The Dual Mechanism for Processing English and Japanese Verbs

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Abstract

A verb can be associated with a variety of morphological elements such as tense/aspect markers, person/number agreement morphemes and modality affixes, therefore the understanding capacity of word forms plays an important role in the processing of verb forms with a complex morphological system. English verbs are classified into three types; (1) regular verbs adding *–ed*, (2) analogically assumed *irregular verbs*, and (3) *irregular verbs* which are notably different than those of type (2). The processing of the first, regular type of verbs and the second, irregular type of verbs is termed the *dual processing model*. As described by the *dual mechanism*, the past tense of English verbs appears to be separately processed; regular verbs are *inflectionally generated* whereas irregular verbs are *analogically associated*. The derivative and non-derivative relations of Japanese verbs could function like the dual mechanism described for English verbs. Our study (Sakai, Tamaoka, Kawahara, Fujiki, & Fukuda, 2004) utilized three conditions for its experiment, (1) potential verb form (e.g., *kowaseru*), (2) intransitive verb form (e.g., *kowareru*) and (3) white noise as a control condition, with results indicating that the potential-form primed condition had a significant priming effect of 83 milliseconds. Priming effects were also seen to have reduced the error rate by 4.76 percent. On the contrary, no priming effect (Δ1 ms and Δ 1.19%) was found in the intransitive-form primed condition. Therefore, as with the dual mechanism for the processing of English verbs, our study shows that Japanese verbs must have two processing mechanisms; verb forms with derivative relations (the same stem) are processed with *rule-based regularity*, whereas verbs of transitive/intransitive alternation follow the processing of *analogical memory*.

1. Language Rules Held by Pre-school Children

In the English language, there is no such noun as *wug*. In the field of psycholinguistics, however, there is a unique method of measuring acquired language rules, called the *wug test* (Berko, 1958). A sample test item is administered as follows: First, a picture of a bird is introduced to a child with the statement, 'This is a wug'. Next, another picture of the same bird is held beside the one already shown, and the child is told, 'There are two of

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them'. Soon after, the child is prompted, 'There are two ___', to suggest the child use a plural form to complete the sentence. Three quarters of pre-school children could correctly respond *wugs*, whereas students in the first year of elementary school correctly responded *wugs* at the rate of 99 percent.

This method can be applied to check the extent to which children have acquired the ability to correctly produce the past tense form. Non-verbs, such as *zick* are similarly used with a picture and introductions such as 'Someone is zicking' and 'He did the same thing yesterday', followed by the question, 'What did this man do yesterday' and so forth. If children could respond, 'The man zicked yesterday', we can judge that they had already acquired the past tense from. However, children often apply the rule of adding *–ed* to irregular verbs to form incorrect conjugations such as *drinked* for *drink* instead of *drank*. This tendency is referred to as *overgeneralization*, *overgeneration* or *overregularization* (for details, see Clark, 2003; Pinker, 1999; for Japanese explanation, see Otsu, Ikeuchi, Imanishi, & Suiko, 2002). Using the *wug test* (Berko, 1958) or similar types of instruments, other studies have assumed that children have innate abilities to obtain language rules.

2. The Dual Mechanism Concept

The *wug test* examines children's acquisition of fundamental rules regarding plural forms and past tense. However, there are numerous, frequently-used irregular verbs in the English language (e.g., *sink - sank*, *ring - rang*). This rule cannot apply to *think*, the past tense of which is not *thank*, but *thought*. Among commonly-used English verbs, about 150 to 180 are these irregularly conjugated ones. An interesting phenomena is observed among children acquiring English as a native language: they overuse rather locally-applicable rules of irregular verbs. For example, an analogical rule for the past tense of irregular verbs is /u:/ substituted with /ou/ in the middle, such as *grew* for *grow*, *knew* for *know*, and *threw* for *throw*. Based upon these cases, it can be assumed that a child is likely to associate *flew* with the past tense for *flow*, but it is actually the past tense form of *fly*. However, it should be noted that, although errors in irregular forms of English past tense were expected to be high (Kuczaj, 1977), actual error sample data did not support this prediction. The study of Xu and Pinker (1995) found quite low error rates on the basis of 20,000 past tense and participle usages from nine children in the CHILDES (Child Language Data Exchange System. MacWhinney, 2000) database. Thus, once the irregular past tense forms are acquired, children seem to be able to use the correct forms.

