IMPLICIT VS. EXPLICIT LEARNING IN GERMAN NOUN PLURALS

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Over the past few decades there has been a lot of debate about language learning and the opinion about the status of mental rule during the process of language learning is still divided between different researches. The present study examines learning morphology of German noun plurals based on rules, examples or on both, rules and examples.The results across these three experimental conditions suggest that the morphological patterns are learned more easily in the form of rules and thus, seem to be more easily captured by dual-route (which suggest that rules and exceptions are processed by two qualitatively different mechanisms) than single route theories (which suggest a singe mechanism for processing both rules and exceptions). However, a closer examination of error patterns across the five rules (-e, -n, -er, Ø, -s) revealed results confronting dual-route theories and suggest the existence of two rule-mechanisms (-n and -s) rather than one for learning regular inflection in German plural nouns. Moreover, the second rule (with plural ending –n) was the easiest one to be learned, although it is the fifth rule (with plural ending –s) which is considered as a default rule in German.

Key words: German, plural inflection, learning, dual-route theories, connectionist theories

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Many aspects of language can be described by rules. An important question is if these rules are mere descriptions or if they actually lie at the basis of cognitive processing of linguistic structures. In other words, are we capturing the real mental rule during the process of learning as do grammarians when trying to write a grammar (ending up with "linguistically significant generalisations"), or are we acquiring abstraction of general structure without an explicit rule? Could exceptional cases (like German plural nouns) help us to answer this question?

Opinion about the status of the mental rule during the process of acquisition of inflectional morphology is divided between different researchers.

Some psycholinguistics such as Ervin-Tripp (1966) and Slobin (1971), as well as some linguists such as Hockett (1968) and Givon (1984), have pointed out that there is no direct evidence that language users actually manipulate rules and rule symbols in their heads in the same way that rules are processed in linguist's grammar (MacWhinney, Leinbach, Taraban & McDonald, 1989). Similarly, Cook (2006) reported that when people learn artificial grammars they actually use surface information, allowing them to behave as if they have learnt rules. In fact, they use knowledge they can not report. More recent evidence from a speeded production study of the English past tense suggested that while children behave as if they are aware of rules, adults did not exploit this rule-sensitivity (Westermann et al., 2008).

How then is it that children behave as if they know the rules, even if they are not learning those rules as discrete entities? Can people become sensitive to the rules of the grammar without explicit teaching?

Learning of the English past tense has been long studied as a general touchstone for the development of morphology and productive rules in children. (Rumelhart & McClelland, 1986; Plunkett & Marchman, 1991; MacWhinney et al., 1989;, Plunkett & Juola, 1999; Westermann, 1998, Westermann et al., 2008).

The phenomenon seems to be very simple. English verbs can be broken down into two categories: regular and irregular verbs. The past tense of a regular verb (majority) can be obtained by simply adding -ed to the stem. Irregular verbs (a significant, frequent minority) on the other hand seem to be unsystematic: there is a wide variety of irregular inflections.

When children have to learn the inflection of the past tense, they go through three stages. In the first stage their use of the past tense is infrequent, but when they use the past tense they do so correctly. In the second stage they use the past tense more often, but they start over-regularizing the irregular verbs. So instead of saying broke, they may now say breaked. On the other hand, inflection of regular verbs increases dramatically, indicating that the child has somehow learned the general regular pattern. In the third stage, they inflect irregular verbs correctly again. This pattern of learning is often referred to as U-shaped profile of learning.

Although learning the past tense seems to be a rather simple problem, it nevertheless encompasses a number of issues in language acquisition and learning in general. Presumably, the past tense has two aspects: on the one hand there is a general rule, and on the other hand there is set of highly frequent exceptions. Children are able to learn both aspects of the English past tense. A first intuitive

proposal of this phenomenon was that children exploit two mechanisms for learning the English past tense: rule-governed learning for regular verbs and memory (cues or routes) for learning irregular verbs (exceptions which are more frequent in spoken language).

Although interpretations of this phenomenon vary, they are generally separated into two dominant theories. Dual mechanism theories (Marcus, 1992; Pinker & Prince 1988; Marcus et al., 1995) on the one hand have suggested two qualitatively distinct mechanisms, one for regular forms produced by rule, and one for irregular forms stored in associative memory. Regular inflection is productive, so that a mental rule applied in its production will be applied to new words. On the other hand, irregular words cannot be efficiently captured by rules, but because of the existence of sub-groups in irregulars (sleep, weep, creep…; ring, sing, spring…) they will be best captured in an associative-memory-like lexicon.

In order to produce the past tense in English (Figure 1), the incoming word will be first 'looked up' in the associative lexicon, and if an entry is not found, the rule will be applied. So, the rule in the dual mechanism theory has default status since it is applied whenever no lexical entry is found. A suggested mechanism, which interacts between the rule and the lexicon, is the blocking mechanism: when a lexical entry is found, it blocks application of the rule. This means that the rule will be applied whenever the word is not found in the associative memory lexicon.

Figure 1. Dual route theory – blocking mechanism
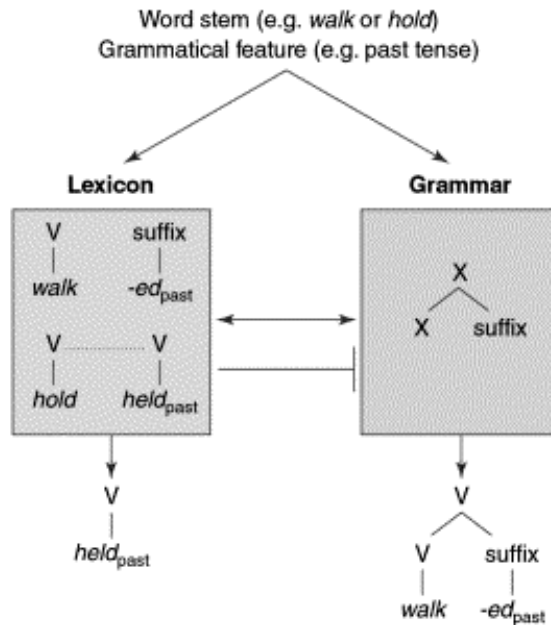
(Reprinted with permission from Pinker and Ullman, 2002)

Although this theory is capable of explaining a wide range of data and seems intuitively attractive it has some limitations. Many of the verbs that children learn during the first stage of past tense acquisition are irregular and these verbs are grouped into sub-groups (such as ring-rang, sing-sang). So, children might take one of these sub-regularities and construe it as a rule for English and as a consequence of such they may produce so-called irregularisations such as pick-puck. McLeod, Plunkett and Rolls (1998) found fault with the missing component to the symbolic account of the acquisition of the English past tense. They suggest that the dual-route approach does not tell us how children learn the rule by which the past tense of English is formed. It could be argued that children do not learn this rule, but the emergence of the past tense suffix in language development may reflect a process of maturation. In other words, knowledge required during inflectional processes of forming the past tense may be part of an innate language capacity according to McLeod at al.

