An Empirical Study on "A1+A2" Compound Adjectives in Native and Second Language Learners of Chinese

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Abstract: This study investigates the cognitive processing characteristics of morphemic and holistic meanings of metaphorical "A1+A2" compound adjectives in native Chinese speakers and second language (L2) learners. The results indicate that both native speakers and L2 learners exhibit similar cognitive processing patterns in understanding the morphemic meanings of A1 and A2, suggesting that the contributions of the two morphemes to the holistic word meaning are roughly equivalent. Both groups also show consistent cognitive processing patterns for the morphemic and holistic meanings of disyllabic compound adjectives. However, significant differences were observed in the understanding of metaphorical meanings in zero-context situations, with high-level L2 learners showing slower recognition speeds compared to native speakers.

Based on these findings, several pedagogical recommendations are proposed: integrating morphemic and holistic word teaching, introducing metaphorical concepts to enhance vocabulary teaching, and providing explanations within appropriate contexts.

Keywords: Chinese compound adjectives; Lexical processing; Morphemes; Holistic word meaning; Chinese L2 learners

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1. Introduction

Research on the cognitive processing of modern Chinese vocabulary by L2 learners has emerged later compared to studies on alphabetic languages. The current models of Chinese lexical access and representation are primarily based on the Prototypical Representation Model proposed by Rastle (2000), which posits that the mental lexicon contains three dimensions: phonology, morphology, and holistic word meaning. When processing compound words, learners must navigate through these different levels of features, as phonological, orthographic, and morphological information are interwoven.

Metaphorical research has predominantly focused on nouns and verbs, with adjectives receiving less attention. Studies on metaphorical nouns have been the most prevalent, as discussed in previous sections on "metaphorical vocabulary research across different analogies." Research on Chinese verb metaphors has mainly focused on the interpretation of common verbs or verb phrases. However, empirical studies examining the characteristics of different word classes with L2 learners as subjects are scarce. Given this gap, this study aims to explore the process of understanding adjective meanings in Chinese L2 learners from a metaphorical perspective. Using behavioral experiments and statistical methods, we observe the characteristics of high-level Chinese L2 learners in processing disyllabic compound adjectives and compare them with native speakers. The findings are expected to provide cognitive insights for teaching Chinese adjectives.

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2. Experimental Design

(1) Purpose of the experiment

This study employs psycholinguistic methods to investigate the cognitive processing of "A1+A2" disyllabic compound adjectives in high-level Chinese L2 learners. The results are compared with those of native speakers to identify the cognitive characteristics of high-level L2 learners in processing compound adjectives.

(2) Experimental design

The experiment adopts a single-factor, three-level between-subjects design. The independent variable is the participant group, which includes native Chinese speakers (22 participants) and high-level Chinese L2 learners (22 participants, HSK Level 5 or above). The semantic relationship between word pairs serves as the within-subject variable, with three levels: A1 morphemic meaning pairs, A2 morphemic meaning pairs, and holistic word meaning pairs. For example, for the word " 细 腻 " (delicate), the presentation format is " 细 腻 --XX," where "XX" represents the meanings of " 细 " (fine), " 腻 " (smooth), and " 细腻 " (delicate). The reaction times for the three types of word pairs are compared between groups to assess the cognitive processing characteristics of high-level L2 learners in understanding Chinese vocabulary meanings. The experiment uses a word-pair paradigm, where word pairs are presented randomly in the format "Word 1------Word 2." Participants are required to judge whether the two words in each pair are semantically related and respond with "yes" or "no."

(3) Hypotheses

1) Native Chinese speakers and high-level L2 learners will show similar contributions of A1 and A2 morphemes to the holistic word meaning, with no significant difference in the processing time for understanding the morphemic meanings.

2) Native speakers and high-level L2 learners will exhibit differences in the processing of morphemic and holistic word meanings, with variations in both processing methods and speeds.

3) There will be no significant difference between native speakers and high-level L2 learners in understanding holistic word meanings in zero-context situations.

