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Regression and Threshold Hypotheses in English Language Attrition Through Computer Aided Education: A Computer Technology Assisted Behavioral Study

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Abstract: Regression and threshold hypotheses are widely-held theories in the field of language attrition despite the fact that few empirical studies have been carried out to validate them. This study, aiming to validate both hypotheses, examined the reaction time and error percentage of three groups of participants who were middle school students, workers and English teachers with the aid of computer via an empirical study. The results showed that the threshold hypothesis was nearly sound. In contrast, the regression hypothesis was hardly convincible. The possible reasons for the results were also explored and further suggestions regarding language attrition were put forward as well.

Key words: Regression hypothesis, threshold hypothesis, foreign language attrition, computer aided education

INTRODUCTION

Language attrition is, in this study, defined as the loss of a first, second or foreign language or a portion of that language over a certain incubation time at the individual level. It is considered as language proficiency degradation during the process of natural language contact rather than the phenomenon which happens when learners suffer some trauma or any other pathological hurt.

There are numerous hypotheses in the field of language attrition, such as the threshold hypothesis, the regression hypothesis, the activation threshold hypothesis and the inverse hypothesis. The regression and threshold hypotheses are among those that received the most debates and theoretical explorations.

The regression hypothesis is widely acknowledged, but evidenced by few empirical studies, possibly due to the fact that many researchers consider it as self-evident and hence no need to conduct any experiment. Regression hypothesis supposes that language attrition is an inverse process compared to language acquisition, i.e., first in, last out or vice versa. In other words, the processes of language attrition and acquisition mirror each other (Jakobson, 1941). For another, threshold hypothesis is a well-known theory in the discipline of language attrition as well. It means that if learners' language proficiency reaches a certain level or a set of language knowledge has been systematically internalized in the brain, then the knowledge will become relatively resistant against attrition, i.e., it will not be easy to be attrited.

The overall aim of the study is to (1) Test the regression hypothesis and (2) Test the threshold hypothesis. The questions raised in this study are: (1) Is the regression hypothesis convincing? and (2) Is the threshold hypothesis convincing? Two hypotheses were therefore established as: (1) The regression hypothesis is convincing and (2) Threshold hypothesis is convincing.

LITERATURE REVIEW

Comparisons of different language systems in flux have traditionally been popular in linguistic research (Keijzer, 2009), as "the study of language during its unstable or changing phases is an excellent tool for discovering the essence of language itself" (Slobin, 1977). Only when fluctuating language varieties are compared can constraints that govern all these unstable phases be classified (Keijzer, 2009). In other words, it is when things go wrong that a window on the grammar in the speaker's mind can be provided, allowing insights into how language functions when things "are not quite right" (Keijzer, 2009; Corder, 1967). Various fluctuating language systems, such as varieties arising from historical language change, language contact and pidginization and creolization (Slobin, 1977) have been investigated in this tradition (Keijzer, 2009). It is the comparison between language acquisition and language attrition which has traditionally received most attention, since "symmetry in the construction and dissolution of language may tell us more about the structure and storage of language" (Keijzer, 2009; De Bot and Weltens, 1991). In particular, such research has been guided by the question whether

sequences and patterns found in language attrition are the reverse of those observed in language acquisition. This idea is captured in the regression hypothesis (Keijzer, 2009).

Dynamic Systems Theory (DST) is worth mentioning when discussing the regression hypothesis. Dynamic System Theory views attrition and acquisition as two sides of the same coin: language is dynamic and every language user passes through stages of growth and decline throughout his or her life (De Bot, 2007). Although it is hard to predict the changes from one point to another because of all the dynamic variables that are involved, there are certain set points to which the language system is drawn, so-called attractor states. As these occur in both language attrition and acquisition, similarities are likely to show up (Keijzer, 2007). DST basically originates in the natural sciences and mathematics. Therefore, it remains unclear if it could be applied to the regression hypothesis in the field of language attrition.

Few studies indicated solid support for regression hypothesis though it is widely acknowledged and applied in the research. The young were found to suffer more attrition than the old and the productive nouns appear more easily attrited than the receptive (Cohen, 1989). This does not conform to the regression hypothesis. The early obtained German linguistic elements kept longer than those got later and the last acquired knowledge is attrited earlier than the first obtained to a large extent (Kuhberg, 1992). This implies that the acquisition of German language appears the mirror of the attrition only partly and it is hard to infer whether the rest can mirror each other or not. The attrition in morphology may coincide with regression hypothesis. The syntax, however, may not conform to the regression hypothesis at all (Keijzer, 2009).

