

Exploring Metaphorical Polysemy with Multiple Correspondence Analysis:

A Corpus-based Study on the Predicative *hēi* ‘black’ in Chinese

Jinmeng Dou

Department of Linguistics and Translation,
City University of Hong Kong,
Hong Kong, People’s Republic of China
jmdou2-c@my.cityu.edu.hk

Meichun Liu

Department of Linguistics and Translation,
City University of Hong Kong,
Hong Kong, People’s Republic of China
meichliu@cityu.edu.hk

Abstract

This paper provides a corpus-based, statistical analysis to explore the semantic (dis)similarities of four metaphorical meanings of the Chinese color term *hēi* ‘black’ regarding its predicative usages. With the Behavioral Profiles approach, 379 instances were manually annotated with 35 contextual features proposed from three categories, including lexical-collocational, morphosyntactic and semantic, and discourse information, to capture the contextual variations of *hēi*. Based on the annotated data, the Multiple Correspondence analysis (MCA) technique is then used to visualize the semantic distribution of the four meanings of *hēi* and their strength of associations with the distinctive features. It is found that the semantic (dis)similarities of the four meanings of *hēi* are well profiled by the MCA results, which demonstrates the effectiveness of the MCA method in studying metaphorical polysemy.

1 Introduction

As a common source of metaphor, Color Terms (CTs) possess a diverse range of metaphorical meanings in various languages beyond their literal meanings pertaining to the natural color, which can be viewed as metaphorical polysemy (Apresjan, 1974; Jurafsky, 1996). Without exception, Chinese CTs also show metaphorical polysemy with varied usage patterns. For example, one of the earliest-acquired Chinese CTs, *hēi* 黑 ‘black’ (Berlin & Kays, 1969; Wu, 2011), is continuously extended to different metaphorical meanings with flexible contextual variations.

Except for the attributive uses (e.g., *hēi-shèhuì* 黑社会 ‘black-society: underground’), *hēi* frequently occurs as a predicate when referring to metaphorical meanings. Example (1) below provides initial illustrations for the metaphorical usages:

- (1) a. 她无意中黑了青岛一把。
tā wúyìzhōng hēi le qīngdǎo yī bǎ
she unconsciously black LE Qingdao
one-CL
‘She accidentally blackened Qingdao for once.’
- b. 穆司爵脸黑了。
Mù-sījué liǎn hēi le
NAME face black LE
‘Mu Sijue’s face blackened.’

As shown in (1), the predicate *hēi* can either serve as a transitive verb to denote ‘an action that damages or destroys someone’s reputation’ as in (1a), or an intransitive verb ‘to get angry’ as in (1b). It is noteworthy that the contexts of *hēi* referring to different metaphorical meanings may vary as they correlate with the possible semantic (dis)similarities regarding Distributional Semantics (Harris, 1954; Firth, 1951). However, most previous studies discussed the possible meanings of CTs from a purely analytical ground and regarded the different senses as discrete primes, ignoring their potential semantic relations. Given that, this study aims to explore the semantic (dis)similarities of the varied metaphorical meanings of *hēi* as a predicate with the corpus-based Behavioral Profiles (BP) approach.

The paper is organized as follows. Section 2 offers a literature review of relevant previous studies. Section 3 introduces the research methodology. Section 4 applies the MCA method to identify the distinctive contextual variations of each metaphorical meaning denoted by the predicative *hēi* based on the annotated distinctive contextual features. Section 5 concludes this study.

2 Literature Review

While polysemy is a universal phenomenon in languages (Copestake & Briscoe, 1995; Jackendoff, 2002; Murphy, 2002; Pustejovsky, 1995), metaphorical polysemy is regarded as a special type of polysemy (Apresjan, 1974). Metaphorical polysemy of CTs has been demonstrated in many languages, such as English (Allan, 2009), European languages (Hill, 2008), and Persian (Amouzadeha et al., 2011; Aliakbari & Khosravian, 2013). Besides, several translation-related studies also suggested that some metaphorical meanings of CTs are language-specific or culturally exclusive (Wierzbicka, 1990; Ghafel & Mirzaie, 2014; Chatti, 2016; Hastürkoğlu, 2018; Al-Jarf, 2019).

