Age-Related Decline of Classifier Usage in Southwestern Mandarin

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Abstract

This pilot study examined the age-related decline of classifier usage in Southwestern Mandarin through comparing classifier score and the number of the default classifier *ge* among older adults aged 50-87 years. They were grouped into healthy, mild cognitive impairment (MCI) and Alzheimer's disease (AD) groups based on Montreal Cognitive Assessment. AD group used significantly more inappropriate classifiers and the default classifier *ge* than healthy group. Results also showed a significant correlation between cognitive/semantic abilities and classifier usage, indicating that the deficit of classifier usage was associated with declined cognitive/semantic abilities. Decline of semantic cognition with aging, specifically semantic store and processing, has been postulated as possible underlying explanation. However, no significant difference was found in classifier usage between healthy and MCI groups, which might reveal that their classifier usage and semantic cognition was still normal.

Index Terms: classifiers, language decline, semantic cognition, aging

1. Introduction

As the population ages, an increasing number of older adults suffer from neurodegenerative diseases, such as Mild Cognitive Impairment (MCI) and Alzheimer's disease (AD). Their language variations have received much attention, as these could give us a new window to observe the language performances and cognitive mechanisms that are easily overlooked in normal conditions. Some research also suggested that certain language variations might be one of the earliest manifestations of cognitive decline, which makes speech or language a practical and diagnostic tool to detect cognitive status [1]. Therefore, research on language variations of older adults would make contributions to not only the exploration of cognitive basis of language but also clinical diagnose.

Although the age-related or neurodegenerative cognitive decline is more measured with episodic memory, previous research has indicated that semantic cognition is also affected to different extents [2, 3]. Semantic cognition refers to the appropriate usage of knowledge about the world, including meanings of words and features of objects [4]. It includes the integration of at least two components, that is, semantic store and semantic control/processing [5]. It has been well-established that semantic store and semantic processing are affected by aging and cognitive degeneration [4, 6].

Typically, studies in this area aim to understand how aspects of language (e.g., phonology or morphology) depend upon basic cognitive faculties, such as various forms of memory. However, most of these studies are based on languages and populations in Western, Educated, Industrialized, Rich and Democratic (WEIRD) countries [7]. The present project investigates the use of noun classifiers which is an aspect of the morphology of the Chinese language. In Chinese, nouns are differentiated by a special set of morphemes called classifiers [8] [1] when counting objects. Classifiers typically occur in a particular construction as shown in the following example from Southwestern Mandarin:

Numeral	-	CLASSIFIER	-	Noun
三	-	匹	-	马
san	-	*pi*	-	*ma*
three	-	0	-	horses

If the noun in the example was changed from 马 (*ma,* 'horse') to 蛇 (*she,* 'snake'), the classifier should be correspondingly changed from 匹 (*pi*) to 条 (*tiao*) (i.e., *san tiao she* for three snakes). The *tiao* is used to describe flexible and long objects like ropes. There is a high consistency in the use of classifiers within a speech community.

Count classifiers could reflect some properties and intrinsic characteristics of corresponding nouns, and their relationship is more than arbitrary, thus classifier systems could reflect human categorization and conceptual structure to some extent [9]. The choice of classifiers is not only simple memorization or grammatical rules, but also subject to the complex cognitive factors underlying human categorization of objects in the real world [10]. Therefore, classifiers may provide a window to observe underlying semantic cognition.

Among numerous classifiers, '个' (*ge*) is thought as the default classifier and can replace most other classifiers. According to previous research, *ge* is the first classifier which appears in the speech production of children [11]. Under 4 years old, children are found to overuse the default classifier *ge* [12]. Moreover, Broca's and Wernicke's aphasics are more likely to overuse the default form compared with normal controls [13]. Therefore, the overuse of the default classifier

[1] The present project investigates count classifiers. For mass nouns, English also requires measure words in such construction (e.g., *a cup of water*), which is more parallel to Chinese (i.e., *yi bei shui*). The use of classifiers varies significantly across Chinese dialects. Our concern here focuses on Southwestern Mandarin.

ge seems to be an indication of relatively immature and/or impaired cognitive and language abilities.