As for the threshold hypothesis, it is only evidenced by Hanson (1999), who confirmed it via investigating the negative English sentences.

Despite the fact that neither regression nor threshold hypothesis has been fully supported and that few empirical studies have been conducted, most of related literature has considered both hypotheses reasonable and both are widely applied to the research of language attrition.

How to validate the regression and threshold hypotheses seems a puzzling job which may account for the phenomenon why they have rarely been evidenced. It is reasonable to identify both hypotheses in terms of negative English sentences since many scholars have reached a general consensus on developmental sequence of negative English sentence except for some minor differences (Milon, 1974; Cancino *et al.*, 1978; Wode, 1981; Larsen-Freeman and Long, 1991). There is a sound generalization of the sequence described in Table 1 (Larsen-Freeman and Long, 1991).

CURRENT STUDY

As mentioned above, the regression hypothesis in language attrition refers to that the sequence of language acquisition mirrors that of attrition. Since, the sequence of acquisition in negative English sentences has been universally acknowledged, the most important task for this study is to identify the sequence of attrition in negative English sentences. As shown in Table 1, it is commonly accepted that there are four stages in acquisition of negative English sentences, if the attrition sequence is the opposite of the acquisition, then the regression hypothesis may be valid. Otherwise, it may be inappropriate to consider the regression hypothesis as a solid rule. However, whether we can prove or disprove the opposite sequence in this study, it may be difficult for us to determine the soundness of regression hypothesis. The determination of sequence of negative English sentences may not decide the sequence of other types of sentence, such as simple sentence, compound sentence and complicated sentence. In other words, it is possible that even the sequence of negative English sentences conforms to the regression hypothesis while other sentences may not. After all, to decide the sequence of acquisition and attrition in negative English sentences can at least identify the regression hypothesis in terms of negative sentences, hence meaningful.

METHODS ETHICS STATEMENT

The research lacks consent because the data were analyzed anonymously. The research has been approved by the Author's institutional review board-School of Foreign Languages of Hohai University which waived the need for written informed consent from the participants.

PARTICIPANTS

All the participants were Chinese speakers, for whom English was a foreign language. Generally, participants

Table 1: Developmental sequence of negative english sentence

No.	Stages of development	Examples
1	Negation outside sentences	No one have money
2	Negation on partial elements	I not teacher
3	Negation on link and modal verbs within sentences	You cannot see it
4	Negation on action verbs within sentences	They didn't finish the work yesterday

were students from Nanjing Foreign Languages School (the best middle school in Nanjing City), English teachers and workers who had received undergraduate computer aided English education. Workers did not receive any English education and had no immediate access to English when working. Specifically, the above participants were divided into three groups. Group 1, to identify the developmental sequence of negative English sentence acquisition, consisted of 12 middle school students (3 from 1st-4th semester, respectively), 6 females and 6 males (mean age: 17.5). Group 2 was made up of 12 workers who had completed their undergraduate education (3 workers had graduated for 6, 12, 18 and 24 months, respectively), among whom 6 scored over 500 points and 6 less than 400 points in College English Test Band 4 (mean age: 24.3). Group 3 (mean age: 31.6) involved 12 English teachers who had taught English for at least 1 year, was regarded as the control group to compare with the other groups.

STIMULI

Stimuli consisted of 120 negative English sentences designed according to four developmental stages summarized in Table 1. Every 30 sentences represented one stage. Participants had to judge whether each sentence was true or false. Each sentence was presented at a time in white at the center of a black screen, connected to a computer. The stimuli were 1 cm high and on average 5 cm wide. The viewing distance was approximately 50 cm.

PROCEDURE

Each participant was tested individually. The instruction which appeared on the screen at the beginning of the experiment, stressed speed as well as accuracy. Each trial started with a black screen followed by a cue. After 1000 m sec, the stimulus was presented in the middle of the cue frame. The cue and the stimulus remained on the screen until a response was given. The interval between the response of the participant and the next cue was 500 m sec.