(4) Participant selection

Participants were divided into two groups: high-level Chinese L2 learners and native Chinese speakers, each consisting of 22 undergraduate and graduate students.

The experiment aimed to observe the time course of L2 learners' understanding of adjective meanings, requiring participants to have not only the ability to recognize Chinese vocabulary but also the proficiency to use it fluently. Therefore, the selected L2 learners were non-heritage learners aged 18 to 26, with at least two years of residence in China and formal Chinese learning starting after the critical period of language acquisition (age 12). All L2 participants had obtained HSK Level 5 certificates before the experiment.

Native Chinese participants were non-linguistics majors aged 18 to 26. All participants had normal vision and reading abilities and had no prior experience with similar experiments.

(5) Experimental materials

The experimental materials consisted of three types of word pairs: A1 morphemic meaning pairs, A2 morphemic meaning pairs, and holistic word meaning (metaphorical) pairs, with 30 pairs for each type. The A1 and A2 morphemic meaning pairs were designed to stimulate participants' understanding of the meanings, with low formal relatedness but high content relatedness. This design aimed to reduce participants' tendency to respond "yes" and encourage deeper thinking.

Table 1. Examples of Experimental Materials

Word Pair Type	Example 1	Example 2
A1 Meaning	头发 - 细腻 (hair-delicate)	剪刀 - 尖酸 (scissors-sarcastic)
A2 Meaning	奶油 - 细腻 (cream-delicate)	白醋 - 尖酸 (vinegar-sarcastic)
Holistic Meaning	心思 - 细腻 (mind-delicate)	语气 - 尖酸 (tone-sarcastic)

First, based on the "A1+A2" adjective structure, 150 disyllabic compound adjectives were selected from the Modern Chinese Dictionary (7th Edition) and the Chinese Adjective Usage Dictionary. These words were chosen if the original meanings of the two morphemes were partially but not completely lost in the new word meaning.

To ensure that the morphemic meanings of the target words could provide clues rather than being completely lost, the semantic transparency of each word was calculated using a formula for Chinese compound word transparency. The median transparency value was calculated, and words with transparency values around the median were selected to ensure a balanced range of transparency.

To balance the difficulty of the vocabulary, the selected words were cross-referenced with the International Chinese Education Chinese Proficiency Standards, and words with morphemes at or below Level 5 were chosen to reduce the cognitive load on high-level L2 learners. The holistic word meaning pairs were constructed by searching the CCL (Peking University Modern Chinese Corpus), and the familiarity of the word pairs was assessed by 25 Chinese language teachers using a 7-point scale (1 = completely unfamiliar, 7 = completely familiar). Based on the survey results, 30 word pairs with the highest familiarity were selected as experimental materials, with corresponding morphemic meaning pairs constructed for each.

(6) Experimental procedure and equipment

The experiment consisted of a learning phase and an experimental phase. To familiarize participants with the task, five practice word pairs were presented before the formal experiment. These practice pairs were similar in difficulty to the experimental materials but were not part of the actual experiment. After the practice phase, participants were briefed on the task, and were reminded to focus during each block. Participants were allowed to rest between blocks if needed.

The formal experiment consisted of 90 stimulus word pairs, randomly divided into three blocks. Each block contained 10 A1 morphemic meaning pairs, 10 A2 morphemic meaning pairs, and 10 holistic word meaning pairs. To prevent participants from making multiple judgments on the same target word, the three types of word pairs were randomly mixed into a single stimulus presentation sequence, with 30 trials per block presented in random order.

3. Results and Analysis

The reaction times for participants' semantic judgments were automatically recorded by the software. Data from the practice phase were excluded, and the raw data from the formal experiment (including 44 participants, both native speakers and L2 learners) were imported into Excel for processing. Reaction times shorter than 300 milliseconds were excluded from analysis. To avoid the influence of outliers, data outside the range of mean ± 3 standard deviations were removed.

