphasis on linguistically unfamiliar vocabulary and the reliance on test outcomes alone to evaluate learning strategies further limit one's understanding. Therefore, there is a need for research to clarify the mechanisms underlying deep processing, investigate its relevance to authentic language learning contexts, and interconnects the gap between theoretical models and classroom practice. In light of these objectives, the research addresses four main questions: the effect of structural processing on vocabulary consolidation, with the hypothesis that structural processing will have a significant effect; the effect of semantic processing type on consolidation, with the hypothesis that different types of semantic processing will significantly affect consolidation; the principles underlying varying effectiveness of vocabulary acquisition strategies, with the hypothesis that identifiable principles contribute to strategy effectiveness; and whether processing depth can be characterized beyond the structural/semantic dichotomy, with the hypothesis that depth of processing can be meaningfully defined beyond this distinction.

This study seeks to address this by empirically examining how processing depth affects vocabulary consolidation through employing two experiments that follow a sequential design. In the first experiment, a within-subjects design was used to compare the effectiveness of structural processing and two types of semantic processing on the retention of unfamiliar vocabulary items. In addition, the study also analyzed the semantic outputs generated by participants during these tasks to identify the principles driving performance differences, such as elaboration, relevance, or distinctiveness. The second experiment extends this inquiry into a classroom setting. Using a between-subjects design, it evaluates whether training learners in vocabulary strategies modeled after the different processing types leads to differential outcomes in vocabulary consolidation. This phase also incorporates participant feedback to further gain insights on why certain strategies outperform others in order to move beyond purely using test scores to account for efficiency and to uncover the cognitive mechanisms at work.

Combining experimental conditioning with contextual practicality can help to contribute to a more dynamic understanding of processing depth and its role in vocabulary acquisition beyond a rigid categorization. This can aid in connecting theoretical debates in cognitive psychology with practical goals in language education. The goal is not to only assess which

vocabulary strategies work more efficiently, but also to understand why and how they do so, in order to offer pedagogically valuable insights into language learning mechanisms.

The present study attempts to follow this approach by using a various set of findings to characterize the notion of processing depth beyond its semantic and structural dichotomy and to examine its practical effect on vocabulary acquisition. One way to operationalize depth of processing in language learning research is through explicit vocabulary learning strategies, which can be designed to mirror different types of processing, as is the case for the second experiment of the present study. In this context, explicit vocabulary learning strategies can be defined as deliberate actions taken to acquire new lexical items, often involving frequent exposure and intentional practice. Several definitions revolve around the notion that strategies are consciously selected by learners to improve learning outcomes (Chamot, 2004; Cohen, 1998). Others, however, acknowledge that strategies may also operate unconsciously (Hismanoglu, 2000; Ngan, 2022). Generally, empirical research investigating the efficacy of these strategies falls into two main types which are category-based and strategy-specific studies.

Category-based research in vocabulary acquisition often relies on the comparison of different categories of strategies with one another based on established vocabulary categorization taxonomies. Generally, fewer have been forwarded in comparison to strategy-based research, but some studies attempted to investigate the effect of vocabulary training on recall using categorizations of different taxonomies. Ghobrani and Riabi (2011), Sozler (2012), and Abbassi, Hassaskhah, and Tahriri (2018) followed similar procedures when investigating the effect of category-based vocabulary training. These studies adopted experimental designs and implemented Oxford's taxonomy of vocabulary learning strategies since they specifically investigated the effect of memory strategies on vocabulary recall. They called for the use of memory strategies based on their findings.

Besides category-based research, there is another line of vocabulary acquisition research that tests the effectiveness of individual vocabulary learning strategies. Unlike broader taxonomies, strategy-based research targets specific strategies to evaluate their impact on vocabulary consolidation. For example, vocalization strategies have shown positive outcomes due to the production effect, where spoken items are more easily recalled than silently read ones (Hashizaki, 2024; Krishnan, Watkins & Bishop, 2017; MacLeod et al., 2010). Rote repetition has mixed results: while claimed to be effective in short-term recall (Altalhab, 2018), it lacks the depth needed for long-term retention unless combined with spacing or retrieval practice (Kang, 2016). Spaced repetition, in particular, has been validated for its role in improving durable learning (Lotfolahi & Salehi, 2016). Imagery strategies have also yielded notable findings. Zahedi and Abdi (2012) report that mental imagery outperformed direct translation. Similarly, the keyword method, with its combination of acoustic and semantic associations, has consistently demonstrated robust outcomes in both short- and long-term recall (Davoudi & Yousefi, 2016; Piribabadi & Rahmany, 2014; Siriganjanavong, 2013; Qu, Liu, Qiao, & Wang, 2024).