Until 1986 the DMT point of view was dominant, but in the past three decades it has been challenged by applying computational models to simulate observed humans patterns in learning the English past tense. Connectionists (Rumelhart & McClelland, 1986; Plunkett & Marchman, 1991; MacWhinney & Leinbach, 1991; Plunkett & Juola, 1999; and others) argue that a single connectionist network is capable of producing both regular and irregular forms in a homogeneous architecture.

Ever since 1986, when Rumelhart and McClelland published their original neural network model, learning of the past tense in English has become one of the central topics of debate in cognitive science: connectionist vs. dual-route theory.

Can a system without any explicit representations of rules account for rule-like behaviour? Is it possible that seemingly dual-route behaviour can be accommodated by a single mechanism employing just a single route?

Rumelhart and McClelland were first to suggest that both regular and irregular verbs could be learned by a single associative mechanism in a homogeneous architecture. The important point Rumelhart and McClelland made was that this does not necessarily imply that knowledge of the English past tense is actually represented as a rule in the cognitive system: their simple feed-forward network model has no separate store for rules, but it nevertheless exhibits rule-like behaviour in the form of U-shaped learning. They varied the input to a connectionist model during learning and showed that by using a single mechanism important aspects of the three stages of English past tense acquisition could be simulated.

Ever since the Rumelhart and McClelland model was postulated, the neural network approach has been challenged (e.g., Pinker & Prince, 1988), improved (e.g., Plunkett & Marchman, 1991), challenged again (e.g., Marcus et al., 1995) and improved again (e.g., Plunkett & Juola, 1999).

One of the main criticisms against modelling of regular morphology by single connectionist networks is that their generalization capacity (behaviour on the novel, unknown words) seems to be of a different nature to that of a human speaker because it depends on a high type frequency of the regular process to be generalized.

In other words, the associative kind of morphology as in a connectionist network becomes especially problematic if regular forms are much rarer. That is because regular generalization (production of novel regular forms) in the dual-route account is based on the rule and proceeds independently of known regulars, whereas single-route accounts base regular generalization on known regular forms. For languages such as English, this renders correct results because regular inflection is also highly frequent, however, infrequent regular inflections do exist in other languages such as Arabic and German. These languages offer the chance to demonstrate that human speakers can and do generalize regular morphology irrespective of frequency. Such a finding would allow rejection of the possibility that in human speakers the representations of regular morphology is of the same associative kind as it is in connectionist networks. (Goebel & Indefrey, 2000)

German noun plurals seem as an excellent testing case for this kind of problem[2]. German plurals are formed by using five different endings (-s, -er, -e, -n, -∅) along with possible vowel changes. The use of these endings with specific nouns is not readily captured by standard rules. Among the five German plural affixes, *-n* is the most common, as the frequency distribution is shown in Table 1.

Table1. Frequency Distribution of German Plural Forms in CELEX (Marcus et al. 1995)

Plural type	Types	Tokens
-∅	4,320 (17%)	87,088 (29%)
-n	12,365 (**48%**)	134,492 (**45%**)
-e	6,836 (27%)	62,239 (21%)
-er	1,067 (4%)	10,158 (3%)
-s	1,061 (**4%**)	5,468 (**2%**)

Type frequency in the table refers to the number of different words with a particular ending in each class, each counted once, whereas token frequency refers to the number of occurrences of the particular ending.

Despite its high frequency, the *–n* plural does not serve as the regular default as claimed by Pinker, Prince, Marcus and others. On the contrary, they argued that the German plural *–s* serves as the regular default as it is case with English *–s* or *–ed* for noun plurals and verb past tenses and it is considered by many linguists to be an emergency plural, that is it does not have any specific application criteria other than

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[2] As Marcus (1995) noted the complexity of German seems like a connectionist's dream at the first sight: "A person who has not studied German can form no idea of what a perplexing language is. Surely, there is not another language that is so slip-shod and systemless, and so slippery and elusive to the grasp. One is washed about in it, hither and thither, in the most helpless way; and when at last he thinks he has captured a rule which offers firm ground to take a rest amid the general rage and turmoil of the ten parts of speech, he turns over the page and reads, "Let the pupil make careful note of the following exceptions." He turns his eye down and finds that there are more exceptions to the rule than instances of it." (Mark Twain, 1880)

the failure of the other plural allomorphs to apply. Obviously this could entail a learning problem for human speakers as well as for connectionist networks.

In English, most verbs and nouns are regular, that is, regular verbs and nouns have a high type frequency, but relatively low token frequency, allowing a network to construct a broadly defined default category. Irregular verbs and nouns in English, on the other hand, have a low type frequency, but a high token frequency, permitting the memorization of the irregular past tenses in terms of a few phonological subcategories. The default inflection of plural nouns in German appears to have low type frequency and low token frequency, and therefore seem to be outside the capabilities of connectionist networks.

However, Penke and Krause (2002) tested the claim that the regular inflection equals default inflection, which is one of the central claims of the dual-mechanism theory. For German plural formation this would predict that all the German noun plurals other than *–s* are stored irregular forms. Penke and Krause presented two sorts of data (from agrammatic aphasics who were completing a short phrase consisting of a given singular noun and lexical decision task with unimpaired subjects) as evidence that regular inflection is not necessarily identical to default inflection. On the contrary, they suggested that feminine noun plurals on *–n*, although clearly not the German default plural, results from a process of regular affixation.

Szagun (2001) reported results of a longitudinal study that examined the acquisition of German noun plurals, growth and error rates made by children. Szagun found that onset of use of plural forms was early, with *–n* and *–e* plurals displaying the fastest growth. Errors were produced from the beginning with high error rates. Major error types, -n, -s and no marking did not differ in frequencies, but the error *–e* (when the suffix *–e* is used incorrectly instead of *–en* for instance) occurred significantly less frequently than no marking error. Error rates did not differ over age.

To summarize, the German plural is in some sense similar to the English past tense, but more complicated. There is competition among candidate rules in the German plural, while the English past tense has only one apparent candidate rule, and the eventual rule is based on nouns that have a low frequency, as opposed to the high frequency of regular English verbs. The German plural is therefore an interesting test case for the existing inflectional morphology theories: can connectionist theories successfully account for the German plural as well?

