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MENTAL REPRESENTATION OF ENGLISH PAST TENSE MORPHOLOGY BY JORDANIAN EFL STUDENTS: A DUAL MECHANISM ANALYSIS

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Abstract

The study aims to examine if dual mechanism asymmetrical processing is applicable to L2 processing. A lexical elicitation task of the past tense is designed to measure the effect of phonological neighborhood similarity. The task includes a trio of non-verbs for existing regular and irregular verbs at three levels of phonological similarity which are the prototypical, intermediate, and distant. Forty high-proficiency Jordanian learners of EFL at the Hashemite University participated in this task. The results show that the dual mechanism asymmetrical processing is noticeable in the result of the study as the irregular past tense inflection is sensitive to phonological neighborhood similarity while the regular past tense inflection is not. The number of the irregular non-verbs being irregularly inflected decreases as the similarity decreases when moving from prototypical, to intermediate, to distant level.

Keywords

dual mechanism, associative memory, generative rules, cognitive processing of EFL, English past tense

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REPRESENTACIÓN MENTAL DE LA MORFOLOGÍA DEL TIEMPO PASADO EN INGLÉS EN ESTUDIANTES DE EFL DE JORDANIA: UN ANÁLISIS DE MECANISMO DUAL

Resumen

El estudio tiene como objetivo examinar si el procesamiento asimétrico de mecanismo dual es aplicable al procesamiento de una L2. Se ha diseñado una tarea de elicitación léxica del tiempo de pasado para medir el efecto de la similitud de fonemas vecinos. La tarea incluye un trío de no-verbos que se corresponden con verbos regulares e irregulares existentes en tres niveles de similitud fonológica, que son el prototípico, el intermedio y el distante. Participaron en esta tarea cuarenta estudiantes jordanos de alto nivel de inglés como lengua extranjera en la Universidad Hachemita. Los resultados muestran que el procesamiento asimétrico del mecanismo dual es notable, ya que la flexión del tiempo de pasado irregular es sensible a la similitud de los fonemas vecinos, mientras que la del pasado regular no lo es. El número de no-verbos irregulares que se flexionan irregularmente disminuye a medida que disminuye la similitud al pasar del nivel prototípico al intermedio y al distante.

Keywords

mecanismo dual, memoria asociativa, reglas generativas, procesamiento cognitivo de EFL, tiempo de pasado en inglés

REPRESENTACIÓ MENTAL DE LA MORFOLOGIA DEL TEMPS PASSAT EN ANGLÈS EN ESTUDIANTS D'EFL DE JORDÀNIA: UNA ANÀLISI DE MECANISME DUAL

Resum

L'objectiu d'aquest estudi és examinar si el processament asimètric de mecanisme dual es pot aplicar al processament d'una L2. S'ha dissenyat una tasca d'elicitació lèxica del temps de passat per mesurar l'efecte de la similitud de fonemes veïns. La tasca inclou un conjunt de tres no-verbs que es corresponen amb verbs regulars i irregulars que existeixen en tres nivells de similitud fonològica, que són el prototípic, l'intermedi i el distant. Hi van participar quaranta estudiants jordans d'un alt nivell d'anglès com a llengua estrangera de la Universitat Hachemita. Els resultats mostren que el processament asimètric del mecanisme dual és notable, ja que la flexió del temps de passat irregular és sensible a la similitud dels fonemes veïns, mentre que la del passat regular no ho és. El nombre de no-verbs irregulars que es flexionen irregularment baixa a mesura que en disminueix la similitud en passar del nivell prototípic a l'intermedi i al distant.

Paraules clau

mecanisme dual, memòria associativa, regles generatives, processament cognitiu d'EFL, temps de passat en anglès

1. Introduction

1. Theoretical background

Different theories and hypotheses (e.g. Chomsky & Halle 1968; Plunkett & Marchman 1993) aimed to explain the mental processing and representation of language. For a long time, language has been explained within the combinatorial framework by which simple forms are combined into complex ones through the application of rules (e.g.

applying the rule of adding the plural suffix -s to a noun in order to get the plural form as in: *cup* +s = *cups*). Thus, language processing has been viewed from a rule-based perspective. On the contrary, the associative memory account (e.g. Rumelhart & McClelland 1986) assumes that language processing became the task of associative memory while rules were set aside as tools that do not produce language but describe it (McClelland & Patterson 2002). Thus, the rule of stem +*ed* is used to describe the past tense in English, while the -*ed* past form of verbs is retrieved through associative memory processing. In short, it becomes a matter of debate on whether the cognitive processing of language is memory-based by which regular and irregular forms are processed through mapping in memory, rule-based by which the regular and irregular forms are processed through rule, or an exploitation of both as claimed by dual mechanism asymmetrical processing in a later stage.

Rule-based mechanism, adopted by generative grammar models, has prevailed for a long time. It deals with language cognitive presentation and processing. The account proposed by behaviorism on language as a result of learning process of imitation and feedback was encountered by nativists or innatists which proposed that language was an innate capacity or endowment by which human was the only subspecies with the aptitude to acquire and process language (Richards & Rodgers 2001). Due to the connection between mental grammar and language, models of generative grammar would explain language processing through rules.

The early model of generative grammar is Chomsky's standard theory (1957: 965). It argues that language in mind is handled by two sections: the first is the lexicon which is a repertoire that contains a list of words while the second is the mental grammar or rules. According to this model, memory is merely a place to store and retrieve words (Spenser 1991). So, productivity has been assigned exclusively to the rules. These mental rules are combinatorial as they have the ability to combine linguistic items (Berent et al. 2002). Accordingly, rules would turn simple forms into unlimited number of complex linguistic chunks like transforming simple words into complex words, words into phrases, phrases into clauses, and clauses into sentences. For example, past tense is formed by applying the rule of adding the suffix -*ed* to a verb root (e.g. *cook* +past [ed] =*cooked*). While

regular forms are produced by rule, the irregular must be listed in memory. Irregular verbs share similarity in pattern of change like *i* to *a* (e.g. *drink-drank*, *sink-sank*, *shrink-shrank*) as well as similarity between the root and the past (e.g. *swing-swung*) (Pinker & Prince 1991), as the stem and the past tense have the same sounds expect for the vowel that is changed. Thus, the irregular being listed in memory ignores these similarities.