The connection between these strategy and category-based findings and the broader theoretical framework of deep processing becomes clearer when revisiting its original formulation. When initially introduced by Craik and Lockhart (1972), the depth of processing framework posited that the durability of memory traces is a function of the cognitive operations performed on them. In other words, semantic and elaborate interaction with stimuli yields better recall than shallow, surface-level processing. This theory has been extensively validated in the context of general memory. However, its relevance to vocabulary learning, especially in a foreign language context, remains underexplored. Still, deep processing has been advocated as a way to improve foreign language learning, particularly in the acquisition of vocabulary. For example, theoretical perspectives (Dragomir and Niculescu, 2022) suggest that interacting with the target words at a deep level by using them in meaningful contexts can significantly improve

retention. However, despite this promising theoretical support, empirical research that examines the impact of deep processing on unfamiliar vocabulary items is relatively limited. Only a handful of studies (García-Gámez & Macizo, 2022) have tested on unfamiliar vocabulary items and they have mostly followed the original premises that connect depth of processing to its semantic dimension. Most existing studies (e.g. Barton, 2010; Chang, 2017; Griffiths, 2002; Mundorf et al., 2022; Pollack, 2022) have investigated depth of processing using familiar vocabulary items or non-linguistic stimuli.

It is important to integrate insights from both strategy research and cognitive theory to gain a holistic perspective in the field, and cognitive theories such as the Levels of Processing framework can provide a strong rationale to do so. Depth, as a contributing factor, must not be overlooked when investigating vocabulary acquisition, given its important position in memory, cognition and learning. Moreover, the multidimensionality of vocabulary knowledge, along with its interaction with cognitive and affective variables, further emphasize this connection. Therefore, the current study aims to examine how processing depth influences the consolidation of foreign language vocabulary items, particularly through the lens of explicit learning.

RESEARCH METHOD

Research Design

The research was conducted in two complementary phases, combining a controlled experimental design with a classroom-based instructional study to examine the role of processing depth in vocabulary consolidation. The first experiment adopted a within-subject, repeated-measures design in which each participant took part in three processing conditions, structural, conventional semantic, and unconventional semantic, targeting a total of twelve items. After a 25-minute treatment phase, a distractor questionnaire was administered to decrease potential carryover effects. Afterward, participants completed a surprise post-test measuring three facets of recall: form recognition, meaning recognition, and form-meaning association. A second post-test was administered a week later, along with a task-recognition component, to assess the durability of recall and strategy attribution. The present study will analyze the results of the delayed post-test.

The second phase employed a between-subject design to examine the instructional application of processing depth. The three strategies of rote repetition, sentence production, and the keyword method were selected to mirror the mechanisms of the structural, conventional, and unconventional processing tasks from the first experiment. Training lasted for five weeks. Teachers acted as facilitators and continuously forwarded vocabulary lists into class routines and homework assignments. The control group used self-selected strategies. In contrast, experimental groups received targeted strategy instruction and practiced applying these techniques using curated word lists aligned with curricular themes. The final list of twelve words was studied independently by students and later served as the basis for a surprise recall test combining gap-filling and multiple-choice items.

Research Participants

The first experiment included 45 participants from different high schools and universities. Only participants who completed the different sets of post-tests and met linguistic background requirements were included in the final analysis. The second experiment included 122 high school students. Participants were assigned to four groups: a control group (n = 47) and three experimental groups (n = 75), each trained in a different vocabulary consolidation strategy. The experimental group that was assigned rote repetition had 24 participants. The second group was assigned sentence production and had 30 participants. Lastly, the third and final experimental group was assigned the keyword method and had 21 participants.

Instruments

For the first experiment, the target words were carefully selected to control for confounding variables. All items were of rare frequency but semantically familiar, two-syllable nouns, with six letters and high concreteness. Items were chosen to avoid phonological ambiguity, semantic priming, cross-linguistic interference, and morphological overlap. Each processing task was designed to operationalize a specific type of depth. Specifically, structural Processing required orthographic analysis (e.g., analyzing vowels and consonants). Conventional Semantic tasks involved generating sentences using thematically related word pairs. Unconventional Semantic tasks required constructing sentences from contextually incongruent pairs, designed to stimulate higher cognitive effort and associative novelty. In contrast to the tightly controlled stimuli of the first experiment, the second experiment prioritized ecological validity. Word lists included items of moderate frequency and thematic relevance, designed to reflect typical classroom conditions.