Marcus et al. (1995) claimed that even though the German suffix *–s* is applied to a minority of nouns it is generalized freely. They found that the onset and children's over-regularisation errors were not predicted by increases in the number, or the proportion, of the regular verbs in the parental input or the child's own vocabulary, contrary to predictions of Rumelhart and McClelland (1986) and Plunkett and Marchman (1990). The very infrequent plural suffix *–s* in German served them as crucial evidence: despite its low frequency compared to English, it is generalized in heterogeneous default circumstances, just like its English counterparts.

The present study aimed at contrasting directly the two theories (connectionist and dual-route) by training people to learn German noun plurals under different conditions in which presence or absence of explicitly defined rules was manipulated. Thus, the main motivation of the study was to investigate if plural forms can be better learned by explicit rules or via association or by both. The connections account would not predict a learning advantage for those participants who were trained with explicitly given rules in comparison to those who were trained without explicitly given rules. On the other hand, DMT would predict that morphological patterns are better learned in the form of rules, i.e. participants are expected to rely on a single mechanism when learning regular pattern and on an associative mechanism when learning all other forms.

METHOD

Subjects

Sixty four native English speakers with no knowledge of German at all were recruited for the experiment. All of the participants were undergraduate or graduate Oxford University students. Four participants dropped out because of their poor performance in the training phase of the experiment, so that there were 20 participants in each of the three conditions in the end. Of these 60 participants 25 were male and 35 female. The mean age was 21.3 and the age range was from 15 to 45 years. Participants were either paid for their participation or given extra credit units as a part of the special Department's research scheme.

Design

The between-subjects study involved three different experimental conditions of brief language learning tasks. In the first condition subjects were presented with 60 singular-plural pairs of German nouns, generated from five different rules. In the second condition participants were presented with five different rules for obtaining noun plurals in German. In the third condition subjects were presented with both list of five rules and with a set of the examples for each of the given rules. All three groups were afterwards tested on the same final generalization test. Thus, the presence or absence of the explicit rule during the process of learning was manipulated in the present study.

Material

The five different rules for obtaining German noun plurals were chosen from German grammar (presented in Table 2) and 90 examples, singular-plural pairs (18 for each of the rules) were chosen from the CELEX database. Sixty of the 90 singular-plural pairs were used in the first and third condition during the phase of memorization and 30 of these words were again used in the final test in all three conditions. The remaining 30 of 90 singular-plural pairs were used across the three conditions in the final test only.

It should be noted here that German language is rather used as an artificial language in the present study since examples were not selected according to their type/token frequencies in the real language.

Table2. The list of the five rules for obtaining noun plurals in German

RULE	GENDER	SINGULAR	LENGTH	PLURAL	EXAMPLE
1	Masculine (**der**)	-	monosyllabic	ending **-e**	der Film – Filme
2	Feminine (**die**)	ending **-e**	bi-syllabic	ending **-n**	die Schule - Schulen
3	Neuter (**das**)	-	monosyllabic	ending **-er**	das Kind - Kinder
4	M, N (**der, das**)	endings **-el, -en, -er**	bi-syllabic	no change **-∅**	der Kellner- Kellner
5	M, F, N (**der, die, das**)	-	-	**-s**	das Auto - Autos

The fifth rule can be considered to be a default rule, i.e. it is applied when none of the other rules apply, so that plural ending –s is expected to be added to the novel nouns. Other rules (with plural endings –e, –n, –er, no change) are more specific and although more frequent in German language are considered to be exceptions from the rule (Marcus et al., 1995).

Procedure

Subjects were seated at a computer in a quiet room. In the first condition they were presented with a list of 60 singular-plural German noun pairs in the paper form and asked to memorize the given list in five minutes. Participants from the second group were asked to memorize the list of five rules for obtaining German noun plurals in five minutes, whereas the participants in the third condition were

asked to memorize both the list of rules and list of examples for each of the given rules in five minutes.

After five minutes participants from all three conditions were tested in order to check whether they were processing the given material for memorizing. Fifteen questions, one at a time, were presented on a computer monitor in front of the participants. This part of the experiment was set up using the SuperLab program with self-timed and balance answering, that is a presented question remained on the computer screen until the subject pressed a key after which (after one second) the next question would appear on the screen. All the answers as well as the reaction times were recorded automatically.

To test mastery of the training material, in the first condition participants were presented with a singular form of the noun along with five possible plural options and their task in each of the 15 questions was to choose the correct plural noun for the given singular noun. For example:

der Stift   - 1. Stifte
             - 2. Stiften
             - 3. Stifter
             - 4. Stift
             - 5. Stifts

In the second condition 15 questions were generated from the five given rules and the task was to choose the correct answer from five offered ones. For example:

All masculine monosyllabic nouns form the plural by adding:
        1. - e
        2. - n
        3. - er
        4. - no change
        5. - s

In the third condition after five minutes of memorizing both the list of five rules and list of examples for the given rules, participants were presented with eight multiple choice questions about the rules, like in the second condition and with seven multiple choice questions like in condition one.

If it was found that after five minutes of memorizing participants did not reach the criterion, which was eight correctly answered questions from 15 in the first and in the second condition and four from eight and four from seven questions in the third condition, they were given the list of examples (in the first condition), the list of rules (in the second condition) or the list of rules and examples (in the third condition) for another three minutes after which they were again tested against the criterion. If they were not successful in the answering they were allowed to study the given material for another two minutes.

If the participants could not satisfy the criterion after ten minutes of memorizing in total, they were eliminated with presupposition that they were not processing the given material. There were four participants out of 64 who were eliminated from the study for this reason.

If the participants reached the criterion after five minutes of memorization they were asked to proceed to the final test. In the final test, which was identical across the three conditions, participants were presented with 60 questions one at a time on the computer monitor in front of them. The answers and reaction times were again coded automatically. Singular form and plural stem of the German nouns were given in each of the 60 questions and the participants were asked to choose one of the five different endings for which they thought that is the correct one. For example:

 der Keller – Keller_____
-   1. –e
-   2. –n
-   3. –er
-   4. - no change
-   5. –s

The whole procedure lasted for about 20-25 minutes after which the participants were debriefed.

RESULTS

The data analysis of the behavioural study was aimed at exploring learning performance, reaction times and error patterns across the experimental conditions. Participants from the first experimental condition were learning German noun plurals by memorising the list of examples, singular-plural pairs (E-condition). Participants from the second experimental condition were memorising the list of rules for obtaining German noun plurals (R-condition) and the participants from the third experimental group were learning German noun plurals by memorising both list of rules and list of examples for each of the rules (ER-condition).