Later, rule-based models like Chomsky & Halle (1968) and Halle & Mohanan (1985) suggested some minor rules to process the irregular verbs instead of the full listing. The minor rules suggested for the irregular inflection were not totally capable of grasping the whole set of irregular verbs within these rules. For example, the rule of changing *i* to *a* would involve verbs like *sing-sang* and *ring rang* while falsely involving verbs like *fling* and *bring* (Bybee & Slobin 1982). In short, the rule-based models managed to explain the morphological processing of regular, while they failed to explain the irregular processing.

In 1980s, connectionist network model presented a challenge to the rule-based model. Rumelhart & McClelland's (1986) connectionist model of past tense explained the cognitive processing and representation of language as the result of associative memory. Processing language is achieved through the parallel distribution processing (PDP) mechanism. PDP mechanism is a network of connected input and output units by which there is an association or mapping of the phonological features of the input and output units (Marcus 1998). The input and output units are connected through some weighted connections and the relation between the units is governed by the weights over the connections. The weights are adjusted according to the feedback algorithm and the training set that the model is trained on. The feedback algorithm draws analogy between the desired output suggested by the training set and the resulting output, as the feedback algorithm aims to reduce the difference between them by adjustment of the weights which would result in having the correct linguistic form or output (Marcus 1998). Since the memory is associative, there must be some factors that trigger and strengthen this association like frequency and phonological neighborhood similarity. Words with high frequency would have easier retrieval. Moreover, the phonological similarity of a new word to other words in the training set would enable the generalization of the pattern of inflection to the novel word based on phonological similarity of already existing forms (Pinker 1999).

With the rules being out of the picture, productivity is assigned to memory only as words whether regular or irregular are processed by memory. Rules were barely descriptive tools that describe language in use and hold no productive ability (McClelland & Patterson 2002). Rumelhart & McClelland model (1986) managed to produce the past tense of irregular, while facing difficulties in processing regular. Later on, other associative models (e.g. Plunkett & Marchman 1993, Plunkett & Juola 1999) suggested some refinements like the addition of intermediate layers (hidden layers) between the input and output units in an attempt to overcome the problems that Rumelhart & McClelland model (1986) faced. Still, these models along with the refinements have failed.

Due to failure of both rule and associative memory models, dual mechanism was suggested by Pinker and his colleagues such as Marcus, Ullman, and Prince. According to dual mechanism, regular is produced by rule application. On the other hand, the irregular is generated by associative memory. Memory in the dual mechanism is not the exact replica of the memory in the associative sense of connectionist models. While connectionism draws association between phonological features of words, memory in dual mechanism associates words in form of pairs (e.g. *fling-flung*) in addition to the phonological features of the words (Pinker 1999) as the verb *fling* and its past tense *flung* share the same sounds except for the vowels. Dual mechanism distinction between rule and memory is suggested to be universally applied to other human languages (Pinker 1999). Thus, the dual mechanism asymmetrical processing is not restricted to English past tense as it has been used to explain linguistic phenomenon in other human languages like the case of plural in Arabic (e.g. Alshboul et al. 2010, Alshboul et al. 2012) and German (e.g. Marcus et al. 1995).

2. Questions and hypothesis of the study

This study addresses two questions:

1- To what extent do Jordanian learners of EFL exhibit discrepancy in response to phonological neighborhood similarity when inflecting regular and irregular past tense?

The study predicts that English past tense processing by Jordanian learners of EFL conforms to the dual mechanism asymmetrical processing of memory and rule. Thus, the study assumes that regular past tense inflection being the result of rule application should not be affected by phonological neighborhood similarity, while irregular inflection as it depends on memory should be sensitive to phonological similarity.

2- To what extent do Jordanian EFL learners exhibit a greater reliance on memory or rule application when employing both faculties to process regular and irregular past forms?

The study predicts that when exploiting both memory and rule, there would be a slight dependence on rule. The repeated or frequent exposure to words would enhance their chances of being memorized (Ullman 1999). Thus, reliance on rule would be expected due to the lack of exposure to language. EFL learners do not live in a native speaking environment. This lack of exposure to language would cause a weak memory trace for the irregular words. Moreover, the lack of exposure results in having a poor lexicon which might not enable an effective mapping in memory for the irregular past tense inflection. Consequently, retrieval failure of irregular verbs is expected as a result of having weak memory trace and poor lexicon. The heavier reliance on rule would be reflected through the increased exploitation of the suffix *-ed* to regularly inflect some irregular verbs.

3. Methodology

3.1 Background and rational of the experiment

Past tense in English has been the field of debate among the rule-based, memory-based, and dual mechanism theories. This debate of past tense among these theories is grounded in the framework of psycholinguistics or the mental processing of language. Mental encoding and decoding of language is the essence of verbal communication (Lunenburg 2010). Consequently, experiments in psycholinguistic studies concerning mental representation of past tense have been designed as either experiments of

encoding of past tense known as lexical elicitation tasks (e.g. Muftah 2016; Kirkici 2005) or decoding of past tense known as lexical decision tasks (e.g. Ullman, 1999). Moreover, some studies that have investigated the past tense involved both types of experiments the lexical elicitation and the lexical decision (e.g. Prasada & Pinker 1993).