Data Analysis

Normality tests were first conducted to determine appropriate statistical procedures. Vocabulary recall scores were analyzed using non-parametric Friedman tests, followed by Dunn-Bonferroni post hoc comparisons to detect differences across processing types. Mean rank scores were computed to facilitate interpretation. Reliability was assessed via Cronbach's alpha and test-retest methods. Additional analyses included content analysis of participants' semantic productions and post-experimental feedback, and quantitative coding of input responses to identify cognitive, affective, and attentional features of each processing task.

RESEARCH FINDINGS AND DISCUSSION

Research Findings

Analysis of the First Experiment

Before proceeding to data analysis, the assumption of normality was assessed using the Shapiro-Wilk test. For structural processing, the test indicated a departure from normality ($W = 0.898$, $p = 0.001$). In contrast, conventional semantic processing did not significantly deviate from normality ($W = 0.953$, $p = 0.066$). However, unconventional semantic processing again showed non-normality ($W = 0.908$, $p = 0.002$). In light of these deviations from normality, the median scores were observed and a non-parametric test was subsequently selected.

In a ranking from highest to lowest scores, the unconventional semantic post-test exhibited scores ranging from 1.00 to 12.00, with a mean score of 7.88 (SD = 3.16). The conventional semantic post-test yielded scores ranging from 0.00 to 12.00, and a mean score of 6.73 (SD = 2.94). The structural post-test, ranking last, yielded scores that ranged from 1.00 to 12.00, with a mean score of 4.88 (SD = 2.35). As evident from the box plot below, the median scores for the post-test results were as follows: The unconventional processing task exhibited a median score of 7 (IQR: 6 to 12), the conventional processing task had a median score of 6 (IQR: 5 to 8.5), while the structural processing task displayed a median score of 4 (IQR: 3 to 6). Notably, these median values align with the same ranking order as the mean scores.

The Friedman test exhibited a highly statistically significant difference in the observed scores among participants, $\chi2(2) = 43.524$, df=2, p= ,000 ($p < 0.001$). This outcome indicates significant variations in consolidation performance scores across the three types of processing depth employed. Consequently, Dunn-Bonferroni post hoc tests were carried out to target pairwise comparisons. In accordance with the Friedman test, The Dunn-Bonferroni post hoc tests showed that there were statistically significant differences between the effects of all three types of processing. To ensure robust control over Type I errors, two Bonferroni adjustments were applied. First, the Dunn-Bonferroni test provided an initial adjustment for multiple comparisons. Additionally, a manual Bonferroni correction was performed to further refine the significance level. The original significance level of 0.05 was adjusted for the three pairwise comparisons. This resulted in a corrected significance level of 0.0167.

The first pairwise comparison of the Dunn-Bonferroni test showed that there was a statistically significant difference between the effects of structural processing and conventional semantic processing, $p = .018$ ($p < 0.016$). A second pairwise comparison between conventional depth of processing and unconventional semantic depth of processing also indicated a significant difference, $p = .000$ ($p < 0.016$). A final comparison between structural depth of processing and unconventional depth of processing exhibited a high significant difference, $p = .004$ ($p < 0.016$). It is important to note that the significance values presented, thus far, are all adjusted values using the dun-Bonferroni test. Furthermore, they are all compared against a corrected significance level ($p = 0.016$). The unadjusted comparisons revealed significant differences between structural and conventional semantic processing ($p = 0.006$), structural and unconventional semantic processing ($p = 0.000$), and conventional and unconventional semantic processing ($p = 0.001$).

Analysis of the Second Experiment

Building on the insights gained from the first experiment, the second experiment aimed to further explore the impact of processing depth on vocabulary recall by incorporating practical vocabulary consolidation strategies. The focus shifted from conceptual processing types to the application of specific instructional methods designed to target vocabulary consolidation. The experiment evaluated the effectiveness of three distinct consolidation strategies, which are rote repetition, sentence production, and the keyword method, and compared them to a control group that did not receive any strategy training.

The mean and standard deviation were calculated for each of the four groups in the second experiment. In an order from lowest to highest, the rote experimental group yielded a mean score of 10.66 (SD= 3.01), with scores ranging from 2 to 14. Following this, the control group yielded a mean score of 11.51 (SD= 4.22), with its scores ranging from 4 to 24. Subsequently, the sentence production experimental group had a mean score of 16.90 (SD= 4.03), with scores ranging from 13 to 24. Yielding the highest score, the keyword method experimental group exhibited a mean value of 23.09 (SD= 1.90), with scores ranging from 16 to 24.

