How does grammatical category influence conceptual categorization: The case of Chinese classifiers

Jialing Liang, Xixian Liao
{jialing.liang, xixian.liao} @upf.edu
Department of Translation and Language Sciences
Universitat Pompeu Fabra, Spain

Abstract

Classifiers play a fundamental role in shaping how objects are categorized in Mandarin Chinese. We conducted object naming experiments with different types of classifiers as prompts and analyzed the distribution of names via the taxonomic device, by which nouns are divided into three levels according to the level of specificity, i.e., basic (e.g. apple), superordinate (e.g. fruit) and subordinate (e.g. golden apple) levels. We observe that different classifiers induce distinct distributions of names across the three levels. Under the general classifier condition, participants use more general terms for home furnishing objects (e.g., 'furniture') but not for animals, whereas the specific classifier condition consistently reveals a preference for basic level names (e.g., 'table'), which are less general and represent the most inclusive category at which objects share common features and can be easily recognized. These findings contribute to our understanding of language production in Mandarin Chinese and highlight the importance of considering grammatical factors when examining referential expression choices.

Keywords: Chinese classifiers; conceptual categorization; referring expression choices; Language production

Introduction

Variability in the selection of referring expressions for a given object on a given occasion is a common phenomenon in human language. For instance, a single entity can be truthfully referred to as a "dog", a "Dalmatian", or simply as an "animal". However, the underlying reason for why individuals choose one term over another still remains a subject of keen interest in research on language production (Levelt, 1989; Murphy, 2002; Degen, Franke, & Jager, 2013). Just as these names vary in specificity, classifiers in Mandarin Chinese similarly vary between general and specific. This raises the question of whether the usage patterns of classifiers and nouns align or diverge in terms of specificity. Accordingly, this study aims to explore how classifiers influence these choices, focusing specifically on the impact of the classifier rather than on the broader factors influencing referring expression choice.

Previous studies suggest that the choice of referring expressions at different conceptual levels depends on various factors (Grice, 1975; Degen et al., 2013). Taxonomy has been considered one of the most important criteria in organizing concepts. Rosch et al. (1976) first pointed to the role of basic-level effects and showed that not all levels of taxonomy behave the same for object categorization. The basic level is privileged for its popular usage in everyday speech (Johnson & Mervis, 1997). For example, when encountering an entity (e.g. an apple) in an ordinary situation, we are less likely to categorize it at its specific level (e.g., golden apple) or its more general level (e.g., fruit) but rather we use the basic level (apple). Basic-level terms thus might be considered the first choice for referring expression choice given this and the fact that they are often shorter in length and morphologically simple forms (Geeraerts et al., 1994). Nonetheless, atypical category members fail to show basic-level effects. For example, when seeing a picture of a penguin, people are more likely to say "penguin" rather than "bird" (Jolicoeur et al., 1984). In addition, contextual informativeness has also proven to be important during the selection of words (Graf et al., 2016). For example, in the presence of more than one dog, the likelihood of naming the entity by "dog" will be largely reduced.

Most previous research on naming choices has been done on English. In English, a bare noun is typically sufficient when referring to an entity. However, in Mandarin Chinese, when referring to objects, there are two alternative options: 1) employing bare nouns and 2) using classifiers. For instance, an individual may label the object as "狗" (gou) for "dog" or "一条狗" (yi tiao gou) for "a dog". The key distinction between the two choices here lies in whether the speaker intends to specify the quantity of the object, with classifiers being obligatory when a quantity expression is used.