As evidence in psycholinguistics is established upon investigating the frequency and phonological neighborhood similarity (Ullman 2001), the lexical decision and elicitation experiments are established to measure the effect of frequency or phonological neighborhood similarity. The sensitivity to phonological similarity and frequency is an indicative of the form being stored in memory (Rodríguez-González 2012). This is due to the fact that memory processing depends on drawing associations which are triggered and strengthened through frequency and phonological similarity. Accordingly, the claim of dual mechanism asymmetrical processing by which the regular is processed by the rule and the irregular is processed by memory is accompanied with the hypothesis of irregular's sensitivity to phonological neighborhood similarity and frequency. On the contrary, the single mechanism memory based claimed that both types of verbs are processed by memory which requires having frequency and phonological similarity effect for both. To the single mechanism rule-based approach, regular and irregular are product of rule that would suppress differences and ignore similarities. So, frequency and similarity don't hold any effect regarding the regular and irregular inflection.

As for the current study (in a similar fashion to Prasada & Pinker 1993), it has referred to lexical elicitation task as the participants are required to provide (i.e. encode) the past tense of regular and irregular non-verbs forms. It aims to examine the effect of phonological similarity over three levels of non-verb forms to check if dual mechanism asymmetrical processing proves its applicability to the processing of L2 by Jordanian EFL learners or that single mechanism whether rule-based or memory-based would prevail.

3.2 Participants

The participants of the study are Jordanian university EFL learners, 3rd and 4th year students at the Hashemite University. Participants are native speakers of Arabic. The

participants have GPA of (3.5) up to (4). They are chosen to be of high proficiency as they are expected to have mastered the rules and have a better lexicon.

3.3 Data collection instruments

The data collection instrument in the current study is a lexical elicitation task that is designed upon phonological neighborhood similarity. The task contains two groups of (10) regular verbs (e.g. *help*) and (10) irregular verbs (e.g. *drive*) that consist of one vowel and three consonants. Three groups of non-verb forms have been created for the verbs. The groups of non-verb forms are similar to the real verbs but differ in consonants. So, the instrument contains (60) non-verb forms which are (30) regular non-verb forms and (30) irregular non-verb forms. The first group is the prototypical which differs in one constant. The second group is the intermediate which differs in two consonants. The third group is the distant which differs in three consonants.

Example:

Regular verb	Prototypical	Intermediate	Distant
<i>help</i>	<i>felp</i>	<i>ferp</i>	<i>ferk</i>
Irregular verb	Prototypical	Intermediate	Distant
<i>drive</i>	<i>Prive</i>	<i>plive</i>	<i>plize</i>

To avoid having the phonologically strange sounds, the resulting clusters are within the scope of the phonologically permissible combinations of sounds in English. Moreover, all the consonants were replaced with other consonants that match them in manner of articulation while differing in place of articulation. So, verbs won't be totally strange to the participants as there is a connection between the original and changed consonants where they share manner of articulation. When the lexical elicitation task is formed, it is checked repeatedly and approved by the supervisor and then approved by two linguistic professors before being given to the participants.

Both regular and irregular non-verb forms have equal number of sounds. However, in case of the verbs *cling* and *bring*, the /ŋ/ *ing* has been replaced with *n* and *d* instead of one nasal sound due to the fact that participants are EFL learners who might be referring

to the *ing* in the orthographic sense as *n* and *g* instead of referring to *ing* in the phonological sense as /ŋ/. Thus, to avoid the confusion that might happen to the participants, the nasal /ŋ/ has been replaced with the nasal *n* as well as the *d* that is used to substitute the *g*. This condition can be noticed in two non-verb forms at the distant level out of the (60) non-verb forms included in this lexical elicitation task which are *dwind* for the verbs *bring* and *prind* for the verb *cling*. These two cases include five sounds due to the addition of the *g*, while all the remaining verbs contain the same number of sounds (i.e. four sounds).

The sounds of the chosen verbs in this study are considered according to the American pronunciation. Thus in this study, the verb *curve* is considered as four sounds /k3rv/ according to the American pronunciation rather than the British pronunciation of *curve* that considers it as three sounds /k3:v/. Moreover, irregular verbs were chosen to cover different patterns of inflection like *d* to *t* pattern as in *build-built*, and *i* to *a* pattern as in *swim-swam*. Irregular verbs that have two past forms regular and irregular (e.g. *dream, dreamed-dreamt*) were excluded due to the availability of regular and irregular forms.

3.4 Data collection procedures

To fulfill the goals of the current study, lexical elicitation task is used. This task (see appendix B) has been distributed to the subjects in the 2nd semester of the academic year 2017 in Hashemite University. The regular and irregular non-verb forms created according to the three degrees of phonological similarity were presented to the subjects while the original verbs were not presented. The participants were told that they were given a list of non-verb forms. They were given the instructions to provide the past tense form (verb 2) of each verb not the past participle and to pay attention to the spelling problems. Some examples of real verbs along with their past tense were provided to the participants as examples of past tense forms (e.g. *sink, sank* and *clean, cleaned*).

The elicited responses are observed according to the phonological neighborhood similarity effect to determine the mechanism responsible for morphological processing of

EFL learners. If the chances of the irregular non-verb forms being irregularly inflected decrease when similarity decreases while regular verbs are not affected, then the results are supportive to the dual mechanism. If some cases of irregular are *-ed* suffixed, then there would be a slight degree of reliance on rule. If some cases of regular verbs would be irregularly inflected, then a heavier reliance on memory is recorded as the irregular inflection is processed by associative memory. On the other, if either sensitivity to similarity or the lack of it is marked in all cases of regular and irregular then single mechanism prevails and dual mechanism asymmetrical processing is rejected.

3.5 Data analysis procedures

The participants were required to produce the past tense of the regular and irregular non-verb forms for the three groups (prototype, intermediate, distant) then the responses were elicited and analyzed. Participants were allowed to produce only one form either regular or irregular for each non-verb form. The two thousand four hundred responses (i.e. past inflection of non-verb forms) for forty participants were examined. Responses were counted as regular if they included the suffix *-ed*. For example, some participants have inflected the regular non-verbs forms of *glushas glushed*, and *ferve as ferved* which are counted as regular. On the other hand, the cases where there was a vowel change (ablaut), the addition of the suffix *-t* or both were considered as markers of irregular forms. For example, some participants have inflected the irregular non-verbs forms of *fleep as flept* and *pleak as plok* which were considered as irregular forms. Some of the participants' written responses were excluded as they have provided the past participle (verb 3) not the past tense (verb 2) such as *pleaken* for the irregular non-verb *pleak*. Some papers were also excluded as some responses were not provided.