Negative English sentences were within-subjects independent variables. Reaction time and right percentage were measured as dependent variables. At the beginning of the experiment, participants performed a short practice block with four trials in order to get used to the key and to see each cue once which was followed by an experiment block with 120 trials. Participants were required to press "1" if they thought the sentence was right and "2" if wrong.

RESULTS

The first two trials of each block, as well as RTs above 3500 m sec or below 200 m sec (1.5% of otherwise correct trials) were discarded from data analysis.

Hypothesis 1: Regression hypothesis is convincing:

Generally, the RT analysis of variance (ANOVA) reveals significant main effect at different stages of development of negative English sentences for middle school students which shows that the developmental sequences of negative English sentences are in conformity with those demonstrated by Larsen-Freeman and Long (1991). On the contrary, the RT analysis of ANOVA fails to reveal significant main effect at different stages of attrition of negative English sentences for workers which indicates that the forgetting processes of negative English sentences do not mirror the acquisition. This result obviously does not support the regression hypothesis.

Specifically, mean Reaction Time (RT) of first-stage negative English sentences of students in 1st semester appears significantly less than that of students in other semesters ($F = 7.43, p < 0.05$); RT of second-stage negative English sentences of students in 2nd semester appears significantly less than that of students in other semesters ($F = 9.35, p < 0.05$); RT of third-stage negative English sentences of students in 3rd semester appears significantly less than that of students in other semesters ($F = 3.31, p < 0.05$); RT of fourth-stage negative English sentences of students in 4th semester appears significantly less than that of students in other semesters ($F = 7.82, p < 0.05$). This shows that the students in the 1st semester master the first-stage negative sentences better than those in other stages that the students in the 2nd semester master the second-stage negative sentences better than those in other stages that the students in the 3rd semester master the third-stage negative sentences better than those in other stages that the students in the 4th semester master the fourth-stage negative sentences better than those in other stages. In a word, the findings as advocate the developmental sequences of negative English sentences.

Similarly, it is found that mean Error Percentage (EP) of first-stage negative English sentences of students in 1st semester appears significantly less than that of students in 3rd ($p = 0.049$) and 4th semesters ($p = 0.01$) while no insignificant differences are found in 2nd semester ($p = 0.576$); mean EP in second-stage negative English sentences of students in 2nd semester appears significantly less than that of students in 1st ($p = 0.09$) and 4th ($p = 0.04$) semesters while no significant differences are found in the 3rd semester

($p > 0.05$); mean EP in third-stage negative English sentences of students in 3rd semester appears significantly less than that of students in other semesters ($p < 0.05$); mean EP in fourth-stage negative English sentences of students in 4th semester appears significantly less than that of students in the 1st ($p = 0.04$) and 2nd ($p = 0.08$) semesters while no significant differences are found in the 3rd semester ($p = 0.065$). It could be summarized that the findings are generally in conformity with the developmental process of negative English sentences.

However, we found different pictures in terms of workers who scored over 500 points in CET4. For the workers who scored over 500, after they worked for half a year, RT in the first-stage negative sentences is significantly longer than that in the second ($p = 0.00$) and third-stage sentences ($p = 0.04$) while insignificantly shorter than the fourth-stage sentences ($p = 0.503$); after they worked for one year, RT in the second-stage negative sentences is significantly longer than that in the third ($p = 0.00$) and fourth-stage ($p = 0.009$) sentences while insignificantly shorter than the first-stage sentences ($p = 0.646$); after they worked for one year and a half, RT in the third-stage negative sentences is significantly longer than that in the other sentences ($p = 0.00$); after they worked for two years, RT in the fourth-stage negative sentences is insignificantly longer than that in first ($p = 0.039$), second ($p = 0.962$) and third-stage sentences ($p = 0.955$). This result demonstrates that only after the workers worked for one year and a half, they can forget the knowledge in third-stage negative sentences much more than that in the other stages which indicates the conformity with the regression hypothesis. By contrast, when workers worked for other periods studied, we failed to find any evidence supporting the regression hypothesis.