Classifiers in Chinese are divided into two main types: count classifiers, the type of interest here, and mass classifiers (Tai, 1992; Cheng et al., 1998; Li, 2011). Our study focuses on count classifiers, which are characterized by their intrinsic semantics and the semantic constraints they establish when paired with nouns. Count classifiers can be subdivided into SPECIFIC classifiers (SCL) and GENERAL classifiers (GCL) based on the granularity of their semantic information, and the semantic constraints they place on the following nouns. Specifically, General Classifiers (GCL) place fewer semantic constraints compared to specific classifiers. This is related to the fact that GCLs can combine with a broader range of nouns than Specific Classifiers (SCLs) (Zhang, 2007). As proposed by Schmitt and Zhang (1998), a classifier of broad scope, specifically a general classifier in our context, is linked to a greater number of concepts compared to a classifier of narrow scope, represented by specific classifiers in our case. These distinctions allow SCLs

In L. K. Samuelson, S. L. Frank, M. Toneva, A. Mackey, & E. Hazeltine (Eds.), *Proceedings of the 46th Annual Conference of the Cognitive Science Society.*

to disambiguate visually ambiguous referents (Huettig et al., 2010). For instance, providing participants with a specific classifier like "条" (tiao), typically associated with long objects such as "snake", but which can also be used with "dog", virtually precluded the possibility of participants naming it "cat" or "animal". However, if a general classifier such as "只" (zhi), applicable to all animals, were used, the outcomes would likely align with those observed in cases where no classifiers were employed.

In this study, we focus on examining the influence of Chinese classifiers, which are inherently grammatical, on people's lexical choices at the taxonomic/conceptual level. To our knowledge, this specific area of research has been little explored. To address this gap, we conducted an object naming experiment where participants were presented with prompts featuring either a SCL, a GCL, or no classifier at all. We explored the following two hypotheses: **Hypothesis 1** (H1): As classifiers impose restrictions on the nouns that follow them, we predict divergent outcomes between using classifiers and not using them; and **Hypothesis 2** (H2): As SCLs convey more precise meanings and exhibit greater limitations in their combinatoric possibilities with nouns than do GCLs, we expect different choices of names following a GCL versus a SCL.

Classifiers in Mandarin Chinese

Differing from non-classifier languages such as English, in Mandarin Chinese, a noun cannot be modified directly by a numeral such as in *two people* or *three books*; the presence of classifiers is generally obligatory when the noun phrase includes a numeral, e.g., *liang ge ren* " two CL.general people", *san ben shu* "three CL.volumn book". Classifiers in Chinese are divided into two main types: count classifiers and mass classifiers (Cheng et al., 1998). Mass classifiers are also called "measure words" or "measural classifiers", which serve to indicate a specific quantity or measure of something, such as box, cupful, or liter. Count classifiers are characterized by establishing semantic constraints when paired with subsequent nouns. In the current study, we will specifically focus on count classifiers, referred to hereafter as simply "classifiers" (CLs).

General classifiers in this study

Besides quantifying, one of the most important functions of count classifiers is categorizing. They categorize nouns based on the intrinsic properties of the objects they describe, such as animacy, shape, size, consistency, and so on (Gao & Malt, 2009). Based on their information content, count CLs are subdivided into general and specific classifiers (Cheng et al., 1998). In Chinese, a general classifier is commonly used when a more specific classifier is not readily applicable (Erbaugh, 1986). The general classifier "个" (*ge*) is versatile and can be employed for a heterogeneous class of objects such as human, desk, and even abstract noun such as dream, see (1a). Another general classifier is the classifier "只" (*zhi*), which can be consistently used in the animal realm, see in (1b).

(1) a. 一 个 人 / 桌子 / 梦想
yi ge ren / zhuo-zi / meng-xiang
one CL people / desk / dream
'one people / desk / dream'

b. 一 只 狗 / 猪
yi zhi gou / zhu
one CL dog / pig
'one dog / pig'

The use of *ge* for animals and *zhi* for humans is generally infelicitous; though the utilization of *ge* for animals undeniably exists, its acceptance is not systematic, depending e.g. on regional dialects. Notably, there is a dearth of studies treating *zhi* as a general classifier, despite some linguists exploring its applicability in the animal domain (Ahrens, 1994; Tai, 1992; Myers, 2000).