Table 1
Descriptive Statistics for the Second Experiment Groups

Group	N	Minimum	Maximum	Mean	Standard Deviation
Control Group	47	4	24	11.51	4.22
Rote Experimental Group	24	2	14	10.66	3.01
Sentence Production Experimental Group	30	13	24	16.90	4.03
Keyword Method Experimental Group	21	16	24	23.09	1.90

The box plots, below, display the median and interquartile range for each group in the second experiment. The control group had a median of 12 (IQR: 8-13). Similarly, the rote experimental group also yielded a median of 12 (IQR: 8.75-12.75). The sentence production Experimental group yielded a higher median of 15.50 (IQR: 14-19.25). Finally, the keyword method experimental group showed the highest median of 24 (IQR: 23-24).

Before conducting further analysis, the internal consistency of the post-tests was evaluated using Cronbach's alpha. As a result, the control group yielded an alpha of 0.637, while the rote repetition group had one of 0.743. The sentence production group demonstrated a reliability of 0.708, and the keyword method group recorded an alpha of 0.719. Subsequently, various statistical tests were conducted to analyze the post-test results.

To assess the normality assumption within each group, multiple Shapiro-Wilk tests were conducted. The results indicated that the data significantly deviated from a normal distribution in the control group ($W = 0.912$, $p = 0.002$), the rote group ($W = 0.786$, $p = 0.001$), the sentence

creation group (W = 0.856, p = 0.001), and the keyword method group (W = 0.521, p = 0.000). The Kruskal-Wallis test was employed to examine potential differences among the different groups. It revealed a highly significant difference among the groups H (3) = 76.592, p= .000 (p < 0.001).

After finding a significant difference among the groups in the Kruskal-Wallis test, post-hoc pairwise comparisons using Dunn's test were conducted to determine specific group differences. The results revealed that the keyword method group had significantly higher mean ranks compared to the control group (p = 0.000), the rote group (p =0.000), and the sentence creation group (p= 0.05). Additionally, the sentence creation group had significantly higher mean ranks compared to the control group (p < 0.001), and the rote group (p = 0.000). However, no significant differences were found between the control group and the rote one (p= 1.000). These findings suggested that the keyword method and the sentence creation groups performed significantly better than the control and rote groups in the post-test.

Analysis of Post-Experimental Feedback

Given that the experimental group yielded the highest scores, participants were requested to provide qualitative insights by responding to an open-ended question regarding their experience with the keyword method. The answers of participants were then analyzed through a thematic analysis. A thorough initial examination of students' responses took place and recurring themes to the recall principles were identified. Based on this initial examination, the following principles emerged: enjoyment, distinctiveness, cognitive effort, and motivation. The answers of participants were then analyzed a second time and categorized on the basis of the presence of these recall principles. When analyzing qualitative data, a systematic approach was employed to code participants' responses based on the presence or absence of recall principles identified in the literature. Three distinct columns “yes”, “no” and “unmentioned” were created to categorize each response according to whether it contained, did not contain, or made no mention of each recall principle.

Analysis of post-experimental feedback revealed that students attributed the effectiveness of the keyword method to several key recall principles, namely distinctiveness (61.9%), enjoyment (61.9%), cognitive challenge (42.9%), and motivation (9.5%). The majority emphasized its novelty and distinctiveness, often describing it as new, unusual, or amusing, while many also discussed its enjoyable nature. Even though a sizeable proportion noted that the strategy was cognitively demanding, they regarded the challenge as manageable and even beneficial for retention. A few students further mentioned feeling motivated when using the method. In addition to these recall principles, 85.7% of participants expressed strong perceptions of the strategy’s effectiveness in supporting recall, with some forwarding intentions to adopt it in future learning. Opinions on its efficiency (9.5%) were mixed, with some citing time benefits and others noting its demanding nature.

Discussion

The concept of processing depth is multidimensional; its definition must not oversimplify the complex cognitive processes involved and their influence in operating memory performance. Processing depth is not only determined by its semantic and structural properties but is also determined by other cognitive factors that control the work of memory and language acquisition. These elements influence how input is encoded and retained, particularly in the context of vocabulary consolidation. These considerations will be examined in light of the findings from both experiments.

First Phase: Insights from the First Experiment

Findings from the first experiment showed that structural processing produced significantly lower recall scores than both conventional and unconventional semantic processing. This indicates that semantic processing produced a more effective impact for

vocabulary consolidation. The difference may be explained by variations in attention, cognitive challenge, and distinctiveness across tasks.

The disadvantageous nature of structural processing in comparison to semantic processing can be attributed, in part, to the role of attention. Structural processing still required a degree of attention since participants were asked to write and carefully observe the target words repeatedly and analyze their structural characteristics. The need to verify multiple structural characteristics may have required revisiting the target words several times, especially when a word displayed two or three features simultaneously. This stands in contrast to the semantic tasks, where participants wrote the word once in a sentence of their choice. However, the structural task posed a potential drawback in the form of diverted attention. Participants in this task might have become overly focused on the perceptual and structural properties of the words, which potentially overshadowed their intended meaning.