Quantitative analysis was employed using SPSS version 17. The non-verb forms in this lexical elicitation task are categorized into 6 groups as the regular and irregular non-verb forms were divided to three groups prototypical, intermediate and distant. The participants' responses on each level are inspected to see whether they are counted as regular or irregular. As each participant's responses regarding these six categories are entered into SPSS, the means of these categories were calculated. The difference

between the means is measured by repeated measure ANOVA test and analyzed according to the results obtained from ANOVA (i.e. analysis of variance) test. The ANOVA is executed in order to see if there is a statistically significant difference among the means of regular and irregular responses across the three levels of similarity. Thus, the trios established for the list of 20 regular and irregular English verbs are analyzed according to effect of the phonological neighborhood similarity indicated by ANOVA results. The difference between the means of the three groups indicated by ANOVA would reflect the effect of phonological similarity, while the lack of difference would mean that the phonological similarity is ignored when producing the past tense. An independent T test is also conducted at the prototypical level to see if there is a significant difference between the means of the regularly and irregularly inflected non-verb forms. The difference between the means of regularly and irregularly inflected verbs indicated by the independent T-test would reflect a reliance on memory or rule. However, the lack of significant difference between the means reflects the fact that both memory and rule are exploited with no degree of reliance on memory or rule.

4. Results and discussion

4.1 The mechanism responsible for EFL learner's processing of past tense

The first question of the study aims to investigate whether the regular and irregular verbs are asymmetrically processed. If the irregular is processed by associative memory, then it is affected by phonological similarity. If the regular is the result of rule application, then it is not affected as the *-ed* rule applies regardless of similarities or lack of it. Such asymmetrical processing is an indicative of the applicability of the dual mechanism processing to the scope of EFL. Descriptive statistics are provided below for the results of the regular and irregular inflection in the lexical elicitation task which would help to answer the first question.

4.1.1 The irregular non-verb forms inflection

At the irregular prototypical level, the recorded mean for the irregularly inflected responses was (7.42) followed by (6.0) for the irregular intermediate level and (4.85) for the irregular distant level. Below are the means, the percentages and standard deviations for the participants' scores regarding the irregular non-verbs in the lexical elicitation task taken by (40) Jordanian EFL learners. By examining the means of irregularly inflected non-verbs recorded across the three levels of phonological similarity (see table 1), it can be noticed that the average score of the participants at the prototypical level is the highest with the mean of (7.42). On the contrary, the participants' achievement is the lowest at the distant level with the mean of (4.85).

Levels of phonological similarity	Mean	(irregular inflection percentage)	Standard Deviation	N
Irregular prototypical	7.4250	74 %	1.37538	40
Irregular intermediate	6.0000	60 %	1.39596	40
Irregular distant	4.8500	48.5 %	1.59406	40

Table 1. Mean, percentage and standard deviation for the irregular non-verbs across the different levels of the phonological similarity.

Note: there are ten irregular non-verbs in each level and 30 irregular non-verbs as a total.

The means are out of 10

N: number of participants

According to Table 1, it can be noticed that the highest percentage of irregularly inflected responses is at the prototypical level by the mean of 7.42 (SD = 1.37) which covers (74%) of the responses. However, there has been a decrease marked across the means of irregularly inflected responses when moving from the prototypical level to the intermediate that has the mean of (6.0) (SD = 1.39) which covers (60%). The decrease can also be noticed when moving from the intermediate level to the distant level that has the mean of 4.85 (SD=1.5) which equals (48.5%) of the irregularly inflected responses.

Furthermore, the decrease in the number of the irregularly inflected verbs can also be noticed when referring to the range of participants' scores across the three levels of phonological similarity. The highest score at the prototypical level is (10) while the highest

scores at the intermediate and the distant levels are (9) and (7) respectively. The lowest score at the prototypical level is (4), while at the intermediate level the lowest score is (2). As for the distant level, the lowest mark being recorded is (1). Thus, the decrease can also be marked among the range of the maximum and minimum scores across the three levels of phonological similarity.

One way repeated measure ANOVA is performed over the irregular inflection responses provided by the participants across the three levels of phonological similarity by which the independent variable is the phonological similarity.

Repeated measure ANOVA test result for the irregular non-verbs across the three levels of phonological similarity:

Repeated measure ANOVA result	Significance
(F (2,39)=199.7,P<.05).	P<.05

Note: computed using P value of =.05

The repeated measure ANOVA result ($F(2,39) = 199.7, P < .05$) indicates that there is a significant difference across these levels. The repeated measure ANOVA result is below the P value of 0.05. Thus, the null hypothesis is rejected and the difference between the means of the irregularly inflected responses across the three levels of similarity is significant. So, the phonological similarity plays a significant role regarding the irregular inflection and the decrease in the number of the irregularly inflected non-verb forms that is marked across the means of the three levels is significant. Consequently, the results suggest that the participants are affected by phonological similarity by which the number of the irregularly inflected non-verbs decreases due to the decrease in similarity.

The irregular verb is sensitive to similarity, so the chances of being irregularly inflected decrease when the similarity decreases. Accordingly, the number of irregular non-verbs that are regularly inflected increases across the three levels of phonological similarity from the prototypical (i.e. 7.42), the intermediate (i.e. 6.0), up to the distant (i.e. 4.85). Thus, the more the participants would think of the non-verbs as regular ones due to the increased distance from the base irregular verbs, the more likely that they are

going to produce the *-ed* suffixed responses. The lowest mean of the *-ed* suffixed responses is at the prototypical level which is (2.5). The mean of the *-ed* suffixed responses has increased as the similarity decreases with the means of (4.0) for the intermediate level, followed by (5.1) for the distant level (see table 2).