As proposed by Croft (1994), numeral classifier systems universally distinguish between animate (mostly human) and inanimate (nonhuman) classes. In his proposed hierarchy of semantic distinctions for numeral classifier systems, animacy occupies the most prominent position. This hierarchy is delineated into two branches: Animate/Human and Inanimate/Nonhuman. In our case, *ge* cannot be used with animal words, while *zhi* can, thus the usage of *ge* and *zhi* together can indicate non-animal and animal analogousness respectively. Additionally, *zhi* exhibits a broader semantic scope compared to other specific animal-related classifiers, allowing it to replace them in the animal domain. In light of these considerations, we have chosen to adopt *zhi* as a general classifier in the current study. This choice aims to uncover the relationship between grammatical categories and naming choices, addressing the oversight of neglecting *zhi*'s prominence in the animal domain.

While *ge* and *zhi* are general classifiers in non-animal and animal domains respectively, it's important to note that many nouns have their own specific classifiers that are tailored to particular categories of nouns, see (2a–2b). "张" (*zhang*) in (2a) is a classifier commonly used for flat or sheet-like objects and "头" (*tou*) 'head' in (2b) is primarily used for domestic animals.

(2) a. 一 张 桌子
yi zhang zhuo-zi
one CL-flatness desk
'a/one desk'

b. 一 头 猪
yi tou zhu
one CL-head pig
'a/one pig'

In essence, general classifiers (GCLs) demonstrate versatility by accommodating a broad range of nouns, i.e., imposing fewer semantic constraints on the subsequent noun. Conversely, specific classifiers (SCLs) inherently convey specific meanings, such as indicating flatness (see (2a)).

Experiment

The present experiment builds on He et al. (2023), in which a new dataset, ManyNames ZH, encompassing 1319 images with an average of 20 names per image, was generated for object naming in Mandarin Chinese. To ensure meaningful comparisons, we rigorously followed the predefined criteria these authors used to choose the images for their study, which involved using the identical set of images employed in He et al. (2023)'s study, as well as replicating their procedure. Certain adjustments to materials were made to align with the specific objectives of the current study (see under "Materials" below).

Method

Participants 146 native speakers of Mandarin Chinese (61F, 82M, 1 non-binary and 2 unknown gender) were recruited via Prolific.Co (129) and Amazon Mechanical Turk (17)[1]. Participants received a compensation of 9.46 euros/h.

Materials The images used for this study were sampled from the ManyNames ZH dataset, which comprised a total of 1319 images across seven domains: PEOPLE, ANIMAL_PLANTS, HOME, CLOTHING, VEHICLE, FOOD, BUILDINGS. When choosing images from ManyNames ZH, we employed the following criteria: 1) We focused on images from the ANIMAL[2]and HOME domains, as objects of these domains are more likely to be associated with both general and specific classifiers; 2) The potential target names for the objects had to be compatible with both general and specific classifiers; 3) We ensured that the images represented real (as opposed to e.g. toy) and unambiguous objects. A total of 168 images were chosen as visual stimuli for the present study. These images were presented to participants along with prompts using either general classifiers (GCL) or specific classifiers (SCL), yielding a total of 336 unique combinations.

For the study, we established three distinct conditions: the 'No Classifier' condition (No), the 'General Classifier' condition (G), and the 'Specific Classifier' condition (S). The data for the 'No Classifier' condition are derived from He et al. (2023), while the data for the 'General Classifier' (G) and 'Specific Classifier' (S) conditions are from the present study. In the experiment, we employed two general classifiers, *ge* (个) and *zhi* (只), and five specific classifiers, namely *tou* (头), *tiao* (条), *pi* (匹), *zhang* (张), and *ba* (把).