However, the age-related decline of cognition is different from the relatively immature or impaired cognition in children and aphasics. Children's brain is not well developed and aphasia has more focused damaged regions, while aging and AD is caused by atrophy of whole brain [14]. Limited attempt has been made to figure out the classifier usage in older adults. Chou et al. [15] conducted an experiment on event-related potentials regarding classifier-noun agreement in older adults and found that older adults were unable to use classifiers to predict the following nouns, which implies the declined comprehension of classifier construction. However, the production of classifiers in older adults remains unclear.

The present pilot study tries to explore the usage of classifiers among older adults speaking Mianyang dialect, a variety of Southwestern Mandarin spoken in Sichuan. The aims are to 1) compare classifier usage between older adults with different cognitive abilities, specifically, whether there is a decline in classifier usage, such as more default classifiers, substitutions and omissions; 2) explore which classifiers are more likely to be substituted and the underlying patterns.

2. Method

2.1. Participants

Twenty-two older adults (8 males, mean age ± SD = 53.59 ± 10.19) were recruited for this study.[1] They are all native speakers of Mianyang dialect. Their demographic information was collected, including distribution of age, gender, education level, etc. Two relatively younger adults aged 50 years were included since the cognitive decline is not restricted to old age and is observed throughout the adulthood. The aging trend may start early and be gradual. All 22 participants are retired (age range: 50-87 yr) and have a relatively low education level (0-12 yr).

2.2. Materials and procedure

Participants were assessed individually. The examiner and participant started with an informal conversation as a warm-up to collect their demographic information. Then, they were instructed to finish the Montreal Cognitive Assessment (MoCA) test ([16], Mandarin version 7.3) to measure their cognitive abilities. The full score of MoCA test is 30 points. Since this version has been thought to be valid for Chengdu dialect which is another dialect of Southwestern Mandarin [17] and quite similar to Mianyang dialect, it should also be effective for Mianyang dialect, although there is no particular version for Mianyang dialect.

After that, they were required to describe pictures of objects by counting them. The stimuli consisted of 57 randomly presented pictures, which were all line-drawing of familiar objects in daily life. There were three or more identical objects in each picture which were designed to elicit classifiers, as one object in the picture might not induce numeral classifier and two same objects might induce structures such as '一对，一双' (one pair of) instead of specific classifiers for nouns. During the experiment, the examiner asked "Could you please tell me the number of objects in each picture? How many are there?" (可以请您告诉我每张图中物体的数量吗?有多少?) They were guided to produce the structure "number + classifier + noun" and they were not told that classifiers were the targets of their answers. An example picture was shown as a practice to ensure that they understood the task. The whole process was audio recorded for later transcription, scoring verification and analysis.

2.3. Rating

Since a stimulus may induce various descriptions leading to different classifiers for one object, a questionnaire was designed according to the production of 22 participants to measure whether they produced appropriate classifiers. Another 24 raters (13 males; mean age ± SD = 54.71 ± 3.88 yr) who are also native speakers of Mianyang dialect were recruited to finish the questionnaire. They were required to rate whether the descriptions of pictures were appropriate according to their language experience and they were uninformed that classifiers were the targets. They were shown the same pictures in the classifier task and required to rate each description by a 5-point Likert scale ranging from inappropriate to appropriate classifiers for an object.

2.4. Data analysis

An average score from 24 raters was analyzed for every description of each object, and the average score of each object and each participant was also calculated. Classifier score represented the sum of scores for each participant from 24 raters. Semantic score was defined as the sum of subtest scores (i.e., 4 points) including 3 points for picture naming and 1 point for verbal fluency in MoCA.