With regard to Chinese CTs, some studies have discussed their metaphorical extensions and the underlying cognitive mechanisms, such as Wu (1986), Zhang (1988), Xing (2008), Li and Bai (2013), Lai and Chung (2018), etc. Nevertheless, most of them are qualitative analyses based on intuitive judgments with elicited examples without considering their contextual variations or the relations between different senses. As one of the Chinese basic CTs, *hēi* continues to be extended over time to derive various metaphorical meanings, showing multiple form-meaning mapping relations in its metaphorical uses. Specifically, the intransitive verbal uses of *hēi* can either refer to ‘being malevolent’ (e.g., *xīnhēile* 心黑了 ‘heart blackened’) or ‘being angry’ (e.g., *liǎnhēile* 脸黑了 ‘face blackened’) depending on the collocated subjects. Besides, the frequent occurrence of the predicative *hēi* with various metaphorical extensions can be barely found in other Chinese CTs, indicating distinct cognitive mechanisms of this term. Hence, this study selects the different metaphorical meanings of the predicative *hēi* as the research object to explore the form-meaning correlations with the BP approach.

Behavioral Profiles (Divjak & Gries, 2009; Gries & Divjak, 2009), as a corpus-based approach, combines the analysis of manually annotated usage features, also named ID tags,

(Gries, 2006) with multifactorial statistical tools. In this study, Multiple Correspondence analysis (MCA) (Benzécri, 1992; Greenacre & Blasius, 2006) is adopted to conduct the statistical feature analysis. Pertaining to correspondence analysis, MCA can simultaneously summarize and visualize the correlations between multiple linguistic features that structure the behaviors of the datasets in relation to syntax, semantics, or pragmatics by showing their relative proximity in a biplot. Previous studies have demonstrated the effectiveness of MCA in analyzing lexical semantic issues, e.g., Glynn (2014a) on several mental and communicative predicates in English, Glynn (2016) on the polysemy of the verb *annoy*, Krawczak and Glynn (2015) on three English constructions, as well as Tantucci and Wang (2020) on the aspect marker *guo* and the sentence-final particle *ba* in Chinese.

Furthermore, some significant effects of metaphor have been detected in depicting the semantic (dis)similarities of polysemous lexemes in previous studies. Gries (2006) argued that the metaphorical mappings identified from the polysemous extensions can strongly increase the predictive power of sense recognition and the descriptive power of the clustering algorithm. Besides, other BP studies also indicated the predictive power of metaphor in profiling the semantic relations of polysemy, e.g., Glynn (2014b), Jansegers et al. (2015), Jansegers and Gries (2017), and Ioannou (2020).

3 Data Preparation

3.1 Data Collection

Based on proposals of previous studies and the Contemporary Chinese Dictionary (7th ed.), four metaphorical meanings commonly associated with the predicative *hēi* were selected for the BP analysis, as detailed in Table 1. Consequently, 379 instances pertaining to the four meanings of the predicative *hēi* (94 for “Slander/Entrap”, 90 for “Evil/Malevolent”, 95 for “Angry/Sullen”, and 100 for “Network Attack”) were randomly collected from two corpora in Sketch Engine - the Corpus of Chinese Simplified Web 2017 Sample and the Chinese Gigaword 2 Corpus (Mainland, simplified), which guarantee a relatively balanced coverage as the former is composed of internet texts and the latter newswires.

Senses & Examples

1. Slander/Entrap

赵丽颖还一直被黑。

Zhào-liyǐng hái yìzhí bèi hēi

NAME still always PASSIVE black

‘Zhao Liying is still always blackened.’

2. Evil/Malevolent

这里的人心太黑。

zhèlǐ de rén xīn tài hēi

here DE people heart too black

‘The hearts of the people here are too black.’

3. Angry/Sullen

齐王的脸更黑了。

Qí-wáng de liǎn gèng hēi le

King-Qi DE face more black LE

‘King Qi’s face is even darker.’

4. Network Attack

这家网站已经被黑。

zhè-jia wǎngzhàn yǐjīng bèi hēi

this-CL website already PASSIVE black

‘This website has been hacked.’