English verbs are classified into three types (Pinker & Prince, 1994; for an explanation in Japanese, refer to Ito & Sugioka, 2002). First, as the default rule, the simple past tense for a majority of verbs is created by

simply adding *-ed*. These verbs are referred to as *regular* verbs. Second, the past tense form of some *irregular* verbs can be analogically assumed, such as in the aforementioned case of *grew* for *grow*. Third, the present and past tense forms of a few irregular verbs are notably different. A typical case is the verb *be*: the present tenses are *am* for I, *are* for you, we and they, and *is* for he and she; the past tense similarly varies *was* for I, he and she, and *were* for you, we and they. Since the tense forms of *be* do not follow either regular or analogical rules, native English speakers have to memorize all these forms. This type of conjugation is known as *suppletion*, which is actually learned by memory. The processing of the first, *regular* type of verbs and the second, *irregular* type of verbs is termed the *dual processing model* or *dual mechanism*.

3. Testing the Dual Mechanism through Psychological Experiments

Do native English speakers really perform distinct processing for two different types of verbs as described by the dual mechanism, *-ed* addition and analogical memory? Marslen-Wilson, Hare and Older (1993) conducted a verb correctness decision task with an experimental method called *priming*. In the priming experiment of Marslen-Wilson, et al. (1993), target stimuli were comprised of past tense forms of verbs (e.g., *walked* for the default form and *rang* for the analogical form) while primed stimuli were the present forms of the same verbs (e.g., *walk* for the default type and *ring* for the analogical type). To avoid orthographic similarity effects for default verbs whose past tense is produced simply by adding *-ed* (e.g., *kick - kicked*) their experiment further utilized a cross-modal method, presenting priming stimuli auditorily and target stimuli visually.

An assumption of Marslen-Wilson et al. (1993) is as follows. The past tense of default verbs is produced by the inflectional morphology *-ed*, so that a primed verb of the present tense (e.g., *assist*, *kick*, and *walk*) must facilitate (speed up) performance of lexical decisions for target verbs of the past tense (e.g., *assisted*, *kicked* and *walked*). On the contrary, analogical irregular verbs such as *sing*, *drink*, *sink* and *swim* have certain rules which are limited to a small number of irregular verbs. These authors therefore assumed that the priming effects of these irregular verbs would be quite weak in comparison to regular verbs. As expected, the results of the experiment by Marslen-Wilson et al. (1993) indicated significant priming effects on default regular verbs, but not on analogical irregular verbs. This finding suggested that the past tense of regular verbs is inflectionally generated on the basis of the inflectional morphology *-ed*. On the other hand, if one could be forgiven for interpreting these authors' findings rather simplistically, using the example of the past tense of *rang* for *ring*, these analogical irregular verbs cannot be produced inflectionally, but rather must

be memorized with an analogical association as *ring - rang*. As such, the past tense of English verbs appears to be separately processed; as described by the *dual mechanism*, regular verbs are *inflectionally generated* whereas irregular verbs (except *suppletion* verbs) are *analogically associated.*

4. Derivative Relations of Japanese Verb Forms

The Japanese language is classified as an *agglutinative language*. In this type of language, grammatical categories such as noun case, verb aspect and tense can be marked by adding functional words and affixes to a stem. Consider the sentence, *Saabisu-zangyoo-o saserare sooni natta* (サービス残業をさせられそうになった) meaning 'I was almost made to work overtime without pay'. Based on traditional Japanese grammar (国文法, *kokubunpoo*), this sentence could be divided into many small components: A compound noun *saabisu-zankyoo*, an accusative case marker *-o*, a verb *sa* (未然形, indeterminate form of *suru*), a causative auxiliary verb *-se* (未然形, indeterminate form of *seru*), a passive auxiliary verb *-rare* (連用形, the infinite form of *rareru*), a manner auxiliary verb *-sooni* (連用形, the infinite form of *sooda*), a verb *-nat* (連用形, the infinite form of *naru*), and a past tense auxiliary verb *-ta* (終止形, the finite form of *ta*). As such, this simple sentence is constructed by various inflections.