Levels of phonological similarity	Mean	irregular inflection percentage	Standard Deviation	N
Irregular prototypical	2.5750	25.75 %	1.37538	40
Irregular intermediate	4.0000	40 %	1.39596	40
Irregular distant	5.1500	51.5 %	1.59406	40

Table 2. Mean, percentage and standard deviation for the regularly inflected irregular non-verbs across the different levels of the phonological similarity.

Note: there are ten irregular non-verbs in each level and 30 irregular non-verbs as a total.

The means are out of 10

N: number of participants.

According to Table 2, the lowest number of the *-ed* suffixed responses is at the prototypical level with the mean of (2.57) which equals (25.75%). Prototypical level is the closest and most similar to the irregular base verbs, thus the chances of the participants thinking of the non-verb as an irregular one are high. For the intermediate level, the mean of regularly inflected responses increases to (4) which covers (40%) of the responses. This increase of the *-ed* suffixed responses at the intermediate level is due to the fact that the similarity to the irregular base decreases. The distant level has the least degree of similarity to the irregular base. So at the distant level, the chances of the participants thinking of the given non-verb as an irregular and providing an irregular inflected form are very limited. Accordingly, the number of the *-ed* suffixed responses at the distant level are the highest with the mean of (5.15) which covers (51.5%).

4.1.2 The regular non-verb form inflection

The means of the regular non-verbs that are regularly (i.e. *-ed* suffixed) inflected across the three levels of phonological similarity (the prototypical, intermediate and

distant levels) don't seem to reflect a significant change across these means as the highest score is (8.90) at the prototypical level while the lowest is (8.85) for the intermediate and distant levels. Table 3 below presents the means, percentages, and standard deviations for the regular non-verbs across the three levels of phonological similarity.

Levels of phonological similarity	Mean	Regular inflection percentage	Standard Deviation	N
Regular prototypical	8.9000	89 %	.90014	40
Regular intermediate	8.8500	88.5 %	.86380	40
Regular distant	8.8500	88.5 %	.80224	40

Table 3. Mean, percentage, and standard deviation for the regular non-verb across the different levels of phonological similarity.

Note: there are ten regular non-verbs in each level and 30 regular non-verbs as a total.

The means are out of 10

N: number of participants.

Table 3 shows that the mean of the regularly inflected non-verbs at the prototypical level is 8.90 (SD=.90) which equals (89%) of the regularly inflected responses. Referring to the intermediate level, the mean of the regularly inflected non-verbs is 8.85 (SD = .86) and it is also the same value of 8.85(SD = .80) for the distant level which equals (88.5 %). It can be noticed that even when moving across the three levels of phonological similarity, the means of the regular non-verbs don't seem to change dramatically. Even when moving from the intermediate level to the distant level by which the similarity is very low, the means of the regularly inflected responses are stable and don't change. This stability can also be noticed when referring to the range of the participants' scores across the three levels. At the prototypical, intermediate and distant levels, the highest score is (10). The lowest score for these three levels is (7).

One way repeated measure ANOVA is conducted over the regular inflection results of the participants across the three levels of phonological similarity by which the phonological similarity is the independent variable.

Repeated measure ANOVA test result for the regular non-verbs across the three levels of phonological similarity:

Repeated measure ANOVA result	Significance
(F (2,39)=.103,P=.750).	P=.750

Note: computed using P value of $\alpha = .05$

The P value equals (.750) which exceeds (.05). Thus, the repeated measure ANOVA result (F (2, 39) = .103, P = .750) indicates that there is no significant difference across the three levels of phonological similarity. So, the phonological similarity doesn't have a significant role regarding the regular inflection. As the results suggest that there was no difference marked across the means of the three levels, it can be an indication that the participants did not show any sensitivity to phonological similarity as the means of the regularly inflected verbs were not affected by the decrease in similarity.

4.3 *Reliance on memory or rule*

The second question investigates whether there is a heavier reliance on rule or memory when processing the past tense. Reliance on rule would be expected due to the lack of exposure to language in a non-native speaking environment which might result in having a weak memory trace for the words and a poor lexicon. On the other hand, reliance on memory might be expected due to the effect of critical period as the participants acquire the language at later stages. Consequently, the participants might not have a full mastery or a good command of the rule system which would result in storing information of language by memory rather than deeply processing it. The study aims to investigate which of these scenarios is applicable to the case of Jordanian EFL learners' processing of the past tense. Descriptive statistics are provided below for the results regarding the second question.

When phonological similarity decreases, the chances of being irregularly inflected decreases because the irregular is sensitive to similarity. Moving from prototypical, intermediate to distant, the decrease is inevitable in case of irregular. So, the number of

irregularly inflected non-verbs decrease at intermediate and distant levels and most of the irregular verbs would be regularly inflected (i.e. *-ed* suffixed). On the other hand, the number of the regularly inflected non-verbs is stable as it is not sensitive to similarity. Thus, comparison between regular and irregular forms to determine the degree of reliance on memory or rule at these two levels cannot be executed as it will be supportive and biased to the rule inflection (*-ed* suffixed). Accordingly, the study refers to the prototypical level to compare the participants' scores regarding regular and irregular non-verbs to see if there is a degree of reliance on memory or rule. The similarity at the prototypical level is very high bearing in mind that only one consonant is changed. As the similarity is high, the chances of drawing on phonological similarity to the irregular base, establishing memory association and providing irregular inflection are very high. Thus, the means of the regularly and irregularly inflected verbs at the prototypical levels can reflect if there is a slight reliance on memory or rule when exploiting both to process the past tense. At the prototypical level, the mean of the irregularly inflected non-verbs is (7.42), while the mean of the regularly inflected non-verbs is (8.9).

Level of phonological similarity	Type of non-verb	Mean	Percentage	Standard Deviation	N
Prototypical	Irregular	7.4250	74%	1.37538	40
Prototypical	Regular	8.9000	89%	.90014	40

Table 4. Mean, percentage and standard deviation for the irregular and regular non-verbs at the prototypical level of phonological similarity.