Table 1: Four metaphorical senses pertaining to the predicative *hēi*

3.2 Data Annotation

In line with previous studies (Gries, 2006; Gries & Divjak, 2009; Liesenfeld et al., 2020), a total of 35 contextual features containing 99 variable levels fall into three categories: the lexical-collocational patterns (24), morphosyntactic and semantic behaviors (4), and discourse information (7), as shown in Table 3. For the lexical-collocational

patterns, the selected features pertain to the collocations of *hēi* with other lexical categories, such as Degree Markers. The morphosyntactic and semantic features mainly concern the syntactic categories of *hēi* and the semantic types of its surrounding arguments in the same constituent, e.g., the POS of *hēi*, the semantic type of subjects collocated with *hēi*. The discourse features refer to the contextual information beyond phrasal structures, including the functional types of the clause containing *hēi*, the mood, etc.

Instance	Tag 1	Tag 2	...	Tag <i>j</i>
Instance 1	C_{11}	C_{12}		C_{1j}
Instance 2	C_{21}	C_{22}		C_{2j}
...
Instance <i>i</i>	C_{i1}	C_{i2}		C_{ij}

Table 2. Data format for the annotation

The 35 contextual features were then manually annotated on 379 instances, which produced a data frame of 37,521 data points. The annotation was performed (Table 2) by two native speakers who are linguistically well-trained. Moreover, Cohen’s Kappa coefficient was adopted to measure the inter-rater reliability. Based on the annotation of the two annotators, a high degree of Cohen’s Kappa (0.9066, greater than the threshold value 0.8) was obtained, indicating an almost perfect strength of agreement between the two annotators (Landis & Koch, 1977; Altman, 1991; McHugh, 2012). Then, the annotations of the remaining inconsistent cases were determined by the two annotators after a discussion.

Based on the annotated data, the MCA was conducted by means of the *FactoMiner* package in R language.

Feature Type	Feature	Feature Levels
1. Lexical-Collocational Information		
modifier	Negation Marker	2: yes/no
modifier	Degree Marker	2: yes/no
modifier	<i>bèi</i> 被	2: yes/no
modifier	<i>yě</i> 也	2: yes/no
modifier	<i>qǐ</i> 起	2: yes/no
modifier	<i>le</i> 了	2: yes/no
modifier	<i>zhe</i> 着	2: yes/no
modifier	<i>dōu</i> 都	2: yes/no
modifier	<i>hái</i> 还	2: yes/no

modifier	<i>jiù</i> 就	2: yes/no
modifier	<i>guò</i> 过	2: yes/no
modifier	<i>ràng/lìng/shǐ</i> 让/令/使	2: yes/no
modifier	Past Time Marker	2: yes/no
modifier	Future Time Marker	2: yes/no
modifier	Comparison Marker	2: yes/no
modifier	Frequency/Duration Marker	2: yes/no
modifier	Capability/Intention Marker	2: yes/no
modifier	<i>yuè/yù</i> 越/愈	2: yes/no
modifier	Doubt Marker	2: yes/no
<i>hēi</i>	The freq. of <i>hēi</i> exceeds one time	3:no/yes diff M/yes same M
color terms	Cooccurred with other color terms	2: yes/no
noun phrase	Color object	2: yes/no
notional word	parallel with <i>hēi</i> (e.g., 黑恶 black-evil)	3: no/yes diff M/yes same M
compound word	Phase marker	2: yes/no
2. Morphosyntactic & Semantic Information		
POS	part of speech of <i>hēi</i>	2: verb/adjective
noun phrase	Semantic type: dep-relation: sub	6: see notes
noun phrase	Semantic type: dep-relation: dobj	6: see notes
verb phrase	Semantic type: N collocated with <i>hēi</i>	6: see notes
3. Discoursal Information		
clause	Clause Type	2: main/dependent
clause	Types of dependent clause	3: rel. clause/adv. clause/null
sentence	The omission of co-arguments with <i>hēi</i>	2: yes/no
sentence	Pronouns	2: yes/no
sentence	Explication of <i>hēi</i>	2: yes/no
pragmatic	Whether <i>hēi</i> is ambiguous	2: yes/no
pragmatic	Mood	3: see notes

Table 3: An overview of the proposed 35 contextual features. Notes: 1) The semantic types consist of abstract entity, body part, animate, inanimate object, organization, and null; 2) The sentence mood consists of declarative, interrogative, and imperative.