Learning performance

Pre-test

After the period of memorisation participants were tested in order to check whether they were processing the given material. The one-way analysis of variance

(ANOVA) was carried out to explore the differences across the three conditions in the number of correct answers (out of 15) given in the pre-test. There was a significant difference between the three experimental conditions ($F(2,57)=5.614$, $p<0.01$).

*Figure 2. Means and standard deviations of correct answers given in the pre-test phase*
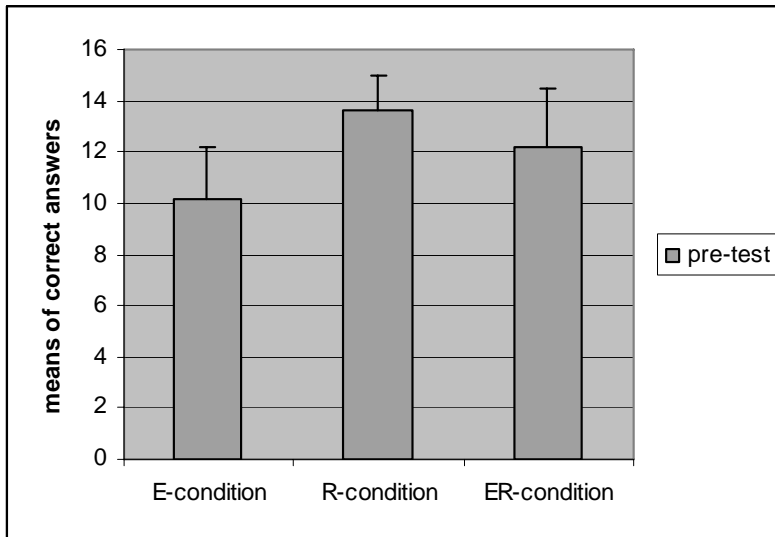
Post-hoc Scheffe test showed a significant difference between E-condition and R-condition ($p<0.01$) and between E-condition and ER-condition ($p<0.01$), but not between R-condition and ER-condition (Graph1). The participants from the R-condition showed better performance on the pre-test than participants from the ER-condition, and participants from the E-condition showed the worst performance in the pre-test.

Final-test

The participants from all three groups were tested on the identical final test. The one-way analyses of variance for the final test revealed significant differences across the conditions ($F/2,57/=6.812$, $p<0.01$). According to post-hoc Scheffe test the E-condition group performed significantly worse compared to both R-condition ($p<0.05$) group and ER-condition group ($p<0.01$) (graph 2).

***Figure 3. Means and standard deviations for correct answers given in the final test***
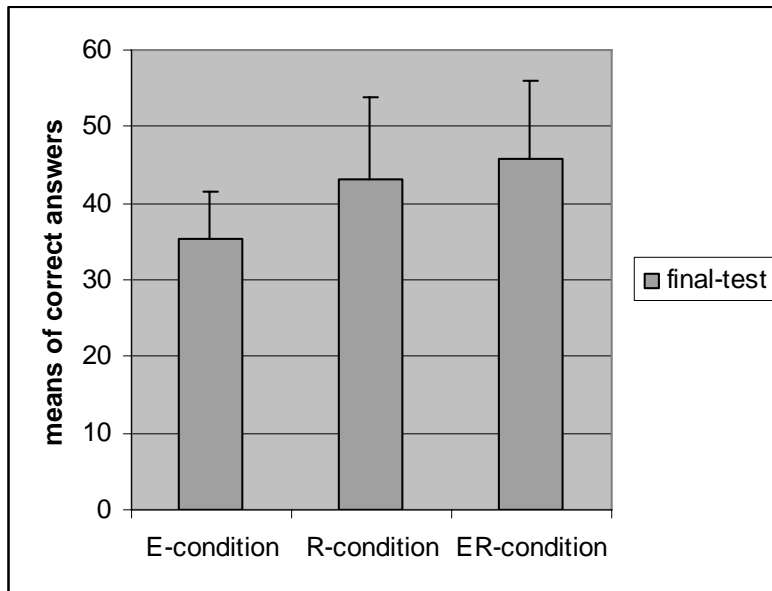
Rules

Considering rules separately, the significant differences across the experimental conditions were found in the number of correct answers given for rule one ($F/2,57/=5.221$, $p<0.01$), in the number of correct answers given for rule three ($F/2,57/=8.472$, $p<0.01$) and in the number of correct answers given for rule four ($F/2,57/=5.945$, $p<0.01$).

More specifically, the ER-condition group was significantly better in giving answers for the rule one (with plural ending –e) than the E-condition group ($p<0.01$). Furthermore, the ER-condition group and the R-condition group were significantly better in giving answers for the third (with plural ending –er) and fourth rule (with no change in plural) compared to the E-condition group (the significance level for all these differences was $p<0.05$) (Figure 4).

Figure 4. Means and standard deviations for correct answers across the experimental conditions for rules one, three and four
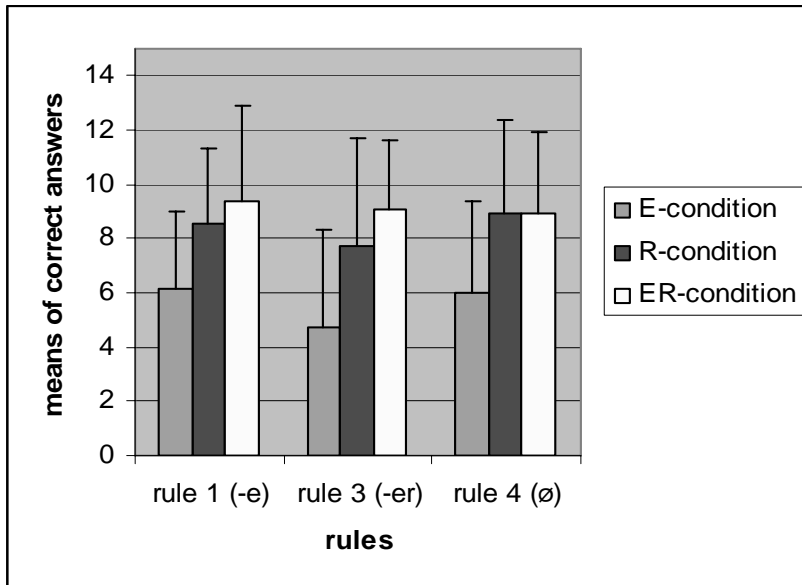

Familiar and novel nouns

Additionally, participants from the E-condition and the ER-condition were compared in the number of correct answers given for the familiar nouns (30 of nouns which they had seen during the period of memorization) and for the novel nouns (30 of nouns which they had seen in the final test for the first time). The R-condition group was excluded from this analyses as they were not exposed to any of the examples, but only to the rules, that is to say all the nouns in the final test were novel nouns for them. The means of correct answers for the familiar and novel nouns according to the conditions can be seen in Figure 5.