Note: there are ten regular non-verbs and ten irregular non-verbs at the prototypical level.

The means are out of 10

N: number of participants

According to Table 4, it can be noticed that the mean of the regularly inflected responses is higher than the mean of the irregularly inflected responses at the prototypical level. At the prototypical level, the irregularly inflected responses have the mean of 7.4 (74%) of the inflected non-verbs which indicates that 26% of the irregular

non-verbs are regularly inflected. On the other hand, the mean of the regularly inflected responses is 8.9 (89%) of the inflected non-verbs which reflects that only 11% of the regular non-verbs are irregularly inflected. Such results reflect a degree of dependency on *-ed* rule.

The independent T test is performed over the results of the regular and irregular at the prototypical level in order to see if the difference between these two groups at the prototypical level is significant.

Independent T-test result for the regular and irregular non-verbs at the prototypical level of phonological similarity:

Independent T-test result	Significance
(t (78) = -5.675, P, <.05	P,<.05

Note: computed using P value of =.05

T the result of the independent T test (t (78) = -5.675, P, <.05) shows that there is a significant difference between means of the regularly and irregularly inflected non-verbs at the prototypical level. As the T test result suggests that the difference between the means of the regular and irregular is significant; it can be an indication that the participants have a significant degree of reliance over *-ed* rule of past tense when inflecting the non-verbs.

To put it clearly, the decrease in the means of the irregularly inflected non-verbs across the three phonological similarity levels suggests that the irregular is processed by associative memory by which its association is triggered by phonological similarity. On the other hand, the means of the regularly inflected non-verb are stable which proves that it is processed by *-ed* rule as it is applied over the members of a class regardless of the similarity or lack of it. Due to having two distinct processing mechanisms, asymmetrical processing promoted by dual mechanism prevails while single mechanism whether memory based or rule based is revoked. Moreover, the results show a degree of dependency on rule when exploiting both memory and rule. The dependency on rule can be considered as a refinement of dual mechanism when applying it to the scope of L2 by which both memory and rule are used.

4.4 Applicability of dual mechanism on the processing of EFL

The first question of the study investigates whether the dual mechanism applies to Jordanian EFL learners' morphological processing particularly the past tense. The answer to this inquiry is reflected through the participant's performance on the lexical elicitation task. Participants' responses are supposed to demonstrate whether dual mechanism would account for the participants' processing of the past tense, or it must be revoked in favor of single mechanism processing. The results show that irregular non-verbs are affected by the phonological similarity by which the chances of being irregularly inflected decrease as the phonological similarity decreases starting with the prototypical, up to distance level. On the other hand, regular inflection didn't show any sensitivity as it was not affected by the decrease of phonological similarity.

According to single mechanism associative memory based (e.g. Rumelhart & McClelland 1986), regular and irregular are processed by associative memory as rules are descriptive patterns only with no productive ability. Memory association is triggered by frequency and phonological similarity. Since regular and irregular are supposed to be processed by memory, both have to be affected by phonological similarity. Consequently, the decrease in the means of inflected verbs that happens when the similarity decreases is supposed to be marked in both cases of regular and irregular non-verbs. However, in the current study the case is not the same; this is because the decrease of the means across the levels of phonological similarity has been recorded in case of irregular non-verb while the means of regular inflection have been stable. Moreover, the results of the repeated measure ANOVA indicate that there is a significant difference among the means of the irregularly inflected verbs, while there is no significant difference recorded in case of regular. Results of the current study agree with the results of other studies (e.g. Prasada & Pinker 1993, Ullman 1999) where the irregular forms show sensitivity to similarity while regular forms don't. Thus, single mechanism associative memory based is revoked and doesn't account for the Jordanian EFL learners processing of past tense.

Single mechanism rule based (e.g. Halle & Mohanan 1985) suggests that regular is inflected by the *-ed* rule while the irregular inflection is governed by some minor rules like the rule of changing *i* to *a* as it is the case of *drink-drank*. When the rule applies, it ignores similarities and suppresses differences then applies as a default pattern (Clahsen 2006). Thus, it is expected that regular and irregular inflection being the result of rule application would not be affected by the phonological similarity. The results of the current study demonstrate that the means of regular inflection are stable and are not affected by similarity as the result of the repeated ANOVA doesn't indicate any significant difference. Still, the means of the irregularly inflected non-verbs are actually affected by phonological similarity as the means of the irregularly inflected non-verbs keep decreasing as a result of the decrease of phonological similarity. Moreover, the result of the repeated measure ANOVA indicated that there is a significant difference among the means of the irregular inflection across the three levels. Thus, single mechanism rule-based has to be rejected too because it doesn't provide an explanation for the Jordanian EFL learners' processing of the past tense.

Dual mechanism argues for the exploitation of both facilities of memory and rule through the asymmetrical processing of regular and irregular by which the regular is processed by rule and the irregular is processed by associative memory. Such a claim comes with the assumption that irregular must be sensitive to phonological similarity and frequency while regular is not. The results of the current study are supportive to the claim of asymmetrical processing suggested by dual mechanism. The decrease in the means of the irregular inflection as a result of the decrease in the levels of phonological similarity proves the sensitivity of irregular pattern to phonological similarity. Thus, it can be argued that irregular is the result of associative memory processing which is triggered by similarity. On the other hand, the stability that has been noticed across the means of the regularly inflected non-verbs suggests that the similarity is ignored and doesn't actually affect the regular inflection. Thus, it can be argued that regular is the result of rule application by which the rule is applied regardless of whether there is similarity or not. Consequently, it can be said that dual mechanism proves its applicability to the Jordanian EFL learners' processing of past tense.

