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Regularity and Irregularity in French Inflectional Morphology

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Abstract

Can regular and irregular verb forms be accommodated by a single representational mechanism or is a dual mechanism account required? In a first experiment, we used a cross-modal repetition priming paradigm to investigate the mental representation of regular and irregular verb forms in French. Subjects heard a spoken prime (such as aimons) immediately followed by lexical decision to a visual probe (such as aimer). We contrasted four types of French verbs, varying in the phonological and morphological regularity of their verb form inflection. These were (i) regular verbs (aimons/aimer) (ii) verbs that undergo predictable phonological changes (sèment/semmer) (iii) verbs to which sub-rules apply (teignent/teindre) and (iv) irregular verbs with idiosyncratic alternations (vont/aller). The infinitive forms of these verbs were presented as target in three prime conditions: preceded either by a regular form, an irregular/modified form (except for the regular verbs), or a control unrelated prime. Morphologically related primes, whether regular or irregular, significantly facilitated lexical decision responses for all four verb classes. The same pattern of results was observed in a second experiment using a masked priming paradigm. These results contrasted with English, where regularly inflected verbs prime their stems but irregular verbs do not. We argue that the pattern observed in French reflects the decomposability of French irregular forms.

Introduction

Psycholinguistic models have proposed a distinction between information that can be obtained through rules and information that must be recalled from a list. On the one hand, distributed approaches argue for a single mechanism underlying the representation and processing of both regular and irregular items (Plunkett & Marchman, 1993) and, on the other hand, symbolic approaches argue for a dual mechanism account, where regular forms are generated by rule but irregular forms are stored as rote-learned whole forms (e.g. Pinker, 1991). Many studies tackle this issue by trying to determine whether the co-occurrence of regular and irregular verb forms in a given language can be accommodated by a single representational mechanism or whether a dual mechanism account is required.

In English, verbs have only three types of morphological processing contexts: 3rd person singular, past tense and progressive forms (jumps, jumping, jumped). This inflec-

tional system offers a sharp contrast between a single, dominant, regular process of past-tense formation (adding the regular affix *-ed* to an unchanged stem) and a small, heterogeneous group of irregular past-tense forms (mostly of an idiosyncratic nature).

Several sources of evidence suggest that the linguistic differences between regular and irregular forms lead to differences in the way these forms are represented in the English mental lexicon. A major source of evidence is research using repetition priming tasks, where a test word is preceded by a related prime word. The target word walk, for example, is preceded either by a morphologically related word (e.g. walked), or an unrelated word (e.g. goal). Previous research done in English shows diminished or absent priming between irregular tense and the stem (drove/drive) versus a strong priming effect between regular pairs such as walked/walk (Kempey & Morton, 1982; Napps, 1989; Stanners, Neiser, Herson & Hall, 1979). Pinker (1991) claimed that these results support the dual mechanism dichotomy. Convergent results have been observed using the cross-modal paradigm, where the prime is presented auditorily (Marslen-Wilson, Hare & Older, 1995). Again significant priming is only observed for regular inflected forms (such as walked/walk) and not for irregular ones (such as dug/dig).

In this framework, priming is explained as reflecting the fact that regular forms share a representation with their stem, and both inflected and non-inflected forms of a given verb map directly onto the representation of the stem at the level of the lexical entry. The morphological priming effect results from the repeated activation of the same morpheme by prime and target. On the contrary, an irregular form will have a separate form representation from the stem to which it is related and this may lead to a reduction of priming between the two items, under specific testing conditions. This may be due either to competition between the two representations (stem and irregular form) or as a consequence of the blocking function assigned to the listed irregular form (the presence of a lexical entry for the irregular form will prevent the application of the default suffix).

One problem with English, however, as a basis for generalisations about regularity and irregularity, is that the English past-tense forms do not differ simply in regularity, but also along a number of dimensions, including contrasts in

basic morphological procedure (suffixation versus stem change), the absence versus presence of phonological constraints on morphological processes, and high versus low type frequency of classes of past forms. In order to disentangle potential evidence about the general properties of morphological systems from the possible idiosyncrasies of English past tense formation, it is necessary to conduct parallel experiments in other languages which exhibit comparable but cleaner contrasts between regular and irregular procedures.

