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Determinants of Ease of Translation.

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In many studies of sentence and text processing of multilinguals as well as monolinguals, researchers have treated words as a basic unit to examine subjects' responses. For example, McDonald and Carpenter (1981) analyzed a temporal relation between eye-fixated words and spoken translation to examine the processes involved in simultaneous translation (i.e., translating a written text in one language into speech in another language; see de Groot, 1998, for a description of forms of translation). Replicating Jarvella's (1971) result with not only listeners but also interpreters, Isham and Lane (1993) also treated words to define serial positions in sentential material. Furthermore, Saito and Abe (1995, 1996) examined errors word by word in translated and recalled sentences and found that more errors occur in the processing stage comprehending original sentences than that producing the translated sentences.

Although the researchers interested in the translation or interpretation process have discussed the mechanism with which subjects analyze source messages and synthesize target ones, they have paid little attention to ease of translation for words. This may be due to a lack of word norms that contain this information. Psycholinguists or cognitive psychologists now can use extended databases of words containing a number of attributes, which are not only objective but also subjective (e.g., MRC Psycholinguistic Database, 1987). However, no standard verbal materials controlled for the ease of translation seems available to the researchers.

If information about ease of translation for words were available, then investigators could design more appropriate experiments than those carried out so far. Moreover, they may also reinterpret the conclusions from previous research in cognitive processes of bilinguals such as translation, interpretation, code-switches, and second language acquisition.

In this article, I review the relevant results of studies in which the participants performed some kind of translation and consider what variables affect the ease of translation. Most of the experiments were conducted by researchers whose interests are in the following: whether word forms and concepts in two languages are represented independently or integrated within unitary lexical and conceptual memory systems; how strongly links between the concepts and the words are connected and how bilinguals manage to make their two languages distinct from each other; what patterns of connections bilinguals develop as a function of proficiency of their nonnative

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languages and the settings in which they learned them; or whether other cognitive systems or processes such as an image system or a reading process function in the same way as they do for monolinguals. These questions are themselves crucial to the understanding of the cognitive processes of bilinguals. However, here I focus only on the participants' performance, which seems to reflect the ease of translation, in each study.

Conceptualization of Ease of Translation

Ease as a Function of a Probability of Correct translation

It is reasonable to regard ease of translation for a given word as the probability with which one accurately translates that word. The probability will be estimated from observed relative frequency or a proportion of correct translation. Thus, the higher a proportion of the accurate translation for a word is, the higher the probability of the translation correctly performed for that word should be. The higher probability in turn implies that the word is more easily translated.

In many studies, researchers had the participants translate a set of words and calculated the proportion of correct translations, although few of these researchers were explicitly concerned with the ease of translation. The investigators used the proportion as measures of memory pathways which forward and backward translation exploit (de Groot et al., 1994), patterns of lexical processing which individuals at various L2 proficiency level employ (Chen and Leung, 1989), or effects of several variables on word translation from L1 to L2 (de Groot, 1992). Others did not engage their participants in an overt translation task but used this measure in order to examine bilinguals' various mental processes such as the interlingual Stroop effect (Chen and Ho, 1986), the translation priming effect (Chen and Ng, 1989), the translation-based generation effect (O'Neill et al., 1993), or the bilingual dual coding theory (Matsumi, 1994; Pavio and Lambert, 1981).

Ease as a Function of Time to Translate

It is also plausible that ease of translation should be reflected in the time necessary to translate a given word. The cognitive processes need a certain amount of time to produce the appropriate translation equivalence. The time would vary according partly to the ease of translation for that word. Thus, the easier it is to translate the word, the shorter the time it takes. As in the case of probability mentioned above, researchers have not often addressed the ease directly although many of them have analyzed translation latencies. The results of these analyses suggest much about the relationship between ease and time of translation.

The translation latency, together with naming latencies for words and line-drawing pictures, is one of the most common measures in studies of bilinguals' memory structures. These studies have addressed an issue of mapping form to meaning (see Kroll and de Groot, 1997, for a recent review). In other words, the researchers have sought to determine the existence, the strength,

and the direction of each connection among a concept, a lexical item of L1, and one of L2 in the long-term memory. For example, Chen and Leung (1989) had their participants translate words as well as name words or line drawings and compared the naming and translation latencies in order to explore the patterns of lexical processing for beginning and proficient learners of a nonnative language. In testing the three hypotheses that were developed based on the bilingual dual coding theory, Matsumi (1993) also analyzed the times necessary to translate an L1 word, name pictures in L2, read an L1 word, and name pictures in L1. In addition, de Groot et al. (1994), de Groot (1992), Ikeda (1994) and Potter et al. (1984) included overt translation in their experimental task and analyzed the translation latencies.