The independent samples t-test showed a significant difference between the two conditions for both familiar and novel nouns, in other words the participants from the ER-condition group gave more correct answers than participants from the E-condition group for both familiar and novel nouns (t /38/=3.307, *p*<0.01) for familiar and (t /38/=4.257, *p*<0.01) for novel nouns, respectively.

Figure 5. Means and standard deviations for correct answers for the novel and familiar nouns for the E-condition and ER-condition (correct answers out of 30)
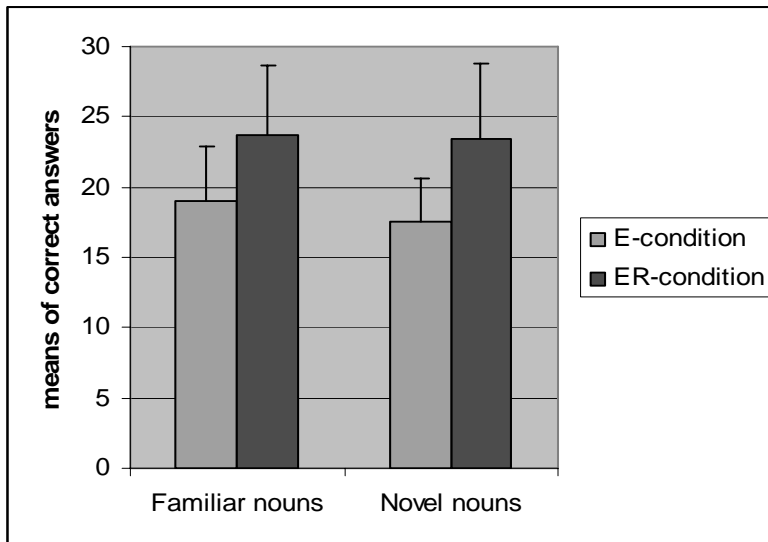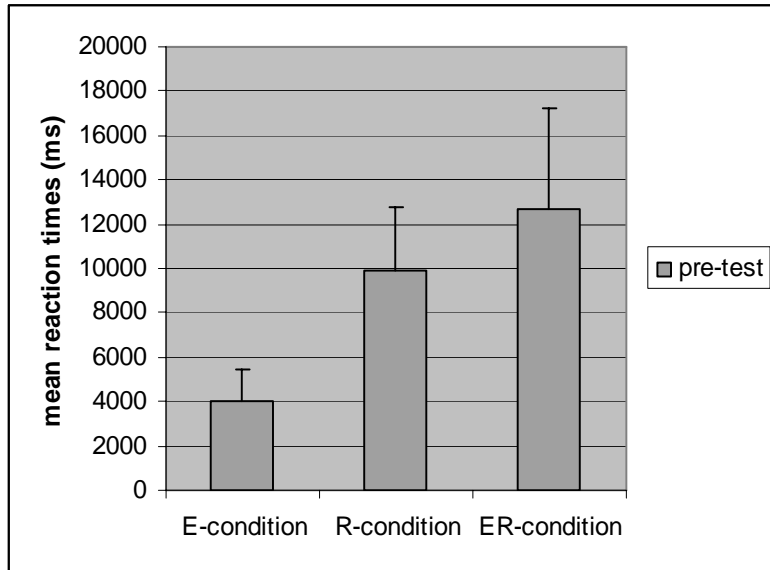

Reaction times

Pre-test

The one-way analysis of variance was carried out to examine the differences in the reaction times for the pre-test between the participants from the three experimental groups. Mean reaction times across the groups are shown in Figure 6.
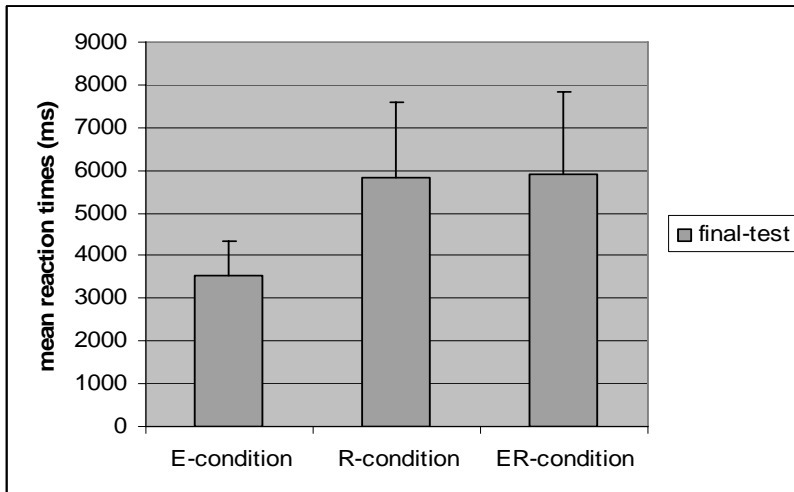
There was a significant difference between the conditions in the reaction times for the pre-test (F/2,57/=39.90, p<0.01). The E-condition group was significantly faster in giving answers on the 15 questions compared to the R-condition group and the ER-condition group and the R-condition group was significantly faster in giving answers than the ER-condition group (the significance level for all these differences was p<0.05).

Figure 6. Mean reaction times and standard deviations across the experimental conditions for the pre-test

Final test

Figure 7. Mean reaction times and standard deviations across the experimental conditions for the final test

According to the results of one-way ANOVA for the final test there was a significant difference in the reaction times across the experimental groups (F/2,57/=16.34, *p<0.01*).
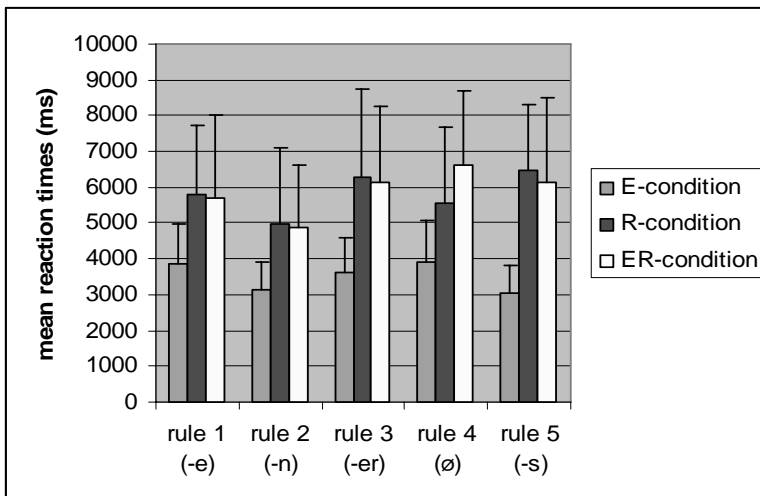
A significant difference was found between the E-condition group and the R-condition group, likewise between the E-condition group and the ER-condition group (*p<0.01*). That is to say, the E-condition group had much quicker responses that the other two groups which had rather equal reaction times (Figure 7).