4 MCA results

4.1 Semantic Distribution

This section discusses the semantic distribution of the four meanings via visualizing the 379 annotated instances with the MCA map. Basically, MCA describes the obtained variations between the categorical variables through several dimensions and uses the so-called ‘Inertia’ to represent the proportion of variation retained by each dimension. The higher the inertia one obtains, the better the dimension is. Table 4 provides an

overview of the inertia of our MCA result on the annotated dataset. It is shown that the variance of the dataset is decomposed into 47 dimensions. Each of them occupies comparatively a value of inertia and thus explains the percentage of the total variation in the data. The reported low score is to be expected regarding the high complexity of our dataset.

Dim.	Eigenvalue	Inertia	Cum. Inertia
1	0.095	6.905	6.905
2	0.072	5.231	12.135
3	0.066	4.847	16.982
4	0.058	4.199	21.181
.....			
47	0.004	0.267	100.000

Table 4: Inertia of MCA results for the four meanings of *hēi*

In line with previous studies, the inter-individual variability of the 379 instances is displayed based on the first two dimensions (12.14%) as in Figure 1. The data points (instances) in this figure are colored according to their corresponding meanings of *hēi* and labeled based on their sequential number (1-94 for “Slander/Entrap”, 95-184 for “Evil/Malevolent”, 185-279 for “Angry/Sullen”, 280-379 for “Network Attack”). The positions of the four metaphorical meanings are predicated with 95% confidence ellipses by regarding them as supplementary variables.

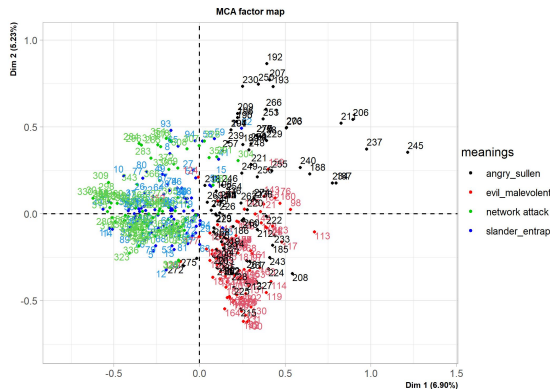


Figure 1: Semantic Distribution of the four meanings of *hēi*

In Figure 1, the two left quadrants are dominated by the blue (“Slander/Entrap”) and green (“Network Attack”) data points, which are overlapped without a distinct boundary. Related to that, their respective confidence ellipses are right next to each other, indicating that these two meanings are strongly associated with each other in semantic properties. On the other hand, the black data points for “Angry/Sullen” are mainly distributed in the top-right quadrant, and the red points for “Evil/Malevolent” in the bottom-right quadrant. Their data points are partially overlapped, which form a fuzzy boundary. It is shown that the usage patterns of these two meanings are semantically distinct, but still share

some common properties to a certain extent. Lastly, distinct semantic dissimilarities can be detected between the two right-quadrant meanings and the two left-quadrant meanings, as their data points are divided into two groups by the *y*-axis in Figure 1.

In sum, the semantic (dis)similarities of the four metaphorical meanings of *hēi* are well illustrated in Figure 1, based on their semantic distributions. In the following sections, we focus on identifying the distinctive usage patterns of the varied meanings to provide explanations for their semantic (dis)similarities.

4.2 Distinctive Contextual Features

To analyze the usage patterns of the four meanings, the top 10 distinctive contextual features that set them apart were identified first, since MCA is not suitable for representing too many features simultaneously due to the difficulty of visualization. Precisely, Cramér’s *V* (Cramér, 1946) was calculated to measure the distinctiveness of the contextual features. The Fisher exact test was used to see whether the Cramér’s *V* is statistically significant. Table 5 lists the top 10 distinctive contextual features based on their Cramér’s *V* and *p*-value.