Workers who scored less than 400 points in CET4 also presented a similar picture. RT in the first-stage negative sentences for the workers (CET < 400) who worked for half a year is significantly shorter than that in the second ($p = 0.024$), third ($p = 0.018$) and fourth-stage ($p = 0.026$) negative English sentences. RT in the second-stage negative sentences for the workers (CET < 400) who worked for one year is insignificantly longer than that in the first ($p = 0.478$), third ($p = 0.108$) and fourth-stage ($p = 0.377$) negative English sentences. RT in the third-stage negative sentences for the workers (CET < 400) who worked for one and a half years is insignificantly shorter than that in the first ($p = 0.421$), second ($p = 0.314$) and fourth-stage ($p = 0.427$) negative English sentences. RT in the fourth-stage negative sentences for the workers (CET < 400) who worked for half

a year is insignificantly shorter than that in the first ($p = 0.115$), second ($p = 0.663$) and third-stage ($p = 0.646$) negative English sentences. It could be summarized that RT for the workers who scored less than 400 points in CET4 did not show any rule in accordance with the regression hypothesis.

Furthermore, it was not found that there were significant differences between EPs in either different stages of negative sentences or workers who worked for different periods. Therefore, the regression hypothesis did not obtain any evidence. Therefore, the hypothesis “the regression hypothesis is convincing” was rejected.

Hypothesis 2: Threshold hypothesis is convincing: It was nearly evidenced that English teachers commanded negative English sentences significantly better than students and workers. RTs in all the negative sentences for English teacher were significantly shorter than that for all the students and workers except in the fourth-stage negative sentences for workers (CET4 > 500) who worked for 2 years ($T = -1.892$, $p = 0.065$). In addition, it was also revealed that English teachers made significant less errors than other participants since EP in them appeared significantly less than that in other participants ($p < 0.05$). It was also generally supported that workers who scored over 500 in CET4 retained significantly more knowledge of negative English sentences than those who scored less than 400. RT in the first, second and third-stage negative English sentences of workers who scored over 500 in CET4 (worked for half a year) was significantly shorter than that of those who scored less than 400 in CET4 ($t = -3.963$, $p = 0.00$; $t = -8.051$, $p = 0.00$; $t = -18.104$, $p = 0.00$). However, RT in the fourth-stage negative English sentences of workers who scored over 500 in CET4 (worked for half a year) was insignificantly longer than that of those who scored less than 400 in CET4 ($t = 1.072$, $p = 0.290$). The above data, to a large extent, supported the threshold hypothesis. Another evidence supporting the threshold hypothesis was that EP in workers who scored over 500 was significantly less than those less than 400 ($p < 0.05$). In other words, workers whose CET4 scores were over 500, showed their relatively solid knowledge in negative sentences, since the correct rate of their choices was significantly higher than those whose CET4 scores were less than 400. On the other hand, workers with scores less than 400 performed significantly more poorly than those with scores over 500. This revealed that those who scored over 500 points in CET4 appeared more resistant to attrition of negative sentences while those who scored less than 400 points seemed more vulnerable to attrition. Therefore, the hypothesis “the threshold hypothesis is convincing” was accepted.

DISCUSSION

It was revealed that the developmental sequences of negative English sentences were in conformity with those described by Larsen-Freeman and Long (1991). Nevertheless, we only found mirror symmetry in the workers who worked for one and a half years in terms of RT rather than EP. In other participants, no mirror symmetries were found which indicated that the regression hypothesis was merely partly supported.

The regression hypothesis may be selective instead of overall. It was argued that the features of adjectival inflection (noun phrase morphology), simple present tense, auxiliary selection (verb phrase morphology), subordination and discontinuous word order (syntax) did not reveal any mirror symmetries between the emigrants and adolescents and regression might be more prevalent in the area of morphology than in syntax (Keijzer, 2009). This study considered regression by investigating the syntax, i.e., the negative English sentences and found not enough evidence in favor of regression. This study is supportive of Keijzer (2009) findings.

Furthermore, there are other arguments that are not consistent with the regression hypothesis. A review of the literature demonstrates that there is very little evidence for this strikingly durable and seemingly sound hypothesis. For example, Jordens *et al.* (1989) explored German case-marking, because the linguistic feature “meets the conditions of gradualness and a more or less fixed order of acquisition” (p. 180). They found no evidence that the sequences of both L1 attrition and acquisition mirrored each other, although they suggested that L2 attrition, different from L1, might conform to the regression hypothesis. Similarly, Hakansson (1995) study of syntax and morphology in the language of expatriate Swedes did not find any demonstration supporting that the sequence of acquisition mirrors that of attrition.