Rules

One-way analyses of variance revealed significant differences in reaction times for each of the five rules across the experimental conditions: for rule one (F/2,57/=6.036, *p<0.01*), for rule two (F/2,57/=9.319, *p<0.01*), for rule three (F/2,57/=8.049, *p<0.01*), for rule four (F/2,57/=8.077, *p<0.01*) and for rule five (F/2,57/=18.423, *p<0.01*).

Exactly the same pattern of differences as in the final test was found for each of the rules (Figure 8). The E-condition group was significantly faster in giving answers for each of the rules than the R-condition group and the ER-condition group (significance level for all differences was *p<0.01*). There was no significant difference in the reaction times between the R-condition group and the ER-condition group. From these results it could be concluded that adding the rules to the examples produces slower reaction times, but not the opposite - when examples are added to the rules.

Figure 8. Mean reaction times and standard deviations across the experimental conditions for the five rules

Familiar and novel nouns

The E-condition group was further compared with the ER-condition group in the speed of giving answers for novel and familiar nouns. The R-condition group was excluded from this analysis as they were not exposed to any of the examples during the period of memorisation, but only to the rules and thus all the nouns in the testing phase were novel for them.

The independent samples t-test revealed a significant difference between the E-condition and the ER-condition group in readiness for giving answers for both novel (t /38/=4.55, p<0.01) and familiar nouns (t /38/=5.18, p<0.01). The E-condition group was faster in giving answers for both familiar and novel nouns than was the ER-condition group (Figure 9).

Figure 9. Mean reaction times for the novel and familiar nouns in the first and third condition
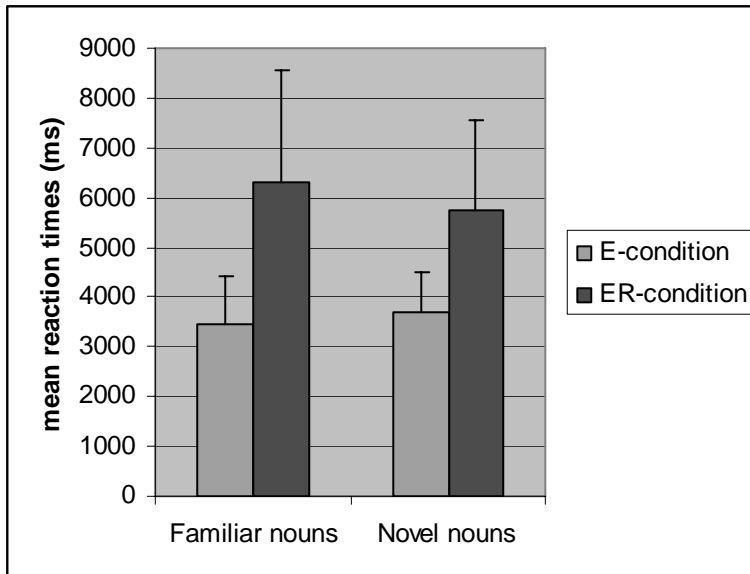
It should be noted here that all the reported differences in reaction times were calculated taking only correct answers into account. This was done in order to eliminate speed-accuracy trade-off, i.e. in order to make sure that greater speed did not sacrifice the accuracy. However, the same pattern of results was observed when the reaction times for both correct and incorrect answers were taken into account.

Error patterns

Finally, the present behavioural study was aiming to examine in more detail the errors given for the each of the rules across the three experimental conditions.

Table 3. Matrix with the number of correct answers and errors across the experimental conditions for each of the five rules (correct answer is shaded)

Target rule	Experimental condition	Answer given by subjects				
		1 (-e)	2(-n)	3 (-er)	4 (ø)	5 (-s)
1 (plural ending –e)	E-condition	123	7	58	29	23
	R-condition	156	12	24	0	48
	ER-condition	188	4	27	2	19
2 (plural ending –n)	E-condition	1	201	5	15	18
	R-condition	0	228	0	0	12
	ER-condition	4	200	21	13	2
3 (plural ending –er)	E-condition	101	1	94	13	31
	R-condition	12	12	168	12	36
	ER-condition	29	1	181	4	25
4 (no change in plural)	E-condition	35	8	28	120	49
	R-condition	36	0	12	168	24
	ER-condition	17	2	20	178	23
5 (plural ending –s)	E-condition	17	13	14	27	169
	R-condition	36	0	12	24	168
	ER-condition	27	23	24	17	149

It can be noted from Table 3 that the easiest rule across the three conditions was rule two (with plural ending –n). Other rules seemed to be more difficult, especially the rule 3 for the E-condition group which tended to add the plural ending –e even more frequently than the correct plural ending –er. The question to be answered here was whether these differences were significant across the five rules and across the three conditions and more importantly whether there was an interaction between the rules and condition in terms of error patterns.

The means of errors across the three conditions for each of the rules is shown in the Figure 10.