Japanese verbs are complex, as is clearly depicted in Figure 1. A stem of *kowas* meaning 'to break' is drawn in the middle of the figure. The transitive verb *kowasu* is constructed by the inflection *+u*. The inflection *+(a)reru* renders the passive form *kowasareru*. Likewise, the causative form *kowasaseru* is structured with the *+(a)seru* inflection. In both passive and causative forms, *+a* is inserted between the stem and the inflectionally generated form. This vowel is phonologically required in order to avoid the appearance of two continuous consonants. The potential form is also constructed adding *+eru* to the stem *kowas* as *kowaseru*. The intransitive, passive, accusative and potential forms in the shaded (gray) boxes of Figure 1 are derived from the inflectional addition to the stem. Thus, they are considered to have *derivational relations* to the stem. On the other hand, the transitive form of *kowareru* cannot be derived from the stem *kowas*, but from the stem *koware*. In this sense, the transitive form does not have a derivational relation to the stem *kowas*. This relation is indicated in Figure 1 with a dotted line to the unshaded (white) box. However, it should be noted that the stem-inflection relations of Figure 1 describe only consonant-stem verbs (五段動詞), not vowel-stem verbs (一段動詞). For instance, the intransitive verb *taberu* meaning 'to eat' is *taberareru*, constructed by the stem *tabe* and the inflection *rareru*. Thus, when referring to vowel-stem verbs, the inflection should be changed. Nevertheless, the figure is applicable to all Japanese verbs.

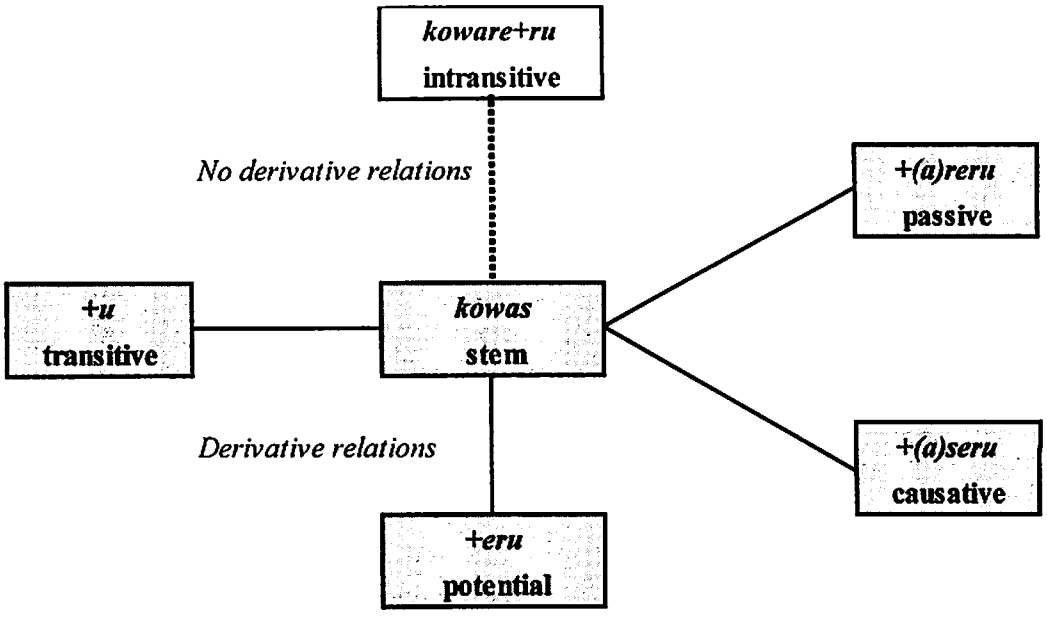

Figure 1. Derivative relations of intransitive, transitive, potential, passive and causative forms among Japanese verbs

5. The Dual Mechanism for Processing Japanese Verbs

The derivative and non-derivative relations of Japanese verbs in Figure 1 could function like the dual mechanism described for English verbs. Since the intransitive form of a verb such as *kowasu* (V_{stem}+$Suffix_{-u}$) meaning 'to destroy' and the potential verb form *kowaseru* (V_{stem}+$Suffix_{-eru}$) are derived from the same stem by applying a rule that is completely regular, these two types of verbs are considered as default verbs in English. In contrast, the intransitive verb form *kowareru* has no derivative relation with the stem *kowas* found in the transitive verb form *kowasu*. In other words, *kowareru* derives from the stem *koware* while *kowasu* from the stem *kowas*. Therefore, these two forms could be understood as two different verbs.