One language that we have looked at already in this light is Italian. This is a much richer inflected language (with many different types of tense and person suffixes) where there are a number of irregular past-tense forms that obey similar criteria for irregularity as the English irregulars, but where they occur in a morphologically more structured and phonologically more predictable linguistic environment. Using a cross-modal priming paradigm, Orsolini and Marslen-Wilson (1997) observed the same amount of priming when the prime was regular and when it was irregular. They suggest a possible account that attempts to capture the sub-regularities of the verb forms through an explicit system of rules rather than relying on an analogical network to represent them implicitly.

Here we report an extension of this research to French, which, like Italian, has a richer inflectional system than English, and which allows us to explore a wider range of types of irregularity. In French, verbs are organised into three basic morphological classes, called conjugations. These distinctions use as first criteria the infinitive form and as second the imperfect form. The major class is conjugation 1, containing verbs with infinitives ending in *-er* (such as aimer, voler...). This is the most productive class and fully regular. Conjugation 2 is formed by verbs that have an infinitive in *-ir* and imperfect in *-iss-* (such as finir, salir...). It is a smaller class than conjugation 1 and it is no longer productive, but it is fully regular. Conjugation 3 contains verbs with infinitives ending in *-ir* (and that do not have an imperfect in *-iss-*), *-oir*, *-re* (such as dormir, boire, peindre...) and the verb aller. Verbs contained in this group are highly irregular.

In our experiment we used four types of verbs. The first condition was wholly regular verbs from the first conjugation such as aimer; the second condition was regular verbs from the first conjugation but that in a few forms have a phonologically triggered surface change, such as amener-amène. These types of phonological changes (reflecting a high/low alternation) are also observed in the case of gender marking (fermier-fermière). We will call this condition the morphophonological constraint group. The third group consisted of irregular verbs from conjugation 3 but where the irregularities were common to at least 10 verbs such as teindre-teignent, peindre-peignent. Verbs in this group are closest to the ones used in the Italian experiment; we will refer to it as the sub-regularity group. The fourth group, more similar to the type of irregularity found in English was made up of highly idiosyncratic suppletive alternations such as aller-vont.

If the patterns of results observed in English and in Italian are not language specific but are due to the type of irregu-

larities then in French we should observe the same amount of priming when the prime is regular and in the morphophonological and sub-regularity irregular conditions. On the contrary, when the prime is an idiosyncratic form, we may, as in English, observe no or less priming than with a regular form. Priming effects in this experiment are evaluated by comparing reaction times when the prime is related versus unrelated to the target, and also by comparing response latencies when the related prime is regular and when it is irregular.

Experiment 1

Method

Material and Design We used a cross-modal paradigm. The prime was auditorily presented and immediately followed by a visual presentation of the target-item. Subjects made a lexical decision response to the visual target, which was preceded by a regular or irregular related or unrelated prime.

Ninety-six verbs falling in four categories were selected, as described earlier, and examples are listed in Table 1 below. We used as the target the infinitive form of the verb. We chose for each verb of each category, three types of prime (verb forms): A regular form, an irregular form and a control (or baseline) word matched on the regular form. To keep the design balanced, regular verb targets were preceded by two different regular targets. Targets were between 4 and 11 letter long.

Table 1: Examples of stimuli.