Figure 10. Mean errors and standard deviations for the five rules across the three experimental conditions
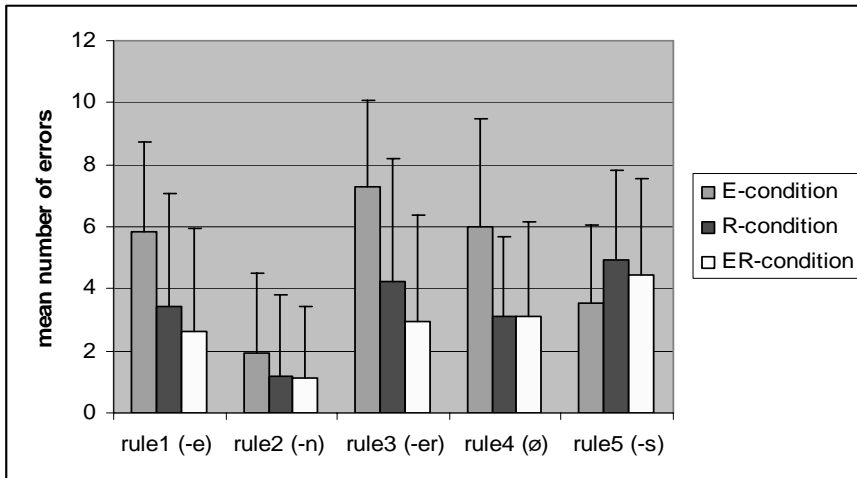
These means suggest that the participants from the E-condition group made the most mistakes in the four of five rules (with plural ending –e, –n, –er, and no change in the plural), whereas in the fifth rule (with plural ending –s) they made less mistakes than did participants from the R-condition and the ER-condition groups. The ER-condition group made slightly less mistakes than participants of the R-condition group.

The one-way ANOVA for repeated measures was carried out in order to examine the error patterns across the conditions for each of the five rules. In this analysis the within-subjects factor was Errors (for the five rules) and the between-subjects factor was Condition (memorizing examples only, rules only, or rules and examples).

There was a significant effect of Errors (F/4,228/=14.60, $p<0.01$). Within-subjects contrast showed a significant difference between Errors for rule 1 and Errors for rule 2 (F/1,57/=34.83, $p<0.01$), Errors for rule 2 and Errors for rule 3 (F/1,57/=40.00, $p<0.01$), Errors for rule 2 and Errors for rule 4 (F/1,57/=31.74, $p<0.01$), Errors for rule 2 and Errors for rule 5 (F/1,57/=40.22, $p<0.01$). This suggests that the rule 2 (with plural ending –n) was the easiest of the 5 rules for the participants to learn.

The second significant main effect was Condition (F/2,57/=240.94, $p<0.01$). The post-hoc Scheffe test of the main effect of Condition indicated a significant difference between the E-condition group and the R-condition group (p<0.05) and between the E-condition group and the ER-condition group (p<0.01). However, the difference between the R- and ER-condition groups was not significant.

The interaction Errors by Condition was also significant (F/8,57/=3.77, $p<0.01$). Within subjects contrast showed a significant interaction Errors by

Condition for the first and fifth rule (F/1,57/=5.93, *p*<0.01), for the third and fifth rule (F/1,57/=8.71, *p*<0.01), for the fourth and fifth rule (F/1,57/=10.54, *p*<0.01) and for the second and third rule (F/1,57/=3.61, *p*<0.01).

Figure 11. Errors by experimental condition interaction
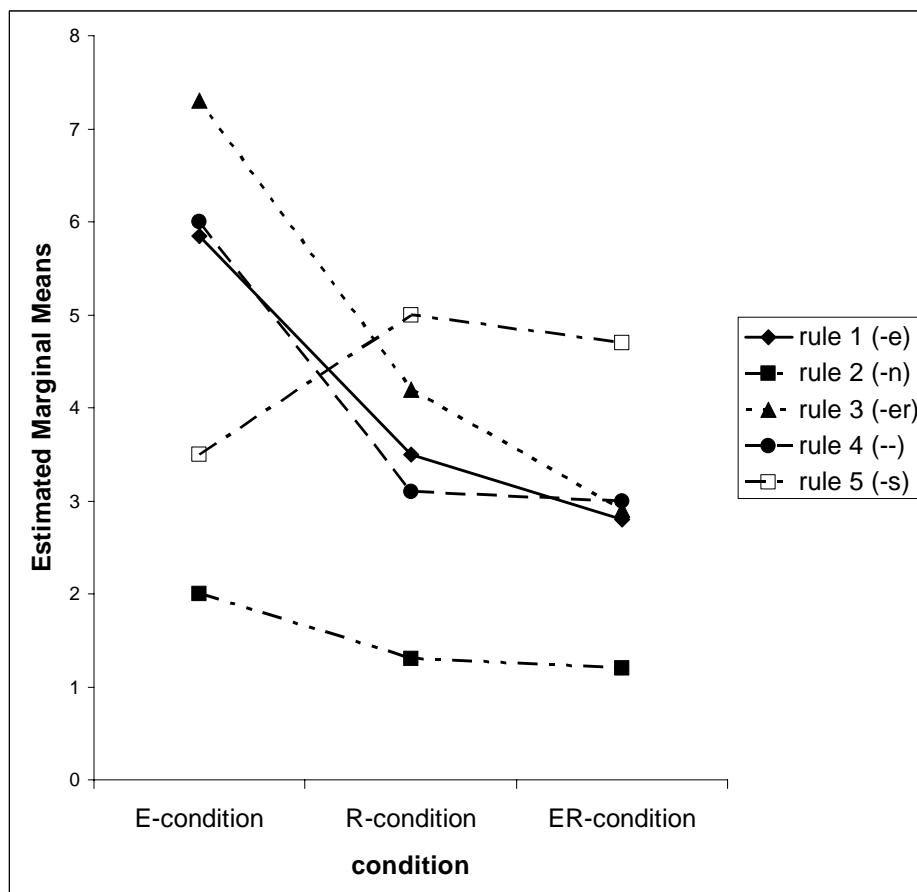
In order to examine Errors by Condition interactions (Figure 11) more closely, i.e. in order to see for which of the rules errors differed significantly across the conditions the Multistage Bonferroni procedures were applied (Howell, 2002). Bonferroni corrected (α=0.0017) t-tests showed significant difference between second (plural ending –n) and first (plural ending –e) rule (t /19/=6.21, *p*<0.001), second and third (plural ending –er) rule (t /19/=5.70, *p*<0.001) second and fourth (no change in plural) rule (t /19/=5.06, *p*<0.001) and between third (plural ending –er) and fifth (plural ending –s) rule (t /19/=5.27, p<0.001) for E-condition. A significant difference was found between second (plural ending –n) and fifth (plural

ending –s) rule (t /19/=4.74, *p*<0.001) for the R-condition, likewise a significant difference between second and fifth rule (t /19/=4.80, p<0.001) was found for the ER-condition.

CONCLUSION

The R-condition group (participants who were learning German noun plurals by memorising the list of the five rules) and the ER-condition group (participants who were learning German noun plurals by memorising both list of rules and the list of examples for each of the rules) were more successful in learning German noun plurals than E-condition group (participants who were memorising list of examples of singular-plural pairs in German).