Another time measure commonly used in studies of memory structures is the decision latency in the lexical decision task. Psycholinguists and cognitive psychologists think that patterns of connections in the mental representation should be explored in the priming paradigm. In this paradigm, investigators often adopt the lexical decision task. Thus, even though this measure is not a direct indicator of time necessary for translation, one can readily find much research which reports the latencies and thereby derive much information about the relationship between the ease of translation and the translation time. The research includes studies of the between-language repetition priming (i.e., the priming effect observed between translation equivalences), as in Cheng and Ng (1989), de Groot and Nas (1991), Kawakami (1994), or Kirsner et al. (1984).

Variables Affecting Ease of Translation

Translator's Proficiency in L2

It is a well-established finding that, besides obvious incomplete knowledge, a proficiency in one's nonnative language affects performance of translation from or to that language (Abunawara, 1992; Chen and Ho, 1986; Chen and Leung, 1989; Kawakami, 1994; Matsumi, 1993, 1994; Pavio and Lambert, 1981). The proficiency viewpoint has been reflected in a recent interpretation of the word association hypothesis and the concept mediation hypothesis. Many researchers think each hypothesis refers to a distinct level of proficiency: The word association hypothesis represents an early stage of L2 acquisition, whereas the concept mediation hypothesis stands for equally developed level of L2 and L1 (Chen and Ho, 1986; Chen and Leung, 1989; Kawakami, 1994)

Chen and Leung (1989), in Experiment 1, recruited three types of participants: proficient Chinese-English undergraduates, beginning Chinese-French undergraduates, and beginning Chinese-English primary school students, and tested the two hypotheses using word and picture naming tasks. They observed reaction times supporting the developmental shift from word-association to concept-mediation representation: For the proficient participants, picture naming in L2 and translating L1 words into L2 were equally efficient, but for the adult beginners, translating L1 words into L2 was faster than picture naming in L2.

Using the between- and within-language Stroop tasks for Chinese-English bilinguals with five

grade levels (Grade 2, 4, 8, and 10 and college), Chen and Ho (1986) tested Magiste's (1984) language proficiency hypothesis on patterns of interference. They demonstrated that the grade level affected the naming time when participants were required to respond in L2: Those who had less knowledge of L2 found it more difficult to name the color of L1 words, whereas those who were more proficient in L2 found it harder to name the color of L2 items.

In Kawakami's (1994) study, English-major university, high school, and junior high school students participated in an experiment which employed the semantic priming paradigm. After the lexical decision task, they were unexpectedly asked to decide whether a word had been presented in that task. Results obtained from the lexical decision task showed priming effects in all conditions for the university students but not for the other two groups. Moreover, retention was better for both the high school and the junior high school students than the university students in the recognition test. The researcher then interpreted these results as indicating that the more individuals are proficient in L2, the more there are direct links between a lexical representation in L2 and a conceptual representation.

The findings described so far imply that the pathways involved in translation by a more proficient individual differ from those in a less proficient one. Recently, Kroll and her colleagues proposed a revised hierarchical memory model which accounts for the fluency effect on translation performance (Kroll and de Groot, 1997; see also Kroll and Stewart, 1994). The model assumed both lexical and conceptual links are active in bilingual memory. The link from the lexical item in L2 to that in L1 is regarded as stronger than the reverse link, but the link between words and concepts is stronger for L1 than L2. The strength of these links is assumed to vary as a function of proficiency in L2 and the relative dominance of L1 to L2. De Groot et al. (1994) obtained support for the asymmetrical performance predicted by the revised hierarchical model: They found that the more one is fluent, the less time forward translation took time than backward translation.

Some other research addressed an issue of different performance by various levels of proficiency in L2, though they did not always examine translation itself. For instance, Matsumi (1993, 1994) accommodated the dual coding theory for bilingual memory (Pavio and Lambert, 1981) to memory for L2 words by bilinguals with different levels of fluency. Junior high school students, university students whose major was not English, and teachers of English in junior high schools participated in Experiment 2 conducted by Matsumi (1993). They first associated English words either with their Japanese equivalents, line drawings depicting them, or both words and drawings, and were then asked unexpectedly to name Japanese words, translate Japanese words into English, and name pictures in Japanese. The result revealed that latencies for translating the words and naming the pictures were not significantly different for the English teachers but that the latencies in the former task were significantly shorter than those in the latter for the junior high school and university students. Furthermore, using translation and copy with either imagery or non-imagery instruction, Matsumi (1994) observed the additive effects predicted by the bilingual dual coding theory both for early and late balanced bilinguals but not for second language learners, whose proficiency of L2 had not reached that of L1.