Allen and Badecker (2002) investigated the processing of English verb morphology to find that a semantically related irregular prime *taught* facilitated the processing of a target *teach* provided that the prime and the target are orthographically distinct. They attributed the lack of priming effects in *gave-give* cases to the blocking effect of orthographic homonyms and the priming effect resulting from semantic relatedness eventually canceling each other out. Their combination theory is still in need of confirmation because Sonnenstuhl, Eisenbeiss and Clahsen (1999), for instance, found weak facilitation effects of irregular stem allomorph primes in their experiments with German diminutives. These conflicting results from research on different languages raise questions as to the universality of the cognitive mechanisms behind the priming and blocking effects. More generally, transitive/intransitive alternation among Japanese verbs is

possibly equivalent to analogically-memorized irregular verbs in English.

Sakai, Tamaoka, Kawahara, Fujiki and Fukuda (2004) applied the framework of derivative and non-derivation relations among Japanese verbs to the dual mechanism in English verbs and conducted an experiment using the priming paradigm with 24 Japanese university students. Three priming conditions were used for their experiment, (1) potential verb form (e.g., *kowaseru*), (2) intransitive verb form (e.g., *kowareru*) and (3) white noise as a control condition. An attractive part of the experiment was that target stimuli were always the same transitive verb form (e.g., *kowasu*) across the three priming conditions. In addition, the first and second priming stimuli consisted of the same *kanji* (e.g., 壊) and an equal number of hiragana (e.g., せる and れる) as in 壊せる (*kowaseru* 'can destroy') and 壊れる (*kowareru* intransitive of 'break'). Twenty-four sets of verbs (see Appendix) were selected for the experiment, comprising (i) transitive verbs (e.g., *kowasu*; transitive of 'break',), (ii) semantically related intransitive verbs without a regular morphological relationship to the target (e.g., *kowareru*; intransitive of 'break'), and (iii) potential form of the transitive verbs with a regular morphological relationship with the target *-eru* (e.g., *kowaseru*; 'be able to break').

Twenty-four native Japanese speakers were offered a nominal monetary incentive to participate in the experiment. After the presentation of a fixation point on the CRT screen for 400ms, the participants heard either white noise or auditory prime words in a stereo headphone set. The visual probe was presented in the standard Japanese orthographic system including kanji and hiragana characters for 400ms immediately after the offset of the auditory prime. The participants were instructed to press a YES key if the visually presented target was a real word and a NO key if it was a non-word. Lexical decision latency was measured from the onset of the presentation of each visual probe.

As in Marslen-Wilson, Hare, and Older (1993), the experiment of Sakai, Tamaoka, Kawahara, Fujiki, and Fukuda (2004) used cross-modal presentation, auditory presentation for primed stimuli and visual presentation for target stimuli. Priming effects were calculated by subtracting the baseline of the white nose condition from the mean reaction times required for lexical decisions of target stimuli. In this experimental design, it was assumed that facilitative priming effects would be observed in the prime-and-target pairs of potential and intransitive forms which share the same stem. In contrast, no priming effects were expected between pairs of transitive and intransitive forms (i.e., transitive/intransitive alternation) which share a different stem. The means of reaction times in the three priming conditions are shown in Figure 2 (a symbol of plus and minus '±' indicates a standard deviation).