Verb Type	Infinitive Target	Forms Regular	Irregular
Regular	<i>aimer</i>	<i>aimerons</i> <i>aimons</i>	<i>n/a</i>
Morpho-phonologic constraints	<i>semer</i>	<i>semons</i>	<i>sème</i>
Sub regularity	<i>teindre</i>	<i>teindra</i>	<i>teignent</i>
Idiosyncratic	<i>aller</i>	<i>allons</i>	<i>iront</i>

For each of the 96 regular primes, we selected a control word that was matched to the regular experimental prime for surface frequency, number of syllables and tense and person of the verb form. None of the neutral condition words were morphologically, semantically or phonologically related to the target. We also constructed filler pairs in order to reduce the proportion of related pairs within the list. We added 64 pairs in which the target was a word (such as calculons/partir), and 160 pairs in which the target was a non-word (such as marchera/enteler). Each prime list was composed of 96 experimental words (of which 64 were related to the target and 32 were not), 64 words with an unrelated target word, 160 words with a nonword target (64

pairs in which prime and target shared formal features and 96 primes followed by a nonword target which was unrelated). To sum up, we had 160 word-word pairs and 160 word-nonword pairs.

In order to avoid the repetition of a given target for a subject, we constructed 3 experimental lists of 320 items each. A given target appeared only once in each list: with a regular related prime in one list, an irregular related prime in the second list and a control prime in the third one. In each list, 2/3 of the experimental prime-target pairs were morphologically related (64 pairs). The number of pairs of each experimental condition was equal (8) in each list. Each subject heard only one list so that each saw a third of the items with a regular related prime, a third with an irregular related prime and a third with a control prime. The list of targets was the same for all subjects, only prime lists varied. To give a break to the subjects we split up each list. Experimental pairs of each condition were equally distributed in each segment of the list. Each part of the list started with 10 items that were not experimental ones. Before starting to hear the list itself, the subject had training with 20 prime-target pairs. The experimental session lasted 25 minutes.

Procedure A French female native speaker recorded primes on a DAT. Each prime was then digitized at a rate of 22kHz and stored on computer hard disk. Each word was isolated in a single independent file. This allowed us to control the time between the end of the prime and the presentation of the target. The prime was binaurally presented to the subject and was immediately followed (ISI 0ms) by the presentation of the target. This latter was written on a CRT screen in front of the subject. The target stayed on the screen until the subject made a response. The task of the subject was to push one of the two buttons on a response box (one for word, the other for non-word), as fast as he or she could. Subjects were alone in the testing room.

Participants Thirty-six students of Psychology at the University Paris V - René Descartes took part to the experiment. All were native French speakers and they were between 18 and 30 years old.

Results

Reaction times higher than 1500 ms were eliminated from the statistical analyses; less than 1% of reaction times were suppressed with this criterion. There were 2% of errors on experimental words. Analyses of variance were conducted on the inverse reaction time data. This allowed outliers to be included without unduly affecting the estimates of condition mean (Ratcliff, 1993; Ulrich & Miller, 1994). Two analyses have been run: one across subject (F1) and the other across item (F2). Reaction times per conditions are presented in Figure 2. This also gives the priming effects and their associated significance values.

First, comparing regular conditions and control conditions, we observed an effect of morphological priming ($F(1,35)=103.17$, $p<.000$; $F(1,92)=119.45$, $p<.000$) and an effect of type of verbs per subjects ($F(3,105)=9.19$,

$p<.000$; $F(1,92)=2.05$, n.s.) but no interaction between these two factors ($F(1,35)<1$; $F(1,92)<1$). Comparing irregular conditions with control conditions, we observed an effect of morphological priming ($F(1,35)=80.43$, $p<.000$; $F(1,92)=142.33$, $p<.000$) and an effect of type of verb ($F(3,105)=7.04$, $p<.000$; $F(1,92)=2.26$, $p=.09$) but no interaction between the two ($F(3,105)=1.31$, n.s.; $F(3,92)=1.83$, n.s.). Comparing regular and irregular conditions, we observed no effect of type of priming ($F(1,35)=2.98$, n.s.; $F(1,92)=1.01$, n.s.), an effect of verb types per subject ($F(3,105)=4.31$, $p<.007$; $F(1,92)=1.13$, n.s.) but again no interaction ($F(1,35)<1$; $F(1,92)<1$).