In a similar fashion to that of Prasada & Pinker (1993), the current study examines the effect of phonological similarity over three levels of non-verb forms. The result of the current study supports Prasada & Pinker (1993) experiment by which the means of the irregularly inflected non-verbs are decreasing as a result of the decrease of similarity, while regular means are stable across the levels of similarity. While Prasada and Pinkers' study (1993) has been conducted over native speakers of English, the current study has been conducted over non-native speakers (i.e. Jordanian EFL learners). Thus, having similar results suggests that dual mechanism does not hold validity to the scope of L1 only but also to the scope of L2. Moreover, it has already been proved by Alshboul et al. (2010) and Alshboul et al. (2012) that dual mechanism applies to Arabic which represents the scope of L1 to the participants in the current study who are Jordanian EFL learners, while the current study provides evidence for the applicability of dual mechanism to EFL. So, the dual mechanism applies to the scope of Arabic as L1 and English as EFL. Dual mechanism is the mechanism responsible for Jordanian EFL processing of English past tense. The applicability of dual mechanism to the scope of L2 highlights the organization of lexicon in terms of processing L1 and L2. It could be claimed that the brain is capable of using both chambers of memory and rule when processing L1 and L2.

4.5 Memory or rule when processing past tense by Jordanian EFL learners

The second question of the study examines whether there is a degree of reliance on memory or rule when employing them to process the past tense. The participant's performance on the lexical elicitation task would answer this question as it would determine whether there is a degree of reliance on rule or memory. The participants' responses at the prototypical level are taken into consideration to answer this question while the intermediate and the distant levels are excluded. The prototypical level has the highest level of similarity to the irregular base verbs because only one consonant is changed, while the intermediate and the distant levels involve (2) and (3) changed consonants respectively. Thus, the forms with irregular inflection at the prototypical level are higher compared to the other levels. Moreover, the means of irregularly inflected

non-verbs decrease across the levels of phonological similarity due to the decrease of phonological similarity. On the other hand, the means of the regularly inflected non-verbs are not affected.

At the prototypical level, the irregularly inflected responses have the mean of 7.4 (74%) which means that (26%) of the irregular non-verbs are regularly inflected. The mean of the regularly inflected responses is 8.9 (89%) which means that only 11% of the regular non-verbs are irregularly inflected. Thus, the number of the regularly inflected non-verbs exceeds the irregularly inflected non-verbs. The independent T test result indicates that there is a significant difference between the two groups of the regularly and irregularly inflected non-verbs at the prototypical level. Such result suggests that the increase regarding the use of the *-ed* suffix is significant which reflects a degree of reliance on *-ed* rule.

The irregular pattern can be generalized to other verbs based on phonological similarity (Ullman 1999). Because the phonological similarity at the prototypical level is high due to the fact that only one consonant is changed at this level, the chances of the irregular verbs to be irregularly inflected verbs are high. Still, the results of the current study suggest that the *-ed* suffix is a quantitatively relied on as an inflection mechanism rather than irregular mechanism like ablaut. This result is supported by other studies. For example, Kirkici (2005) has noticed that Turkish proficient EFL learners exhibit a dependency on rule when inflecting the past tense. Muftah (2016) also marked this dependency on rule by Yamani EFL learners when they are asked to provide the past tense of the verbs. Consequently, the current study can be considered as a refinement of the dual mechanism regarding its application on EFL learners since both memory and rule are used with a slight reliance on rule.

Such results regarding the reliance on *-ed* rule don't reject the critical period effect. EFL learners of language might not be capable of mastering and using rules like native speakers due to the fact that English is not a language that EFL learners would be exposed to at a very early age like native speakers. This critical period effect is the reason behind the native speakers' deep processing of English compared to the shallow processing by EFL learners. The critical period effect has been recorded in syntactic parsing of sentence by native and non-native speakers. Clahsen & Felser (2006) have noticed that non-native

speakers would refer to the meaning of the sentences to do the parsing of sentences, while native speakers would refer to the syntactic information.

The reason behind this mastery and heavier dependence on the *-ed* morpheme might be due to the fact that unlike the syntactic parsing which is bounded to number of rules and conditions, the *-ed* suffix is not bounded to many conditions or rules in order to be applied. Furthermore, concerning the 3rd person singular suffix *-s* used in the present tense, Muftah & Rafik-Galea (2013) have noticed that Arab EFL learners face problems in using the 3rd person singular *-s* such as the omission of this suffix when using the present tense. Comparing the results of Muftah & Rafik-Galea's (2013) study with those of the current study, it can be noticed that the *-ed* has been exceedingly exploited in the current study while the 3rd person singular *-s* suffix is ignored in Muftah & Rafik-Galea (2013) though both are suffixes used to express the tense. It might be due to the fact that the 3rd person singular *-s* suffix is also bounded to certain conditions (i.e. having a singular and 3rd person subject). EFL learners might not be aware of these conditions when using present tense, while *-ed* is not bounded to such condition except for the tense. Thus, the *-ed* can be easily mastered by EFL speakers.

The *-ed* suffix being easily used and applied by EFL learners might account for this dependency on *-ed* rule, still there are also other reasons. The lack of exposure to inputs due to living in a non-native environment might cause the reliance on *-ed* rule. As words are memorized by repeated exposure (Endress & Hauser 2010), the lack of exposure causes weak memory trace of irregular forms which results in retrieval failure. Furthermore, this lack of exposure might lead to a poor lexicon regarding the irregular verbs stored in memory which would not enable the mind to draw association between the stored verbs and the novel verbs. Thus, the generalization of past tense inflection pattern of the irregular verbs stored in lexicon to the new verbs would not be noticeable. As the participants are required to provide the past form of the non-verbs at the lexical elicitation task, they tend to fulfill this task by a heavier reliance on the *-ed* suffix due to the irretrievability of the irregular forms.