On the other hand, the act of constructing a sentence necessitates a higher level of focused attention, because a thorough understanding of the meaning and context is necessary before the incorporation of words into the sentence. In alignment with this perception, Murphy, Schwartz, and Castel (2024) investigated how attention affects value-directed recollection through multiple experiments. It was revealed that divided attention during encoding impaired the recall of the target words, but not during retrieval. This suggests that attentional resources are necessary during encoding for remembering important information, while retrieval can be less sensitive to attention levels. In addition, past studies (Greene & Naveh-Benjamin, 2020; Naveh-Benjamin et al., 2000) have consistently demonstrated that divided attention during the encoding phase disrupts memory performance, as opposed to full attention. Whitehead et al. (2021) also demonstrated, using an experimental design, that mind wandering during the encoding phase of a task impairs memory for stimulus-control associations, which further emphasizes the importance of focused attention in effective encoding. The findings of these studies are reflective of what potentially occurred during structural processing. Despite the absence of external distractors, focusing on the physical attributes of words during structural processing may have unintentionally diverted attention from their meaning, during the encoding stage, lowering cognitive involvement.

An additional explanation for the difference in recall performance between structural processing and semantic processing could be rooted in the principle of cognitive challenge. Drawing a parallel from the field of psychology, a widely accepted theoretical framework known as dual processing posits the existence of two distinct thinking systems. Various theories within this framework have proposed different conceptualizations associated with this duality, but reoccurring characteristics are linked to the processing systems. The first system of thinking is characterized as intuitive, fast, effortless, and unconscious, while the second is attributed with qualities such as controlled, reflective, and analytical (Evans, 2012; Reyna & Brainerd, 2011). Instead of rigidly adhering to the dual-system model of processing and viewing it as a fixed processing system, this duality can be conceptualized as a dichotomy to explain the impact of structural processing on recall.

Structural processing appeared to place lower cognitive demands compared to semantic processing. This might have prompted a quicker and more automated response in identifying physical properties, particularly given the repetitive nature of task items across the processing of all target words (Evans, 2012; Reyna & Brainerd, 2011). In contrast, semantic processing required participants to generate new sentences for all target words, which reduced the reliance on rapid and automated cognitive processes. Consequently, participants were compelled to analytically examine the semantics of individual words and their associations and to contemplate different options to build meaningful connections.

Thus far, it has been established that the superiority of semantic processing over structural processing can be attributed to an interaction between the degree of attention and cognitive

challenge. These attributes are not exclusive to conventional semantic processing but are also, heavily, present in the unconventional semantic task. This potentially explains its heightened performance in terms of recall scores compared to the structural task, as well. This outcome is frequently observed in experimental studies investigating various levels of processing, which leads to structural processing being categorized as shallow and semantic processing as deep (Alipour, Sheybani, & Akhondy, 2012; Chang, 2017; Patel, Jadav, & Mathew, 2015; Pollack, 2022). However, semantic processing cannot be labelled under one category of deep processing, as different types of semantic processing result in different outcomes, as has been observed in the first experiment of the present study. This indicates that variations within semantic processing influence vocabulary consolidation.

It is important, however, to contextualize these findings within a broader perspective. Despite acknowledging the challenge posed by the unconventional semantic task, participants demonstrated a good ability to successfully execute the task. This suggests an aligned balance between the cognitive demand in the task and participants' cognitive capacities and skill sets. The harmony between challenge and performance emphasized the dynamic relationship between task difficulty and cognitive proficiency. The need to strike a balance between cognitive challenge and capacities resonates with the well-established psychological tenet known as the "cognitive load theory" (Sweller et al., 1990). This theory, extensively explored and discussed over the years, posits that an excessive cognitive load surpassing processing capabilities can hinder effective learning (De Jong, 2009; Reedy, 2015). The balance observed between the challenge posed by the unconventional semantic processing and participants' performance aligns with the foundational principles of this theory.

The core of this balance becomes particularly evident when considering the potential outcomes had the cognitive demand been excessively challenging. In such a scenario, it might have resulted in lower scores. However, the challenge presented by the unconventional semantic task seemed to serve as a stimulant that propels attention and control without overwhelming or overburdening participants' cognitive resources. The body of literature in psychology and education generally acknowledges the positive and significant role of enjoyment on learning (Kang & Wu, 2022; Lucardie, 2014; Henrik & Jaworska, 2018). Specifically, when investigated in the context of EFL, an established positive correlation was found between enjoyment and academic achievement (Dewaele & Ergün, 2020; Li et al., 2019). This recognized connection between enjoyment and learning may shed light on one of the factors contributing to the higher score values observed in the unconventional semantic task. The positive effect of enjoyment on learning has often been linked to motivation (Kulakow & Raufelder 2020; Moreno & Huéscar, 2020).