Procedure All materials were equally divided into 7 lists, each containing 48 images. Each image was associated with two classifiers: a GCL and an SCL. No image appeared more than once in a list. Participants were randomly assigned to one of the seven lists. After providing their consent, participants were presented with 48 images each accompanied by either a general or a specific classifier (see Fig.1a and Fig.1b). Participants were instructed to enter the object name in the provided text box to record their responses, combining it with the appropriate "one + CL" structure. It is important to note that the same image appeared with both general and specific classifiers but was named by different participants.

Data Processing

For our analysis, we classified each response as either a basic, superordinate, or subordinate level term. This classification proved challenging due to the diverse nature of responses, many of which did not fit neatly into a clear taxonomic structure like "animal-dog-chihuahua". Examples of such ambiguous responses include "meeting room", "lunch", and "go". In addition, the limited number of synsets and the lack of entries for many Chinese words in the Chinese Open WordNet[3] made automated annotation difficult. Therefore, to achieve more precise categorization and taxonomic classification of the names, two authors of the paper manually annotated each response. This involves the following two steps: data cleaning and level assignment.

Data cleaning To clean the data, carried out three steps:

- Firstly, we checked the responses of each image one by one and merged similar responses. For example, in the case of a picture of a knife, there were 13 responses of [刀 dao: 13] and 1 response of [刀子 dao-zi: 1]. When both *dao* and *dao-zi*[4] were used to refer to a knife, we merged them into a unified basic object category. This resulted in 14 responses at the basic level for the "knife" category, i.e., [knife: 14].

- Secondly, responses containing incorrect descriptions were deleted. For example, instances where the target image was a horse but the response was 女人 ('woman') or contained verbs, e.g., 骑马 ('riding horse') were considered invalid.

- Thirdly, obvious typographical errors were reclassified into appropriate categories. For example, the interjection word 吗 (*ma*), which shares the same pinyin as the word for horse, was reclassified under the 'horse' basic level category.

Level Assignment In Mandarin Chinese, the terms 桌 (*zhuo*) and 桌子 (*zhuo-zi*) are commonly used to denote both a desk and a table. This contrasts with English, where there is a clear distinction between a desk (primarily used for work or study) and a table (used for a variety of purposes, including dining). This linguistic difference poses challenges in using WordNet for automated annotation. For example, if we search *zhuo* or *zhuo-zi* in Chinese WordNet, it incorrectly categorizes them under the hypernym 'table'. This issue of linguistic discrepancy is also evident in the translation of the

[1]Due to the limited availability of native Mandarin Chinese speakers on a single platform, we used two different platforms to recruit annotations for each image.

[2]We narrowed the ANIMAL domain (originally ANIMAL_PLANTS) to feature animal-related images exclusively.

[3]URL: `https://bond-lab.github.io/cow/`

[4]*-zi* here is a suffix attached to nouns, verbs, and adjectives, used to mark part of speech of nouns.

(a) General Classifiers

(b) Specific Classifier

Figure 1: Sample visual display for the object-naming experiment. The English translation for the sentence displayed above the text box was "Please name the object within the red bounding box and press Enter to proceed to the next display".

English word 'entity', which could be represented in Chinese as 物体 (*wuti*), 东西 (*dongxi*), or 物件 (*wujian*). Due to these complexities, we opted against using automatic annotation, which may not accurately differentiate between similar terms. Instead, we manually assigned the taxonomic level for each response according to the following criteria:

- Basic level: The basic level is the most inclusive category at which objects share common features and can be easily recognized, such as 狗 (*gou*) 'dog', 桌 (*zhuo*) 'desk/table', 刀 (*dao*) 'knife', etc.
- Superordinate level: The superordinate level is a more general category that includes more than one basic-level categories. It represents a higher level of abstraction. However, one English word might correspond to various Chinese words as mentioned before, so for example, the superordinate term for 'knife' might be 物体 (*wuti*), 东西 (*dongxi*), or 物件 (*wujian*).
- Subordinate level: The subordinate level is a more specific or detailed category that falls below the basic level. It includes subcategories with more specific characteristics. For example, a subordinate category for 'dog' might be 'chihuahua'.

