Critical Analysis of Eye-tracking Methods in Vocabulary Acquisition under Implicit and Explicit Instruction: A Comprehensive Review

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Abstract. Learning and teaching styles play a crucial role in determining the effectiveness of vocabulary acquisition. Style usually involves both implicit and explicit modes. However, previous studies have produced inconsistent evidence on the effectiveness of these two modes. The purpose of this paper is to elucidate the application of eye-tracking methodology in this area and to contribute to the understanding of vocabulary acquisition based on the exploration of vocabulary acquisition by previous studies using offline methods. The paper begins with a comprehensive overview of theories related to vocabulary acquisition and explicit and implicit acquisition. Then, it introduces the eye-tracking method and examines the major studies that have explored vocabulary acquisition using this technology. The analysis reveals that very few comparative studies have been conducted on eye-tracking methodology in vocabulary acquisition. This paper suggests that there is great potential for applying the eye-tracking method to comparative studies between implicit and explicit instruction.

Keywords: Implicit and explicit instruction, vocabulary acquisition, eye-tracking method.

1. Introduction

It is a complex and challenging process for learners to acquire a second language other than their native language, which involves the development of multiple skills including reading, writing, speaking, and listening. The fundamental and essential element to boost those skills is the acquisition of vocabulary. In order to accumulate enough vocabulary, it is crucial for learners to learn words both explicitly and implicitly. In particular, implicit learning is considered essential for developing vocabulary related to topics not often encountered in familiar environments.

As for the definition of implicit and explicit, it has evolved many times [1]. In 1976, Arthur Reber proposed that the distinguishing factor of implicit learning was the lack of conscious awareness of the structure of the vocabulary being learned [2]. He defined implicit learning as a fundamental process that involves recognizing patterns based on their frequency rather than relying on explicit methods that involve memorization and other strategies [2]. As the definition of consciousness and awareness is challenging, researchers later incorporated intentionality and automaticity into the definition. However, DeKeyser disagreed with the incorporation and chose to describe implicit learning as learning without conscious awareness of what is being learned [1]. As opposite to implicit learning, explicit learning involves actively seeking and discovering rules through studying examples [1].

The effectiveness of two learning modes on vocabulary has also been a topic of debate but with conflicting evidence from various studies. Some research suggests that explicit instruction can enhance the depth and retention of word memorization, while others argue that implicit learning facilitates the use of vocabulary in context [3,4]. The possible reasons that caused the inconsistency vary, from the methodological factors, including what reading materials they adopted, what vocabulary tasks they employed, what environment they put learners into, and how pre-and post-tests were designed, to individual differences, such as the learners' proficiency level, their enjoyment for reading, their degree of short-term memory, their strategies of learning vocabulary. The majority of studies adopting offline methods face challenges in considering both ecological validity and methodological control simultaneously. However, technological advancements have provided further

insights. One such method is eye-tracking technology, which allows researchers to investigate the psychological processes involved in vocabulary acquisition during reading. This method can provide light on how vocabulary is learned by readers when they read lengthy, real texts in a setting that is conducive to natural reading.

The present study commenced by examining prior studies within the vocabulary acquisition area, specifically emphasizing implicit and explicit training, in order to provide a thorough synopsis of the associated theories. The study then presents the eye-tracking method's application in this field, expanding on this theoretical understanding. The goal is to offer insightful information for further research in this field by examining important studies that have used the eye-tracking approach to study vocabulary learning.

2. Vocabulary Acquisition under Implicit and Explicit Instruction

2.1. Implicit and Explicit Learning

How to define implicit learning and explicit instruction and distinguish the key difference between the two is closely related to the very nature of L2 learning and teaching and the exact relationship between input and intake. The inquiry has changed as research has progressed, eventually becoming, What part do awareness and attention play in this process?

Arthur Reber highlights that the central aspect of implicit learning is the absence of conscious awareness regarding the structure being learned [2]. Implicit learning entails perceiving and grasping the structure by paying attention to frequency cues, rather than relying on explicit techniques like mnemonics and strategies [2].

Schmidt outlined three significant problems with the way awareness functions as an input processing mechanism [5]. First, the idea of implicit learning investigates the question of whether language acquisition requires conscious awareness. Second, implicit learning investigates the question of whether learning requires conscious attention. Finally, implicit learning investigates whether learner presumptions based on input originate from an unconscious process of abstraction or from conscious understanding and insight. Schmidt comes to the conclusion that implicit learning is both feasible and successful if learners' attention is directed onto the material that needs to be learnt in tasks. Nevertheless, paying attention on purpose could sometimes be helpful and even crucial for adult learners to pick up redundant grammatical rules.