This study primarily compared the three types of word pairs between groups (native speakers vs. L2 learners) and within groups (three types of word pairs). Data analysis methods included independent samples t-tests and one-way ANOVA to analyze the reaction time data.

(1) Comparison of different word pair types

As shown in Table 2, the specific differences between native speakers and L2 learners are described below. Items 1-6 represent: 1) native speakers' reaction time for A1 morphemic meaning pairs; 2) native speakers' reaction time

for A2 morphemic meaning pairs; 3) native speakers' reaction time for holistic word meaning pairs; 4) L2 learners' reaction time for A1 morphemic meaning pairs; 5) L2 learners' reaction time for A2 morphemic meaning pairs; and 6) L2 learners' reaction time for holistic word meaning pairs.

According to Table 2, the mean reaction times for all three word pair types were faster for native speakers compared to L2 learners. Comparing items 1 (native speakers' A1 morphemic meaning pairs) and 2 (native speakers' A2 morphemic meaning pairs), the reaction times for understanding the morphemic meanings within the holistic word were around 1000 milliseconds, with minimal difference, suggesting that the contributions of the two morphemes to the holistic word meaning are roughly equivalent. Similarly, comparing items 4 (L2 learners' A1 morphemic meaning pairs) and 5 (L2 learners' A2 morphemic meaning pairs), the reaction times for understanding the morphemic meanings were around 2900 milliseconds, with negligible difference, indicating that the contributions of the two morphemes are also roughly equivalent for L2 learners.

Table 2. Descriptive Results of Reaction Time Differences

Item	N	Mean	Std. Deviation
1	22	1030.204	336.040
2	22	1060.040	285.740
3	22	957.650	213.589
4	22	2893.809	1455.100
5	22	2968.254	1395.536
6	22	2616.545	1036.061
Total	132	1921.084	1303.901

This suggests that both native speakers and L2 learners process the morphemic meanings of A1 and A2 in a similar manner, with the two morphemes contributing equally to the holistic word meaning. In terms of processing time, there is no significant difference in the order of understanding the morphemic meanings.

(2) Within-Group comparison of word pair types

To observe the variation in reaction times for the three word pair types within groups, a one-way ANOVA was conducted using SPSS 23.0. The word pair type was treated as the independent variable, and the reaction time as the dependent variable. The analysis aimed to determine whether different levels of the independent variable (word pair type) significantly affected the dependent variable (reaction time). Multiple comparisons were used to compare the data between groups, exploring the processing methods and speeds of native speakers and L2 learners for the three word pair types.

First, the reaction time results for the three word pair types within the native speaker group are shown in Table 3. A3 represents the holistic word meaning pairs. The analysis of reaction times as the dependent variable revealed no significant effect of word pair type ($P = 0.917 > 0.05$, $P = 0.800 > 0.05$, $P = 0.720 > 0.05$).

Table 3. Comparison of Reaction Times for Native Speakers

Combination Type	Comparison Type	Mean Difference	Std. Error	Significance
A1 Morphemic	A2 Morphemic	-29.836	285.468	.917
	A3 Holistic	72.555	285.467	.800
A2 Morphemic	A3 Holistic	102.391	285.467	.720

Second, the reaction time results for the three word pair types within the L2 learner group are shown in Table 4. The analysis of reaction times as the dependent variable revealed no significant effect of word pair type ($P = 0.795 > 0.05$, $P = 0.333 > 0.05$, $P = 0.220 > 0.05$).

Table 4. Comparison of Reaction Times for L2 Learners

Combination Type	Comparison Type	Mean Difference	Std. Error	Significance
A1 Morphemic	A2 Morphemic	-74.44545	285.46745	.795
	A3 Holistic	277.26364	285.46745	.333
A2 Morphemic	A3 Holistic	351.70909	285.46745	.220

The one-way ANOVA results indicate that both native speakers and L2 learners show no significant differences in processing the morphemic and holistic meanings of disyllabic compound adjectives, suggesting that their understanding of these meanings is fundamentally consistent.