Following the data cleaning process, we obtained a total of 8,329 responses categorized as basic level, 990 responses identified as subordinate-level terms, and 105 responses classified as superordinate-level.

Analysis

The data were analyzed using multinomial logistic regressions, where the dependent variable assessed whether the response falls into the basic level, the superordinate level, or the subordinate level. The fixed effects are (1) Classifier Condition (three-level: no classifier, general classifier, specific classifier) with "no classifier" as its reference level, (2) Domain (HOME, ANIMAL) with "ANIMAL" as its reference level, as well as (3) the interaction between them. To assess the significance of the fixed effects, we employed likelihood ratio tests, comparing the full model with the effect in question against a counterpart model devoid of said effect.

The model fitting was conducted using the *nnet* package (v7.3.19; Venables & Ripley, 2002) in R (version 4.3.1; R Core Team, 2021). For each of the variables in the model, we report the coefficients in log odds. Null-hypothesis significance testing was employed to ascertain the statistical significance of the results (alpha level: 0.05).

Results

Table 1 provides a summary of the multinomial regression model. Table 2, on the other hand, presents the post-hoc pairwise comparison results from multinomial logistic regression models examining the naming distribution across different levels in the HOME and ANIMAL domains, visualized in Figure 2. The observed overall relationship classifier usage and lexical choices align with H1: the outcomes between using classifiers versus not using them are different.

Basic Level When comparing participants utilizing a Specific Classifier (S) to those responding without a classifier (No), a consistent pattern emerges across both the HOME and ANIMAL domains. Participants are more likely to use a basic-level name when prompted by a specific classifier compared to in the No Classifier condition (β=0.09, $p < 0.001$). However, a significant preference for basic-level names is observed under the General Classifier (G) condition compared to No only for the ANIMAL domain (β=0.05, $p = 0.007$), but not for the HOME domain (β=0.04, $p = 0.204$).

Subordinate Level When prompted by either a general or specific classifier, participants tend to produce more subordinate-level names for objects in both the ANIMAL and HOME domains, in comparison to in the No Classifier condition.

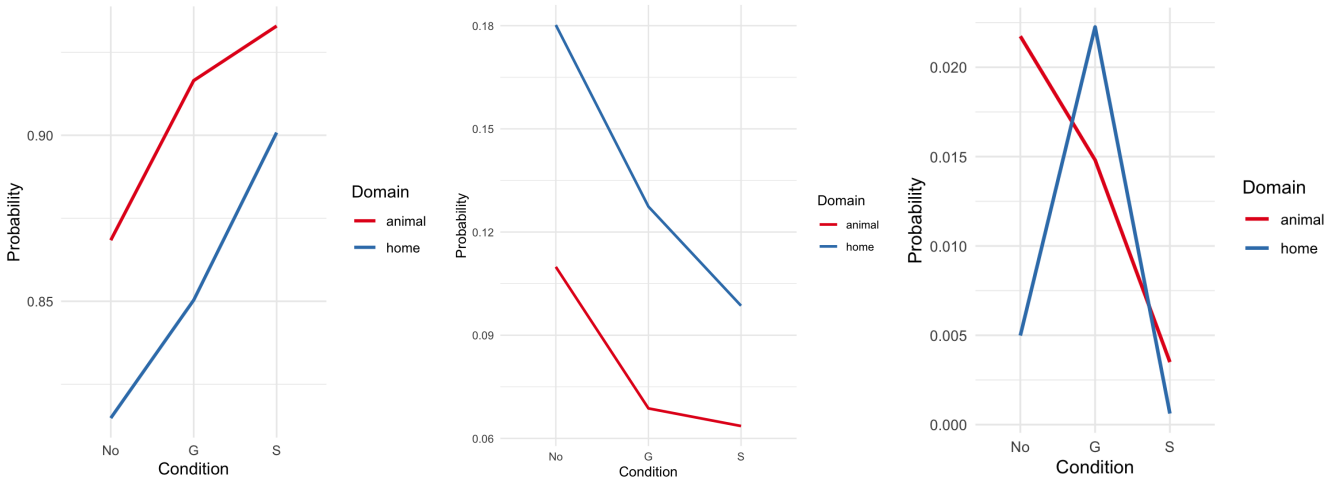
Superordinate Level In comparison with the Specific Classifier condition, using the General Classifier shows a significant effect in eliciting responses at the superordinate level in both the HOME (β=0.02, $p = 0.002$) and ANIMAL