These results show that irregular and regular verb forms prime their infinitive form equally, and that these priming effects do not vary with the type of verb (irregular vs. regular).

Table 2: Results of Experiment 1

Type of verbs	Primes	Targets	RT(ms)	Priming effect
Regular	<i>aimerons</i>	<i>aimer</i>	523	44**
	<i>aimons</i>		530	37**
	<i>porterons</i>		567	
Morpho-phonologic constraints	<i>semons</i>	<i>semer</i>	539	57**
	<i>sème</i>		545	51**
	<i>votons</i>		596	
Sub regularity	<i>teindra</i>	<i>teindre</i>	553	60**
	<i>teignent</i>		551	62**
	<i>nichera</i>		613	
Idiosyncratic	<i>allons</i>	<i>aller</i>	544	49**
	<i>irons</i>		545	48**
	<i>tenons</i>		593	

Note: ** $p < .05$

Discussion

This cross-modal priming experiment presented a pattern of results which was very clear cut: a massive morphological priming effect and no interaction between this effect and the type of primes (regular vs. irregular) or the type of verbs. These results show that in French there is no difference in the amount of priming produced by a regular verb form and the one produced by an irregular verb form on the identification of their infinitive.

A major concern in cross modal experiments is to determine if the priming effects observed for morphologically related pairs are due to shared morphemes in a morphologically structured mental lexicon, or if they are due to the semantic relationships between the morphologically related pairs. Given the across-the-board priming effects in Experiment 1, and given that all the primes and targets were highly semantically as well as morphologically related, we decided to run the same materials in a second experiment using a masked priming technique developed by Forster and Davis (1984). The masked priming technique has been shown to be highly sensitive to overlap at the level of form (Forster, Davis, Schoknecht, & Carter, 1987; Forster and Taft, 1994), but not of meaning. Although masked priming

effects for associatively related pairs have been observed (Sereno, 1991), no pure semantic effect had been reported. In masked priming a forward pattern mask is presented immediately before the prime and the prime is then covered by the target item: this latter is used as a backward mask. The temporal interval between the onset of the priming stimulus and the subsequent target stimulus is very brief (47 ms in our experiment). At these short prime durations, the combination of forward and the backward masking prevents the subject from consciously seeing the prime. The consequence of this is that the participant's responses are not influenced by a conscious appreciation of the relationship between the prime and the target. This reduces the possibility that any priming effect is due to the fact that the participant realises that the prime and the target often share a common morpheme.

Experiment 2

Method

Material and Design Our second experiment used a masked-priming paradigm with the same stimuli as the previous experiment. We added two additional controls: a semantic condition, where the prime and the target were semantically related, to check that the masked priming paradigm was not picking up semantic effects; and an orthographic condition where the prime and the target orthographically overlapped to the same degree as the related pairs but had no semantic or morphologic relationship. We selected 24 target-words. For each target word in this condition (such as *mâcher*), one prime was semantically related to the target (*broyait*), one prime was phonologically related to the target (*machine*) and the third type of prime was an unrelated control (*progrès*). As a consequence of these changes we removed 24 word/word filler pairs to keep the balance between word and nonword answers. As a result this gave us the same number of items in each list as for the previous experiment.

Procedure The same hardware and software were used as in the previous experiment. Each trial consisted of three visual events. The first was a forward pattern mask consisting of a sequence of '#'. The second event was the display of the prime word for 47 ms. The third event was the presentation of a target word or nonword for 500ms. The prime was in lower case and the target in upper case to make sure that the former was appropriately masked. Subjects were asked to make a quick and accurate lexical decision about the target by pressing a 'word' or 'nonword' key. The experiment lasted about 30 minutes and started with 10 practice trials followed by 10 warm-up pairs and then the experimental trials. There were breaks as in the previous experiment. No subjects reported any awareness of the presence of a prime.

Participants Another 42 native French speakers of the same age and from the same population as before took part in the experiment.