In this context, two additional recall principles come into play as potential contributors. The distinctive nature of the unconventional semantic task required participants to craft sentences using word pairs, seemingly, devoid of conventional associations. This task's distinctive demand necessitates a form of lateral thinking, since it requires participants to establish non-prototypical connections. The inclusion of novel thinking during unconventional processing potentially altered participants' cognitive involvement. Through challenging students to explore and establish unconventional word connections, the task served as a means for "thinking outside the box". This, in turn, provides an interpretation for possible enjoyment of the unconventional task compared to the other tasks (Dewaele & Ergün, 2020; Li et al., 2019). The task's unique demand for creative thinking and the generation of unconventional associations showcased the task's ability to stimulate imaginative thinking and enhance the overall processing experience.

The second interpretation suggests that additional principles are involved during unconventional semantic processing, but not during conventional processing. While most of the principles discussed so far were present to a certain degree during both types of semantic

processing, a particularly notable principle, known as distinctiveness, is far more prominent in unconventional processing. This principle, to a greater degree, is exclusive to the unconventional task and might have potentially skewed the recall scores to its advantage. The principle of distinctiveness is grounded in intuitive theory that operationalizes its core nature as a property that violates a prevailing or an established context. It has also been forwarded that peculiarity amongst norms attracts attention, which leads to heightened cognitive processing and improved recall (Hunt, 2006). In the context of the study, unconventional processing is distinctive in nature because it required participants to make associations that diverge from the prevailing norm. It is evident that the structural process may decrease cognitive control due to the repetitive and automatic nature of the responses it generates. The presence of peculiar non-prototypical associations, that differ from pre-existing norms, likely seized students' attention and lead to an intensified cognitive interaction with input.

Second Phase: Insights from the Second Experiment

Rote repetition yielded the lowest scores out of the four groups in the second experiment of the present study. This finding aligns with perspectives suggesting that rote repetition may not be sufficient on its own for vocabulary consolidation (Kang, 2016; Nation, 2001; Yang & Dai, 2011). However, it diverges from other findings in the literature. For instance, Altalhab (2018) found that rote repetition proved effective for long-term recall. Yet, it can be noted that Altahab's research mainly focused on investigating the effect of rote repetition alone, while the second experiment of the present study involved comparing rote repetition against other strategies. If the results of rote repetition were examined in isolation, some progress would still be evident, as students could still recall a number of words. However, because it was compared to other strategies, rote repetition yielded the lowest performance.

In principle, rote repetition was selected as one of the strategies to investigate because of its close representation of structural processing. Specifically, it often relies on the mechanical repetition of the target words without further elaboration. This contrasts with strategies such as sentence production and the keyword method that require different and more elaborate forms of semantic processing. This is not to forward that rote repetition does not include any form of semantic processing. In fact, any kind of stimuli may trigger different associations and semantic interpretations regardless of its nature. However, the lower performance associated with rote repetition suggests that certain factors contributed to this outcome. These insights prompt the need for a comprehensive analysis of the underlying characteristics and mechanisms behind rote repetition to understand the reasons behind its performance. The present study, consistent with Sinhaneti and Kyaw (2012), found that rote repetition, both oral and written, is frequently reported by students as a preferred vocabulary learning strategy, largely due to its perceived simplicity and ease. However, its lower effectiveness observed in the second experiment aligns with findings from Hadi and Guo (2020), who noted that although learners favor cognitive strategies and perceive rote learning as time-efficient, they may lack practical application and long-term retention due to insufficient effort, time management, and underdeveloped memory techniques. So far, it can be established that insufficient cognitive effort due to simplicity, lack of elaboration, overfamiliarity, and reduced enjoyment are all factors that can be used to explain the lower performance of the rote group in comparison to other groups.

As addressed earlier, the strategy training that involved sentence production and the keyword method demonstrated superior results compared to training focused on rote repetition and the control group. Thus far, the observed differences were attributed to several factors, including the degree of cognitive effort and challenge, the level of enjoyment, and the type of elaboration involved. However, there is another important factor that provides a broader understanding of why the keyword method and sentence production strategies outperformed rote repetition, which relates to the bifaceted role of repetition itself. In a paradoxical manner, while rote repetition yielded the lowest results, the positive impact of repetition itself was

evident in the more effective strategies, sentence production and the keyword method (Hadi & Guo 2020). It is evident that when vocabulary instruction occurs in the classroom, an initial processing of the target words is bound to take place. Vocabulary items are rarely presented in isolation. Typically, they are accompanied by definitions, examples, and contextual interpretations. This natural educational aspect was closely mirrored in the second experiment. Each of the four groups was provided with lists of target words, including definitions and examples, throughout the training period. To promote autonomous learning, teachers were instructed to focus on training students on the use of the strategies alone while allowing them to independently work on the target words. Taking this into consideration, this setup ensured that all participants experienced the same level of initial processing.