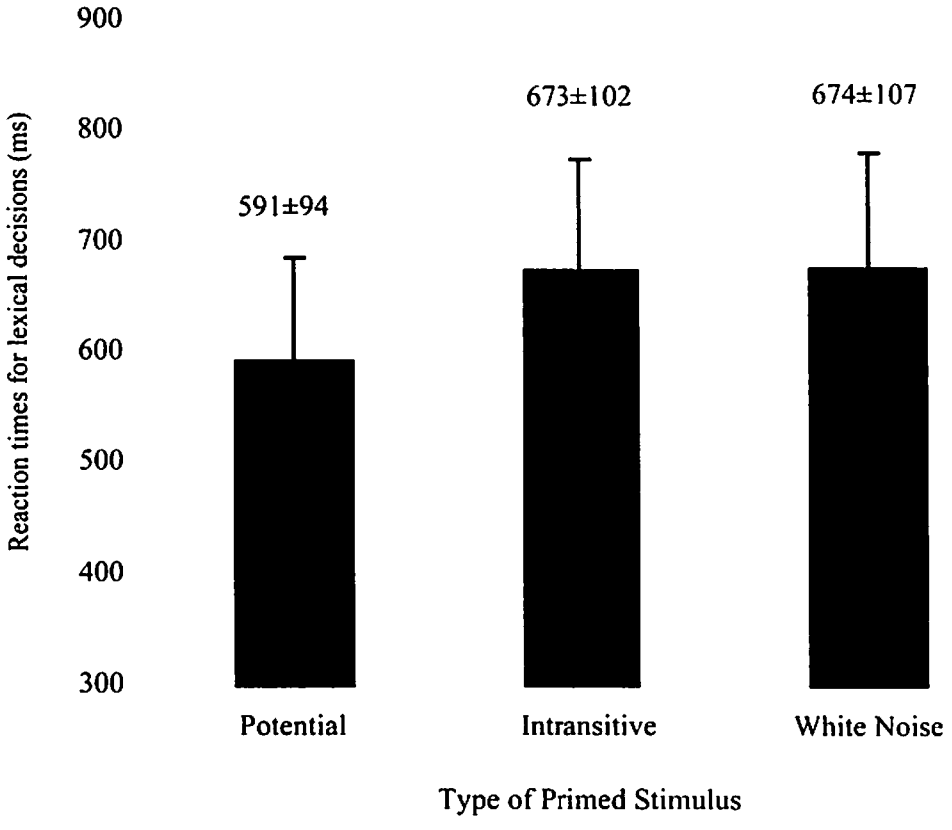

Figure 2. Reaction times for lexical decisions of intransitive verbs as a function of primed conditions

The results of the experiment clearly supported the aforementioned assumption concerning facilitative priming effects on prime-and-target pairs of potential and intransitive forms. The potential-form primed condition showed a priming effect of 83 milliseconds. The difference between the potential prime condition (M=591, SD=94) and the white noise condition (M=674, SD=107) was significant in both participant and stimulus analyses. This was also true in the error rate of 4.76 percent which was reduced by priming effects. On the contrary, no priming effect (Δ 1 ms and Δ 1.19%) was found in the transitive-form primed condition (not significant in either participant or item analyses): the transitive/intransitive alternation had no facilitation effect on lexical decisions. Therefore, as with the dual mechanism for the processing of English verbs, Japanese verbs must have two processing mechanisms. Verb forms with derivative relations (the same stem) are processed with rule-based regularity whereas verbs of transitive/ intransitive alternation follow the processing of analogical memory.

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Appendix

The following list is 24 sets of stimuli used for the experiment (Sakai, Tamaoka, Kawahara, Fujiki & Fukuda, 2004). The stimuli are arranged in the order of (1) transitive form, (2) potential from and (3) intransitive form of transitive.

kowasu 壊す 'break', *kowaseru, kowareru*
sasu 刺す 'sting', *saseru, sasaru*
hogusu ほぐす 'loosen', *hoguseru, hogureru*

kasu 貸す 'lend', *kaseru, karisu*
yogosu 汚す 'dirty', *yogoseru, yogoreru*
hagasu 剥がす 'remove' , *hagaseru, hagaresu*
matagu またぐ 'step over', *matageru, matagaru*
tubusu 潰す 'crush', *tubuseru, tubureru*
taosu 倒す 'topple', *taoseru, taorer*
kosu 越す 'go across (over)', *koseru, koeru*
kakusu 隠す 'hide', *kakuseru, kakureru*
tasu 足す 'add', *taseru, tariru*
nakusu 無くす 'lose' , *nakuseru, nakunaru*
kesu 消す 'extinguish', *keseru, kieru*
tukamu つかむ 'seize', *tukameru, tukamaru*
kuzusu 崩す 'destroy', *kuzuseru, kuzureru*
kobosu こぼす 'spill', *koboseru, koboreru*
arawasu あらわす 'show', *arawaseru, arawareru*
hanasu 離す 'separate', *hanaseru, hanareru*
hazusu 外す 'remove', *hazuseru, hazureru*
nagasu 流す 'splash', *nagaseru, nagareru*
midasu 乱す 'disturb', *midaseru, midareru*
hasamu 挟む 'put between', *hasameru, hasamaru*
husagu ふさぐ 'block', *husageru, husagaru*