		subordinate				superordinate						
		β	s.e.	z	p	β	s.e.	z	p	χ^2	df	p_{χ^2}
Intercept		-2.07	0.08	-26.64	*	-3.69	0.17	-22.15	*			
Condition	general classifier	-0.52	0.12	-4.23	*	-0.44	0.26	-1.67	0.09	121.65	4	*
	specific classifier	-0.62	0.13	-4.92	*	-1.90	0.44	-4.30	*			
Domain	home	0.56	0.10	5.36	*	-1.41	0.41	-3.40	*	75.66	2	*
general classifier : home		0.13	0.16	0.81	0.42	1.89	0.50	3.80	*	20.45	4	*
specific classifier : home		-0.09	0.17	-0.51	0.61	-0.29	1.16	-0.25	0.80			

Table 1: Multinomial logit model predicting taxonomic level of names (baseline level is "basic"), based on classifier condition and domain. * marks predictors that are significant at the .05 alpha level. All predictors in models improved goodness-of-fit to the data. The chi-square value associated with the reduction in data log likelihood when removing each predictor is reported in the right-most columns.

		HOME		ANIMAL	
Level	**Contrast**	**Est.**	***p*-value**	**Est.**	***p*-value**
Basic	No - G	-0.04	0.204	-0.05	0.007 ***
	No - S	-0.09	< 0.001***	-0.07	< 0.001***
	G - S	-0.05	0.015**	-0.02	0.491
Sub	No - G	0.05	0.023**	0.01	0.012 **
	No - S	0.08	$< .001$***	0.05	0.004***
	G - S	0.03	0.219	0.01	0.989
Super	No - G	-0.02	0.022**	0.01	0.667
	No - S	0.01	0.302	0.02	0.005***
	G - S	0.02	0.002***	0.01	0.042**

Table 2: Post-hoc pairwise comparison results from the multinomial logistic regression model. A positive estimate suggests that, relative to the condition on the right, the condition on the left is more likely to elicit a name at the corresponding level.



(a) Basic level (b) Subordinate level (c) Superordinate level

Figure 2: Interaction plots of condition and domain by taxonomic level, showing the predicted probability of participants responding names at specific levels under each classifier condition in each domain.

(β=0.01, p = 0.042) domains. A similar effect is also found when compared with the No classifier condition in the HOME domain (β=0.02, p = 0.022). Additionally, participants tend to use more superordinate names when there is no classifier than when prompted with a specific classifier (β=0.02, p = 0.005). This supports our H2: the inclusion of specific classifiers limits individual's word choice at the superordinate level.

Discussion

Our findings provide valuable insights into the impact of classifiers on lexical choices (specifically related to taxonomic level) when Mandarin Chinese speakers name visually presented objects. Our results support Hypothesis 1, indicating that, in general, classifiers influence an individual's lexical choices at the taxonomic level: the use of classifiers is more likely to elicit basic-level terms compared to scenarios without classifiers. However, this influence varies across domains. In the HOME domain, the use of general classifiers is more likely to prompt the production of superordinate terms compared to the condition where no classifier is used. Conversely, in the ANIMAL domain, the absence of classifiers is more likely to lead to the production of superordinate terms. A particularly intriguing pattern emerged, namely, the increased adoption of subordinate terms when no classifiers were used, contrasting with basic-level effects in a manner distinct from prior research. This pattern points to the potential influence of our specific methodology. The task used in our study, framed picture naming, may provoke specific processing dynamics that differ from those elicited in other kinds of tasks, such as traditional lexical decision tasks. We suggest that the pattern we found could be explained through the lens of the Uniform Information Density (UID) hypothesis (Levy & Jaeger, 2007). According to the UID hypothesis, speakers prefer to produce information at a relatively constant rate. In scenarios where classifiers are not used, the utterances tend to be less informative, compelling speakers to select more descriptive, subordinate terms to achieve a more balanced information density.