There is an evident relationship between vocabulary recall strategies and processing. The idea that these strategies are often referred to as "consolidation strategies" or "recall strategies" might suggest that their primary aim lies within consolidation itself. However, this classification does not fully capture their practical application (Davoudi & Yousefi, 2016). In fact, the effectiveness of these strategies in improving recall depends significantly on the extent of processing beyond the initial exposure. In other words, an effective consolidation strategy may be differentiated from an ineffective one by the degree of elaborative processing it involves. In the context of the second experiment, rote repetition entailed an initial processing stage where students comprehended the meanings and read the definitions of the target words. Nonetheless, the consolidation phase in rote repetition was limited; its main objective was to repeat the words to achieve recall without additional processing (Davoudi & Yousefi, 2016; Koksal, 2013).

On the other hand, sentence production required students to use the target words within sentences. This approach incorporated elaborative processing, as students were required to apply their initial understanding by creating sentences that appropriately used the words. This testing of their ability to use the words in meaningful contexts exemplified a higher level of interaction. The keyword method necessitated the most elaborate processing of all. It required students to associate the target words with similar-sounding items and to construct sentences that reflect these associations, regardless of their typicality (Davoudi & Yousefi, 2016; Koksal, 2013). This strategy involved extensive elaborative processing, as students had to test their initial understanding and develop meaningful connections between the words. It can be forwarded that strategies such as sentence production and the keyword method involve active forms of repetition through elaborative processing, whereas rote repetition was characterized by a passive form of recycling.

Generally, the results of the experimental group using the keyword method concord with the common view in the literature, which suggests that the keyword method is effective for long-term recall (Davoudi & Yousefi, 2016; Koksal, 2013; Qu, Liu, Qiao, & Wang, 2024; Tavakoli & Geram, 2013). Active and elaborated processing is not the only factor that potentially played a role in the effectiveness of the keyword method. Other elements also influenced its efficacy, including principles that relate to general memory performance. Specifically, analysis of students' feedback on the keyword method revealed three underlying principles that may account for its effectiveness: distinctiveness, enjoyment, and cognitive effort. Students discussed the method's novelty and the unconventional associations it required, which made it stand out and promoted deeper processing. They also reported enjoyment, suggesting that positive affect facilitated sustained attention and motivation. Finally, although many described the method as cognitively demanding, the challenge appeared to strike a productive balance, stimulating attention without becoming overwhelming.

Characterization of Depth: The Attentive Depth of Processing Model

The objective of this section is to introduce the Attentive Depth of Processing Model, which represents a key outcome of the present study. This model was developed based on the

findings from the first and second experiments, which investigated the relationship between different types of processing and their effect on vocabulary consolidation. The analysis of the first and second experiments established a significant difference between different types of processing. On the one hand, it was revealed that structural processing yielded lower results than both types of semantic processing. Similarly, strategy training involving rote repetition yielded a lower performance than strategy training involving sentence production and the keyword method. These observations might lead one to argue that structural processing must be labeled as shallow and semantic processing as deep. However, this generalization would risk oversimplifying the disparity between different types of semantic processing by grouping all of them together under the same depth category. The evidence derived from both experiments indicates that this type of reductionist perspective is unable to accurately encapsulate the complex nature of processing depth. It is within this context that the Attentive Depth of Processing Model is proposed, as it seeks to capture the variability in processing depth across different stimuli.

Instead of adhering to rigid divisions that divide structural and semantic processing into shallow and deep, this study posits that depth can be understood as existing on a continuum that is characterized by varying recall principles. Specifically, this continuum is moderated by a set of fundamental principles that govern consolidation which encompass attention, cognitive control, distinctiveness, elaboration, imagery, and input interaction. These principles collectively exert influence over the observed spectrum of processing depth. In other terms, the notion of depth is not entirely dependent on the specific nature of processing, whether it be structural or semantic. Instead, it relies on the intricate relationship between the consolidation principles and the extent to which they are manifested within the stimuli. As has been explained before, this observation gives rise to two distinct theoretical possibilities. Firstly, it can be proposed that the principles guiding recall operate in a circular manner where they all collaborate to achieve optimal recall.