Another reason that might cause this reliance on rule is the methods of teaching the irregular verbs by instructors at schools and universities. Instructors who teach English

grammar courses as well as English Language (99) and English Language (101) would follow certain methods of teaching that might affect the participants' ability to associate verbs and generalize the past tense inflection pattern over the other phonologically similar verbs as to extrapolate the past tense inflection for these verbs. Some professors would present the frequent irregular verbs by putting them in sentences (i.e. a context). Other professors would present the *-ed* suffixed form (i.e. regular form) as the default, then highlighting the fact that verbs that are not *-ed* suffixed are irregular and the learners should memorize the irregular forms. Moreover, the books (e.g. English fundamentals; Headway plus) that are used to teach the students also include lists of the most frequent irregular verbs like *see-saw*, *break-broke*.

When teaching irregular forms, the verbs are being idiosyncratically memorized in either a list of given verbs or a sentence (context), a strong memory trace is created for the verbs only. Thus, when the learner encounters low frequency verbs, s/he is not going to be able to draw an association to extrapolate the past form for such verbs. In such a case, the learners tend to rely on *-ed* suffix as to over-regularize these low frequency verbs. Even if the verb has high frequency, the tendency to depend on *-ed* rule and regularizing such verbs is still expected. The notion of frequency as evidence, when we deal with EFL learners, is questionable due to the fact that frequency of verbs in corpus is actually determined by referring to native speaking environment that is not available to EFL learners. Moreover, EFL learners might face a high frequency verb for the first time; thus, it would be treated as a verb of low frequency which would lead to the over-regularization of this high frequency verb. So, the teaching style might explain the slight degree of reliance on rule that is found in this study.

The degree of reliance on rule can also be the result of following the U-shape pattern of language development. According to dual mechanism explanation of the U-shape pattern by Marcus et al. (1992), at the first stage the learner uses the irregular and regular correctly since both are stored unanalyzed. At the second stage, the learner would acquire the *-ed* rule and become fully aware of the tense pattern. This stage is accompanied with the onset of over-regularization. As the person wants to express the past tense and the past forms of irregular verbs might not be available, s/he would refer to the *-ed* rule to fulfill the necessity of expressing the tense while bridging the gap of

retrieval failure. At the third stage, the learner would master the regular and the irregular with the repeated exposure that results in irregular verbs having a stronger memory trace. Thus, the over-regularization is supposed to gradually disappear due to being the result of retrieval failure that is going to be bridged over time. The study shows that the EFL learners exhibit a degree of reliance on rule. The number of the regularly inflected verbs exceeds the number of irregular inflected verbs. Moreover, 26% of the irregular verbs are regularly inflected (i.e. over-regularized). So, it can be said that learners are in stage number two.

5. Conclusion

The major goal of the study has been to determine whether the asymmetrical processing proposed by the dual mechanism would account for the English past tense processing by Jordanian learners of EFL. The dual mechanism's asymmetrical processing suggests that regular inflection is processed by rule, while irregular is processed by associative memory. The study aims to investigate if EFL learners would exhibit degrees of sensitivity to phonological similarity for both irregular forms (i.e. high degree of sensitivity) and regular forms (i.e. no sensitivity). Such discrepancy would be an indicative for the applicability of dual mechanism in case of EFL. The second goal for this study was to determine whether the EFL learners would show a heavier dependency on memory or rule when exploiting both to process the past tense. To fulfill these goals, a lexical elicitation task for the past tense has been conducted on Jordanian learners of EFL. The results of the study revealed that dual mechanism applied to EFL learners' processing of the past tense. The asymmetrical processing promoted by dual mechanism is active and evident in regular and irregular inflection, as the irregular inflection exhibits sensitivity to phonological similarity which reflects the fact that it is processed by associative memory that draws its association depending on phonological similarity. On the other hand, regular inflection is not sensitive to phonological similarity which suggests that it is inflected by the rule that suppresses differences and ignores similarities when applied.

Furthermore, the result of the study reveals that there is a slight degree of dependency on rule when referring to both faculties of memory and rule to process the past tense. Such dependency can be observed as the number of the regularly inflected verbs exceeds the number of the irregularly inflected ones. Moreover, the number of the irregular verbs being regularly inflected exceeds the number of the regular verbs that are irregularly inflected.

Pedagogical Implications: Learners of English as a foreign language face lots of challenges when learning the system of L2. Thus, it is essential for EFL teachers to recognize the best ways that help the learners to get an excellent command of inflectional system. The study reveals that there is a degree of reliance on *-ed* rule (over-regularization) when inflecting irregular verbs. To avoid the over-regularization when dealing with an irregular verb, Rumelhart & McClelland's (1986) wickelphones can be employed. Irregular verbs can be classified into families according to the pattern of wickelphones they share at the level of input (i.e. verb stem) and at the level of output (i.e. past inflection). When presenting the verbs in forms of lists the learners would focus on the idiosyncratic form of the verbs themselves without establishing any kind of association between the verbs that would help to extrapolate the past tense of the verbs that are not included the list. On the contrary, when the learners focus on the pattern of wickelphones that is shared among the family of verbs rather than on the verbs themselves, the learners would be capable of drawing an association and applying this pattern to verbs that are of low frequency or verbs that are being faced for the first time whether of high or low frequency.

Marcus (1996) has noticed that native speakers of English tend to inflect the verb *strive* as *strived* by referring to the *-ed* suffixed form of the verb instead of the irregular form *strove* because it is not common which implicates that retrieval failure is expected in case of the irregular form of the irregular verb (i.e. *strove*). So, the *-ed* pattern is applied to bridge the gap caused by retrieval failure. To avoid retrieval failure and the resulting over-regularization in case of EFL learners, establishing the patterns of input and output wicklephones would help. For example, the pattern of *eed-ed* is shared by *bleed-bled*, *feed-fed*, *breed-bred*. If the learner is familiar with the verb *feed* while s/he is not familiar with *breed*, then by learning the pattern of *eed-ed* s/he can extrapolate the past tense of

the verb *breed* as *bred*. Even if the learner is facing a non-verb for the sake of an experiment or a task such as *gleed*, s/he is going to inflect the verb as *gled* rather than *gleeded*.

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