Furthermore, our examination of response patterns prompted by General Classifiers (GCL) and Specific Classifiers (SCL) aligns with Hypothesis 2. Under the SCL condition, there is a consistent preference for basic-level names. In contrast, when comparing GCL and SCL, the use of GCL prompts more superordinate names, while SCL prompts do not. In the context of basic-level effects, it is noteworthy that basic-level entities are deemed more cognitively efficient and information-rich than superordinate categories (Rosch et al., 1976). Thus, one plausible explanation is that SCLs, which contain more information, induce the need for additional cognitive processing space to retrieve nouns at levels other than the basic level.

In summary, our study provides evidence supporting both hypotheses we initially considered. The inclusion of classifiers, in general, leads individuals to produce names at both basic and superordinate levels. When no classifiers are used, people tend to generate more concrete names at the subordinate level. The inclusion of general classifiers significantly prompts the production of names at the superordinate level, while specific classifiers consistently lead individuals to produce names at the basic level.

Conclusion

To the best of our knowledge, this is the first study demonstrating that classifier variation is correlated with naming choices within the taxonomy field. Within the broader question of the factors influencing referring expression choice, our study specifically examines the role of Chinese classifiers in a task involving realistic visually presented objects instead of line drawings or decontextualized images. We adopt *zhi* as a general classifier of the animal realm. We find that grammatical categories influenced individuals' naming choices in conceptual organization in distinct ways. General classifiers diminished the dominance of basic-level effects, resulting in an increased usage of superordinate names. In contrast, the introduction of specific classifiers maintained the prevalence of basic-level effects, accompanied by a notable absence of superordinate names. The consistent preference for basic-level and superordinate names when prompted respectively by a specific classifier and a general classifier across both the HOME and ANIMAL domains suggests a robust influence of Chinese classifiers on participants' naming choices. These results highlight the importance of considering grammatical categories when examining object naming processes and provide insights into the mechanisms underlying language production.

Further research in this area can provide a more comprehensive picture of lexical choices across more domains and different linguistic contexts. Additionally, the observed preferences for subordinate terms when no classifiers are used prompts consideration of the potential role of methodology in influencing word production from a cognitive perspective.

Acknowledgments

We extend our deepest gratitude to the anonymous reviewers for their insightful comments and constructive criticisms. We also thank Louise McNally and Gemma Boleda for their invaluable support and guidance throughout the course of this research. Additionally, we are grateful to Paula Rubio-Fernández and the participants of the 2024 CORE Workshop held at UPF, whose probing questions and thoughtful suggestions have contributed immensely to the development of this work. This project has received funding from the Ministerio de Ciencia e Innovación and the Agencia Estatal de Investigación (Spain; ref. PID2020-112602GBI00/MICIN/AEI/10.13039/ 501100011033). We also thank the financial support from the FI-AGAUR grant (2023 FI-3 00015), the Catalan government (SGR 2021 00470), and the Department of Translation and Language Sciences at Universitat Pompeu Fabra.

References

Ahrens, K. (1994). Classifier production in normals and aphasics. *Journal of Chinese Linguistics*, *22*(2), 202–247.

Cheng, L. L.-S., Sybesma, R., et al. (1998). Yi-wan tang, yi-ge tang: Classifiers and massifiers. *Tsing Hua journal of Chinese studies*, *28*(3).