Results

Reaction times higher than 1500 ms were eliminated from the statistical analyses; less than 1% of reaction times were suppressed with this criterion. There were 2% of errors on experimental words. Analyses of variance were conducted on the inverse reaction time data both across subject (F1) and item (F2). Reaction times per condition are presented in Table 3. This also gives the priming effects and their associated significance values.

Table 3: Results of Experiment 2

Conditions	Primes	Targets	RT ms	Priming effect
Regular	<i>aimerons</i>	<i>aimer</i>	551	19**
	<i>aimons</i>		552	18**
	<i>porterons</i>		570	
Morpho-phonologic constraints	<i>semons</i>	<i>semer</i>	569	19**
	<i>sème</i>		566	22**
	<i>votons</i>		588	
Sub regularity	<i>teindra</i>	<i>teindre</i>	564	32**
	<i>teignent</i>		578	18**
	<i>nichera</i>		596	
Idiosyncratic	<i>allons</i>	<i>aller</i>	560	32**
	<i>irons</i>		578	14**
	<i>tenons</i>		592	
Semantic and Orthographic Controls	<i>broyait</i> <i>machine</i> <i>progres</i>	<i>macher</i>	587 599 592	5 -7

Note: ** $p < .05$

Comparing first regular conditions and control conditions, we observed an effect of morphological priming ($F(1,41)=36.74$, $p<.000$; $F(1,92)=59.06$, $p<.000$) and an effect of type of verb per subject ($F(3, 123)=4.73$, $p<.004$; $F(2<1)$) but no interaction between the two factors ($F(1<1$; $F(2<1)$). Comparing irregular conditions with control conditions, we observed an effect of morphological priming ($F(1,41)=22.03$, $p<.000$; $F(1,92)=30.96$, $p<.000$) and an effect of type of verb per subjects ($F(1(3, 123)=7.84$, $p<.000$; $F(2(1, 92)=1.152$, n.s.) but no interaction ($F(1<1$; $F(2<1)$). Comparing regular and irregular conditions, we observed no effect of the type of priming ($F(1(41)=2.16$, n.s.; $F(2(1,92)=2.09$, n.s.), an effect of type of verb per subject ($F(1(3, 123)=4.81$, $p<.003$; $F(2<1)$) but no interaction ($F(1(3,123)=1.31$, n.s; $F(2(3,92)=1.18$, n.s.). In the control condition we found no effect of semantic priming ($F(1(41)=1.8$, n.s.; $F(2(1,21)=1.05$, n.s.) and no effect of orthographic overlap ($F(1(41)<1$; $F(2<1)$), allowing us to rule out accounts of the results in terms of simple form overlap between prime and target.

These results confirmed the results observed in the cross-modal experiment and show that irregular and regular verb forms prime their infinitive form equally, and that these

priming effects do not vary with the type of verb (irregular vs. regular). The fact that these effects are found in a task which is generally insensitive to semantic relations between prime and target - and where the semantic control condition showed no priming - is good evidence that these are genuinely morphological effects, reflecting repeated access to the same underlying morpheme. This morpheme seems to be accessed equally effectively, regardless of the degree or type of irregularity on the prime word.

General Discussion

The question asked here was whether French regular and irregular inflected forms show different priming patterns, in the same way as English. The dual mechanism hypothesis postulates a rule-based symbolic processor that supports the representation and generation of regular forms, while an associative rote-memory system is required to account for irregular forms. Pinker (1991) claimed that the different priming effect observed in English for regular and irregular forms support the dual mechanism dichotomy. Using French we found no such difference. The priming generated by regular inflected words did not differ from the priming generated by irregular forms. The facilitatory effects of morphologically related primes are just as strong whether they involve the same or different underlying roots as their targets. Pairs like *aimons/aimer* prime just as well as pairs like *buvons/boire*. These findings seem inconsistent with the predictions of the dual mechanism hypothesis for the processing behaviour of listed forms in a repetition priming task. In the framework of the dual mechanism account, because Conjugation 3 verbal forms are completely idiosyncratic and unpredictable, they will use rote-learning of irregular stems and they will be stored as independent but linked forms in a pattern-associative memory. For a priming task, this predicts reduced priming between prime/target pairs involving different underlying roots, a prediction confirmed in earlier research in English. The results obtained in French contrast with those obtained in English.