(3) Between-Group comparison of word pair types

To observe the variation in reaction times for the three word pair types between groups (native speakers vs. L2 learners), an independent samples t-test was conducted using SPSS 23.0. The t-test compared the mean reaction times of the two groups to determine whether there were significant differences in the cognitive processing of different word pair types. The results showed significant differences between native speakers and high-level L2 learners, as detailed in Table 5.

Table 5. Differences Between Participant Types

Variable	Participant Type	Mean	Std. Deviation	t	Significance
Reaction Time	Native Speakers	1015.97	281.92	-11.077	0.000
	L2 Learners	2826.20	1297.42		

As shown in Table 6, the t-test results for reaction times ($t = -11.077$, $p < 0.001$) indicate significant differences between participant types. The specific comparison results are shown in Table 2.7, where items 1-7 correspond to the descriptions in Table 2.3. The three word pair types were compared between the two groups, and all comparisons showed significant differences ($p = 0.000 < 0.05$).

Table 6. Multiple Comparisons of Reaction Times Between Groups

Combination Type	Comparison Type	Mean Difference	Std. Error	Significance
1	4	-1863.605	285.46745	.000
	5	-1938.050	285.46745	.000
	6	-1586.341	285.467	.000
2	4	-1833.769	285.467	.000
	5	-1908.214	285.467	.000
	6	-1556.505	285.467	.000
3	4	-1936.159	285.467	.000
	5	-2010.605	285.467	.000
	6	-1658.895	285.467	.000

(4) Discussion of results

1) Based on the mean reaction times for understanding morphemic meanings, native Chinese speakers showed similar reaction times for A1 and A2 morphemic meaning pairs, around 1000 milliseconds, with minimal difference. High-level L2 learners also showed similar reaction times for A1 and A2 morphemic meaning pairs, around 2900 milliseconds. This suggests that both native speakers and L2 learners process the two morphemes in a similar manner, with the two morphemes contributing equally to the holistic word meaning. This finding supports Hypothesis 1, which posits that the two morphemes contribute equally to the holistic word meaning in terms of processing time.

2) The one-way ANOVA results indicate no significant main effect of word pair type ($F = 0.362$, $p > 0.05$), suggesting that there is no fundamental difference in the processing of morphemic and holistic word meanings. Both native speakers and L2 learners show consistent processing patterns for the morphemic and holistic meanings of disyllabic compound adjectives. This result contradicts Hypothesis 2.

Comparing the mean reaction times, the holistic word meaning pairs were processed faster than the morphemic meaning pairs for both native speakers and L2 learners, suggesting that holistic word meaning is the preferred processing route for native speakers. L2 learners also showed faster processing for holistic word meaning pairs compared to morphemic meaning pairs, consistent with native speakers.

However, both native speakers and L2 learners showed slightly faster reaction times for A1 morphemic meaning

pairs compared to A2 morphemic meaning pairs. This may be due to the influence of morpheme position, with the first morpheme having an advantage in processing.

3) The independent samples t-test results indicate significant differences between native speakers and high-level L2 learners ($t = -11.077$, $p < 0.001$). The understanding of holistic word meanings was tested in a zero-context situation, where participants were presented with word pairs without any contextual cues. The results showed that high-level L2 learners (2616.545 ms) were significantly slower than native speakers (957.650 ms) in recognizing holistic word meanings ($p = 0.000$, $p < 0.05$). This contradicts Hypothesis 3.

The recognition of word meanings is often facilitated by contextual cues, but this experiment shows that even without context, native speakers are faster than L2 learners. According to the context-dependency hypothesis, this result may suggest that the morphemic meanings provide a contextual framework for understanding the holistic word meaning.