Besides few empirical studies supporting the regression hypothesis, theoretical reasons to validate it are also needed. When Schmid (2002) attempted to tie the regression hypothesis to Chomskyan nativism, such that attrition is the reversal of an innately specified 4 Kathleen Bardovi-Harlig and Stringer (2010) sequence of autonomous linguistic development, there is arguably a misconception of how generative linguists view both L1 and L2 acquisition Bardovi-Harlig and Stringer (2010).

The regression hypothesis, in other words, the notion “last in, first out and best learned, last out Bardovi-Harlig and Stringer (2010)” is also frustrated by the opinion of Moorcroft and Gardner (1987): “the statistical analysis of some individual grammatical elements showed that most recently learned structures are

more likely to be affected by loss than others, suggesting that a thoroughly learned structure is relatively immune to language loss” (p. 339).

This study might have revealed one of the least consistent findings with regard to the regression hypothesis. Only workers who worked for one and a half years produced mirror symmetry in terms of RT. On one hand, this might be related to the research methodology. Comparison between acquisition and attrition of negative English sentences requires high precision when recording participants behavior. Many factors such as mood, environment, operation of computer software and interest in the research may have exerted some influence on the result. On the other hand, regression in foreign language attrition may be not an overall phenomenon but a subtle and selective one. In other words, some linguistic features, such as morphology, may conform to the regression hypothesis while others, such as negative English sentences, may not.

Participants’ different first languages might have contributed to the result. In this study, all the participants speak the same first language--Chinese which is significantly different from English in terms of morphology and syntax. In syntax, for example, the negation on predicates, subjects and adverbials in English may be placed in different positions in Chinese. To negate a concept, there are great differences between English and Chinese, ranging from lexica to structure. In English, many word categories can be used as negation and examples are noun, pronoun, verb, adjective, adverb, conjunction and so forth. In Chinese, the negation lexica are relatively limited. The negation structure in English also varies from the whole negation, partial negation, double negation to half negation which is presented in different forms in Chinese. Participants with Chinese as the first language may have been interfered by Chinese negation when joining the experiments; hence the results may have been influenced.

Another hypothesis related to the regression hypothesis is that what is the least subject to language attrition is not the first learned knowledge but what is deeply impressed which is an important conception stressing enforcement of what is learned (Berko-Gleason, 1982; Jordens *et al.*, 1986; Lambert, 1989). In case that a learned linguistic feature or knowledge is enforced to a certain degree, it will be more resistant against attrition. It is referred to as threshold hypothesis, involving both the activation threshold hypothesis on the basis of neurolinguistics proposed by Paradis (2007) and the widely held critical threshold hypothesis (Neisser, 1984). It was found that the activation threshold hypothesis was applicable to aphasic patients, since whether the linguistic

representation could be reactivated was found to be partly reliant on frequency of use prior to the damage in brains (Paradis, 2007), i.e., the higher the activation threshold is, the greater the stimuli are needed to reactivate the representation. The critical threshold hypothesis seems a more important hypothesis influencing L2 attrition. It was suggested that in the process of acquisition there might be a general critical threshold after which language knowledge became relatively resistant against attrition (Neisser, 1984).

Language attrition might be selective rather than global due to influence of mother tongue. There is one well known theory in the research of language attrition and acquisition which is referred to as 'flashbulb memories'. Flashbulb Memories have been defined as particularly vivid and long lasting (autobiographical) memories "for circumstances in which one first learned of a very surprising and consequential (or emotionally arousing) event" (Brown and Kulik, 1977). Brown and Kulik (1977) emphasized the evolutionary importance of this biological "Now Print" mechanism (originally postulated by Livingston (Livingston, 1967) that may have been crucial for survival in circumstances when one had to remember the details of potentially life threatening events (e.g., the time and location of first appearance of the rival tribes). In this study, the mother tongue might have acted as "Now Print" in participants' brain, leading to confusion and attrition in a foreign language. Participants might have established relatively solid memories and knowledge of some linguistic structures. This may explain the reason why some linguistic elements were attrited while others still remained and why some conformed to the regression hypothesis while others did not.