The amount of presence of these principles together within a given context directly corresponds to the likelihood of successful recall. To put it another way, the effectiveness of recall may not be solely dependent on which principles are involved, but rather on the overall number of principles at work; the greater their quantitative presence, the higher likelihood of recall to be achieved. This implies that effective recall may not depend on the nature of the principles used but on the collaborative effect of activating multiple principles simultaneously. Secondly, the alternative speculation is that certain recall principles might hold a greater weight compared to others on recall. This suggests that there may be a hierarchy of influence in the sense that not all recall principles contribute equally to the process of memory retention. Some principles may have a more pronounced impact in driving recall more effectively than others.

Based on the outcomes of this study, the second speculation may hold a stronger position. The majority of recall principles were evident in both forms of semantic processing. However, the principles of attention and distinctiveness exhibited higher prominence in the treatments that yielded significantly higher scores, which are unconventional processing and the keyword method. This suggests a plausible speculation that attention serves as a pivotal axis around which depth, governed by different recall principles, orbits. The latter premise can be further reinforced when considering the established notion that attention improves recall at the level of encoding. Two illustrations can be used to exemplify this speculation. First, attention can be a direct consequence of distinctiveness. It is a natural expectation that elements deviating from the established norm have a tendency to capture attention. In this case, it can be observed that attention, governed by distinctiveness, serves as the important axis around the degree of depth. A second example involves cognitive effort. A task that demands cognitive effort necessitates attention. However, when the difficulty level of a task becomes either excessively challenging or exceedingly simple, attention can be reduced, causing a potential decrease in recall

performance. This situation closely applied to both structural processing in the first experiment and rote repetition in the second. This suggests that depth of processing is a dynamic concept that may be influenced by various cognitive and affective factors, and it may not be fully explained by the original structural/semantic dichotomy. The observed patterns indicate that processing depth is better understood as a multi-dimensional construct, shaped by the nature of the cognitive processes involved.

Much like the concept of depth, attention, cognitive effort, and distinctiveness are all multidimensional and must not be viewed as bifaceted notions that reduce their complexity to a binary dichotomy of opposing attributes. To start with, attention should be conceptualized as a continuum that requires maintenance. A key consideration does not only involve what initially grabs attention but also the duration for which this attention can be effectively sustained. A task that is distinctive may initially draw the learner's focus due to its novelty or uniqueness. However, if it proves excessively challenging, the attention it initially drew may be eventually lost. On the other hand, an enjoyable task might not instantaneously command focused attention. Yet its appeal might ensure its sustained attention over time. Therefore, the interaction between novelty, cognitive effort, and enjoyment, or any other principles that attract attention, plays an important role in actively interacting with the target material. Likewise, tasks or stimuli that strike a balance between being challenging, yet achievable, can encourage a deeper connection to the content by promoting sustained focus.

CONCLUSION

Generally, the present study has examined the role of attentional principles as underlying mechanisms behind the continuum of processing depth. This has been outlined in the first and second experiments, along with the Attentive Depth of Processing Model. This sought to provide a general understanding of how different attentional mechanisms influence vocabulary consolidation through processing. Specifically, the results presented in this study suggest that processing depth is not a fixed dichotomy but a dynamic continuum, where different attentional recall principles such as distinctiveness, cognitive effort and enjoyment, collectively, exert influence on depth of processing and, consequently, recall performance.

FUNDING

This research received no specific grant from any public, commercial, or not-for-profit funding agency. All stages of the study, including design, data collection, analysis, interpretation, manuscript preparation, and reporting, were conducted independently by the researchers. Any institutional support provided was limited to regular academic assistance and did not influence the study process, findings, conclusions, or publication decisions in any way.

INFORMED CONSENT STATEMENT

Participation in this study was entirely voluntary. Before taking part, all participants were informed about the purpose, procedures, potential risks, and benefits of the study. They were assured that their identities would be kept confidential and that all information provided would be used solely for research purposes. Participants were also informed that they had the right to withdraw from the study at any time without penalty or loss of any benefits to which they were otherwise entitled. By continuing their participation, they provided informed consent to take part in this research under the conditions described.

DATA AVAILABILITY STATEMENT

The data used in this study cannot be made publicly available due to privacy concerns and ethical obligations related to participant confidentiality. This restriction ensures compliance with ethical research standards and applicable data protection regulations. However, researchers or interested parties who require access to the dataset for validation or further analysis may submit a reasonable request. Such requests will be reviewed on a case-by-case

basis. Data sharing will only be permitted after approval from the appropriate institutional ethics review board to ensure that the proposed use aligns with ethical guidelines and the consent terms agreed to by participants.

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