The challenge of defining implicit learning led to alternative suggestions involving intentionality and automaticity. Intentionality refers to that participants in implicit learning experiments typically intend to learn something, even if they ultimately learn something different from their initial intention. However, DeKeyser believed that the two concepts still could solve the problem of the key issue of defining the role of consciousness and awareness [1]. He chose to define it as the learning process which learners are not aware of what is being learned [1].

2.2. Explicit Instructional Intervention

Instructional intervention is believed to have a positive impact on second language (L2) learning by directing learners' attention to specific linguistic features during L2 processing and increasing the likelihood of noticing certain aspects of the L2.

According on whether students prioritize learning the meaning, concentrating on particular language forms, or combining the two, Long has proposed three different instructional styles [6]. First, meaning-focused training, also known as focus-on-form (FonF) instruction, made the point that learning a second language can occur naturally when a person is exposed to a lot of input in the language and utilizes it in meaningful contexts. Second, form-only training presumes that the target L2 forms should be taught according to linguistic complexity. Lastly, training that uses brief, responsive interventions to focus students' attention on the structural elements of a language feature within the context of meaningful communication and forces them to concentrate on the integration of both forms and meaning.

While Long believes that FonF instruction for researchers is a more familiar process happened during second language acquisition, term form-focused instruction (FFI) was suggested to incorporate more instructional types. This instruction fosters learners to turn their attention to particular forms in meaningful contexts despite their obtrusiveness and proactivity [7]. Doughty and Williams take a middle ground, proposing three criteria for FonF instruction: first, learners are exposed to meaning before they pay attention to linguistic codes; second, learners' needs are analyzed in order to trigger pedagogical treatments; and, third, learners are briefly and overtly attracted to focused attention to form [7].

In the field of experimental design, explicit instruction in L2 learning involves four key areas: presenting rules, providing negative feedback, exposing learners to relevant input, and providing opportunities for practice [5]. Each of these components can be presented and implemented in different ways in experiments and combined to form different pedagogical approaches, including input enhancement [5].

In 1993, Ellis conducted a study to examine the effects of the acquisition of structural linguistic elements by Finnish learners of English with limited proficiency (LEP), subjecting the participants to an intervention method of presenting rules and enhancing visual input [8]. The study incorporated two reading comprehension tasks that embedded the learning targets. The treatment groups were exposed to manipulated input in different ways: visual enhancement of the learning targets using italics (Enhance), explicit presentation of rules (Rule), and a combination of both (Rule & Enhance). It is noted that during the study phase, learners were also asked to verbalize their thoughts (think-aloud protocol). The predicted order of achievement was as follows: Control < Enhance < Rule < Rule & Enhance. It is worth noting, as Ellis points out, that explicit learning does not represent a set of clearly defined formal rules about the targets [8]. Rather, it is a more conscious operation of hypothesizing and testing the nature of the structures present in the input.

2.3. Vocabulary Acquisition

Learning styles are a critical aspect of second language vocabulary acquisition, and a considerable body of literature has examined the essential factors that influence the effectiveness of implicit and explicit learning [3]. In the context of vocabulary acquisition, explicit vocabulary teaching is the common method used in academic settings, involving direct teaching strategies to give a clear explanation of the meaning and use of the target word [1]. By contrast, implicit vocabulary teaching relies on indirect strategies, such as reading while being told to focus on meaning. Specifically, explicitly teaching new words can help language learners focus on words that are comparatively complex in terms of semantics. Those learned vocabulary are intentional vocabulary, which is opposite to incidental vocabulary. Implicit instruction usually involves teaching words in context through reading and highlighting their characteristics, which more focus on guiding learners to pay attention to the words from the perspective of syntactic.

Regarding the effectiveness of the two learning methods, research has generated mixed results, with some studies favoring explicit instruction while others tout the benefits of implicit instruction [3,4].

Using post-tests, Marulis and Neuman investigated the effects of several vocabulary education approaches. Programs that employed explanations or important examples to provide explicit instructions were found to have a bigger effect on vocabulary improvement than those that used implicit instruction [9]. In order to compare the impact of explicit versus implicit training on kids' vocabulary development, Damhuis et al. undertook a study in 2014 [3]. The findings showed that while both forms of training increased vocabulary knowledge, explicit instruction in particular increased vocabulary knowledge at a deeper level [3]. It made the case that explicit vocabulary education was more effective than implicit instruction based on its analysis of the data [3].