The pattern of results observed in French could be explained in terms of connectionist distributed networks, operating sub-symbolically and without syntax (Rumelhart & McClelland, 1986; MacWhinney & Leinbach, 1991; Plunkett & Marchman, 1993). Indeed, the absence of interaction between priming effects observed with regular forms and priming effects observed with irregular forms seems to go against the dual mechanism hypothesis. We could argue that English speakers use rules because the contrast between regular and irregular verbs is sharp, which is not the case in French. In French irregular verbs may often have regular forms in many cases and irregular forms only for particular tenses and persons. As an example table 4 presents the different forms of the irregular verb *aller* for three different tenses and all persons. So for the verb *aller*, while imperfect forms are fully regular (such as *allais*), future forms are all irregular (such as *irai*) and the present forms are both regular and irregular, depending of the person (such as *allons* and *vont*). This complexity and the lack of clear-cut distinction between regular and irregular verbs could discourage

the system from relying on rules. However, the idea that the cognitive system would not be able to use regularities because of the complexity of the verbal system lacks plausibility given the complexity of other processes involved in language understanding.

Also, the result profile observed in French might not, by itself, be an insuperable problem for the dual mechanism account. One possibility is that the processing architecture of French differs from that of English in ways which allow listed allomorphs to prime each other. The idea would be that even if regular forms are retrieved by rule decomposition and not irregular ones, the behavioral output observed (in this case, the priming effect) would be the same even if the underlying processes are different.

Table 4: Verbal forms of the verb *aller* for the three indicative tenses and the three singular and plural persons.

aller (infinitive form)	Present	Imperfect	Future
je (1 sing.)	<i>vais</i>	<i>allais</i>	<i>irai</i>
tu (2 sing.)	<i>vas</i>	<i>allais</i>	<i>iras</i>
il/elle/on (3 sing.)	<i>va</i>	<i>allait</i>	<i>ira</i>
nous (1 plur.)	<i>allons</i>	<i>allions</i>	<i>irons</i>
vous (2 plur.)	<i>allez</i>	<i>alliez</i>	<i>irez</i>
ils/elles (3 plur.)	<i>vont</i>	<i>allaient</i>	<i>iront</i>

Note: sing.: singular; plur.: plural; 1: first person (I or we); 2: second person (you); 3: third person (he/she or they).

Perhaps a more important difference between the idiosyncratic verbal forms in French and the irregular forms in English is that French forms are decomposable while English forms are not. English irregular forms such as *drove* or *gave* are not only irregular but also cannot be further morphologically decomposed. They must be learnt and represented as unanalysable whole forms. In French, even idiosyncratic irregular forms like *buvait* (from *boire*) undergo a regular suffixation procedure: '-ait' is the regular affix for the imperfect third person form. Irregular forms in French are composed of a changed stem plus a regular affix. The irregularity is in the choice of the stem used but the regular suffix procedure applies anyway.

Marslen-Wilson et al. (1995) explain the English results in terms of the inhibitory consequences during acquisition of having to learn, for each irregular stem, to block the application of the default regular suffix. If indeed in English the two possible stems compete with each other during identification in order to block the decomposition process (in case the form that has to be identified is the irregular one), such a process would not be necessary in French. For French irregular verbs, two types of stem would be possible but even if the form presented is irregular there would not be the same type of competition because in both cases decomposition would be necessary to reach identification of the verbal form. Both regular and irregular forms would follow the same processing pathways - which is arguably not the case for regular and irregular forms in English (Marslen-Wilson & Tyler, 1998). If regular and irregular forms can co-exist in this fashion, then both can be linked to the

underlying verbal morpheme without competition from the other - and without the requirement to postulate distinct types of computational procedure to support the generation and analysis of each type of form.

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