Direction of Translation

There are two possible directions with which translation takes place for bilinguals: forward and backward. In forward translation, the bilinguals translate their L1 words, sentences, paragraphs into L2, whereas in backward translation they translate from L2 to L1.

As mentioned above, the revised hierarchical memory model (Kroll and de Groot, 1997; Kroll and Stewart, 1994) assumed that link from the lexical item in L2 to that in L1 is regarded as stronger than the reverse link, but the link between words and concepts is stronger for L1 than L2. Different strength of links could account for some directional effects of translation. These differences in strength would be a consequence of the way in which most second language learners acquire first the L2 words by translating them into L1 words. De Groot et al. (1994) found that a group of semantic variables, such as imageability or definition accuracy, played a larger role in forward translation than backward: In forward translation, correlations between the semantic variables and performance measures, such as translation latency, error rate, and omission score, were higher than those in backward translation. In addition, the forward translation took less time than the backward translation. The results were interpreted as evidence for the revised hierarchical model.

It seems plausible that the strength of the internal links between mental representations might affect not only translation performance but also other processes of bilinguals. For example, Chen and Ng (1989), in Experiment 1, obtained shorter lexical decision latencies for L1 words primed by words in L2 than those for L2 words primed by L1.

Semantic Aspect of Original Words

A number of semantic variables, together with other variables, which might affect performance of word translation, were investigated by de Groot (1992) and de Groot et al. (1994). Among these variables were both objective (e.g., a frequency of a word and its translation equivalence or a length of them) and subjective ones (e.g., familiarity, imageability, or definition accuracy).

In Experiments 1 and 2, de Groot (1992) found that the frequency and imageability of stimulus words affected translation. In Experiment 3, adding to the two variables, the researcher included the following variables: familiarity, context availability (general and verbal)[2], and definition accuracy of the stimulus words; frequency of the response words; lengths of the stimulus and of its translation; and cognate status of the translations. All of these variables correlated significantly with the dependent variables such as reaction time, error rate, or omission score. However, results of additional analyses revealed that four variables each accounted for a unique

[2] The context availability refers to how available retrieval contexts for the translation equivalent of a word is. De Groot (1992) classified context availability as general or verbal. The general contexts available to retrieve a translation are ones such as a common phrase, in this case, including the word to be translated. In contrast, the verbal contexts are so episodic, such as a title of a favorite song, that they are less likely to be shared by others. For more detailed examples, see de Groot (1992), pp 105-106.

translation variance. These variables were frequency of the stimulus words, frequency of the response words, cognate status of the translations, and context availability. Furthermore, the investigator indicated that context availability may underlie the effects both of imageability and of definition accuracy.

The roles which the variables mentioned above play in word translation were further investigated by de Groot et al. (1994). They included other variables, such as response words' imageability, context availability, or definition accuracy, in their analyses. The results of a set of factor analyses clearly indicated that the number of extracted factors was always three or four and that all six semantic variables (imageability, context availability, and definition accuracy for stimulus, and the same three variables for response words) load substantially on one of the factors, namely the Semantic factor.

Familiarity Aspect of Original Words

In experimental material, word frequency is usually controlled because this attribute, contained in almost all word norms, can have a number of effects on performance; this is also the case in word translation.

The familiarity aspect of words, including word frequency, was again studied in detail by de Groot and her colleagues (de Groot, 1992; de Groot et al., 1994). One result of their studies revealed that frequencies both of stimulus and response words influenced translation latency, error rate, and omission score (de Groot, 1992). Furthermore, employing various factor analyses, de Groot et al. (1994) demonstrated that four variables consistently loaded on one of the extracted factors. The variables were familiarity of a stimulus word, familiarity of its translation, frequencies of a stimulus word, and frequency of its translation; the researchers called this factor Familiarity factor.

Other Variables Affecting Word Translation

In addition to the variables described so far, there are other variables that could affect translation performance; of these variables, acquisition situations, language similarity, and cognate status will be discussed.