3. Results

Participants' demographic information, performance on MoCA and classifier task are shown in Table 1. The participants were divided into the following three subgroups based on their MoCA scores: healthy group (n = 4) with the MoCA score above 26 points, MCI group (n = 12) with the MoCA score between 19 to 25 points, and AD group (n = 6) with the MoCA score below 18 points.[2]

One-way ANOVA revealed a significant difference in MoCA score (F = 28.28, p < 0.001), age (F = 4.297, p = 0.029), semantic scores (F = 5.51, p = 0.013) and education (F = 6.27, p = 0.008) among three groups. *Post hoc* analysis of pair-wise comparison in MoCA score with Bonferroni correction showed significant differences between AD group and MCI group (p < 0.001), as well as between AD group and healthy group (p < 0.001). There was no significant difference between healthy and MCI groups (p = 0.053). As for semantic score, the significant difference was only found between healthy and AD group (p = 0.011). With regards to age, the difference was significant only between AD group and healthy group (p = 0.029). The difference in education was significant between AD group and healthy group (p = 0.016), and between AD group and MCI group (p = 0.021).

[1] The present data is collected in summer 2019. Unfortunately, it is not possible to further supplement due to COVID-19.

[2] Noted that it was just a raw categorization based on MoCA score, but not based on medical diagnosis.

Table 1: *MoCA score, demographic variables, and classifier usage of three groups*

	Healthy (n = 4)	MCI (n = 12)	AD (n = 6)	*F(2, 19)*
MoCA (SD)	26.25 (0.50)	21.83 (2.41)	13.00 (4.47)	28.28*** ($p < 0.001$)
Education	9.75 (1.26)	8.00 (3.74)	2.83 (3.54)	6.27** ($p = 0.008$)
Age	62.50 (11.70)	74.58 (7.22)	79.00 (10.18)	4.297* ($p = 0.029$)
Number of *ge*	7.75 (2.99)	13.08 (5.43)	19.00 (4.81)	6.393** ($p = 0.008$)
Classifier score	242.84 (7.60)	234.56 (11.91)	215.18 (11.22)	8.896** ($p = 0.002$)
Semantic score	3.75 (0.50)	2.91 (0.79)	2.17 (0.75)	5.51* ($p = 0.013$)

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. SD = standard deviant.

One-way ANOVA also revealed a significant difference in the number of *ge* ($F = 6.393$, $p = 0.008$) and classifier score ($F = 8.896$, $p = 0.002$) across the three groups. *Post hoc* analysis of pair-wise comparison in the number of *ge* among three groups using Bonferroni correction showed a significant difference only between the AD group and healthy group ($p = 0.007$). AD group produced a significantly larger number of *ge* than healthy group. In addition, the difference of classifier score was significant between healthy and AD groups, and between MCI and AD groups (both *p*s < 0.05), but no significant difference between the healthy and MCI groups ($p = 0.642$). The classifier score of AD group was significantly lower than healthy group ($p = 0.003$) and MCI group ($p = 0.008$).

Table 2: *Correlation between classifier usage and cognitive abilities/demographic variables*

	MoCA	Semantic score	Age	Education
Classifier score	0.779** ($p < 0.001$)	0.625** ($p = 0.002$)	-0.588** ($p = 0.004$)	0.538** ($p = 0.01$)
Number of *ge*	-0.708** ($p < 0.001$)	-0.613** ($p = 0.002$)	0.506* ($p = 0.016$)	-0.53* ($p = 0.011$)

Note: *$p < 0.05$, **$p \leq 0.01$.