Croft, W. (1994). Semantic universals in classifier systems. *Word*, *45*(2).

Degen, J., Franke, M., & Jager, G. (2013). Cost-based pragmatic inference about referential expressions. In *Proceedings of the annual meeting of the cognitive science society.*

Erbaugh, M. S. (1986). Taking stock: The development of Chinese noun classifiers historically and in young children. *Noun classes and categorization*, 399–436.

Gao, M. Y., & Malt, B. C. (2009). Mental representation and cognitive consequences of Chinese individual classifiers. *Language and Cognitive Processes*, *24*(7-8), 1124–1179.

Geeraerts, D., Grondelaers, S., & Bakema, P. (1994). *The structure of lexical variation: Meaning, naming, and context*. Walter de Gruyter.

Graf, C., Degen, J., Hawkins, R. X., & Goodman, N. D. (2016). Animal, dog, or dalmatian? level of abstraction in nominal referring expressions. In *Cogsci.*

Grice, H. P. (1975). Logic and conversation. In *Speech acts.* Brill.

He, Y., Liao, X., Liang, J., & Boleda, G. (2023, December). The impact of familiarity on naming variation: A study on object naming in Mandarin Chinese. In J. Jiang, D. Reitter, & S. Deng (Eds.), *Proceedings of the 27th conference on computational natural language learning (conll).* Singapore: Association for Computational Linguistics.

Huettig, F., Chen, J., Bowerman, M., & Majid, A. (2010). Do language-specific categories shape conceptual processing? Mandarin classifier distinctions influence eye gaze behavior, but only during linguistic processing. *Journal of Cognition and Culture*, *10*(1-2).

Johnson, K. E., & Mervis, C. B. (1997). Effects of varying levels of expertise on the basic level of categorization. *Journal of experimental psychology: General*, *126*(3), 248.

Jolicoeur, P., Gluck, M. A., & Kosslyn, S. M. (1984). Pictures and names: Making the connection. *Cognitive psychology*, *16*(2), 243–275.

Levelt, W. (1989). Speaking: from intention to articulation.

Levy, R., & Jaeger, T. F. (2007, 09). Speakers optimize information density through syntactic reduction. In *Advances in Neural Information Processing Systems 19: Proceedings of the 2006 Conference.* The MIT Press. Retrieved from https://doi.org/10.7551/mitpress/7503.003.0111 doi: 10.7551/mitpress/7503.003.0111

Li, X.-P. (2011). *On the semantics of classifiers in Chinese*. Bar Ilan University.

Murphy, G. (2002). Conceptual approaches i: An overview. In D. Cruse, F. Hundsnurscher, M. Job, & P. Lutzeier (Eds.), *Lexicology* (Vol. 1, pp. 269–277). Walter de Gruyter.

Myers, J. (2000). Rules vs. analogy in mandarin classifier selection. , *1*(2), 187–209.

R Core Team. (2021). R: A language and environment for statistical computing [Computer software manual]. Vienna, Austria. Retrieved from https://www.R-project.org/

Rosch, E., Mervis, C. B., Gray, W. D., Johnson, D. M., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive psychology*, *8*(3), 382–439.

Schmitt, B. H., & Zhang, S. (1998). Language structure and categorization: A study of classifiers in consumer cognition, judgment, and choice. *Journal of Consumer Research*, *25*(2), 108–122.

Tai, J. H. (1992). Variation in classifier systems across Chinese dialects: Towards a cognition-based semantic approach. *Chinese Language and Linguistics*, *1*, 587–608.

Venables, W. N., & Ripley, B. D. (2002). *Modern applied statistics with s* (Fourth ed.). New York: Springer. Retrieved from https://www.stats.ox.ac.uk/pub/MASS4/ (ISBN 0-387-95457-0)

Zhang, H. (2007). Numeral classifiers in Mandarin Chinese. *Journal of East Asian Linguistics*, *16*(1), 43–59.