In summary, this study used behavioral experiments to investigate the processing of different word meanings in native speakers and high-level L2 learners. The results show that both groups process the morphemic meanings of disyllabic compound adjectives similarly, with no significant differences in reaction times. Holistic word meanings are processed significantly faster than individual morphemic meanings. In semantic processing, the A1 and A2 morphemic meaning pairs involve the basic meanings of the morphemes, leading to similar reaction times. In contrast, the holistic word meaning pairs involve metaphorical meanings, which are processed faster because participants rely on conventional usage rather than analyzing the morphemic contributions to the holistic meaning.

However, when comparing the reaction times of native speakers and high-level L2 learners across the three word pair types, native speakers were significantly faster in both morphemic and holistic word meaning processing. This suggests that high-level L2 learners face difficulties in understanding disyllabic compound adjectives in zero-context situations.

4. Pedagogical Recommendations for Teaching Metaphorical Compound Words

Vocabulary is the foundation of language and a driving force for linguistic development. Therefore, it is essential to help advanced Chinese learners develop morphemic awareness, establish semantic networks, and promote the positive influence of metaphorical theory in teaching Chinese as a foreign language. Based on the current state of vocabulary teaching, we propose the following recommendations for teaching metaphorical "A1+A2" compound adjectives.

(1) Integrating morphemic and holistic word teaching

For Chinese learners, developing morphemic awareness is beneficial for learning high-frequency, low-transparency compound words. In the early stages of learning Chinese, the primary task is to master basic morphemes and distinguish homophonic morphemes, laying a solid foundation for future learning. Subsequent stages should involve analyzing the characteristics of different types of morphemes to deepen learners' understanding. The next step is to introduce vocabulary examples, preferably high-frequency, low-transparency words, to help learners grasp Chinese word formation. In later stages, learners should be guided to infer word meanings based on grammatical rules and clear contexts, improving their ability to recognize word meanings and expand their vocabulary through continuous practice.

(2) Promoting vocabulary teaching through metaphorical knowledge

Metaphor can be used to assist Chinese vocabulary teaching. The metaphorical nature of vocabulary, with its broad semantic range and fuzzy boundaries, creates conditions for metaphor formation. Metaphor is an essential cognitive tool for abstract to concrete thinking, and both thought and language are fundamentally metaphorical.

Therefore, the following steps can be taken in teaching:

1) Help students develop an awareness of metaphor. Introduce the concept of metaphor through examples and gradually guide students to understand and build a theoretical framework for metaphor.

2) Select and practice typical metaphors. Based on the initial awareness, teachers can use common metaphorical examples from daily life to reinforce metaphorical knowledge, guiding students to understand the relationship between holistic word meanings and constituent morphemes. Through metaphor, students can better grasp the evolution and usage of word meanings.

3) Review and deepen understanding. Encourage students to apply the metaphors they have learned and attempt to create their own metaphors.

(3) Contextualized teaching

Integrating vocabulary into contexts allows for a more comprehensive and multidimensional presentation of word meanings, enhancing learning efficiency. In teaching, incomplete or unclear annotations often lead to partial or incorrect understanding of vocabulary. Chinese is highly context-dependent, and the same word can have different meanings and usages in different contexts. Therefore, many key words require contextual explanations to enhance understanding.

5. Conclusion

This study, designed from the perspective of metaphorical cognitive processing, shows that both native speakers and L2 learners process the morphemic meanings of A1 and A2 in a similar manner, with the two morphemes contributing equally to the holistic word meaning. Both groups also show consistent processing patterns for the morphemic and holistic meanings of disyllabic compound adjectives. However, significant differences were observed in the understanding of metaphorical meanings in zero-context situations, with high-level L2 learners showing slower recognition speeds compared to native speakers. These findings provide theoretical support for teaching metaphorical vocabulary in international Chinese education, encouraging the application of Chinese lexical research to teaching practices.

In addition to compound adjectives, Chinese has many other metaphorical compound words, such as "N1+N2" and "V1+V2." Future research should explore these structures more comprehensively, aiming to build a metaphorical processing model that aligns with the characteristics of Chinese vocabulary and further serves international Chinese education.

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