Pearson correlation analysis revealed that there was a significantly positive correlation between MoCA score and classifier score ($r = 0.779$, $p < 0.001$) (see Table 2). A significantly negative correlation was found between MoCA score and the number of *ge* ($r = -0.708$, $p < 0.001$). Semantic score was also significantly correlated with classifier performance, showing positive correlation with classifier score ($r = 0.625$, $p = 0.002$) and negative correlation with number of *ge* ($r = -0.613$, $p = 0.002$). Age was negatively correlated with classifier score ($r = 0.588$, $p = 0.004$) and positively correlated with the number of *ge* ($r = 0.506$, $p = 0.016$). Education also had a significantly positive correlation with classifier score ($r = 0.538$, $p = 0.01$) and a negative correlation with the number of *ge* ($r = -0.53$, $p = 0.011$).

Table 3: *The top five objects with lowest scores*

Objects	Watch	Flag	Piano	Mirror	Horse
Score	61.63	63.01	67.05	67.83	70.25
Appropriate classifier	*kuai*	*mian/ gan*	*jia/ mian*	*mian/ ba*	*pi*
Inappropriate classifier	*zhi*	*ge*	*ge*	*ge*	*tiao/ zhi*

In terms of classifier usage, no omission was found in all participants. However, substitutions were observed in every participant to different degrees. Substitution included the replacement by *ge* and inappropriate classifiers, thus leading to lower scores in rating. The score of every object was calculated and the objects with the lowest score and the corresponding appropriate and inappropriate classifiers based on rating are listed in Table 3. The appropriate classifiers for objects are those with mean scores higher than 3 points based on rating. The last row shows inappropriate classifiers.

The number of *ge* for each object was also counted. Considering that *ge* is appropriate for some objects, these objects were not included when observing objects with more inappropriate *ge*. The top five nouns with inappropriate *ge* are listed in Table 4. More than half of the participants produced *ge* to substitute specific classifiers for mirror, ear and cookie, and nearly half of the participants used *ge* to describe flag and piano.

Table 4: *The top five objects with ge*

Objects	Mirror	Ear	Cookie	Flag	Piano
The number of subjects using *ge* (22)	15	14	11	10	10
Appropriate classifier	*mian/ba*	*zhi*	*kuai/ pian*	*mian/gan*	*jia/tai*

4. Discussion

The current research found that the AD group performed poorly in the usage of classifiers in terms of classifier score and the number of *ge*. Besides, general cognitive ability, semantic ability, age and education were all significantly correlated with classifier performance. More specifically, the higher the cognitive ability, the better performance in the classifier task. Participants with higher cognition were more likely to produce specific classifiers for corresponding objects. On the contrary, those with lower cognitive ability tended to use more *ge* or other inappropriate classifiers.

As the usage of classifiers is closely related to features of corresponding nouns, involving world knowledge and being a part of semantic cognition, we found that classifier performance was significantly related to the semantic score. Previous research has found that semantic memory declined relatively slower with advancing age and would maintain to early stage of AD [18] or even until the middle stage of AD [19], when compared with episodic memory. These findings are consistent with the results of this study. The healthy and AD groups showed significant differences in terms of classifier score and the number of *ge*, whereas no significant difference was found between healthy and MCI groups, indicating that semantic memory and classifier performance in healthy and MCI groups were still intact.

As for the pattern of inappropriate usage of classifiers, no omission but two types of substitutions were found: one is inappropriate usage, and the other is the default *ge*. The inappropriate classifiers *zhi* was used by older adults to describe the two objects in Table 3 – watch and horse. According to Ahrens [20], *zhi* is becoming the default classifier in Mandarin, and it is already the second default classifier in Taiwanese. Besides, *zhi* is the default classifier for animals [9]. The Mianyang dialect may be influenced by the Mandarin, and *zhi* is on the way to develop into a second default classifier after *ge*. With regards to the inappropriate classifier *tiao* for horse, it is primarily to be used to describe long objects and some animals like snakes and fishes. Thus, this inappropriate usage is still within the category of animals. As for the other three objects in Table 3 and the five objects in Table 4, they all had inappropriate usage of *ge*. All these eight objects had at least two specific classifiers according to rating, except for the object ear. This may be explained by the competition model [20], which states that a classifier is more easily to be neutralized when its corresponding nouns can be correlated with more than two specific classifiers, thus the connection between every classifier and the object is relatively weak.