Conversely, some study contends that incidental acquisition—which occurs through exposure to written and spoken language—comes into play and that explicit vocabulary instruction alone is insufficient to help learners acquire the enormous amount of words they must know [10]. In order to

evaluate the quantity of vocabulary acquired through reading, Horst, Cobb, and Meara's study used word association tests and multiple-choice meaning recognition tests by applying the multi-component approach [11]. The findings unequivocally demonstrated that words can be learned through reading and that connections can be formed between them. Waring and Takaki investigated whether it is possible to learn the meaning of words that are learned by accident at both the recognition and recall levels using a multiple-choice and translation task. According to the study, participants understood the meaning of about half of the target terms [12]. Furthermore, a study by Pellicer-Sánchez and Schmitt that employed an authentic novel that was more reader-friendly in their experiments discovered a significant quantity of vocabulary learning and backed the efficacy of implicit vocabulary acquisition [4].

However, overall, most of the above studies investigate vocabulary development through reading by comparing participants' performance in pre- and post-tests [4,12]. This approach is considered an offline method, which means it is temporally disconnected from the actual processes under investigation [13]. Given that a range of factors influence the results of such studies, it becomes challenging to design experiments using offline methods that accurately mirror real-life language learning situations while also controlling for extraneous variables. Researchers who investigate the effectiveness of vocabulary development through reading face the challenge of balancing ecological validity with methodological control.

3. Application Eye-tracking Method on Incidental Vocabulary Acquisition

Technological advancements in recent years have helped to address the methodological challenges in the field of vocabulary acquisition, allowing researchers to further delve into the concurrent behavior of the reading process and gain insights into incidental vocabulary acquisition. Such methods are called online methods, including think-aloud protocols, think-aloud protocols, eye-tracking methods, and event-related potentials [12]. Online methodologies are considered a class of data collection methods that can reflect the language processing when participants receive or produce information [13]. It has allowed researchers to investigate various aspects of language processing, including word recognition, sentence comprehension, and reading strategies.

Among all the online methods, researchers consider the eye-tracking method as a valuable and versatile tool that closely mimics the experimental setup of natural reading. Eye-tracking was defined by Godfroid, Boers, and Housen as the online register of behavior of participants' eye movement. Particular focus should be paid to both eye fixation and saccades or eye moments [13].

Those data can provide researchers with an overtly attentive measure of behavior that allows them to examine what is happening during real-time processing. This is in contrast to pre-test/post-test data comparisons, which do not provide the same level of insight into moment-to-moment processing. It uses a more natural reading style without any additional prescribed duties and can disclose features of processing that other psycholinguistic approaches are unable to identify. It also permits the reader to go back and study earlier sections of the text at their convenience. As both self-paced reading and think-aloud protocols are online methods, they may not provide the same level of accuracy as the eye-tracking method since the researcher had no way of knowing what the reader was analyzing and reanalyzing about the text [13].

Few studies have used eye-tracking techniques to look into how incidental vocabulary is learned through reading [11, 13]. Godfroid's research suggested that paying attention to novel linguistic parts in the input leads to their initial encoding in long-term memory, based on the noticing hypothesis [13]. The study successfully demonstrated that for every additional second that participants looked at a new word while reading, the likelihood of correctly recognizing the word on a subsequent vocabulary test increased by 8% [13]. This was achieved by using an eye-tracking method to assess whether learners’ fixation times on novel words in the reading.

In 2016, Pellicer-Sánchez combined the offline and online measures to further confirm the effect of incidental vocabulary learning through reading. Higher competence second language learners

derived the same benefits from reading as did native readers, according to an analysis of data from three vocabulary tests and eye movements [10].

Godfroid and colleagues in 2018 also explored the effect of word learning from the perspective of acquisition of meaning in recall and recognition post-tests. In experiments, the researchers predict the acquisition of the meaning of novel words through the length of time participants are exposed to words in each recall and recognition post-test [14].

In conclusion, eye-tracking technology is a valuable tool for studying cognitive processes in vocabulary learning as it records the concurrent reading behavior of participants. However, studies specifically addressing and comparing the effects of different types of instruction are still relatively limited.

4. Conclusion

In summary, there is a few research comparing vocabulary learning under implicit and explicit training, according to a review of the key works in the field of vocabulary acquisition using the eye-tracking method. Furthermore, this study discovered that eye-tracking investigations supported the significance of incidental vocabulary learning via reading. From a methodological perspective, this research offers insights into how students distribute their visual attention and interpret new words in various learning environments. Future research could increasingly take advantage of the benefits of eye-tracking technology to provide more insights into vocabulary acquisition under various instructional conditions, as the significance of investigating incidental vocabulary acquisition at the instructional level is apparent for educators and practitioners in the field of education.

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