The regression hypothesis could not be comprehensively discussed without exploring the theory of threshold. According to Brown and Kulik's study, flashbulb memories were encoded by a special brain mechanism that switched on automatically whenever the level of stimulus or consequentiality exceeded a certain 'threshold'. Despite the fact that the memory trace is not an identical (photographic) copy of the reception event, it is nevertheless fairly detailed and virtually unsusceptible to any decay or attrition for many years. The level of participants' English proficiency might have reached the threshold because of some extra/intra-linguistic factors, e.g., highly intense contact with English, frequent interaction with English speakers, so much as to form an internalized brain mechanism resistant against attrition. On the contrary, if the proficiency has some distance away from the threshold, the linguistic elements might be susceptible to attrition or forgetting. To

cite an example, in Chinese "no" and "not have" have the highest frequency of use of the negative adverb (Guo, 2010), but in English many alternatives, such as hardly, never, little, few, are frequently available. Learners whose mother tongue is Chinese possibly acquire "no" and "not have" much better than other negative words, thus form "Now Print" mechanism in their brain and consequently these printed linguistic elements are more resistant against attrition.

Anxiety might be easily aroused in the situation of language acquisition (Bailey *et al.*, 2000; Price, 1991) which might have led to different results. As argued by Horwitz *et al.* (1986), oral practice in the classroom is the catalyst for anxiety among Foreign Language (FL) or Second Language (SL) learners and the main sources for anxiety should possibly be listening and speaking activities. Language anxiety tends to arouse problems to SL/FL learners and influence Learner's cognitive performance (Eysenck, 1979; MacIntyre and Gardner, 1994a, b), so that their ability to process and short-circuit the incoming language is weakened. Many studies have explored the negative influence of anxiety on learning achievements in terms of all four language skills: speaking (Liu, 2006), listening (Elkhafaifi, 2005; Kim, 2000; Mills *et al.*, 2006; Song, 2005), reading (Argaman and Abu-Rabia, 2002) and writing (Cheng, 2004; Klima and Bellugi, 1966) used taped conversation as referred data. Except negative English sentences, learners' language skills might also be ready factors to explore the regression and threshold hypotheses.

Organized knowledge structure might have positively influenced the length of acquired language skills maintenance compared with the non-organized. Inferred from Chase and Simon's Chase and Simon (1973) chunking theory, the popular assumption is that organized knowledge improves memory by consolidating more effective processing clues. For Chase and Simon, chunks were integrated units in long-term memory involving elements sharing some dimension of similarity. The learners' richer experience in an area developed larger chunks than those with less experience. Although important details might have altered, the general mechanism of organizational processing continues to underlie contemporary theories of skilled memory (Hunt and Rawson, 2011). According to long-term working memory theory (Ericsson and Kintsch, 1995), individuals with a high level of knowledge are able to use organized knowledge structures (referred to as retrieval structures) to encode information quickly and reliably into long-term memory and subsequently to access that information quickly and reliably from long-term memory (Hunt and Rawson, 2011). Template theory (Gobet, 2000;

Gobet and Simon, 1996) also claims that long lasting memory depends on the use of organized knowledge structures. According to template theory, knowledge structures can include clusters (containing the location of several chess pieces in a commonly occurring pattern) and templates (containing information about fixed locations of around 10-12 pieces, with slots that may be filled with other pieces or clusters in variable locations on the board) to retrieval structures (to organize templates when more than one board configuration must be remembered) (Hunt and Rawson, 2011). In this study, some participants' linguistic elements of negative sentences did not suffer any attrition. They might have established some undetected organized structure. For those who showed attrition in negation might have not successfully formed this sort of structure. Therefore, when EF learners desire to keep the acquired language longer, a profitable way might be to learn language in a more systematic and organized way. Good learners tend to be those who have cultivated a habit of learning language systematically in order to reach the threshold so that attrition could be effectively prevented.

CONCLUSION

Findings in this study agreed to the threshold hypothesis since workers who scored over 500 in CET4 performed significantly better than workers who scored less than 400 and English teachers performed significantly better than most workers and students. English teachers and workers who scored over 500 might have reached the critical threshold and their reactivated level was lower so that their knowledge in negative English sentences showed relatively steadier and more easily reactivated. The regression hypothesis, however, was not fully supported by this study. More empirical studies may be needed to test this anecdotally convincing hypothesis. It seems necessary to conduct empirical studies before we apply both regression and threshold hypotheses to the research of language attrition. However, it is evidently painstaking to test the regression and threshold hypotheses unless cross-disciplinary efforts are made. The validation may need cooperation between many fields such as linguistics, psychology, neurology and cognitive sciences.

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