Two potential explanations for the pattern of classifier usage in older adults mentioned above are declined semantic store and semantic processing:

First is the declined semantic store. Although previous research has revealed that older adults are compatible with or even outperform younger counterparts in terms of vocabulary, which reflects retained or increased semantic store over the lifetime [4], quite low cognitive abilities and semantic scores of the AD group in the present study may reflect declined semantic store which caused poor performance in the classifier task. More tasks on vocabulary size should be conducted in future research. In addition, as there is a significant difference in education between the AD group and the healthy group, the quite low education level of AD group may also contribute to a less complicated semantic network. More research on comparison between low- and high-educated population is needed in the future.

Besides, some research holds that one reason for the declined semantic store in the AD population is the loss of the properties of a concept and the interconnections between semantic features [6]. Therefore, they have a tendency to produce more superordinate concepts [21]. The usage of the default classifier seems similar to this situation. In AD group, the connections between specific classifiers and nouns become weak, especially those nouns with more than one specific classifiers.

Second is the declined semantic processing. Even in older adults with preserved semantic store, semantic processing might be impaired. Semantic processing can be further divided into semantic-specific and domain-general subcomponents. Semantic-specific component is about the goal-directed search through semantic store and this retrieval process is for specific semantic knowledge [4]. Hoffman [4] claimed that controlled retrieval ability is age-invariant. However, some research hold that older adults have more difficulty in controlling semantic retrieval, resulting in a more tip-of-tongue state [22]. Some research on mental lexicon suggested that the semantic network of older adults is less connected, less organized and less efficient [23]. Chou et al. [15] found that older adults were unable to use classifiers to predict the following nouns, which may imply that the connection between classifiers and nouns are weak. For AD group with the quite low cognitive ability in this study, the declined classifier performance might be caused by the weak connection between classifiers and nouns. Semantic association tasks measuring connections between classifiers and nouns should be tested in the future.

As for the domain-general component, more specifically, the semantic selection which refers to the activation of semantic knowledge from multiple competing representations, is thought to decline with age [4, 24]. This ability can explain the nature of the competition model [20]. Since the need to select from competing representations, the process also involves inhibitory executive function to inhibit irrelevant semantic information. It has been well-documented that older adults show executive deficits [5]. It is more difficult for them to inhibit distractors and select the target. This may explain why almost all objects with the inappropriate default classifier *ge* in Table 3 and 4 are those with at least two specific classifiers, as participants have to select one classifier from them.

However, the correlation between classifier performance and semantic memory is lower than that between classifier performance and MoCA score. There may be three potential speculations. First, the classifier task is not a pure test for semantic memory. It may also involve some other types of cognitive domains, such as executive and inhibitory functions, which have declined in older adults. Second, the cognition of older adults may show dedifferentiation and they would recruit other functions to compensate for the impaired specific ones. Hoffman & Morcom [2] concluded that semantic processing of older adults shifted from semantic-specific to domain-general neural resources from a meta-analysis of 47 functional neuroimaging studies. Third, the semantic tasks in the present research have limited scores and are not enough to test participants' semantic memory. More semantic tasks should be included in future research.

5. Conclusion

This research explored the classifier usage in older adults speaking Southwestern Mandarin. Results revealed that the AD group performed significantly worse than the healthy and MCI groups in both cognitive and classifier tasks. However, there was no significant difference between healthy and MCI groups in these tasks, which indicated that their classifier usage and semantic memory maintained intact. There was a significantly positive correlation between semantic score and classifier score, as well as a significantly negative correlation between semantic score and the number of *ge*, indicating that the decline of classifier usage in older adults may be correlated with the decline of semantic cognition. Specifically, older adults with worse semantic cognition were more likely to produce the default classifier *ge* and inappropriate classifiers.

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7. References

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