Hence, it seems that adding rules to examples improves the learning of the German noun plurals in adults. The R-condition group and the ER-condition group were more successful in learning plurals with –e and –er endings and no change in plural compare to E-condition group, whereas there were no significant differences across the groups in learning plurals with endings –n and –s. Rule two (with plural ending –n) was the easiest rule to be learned across the three groups. However, the E-condition group, although less accurate, had much quicker responses than the other two groups with rather equal reaction times. Error patterns for the five rules across the three experimental groups differed significantly suggesting that the rules two (with plural ending -n) and five (with plural ending –s) are processed differently from the other three rules which showed rather similar error patterns.

DISCUSSION

Rule-based theories and connectionist theories as two leading approaches in the ongoing debate about acquisition of inflectional morphology offered different answers on the question: Are morphological patterns learned in the form of rules? While dual-mechanism researchers suggest that we are capturing a real mental rule during the learning process, connectionist models suggest that associative patterns are capable of producing rule-like behaviour without an explicit rule, even in exceptional cases such as German noun –s plurals.

The aim of the present study was to explore whether inflectional system is based on explicit rules or on associations, i.e. whether plural forms can be better learned by explicit rules, via associations or by both.

According to the results of the present study, the participants who were learning German noun plurals by memorizing the list of examples were less

successful compared to the group of participants who were learning German noun plurals by explicitly defined rules and the group of participants who were learning German plural nouns by memorising both explicitly defined rules and the list of examples for each of the rules. However, the participants who were memorising rules only and participants who were memorising both rules and examples showed similar performance. Thus, it could be concluded that adding rules to the examples improved the learning of the German noun plurals, whereas adding examples to the rules did not improve the learning.

More specifically, those participants who were memorising rules only and those participants who were memorising both rules and examples showed better performance in learning German noun plurals with plural ending –er and with no change in plural compared to participants who were memorising examples only. Moreover, participants who were memorising both rules and examples showed better performance in learning German noun plurals with the plural ending –e compare to those participants who were memorising examples only. All three groups were learning equally well nouns with plural ending –s and plural ending –n. These findings would seem to be more easily accounted for dual-route than singe-route theories, as the morphological patterns are learned more easily in the form of rules.

Nevertheless, participants who were learning German noun plurals by memorising examples only, although less accurate, had much quicker responses than the other two groups which had rather equal reaction times. Reaction time differences could thus indicate different learning strategies. The least accurate participants being the fastest ones could simply mean that they were not thinking so much or attending to the accuracy of the responses. Rules may therefore give an advantage only in so far as they persuade participants to pay more attention to the task, not because they are psychologically more real. Alternatively, taking into account recent finings by Westermann et al. (2008) which showed no sensitivity to rules vs. examples in adults, unlike 10-11 year old children, who responded quicker to rule-based past tense forms, it could be concluded that the inexperienced learners are the ones who benefit from rules. Moreover, while the dual-mechanism account would predict similar (and even more enhanced) rule-application in adulthood, the single mechanism account would suggest that the dissociations between regulars and irregulars should become less pronounced. So, does the rule become internalised with the experience then? The current study can not answer this question, but the study which would compare inexperienced with more experienced second language learners training them by explicit rules or just by providing examples could resolve this issue.

Closer examination of the error patterns across the three groups for each of the five rules revealed some critical findings. First of all, the rule two (with plural ending –n) was the easiest one to learn across all three groups. A possible explanation for this would be that this rule was the most predictable, i.e. the most obvious rule to be applied for participants. The second easiest rule for the participants who were learning by memorising examples was rule five (with plural ending –s), whereas groups who were memorising either rules only or both rules and

examples produced the most errors for the same rule. As default rule, that is to say, the rule that is applied when none of the other rules apply (Marcus et. al, 1995), rule five might require going through all the other rules and consequently producing more mistakes. Rules one, three and four showed similar error patterns across the three conditions. These findings suggest that rules five and two are processed differently compared to the other three rules, thus providing support for the claim that rule two (with plural ending –n) besides rule five (with plural ending –s) could be considered as a regular rule in German as well (Szagun (2001), Penke (2002)). Critically, these findings are in conflict with Pinker's dual-route theory of inflectional morphology which suggested one mechanism for a regular rule and one mechanism for exceptions. In fact, they support Penke and Krause's (2002) evidence that regular inflection is not necessarily identical to default inflection. On the contrary, as they suggested that feminine noun plurals on –n, although clearly not the German default plural, results from a process of regular affixation.

As data from the present study provide evidence that inflectional systems such as the German plural marking system should not be readily characterized as regular and irregular, but rather as system which seems to display several regularities, a future studies (in particular those aiming to investigate the acquisitional process of such systems) should take into account input frequencies available to young children, as well as children's vocabularies. Furthermore, to clarify the idea about the mental representations and mechanism(s) underlying regular and irregular inflection being qualitatively distinct, the comparison of the results of the present study with agrammatic Broca's aphasia - which can be accompanied by selective deficits of regular or irregular inflection, could be a valuable next step.

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ABSTRAKT

IMPLICITNO NASPRAM EKSPLICITNOG UČENJA MNOŽINE IMENICA U NJEMAČKOM JEZIKU

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Tokom proteklih nekoliko decenija bilo je mnogo rasprava o učenju jezika. Mišljenja različitih istraživača o statusu mentalnih pravila tokom procesa učenja jezika još uvijek su podijeljena. Ovo istraživanje se bavilo učenjem morfologije množine imenica njemačkog jezika putem pravila, na osnovu primjera, ili na osnovu i pravila i primjera. Rezultati ova tri eksperimentalna uslova sugerišu da se morfološki obrasci lakše uče u formi pravila. Stoga se čini da se ovi rezultati bolje mogu objasniti teorijom koja podrazumijeva dva kvalitativno različita mehanizma procesiranja (dual-route), rađe nego konekcionističkim teorijama koje sugerišu postojanje jednog mehanizma za procesiranje kako pravila, tako i primjera. Međutim, detaljnija analiza grešaka prilikom učenja pet pravila njemačkog jezika (-e, -n, -er, ∅, -s) dala je rezultate koji su u suprotnosti sa "dual-route" teorijom. Ovi nalazi sugerišu postojanje dva, a ne jednog mehanizma procesiranja pravila množine imenica njemačkog jezika. Štaviše, drugo od pet pravila (nastavak -n) je bilo najlakše za učenje, iako se peto pravilo (nastavjak -s) smatra "default" pravilom u njemačkom jeziku.

Ključne riječi: *Njemački jezik, množina imenica, učenje, "dual-route" teorija, konekcionističke teorije*

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