Acquisition situation. The experience in which bilinguals have developed their competence of nonnative languages may affect the processing of those languages. It has often been argued that subject factors like the language history have to been taken into account in studies of bilinguals (Grosjean, 1997). Different experiences for a language might result in different types of bilingual. For example, Lambert, Havelka, and Crosby (1958) classified their participants' acquisition contexts as separated or fused (see below) and further subdivided separate contexts into separated, bicultural, and unicultural. As for the types of bilinguals, many researchers have used the terms such as *compound, coordinate, balanced,* or *imbalanced* (Macnamara, 1967; Macnamara and Krauthammer, 1968; Pavio and Lambert, 1981; Abunuwara, 1992; Matsumi, 1994;

Pavio, 1991; see Baker, 1993, for descriptions of these terms).

Balanced bilinguals participated in the experiments carried out by Matsumi (1994, Experiment 1 and 2) and Pavio and Lambert (1981), in which the bilingual dual coding theory was investigated. Each of the participants had an L2 acquisition history which could be classified as either early or late. Bilinguals with the early acquisition history are those who learned both L1 and L2 in infancy, whereas those classified as late acquired the L2 in childhood or early adolescence. These experiments yielded results consistent with predictions from the bilingual dual coding hypothesis for both the early and the late balanced bilinguals. However, Pavio and Lambert (1981) observed a significant effect of the language history on postexperimental accuracy of recalling the presentation mode (English words, French words, or pictures) of items. The late bilinguals recalled presentation mode better than early bilinguals did. They also found that the language history affected ratings of imagery evoked by translated and copied words: Imagery was reported for more items by late than early bilinguals.

Other researchers found that some bilinguals' cognitive processes other than translation were influenced by the language history or, as its consequence, the type of bilingual. For example, conducting a series of studies, Lambert et al. (1958) investigated the influence of language-acquisition contexts on bilingualism. One of the studies exploited the semantic differential method, in which their participants rated each of four English nouns (*house, drink, poor,* and *me*) and their French translation along a seven-point dimension, such as *fast-slow* or *pleasant-unpleasant*. The participants were all balanced, that is they had a sufficiently high level of L2 competence that no dominance of one language over the other was detected. However, they had experienced a variety of L2-acquisition contexts, as described earlier. The SD rating results showed a larger discrepancy between English and French nouns by the participants with a separate context, such as having learned one language exclusively in the home and the other exclusively outside the home, relative to that by participants with fused contexts, such as having had both parents use the two languages indiscriminately.

Language similarity. Recent theories about a mental lexicon often assume that each item in the lexicon has an entry describing its orthographical and phonological information as well as its meaning and syntactic information. Thus, retrieval of a word from a bilingual's mental lexicons, whether they are independent or interconnected at a lexical level, could be restricted to the language-appropriate lexicon by identifying the rule applied to the word. This issue could be crucial to understanding the cognitive processes involved in code-mixed phenomena, which many researchers have investigated (e.g., Altarriba, Kroll, Sholl, Rayner, 1996; Dalrymple-Alford and Aamiry, 1967; Kolers, 1966; Macnamara and Kushnir, 1971; Soares and Grosjean, 1984).

In cases where bilinguals use languages from the same Indo-European family, the retrieval appears not to be limited to a single lexicon. (see Smith, 1997, pp 155-156, for a brief review). Some research included experiments in which the bilinguals' or trilinguals' languages were not always from a single language family and yet yielded the same results as with the bilinguals whose languages were all members of one language family (e.g., Abunuwara, 1992; Kirsner, Smith, Lockhart, King, and Jain, 1984; Potter, So, Von Eckardt, Feldman, 1984). However, other

researchers mentioned the impact of the distinct orthography and phonology. Although no explicit translation was employed, Chen and Ho (1986) reported and discussed the effect of language similarity on interference produced in the between-language Stroop task.

Cognate status. As for languages with similar orthographical systems, one can consider cognate status between words in the languages. De Groot and her colleagues (1991, 1992, 1994) examined the effect of cognate status in detail. The cognate status was one of the variables that de Groot (1992) found as determinant of word translation. De Groot et al. (1994) also obtained a result showing the cognate status could solely affect translation performance, using a set of factor analyses: The higher in cognate status of a word, the faster and more accurately the translation for that word was produced.

Conclusion

The studies I have reviewed show us that a variety of variables influence ease of translation of words. Each variable pertains to attributes of the words (semantic aspect and familiarity aspect of words), states of translators (translator's proficiency in an L2 and acquisition situation), or the relationship of the two languages between which translation takes place (direction of translation, language similarity, and cognate status). When researchers investigate bilinguals' language processing, they need to control the variables carefully, whatever the processing forms are. In addition, further research will be necessary to assess the effects of the variables more precisely.

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