Feature	Cramér’s <i>V</i>	<i>p</i> -value
POS	0.862	< 0.01
<i>bei</i> 被	0.594	< 0.01
Omission of co-arg	0.593	< 0.01
Semantic type of dobj	0.522	< 0.01
Degree marker	0.478	< 0.01
Semantic type of sub	0.454	< 0.01
<i>zhe</i> 着	0.346	< 0.01
Semantic type of co-N	0.339	< 0.01
Explication	0.279	< 0.01
Color object	0.264	< 0.01

Table 5: Top 10 distinctive contextual features in setting the four meanings apart

In terms of feature types, four of them pertain to lexical-collocational patterns, including passive marker *bèi*, degree markers, aspect marker *zhe*, and color object; four pertain to morphosyntactic and semantic behaviors, including POS of *hēi*, semantic types of co-arguments and other nouns collocated with *hēi*; and two of them refer to discourse information, which are the omission of co-arguments and the explication of *hēi*. It is clear

inanimate color object is frequently observed in such uses to describe the gradation of the black color, as indicated by the features “DgrM_yes”, “CO_yes” and “STCN_Ina”. Example (4) illustrates this usage. Regarding discourse information, the feature “Exp_yes” indicates that the reason why the referred subject is black may also be expressed in the context.

- (4) 他的心[很黑/黑得和碳一样]。
tāde xīn [hěn hēi/hēi dé hé tàn yīyàng]
 his heart [very black/black DE and carbon same]
 ‘His heart is very black (black as carbon).’

For the meaning “Angry/Sullen”, it is found that *hēi* is more likely to be an intransitive verbal predicate of which subjects refer to human or body part. In other words, the features “V” and “STS_AnM” are attracted by the meaning “Angry/Sullen”, which explains their relative distance to the two left-quadrant meanings. Example (5) explains this usage.

- (5) 他的脸瞬间黑了。
tāde liǎn shùnjiān hēi le
 his face instantly black LE
 ‘His face blackened immediately.’

In addition, features “zhe_yes” and “STCN_Bdy” show a strong attraction to “Angry/Sullen”, as *hēi* in this meaning frequently collocates with durative aspect marker *zhe* and nouns pertaining to body part. This usage is illustrated by (6).

- (6) 他黑着脸说话。
tā hēi zhe liǎn shuōhuà
 he black ZHE face speak
 ‘He speaks with a black face.’

In sum, it is found that when referring to “Network attack” and “Slander/Entrap”, *hēi* prototypically serves as a causative-transitive verb to describe the hostile social or interpersonal interactions; when referring to “Evil/Malevolent”, *hēi* tends to be a stative predicate to denote the evaluation on the immoral quality of a human or social entity; when referring to “Angry/Sullen”, *hēi* may serve as an intransitive verbal predicate to depict an unpleasant emotional status.

5 Conclusion and Implication

In this paper, a corpus-based BP analysis was conducted to explore the semantic (dis)similarities in relation to metaphorical polysemy of the predicative uses of the Chinese CT *hēi*. It is found that as a transitive predicate, *hēi* tends to describe an action of social attack as blackening someone or something, with the meanings “Slander/Entrap” or “Network Attack”. From the perspective of Conceptual Metaphor, the findings suggest that a conceptual mapping may be at work, which explains the association of the two meanings: (i) “SOCIAL ATTACK IS BLACKENING”. As an intransitive, stative predicate, *hēi* prototypically depicts a negative evaluation on a social entity, with the meaning “Evil/Malevolent”. A conceptual mapping can be postulated for this meaning as: (ii) “EVALUATION OF IMMORAL QUALITY IS PERCEPTION OF THE BLACK COLOR”. Regarding the meaning “Angry/Sullen”, *hēi* mainly describes the process of turning into an unpleasant mental state, with the conceptual metaphor (iii) “TURNING ANGRY IS TURNING BLACK”. Given the proposed metaphors, the semantic (dis)similarities of the four meanings can be well accounted for based on their entailed conceptual mappings, which can be specified as: “change of social or emotional status corresponds to change of color” for metaphors (i) & (iii), “non-visual evaluation of quality or mental state corresponds to color perception” for metaphors (ii) & (iii).

Ultimately, this study demonstrates the effectiveness of the BP approach with MCA method in exploring metaphorical polysemy, with empirical evidence that can be visually represented.

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