"Prickly Voice" or *"Smelly Voice"*? Comprehending novel synaesthetic metaphors

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Abstract

Linguistic synaesthesia involves conceptual conflicts created by two concepts from two distinct sensory domains. In previous studies, synaesthetic directionality is of pivotal interest. This study goes beyond examining the conventional synaesthetic directionality of five traditional senses by implementing the experimental method and adopting metaphor comprehension theory (i.e., Conceptual Mapping Model in particular) to explore how people comprehend novel synaesthetic metaphors. We used four measurements, including degree of commonness, appropriateness, understandability, and figurativeness, to judge people's comprehension over two main types of novel synaesthetic metaphors (presented as adjective-noun pairs): novel synaesthetic metaphors that follow conventional synaesthetic mappings and novel synaesthetic metaphors that violate conventional synaesthetic mappings. The empirical findings demonstrated that novel synaesthetic metaphors that follow conventional directionality are more common expressions, more appropriate usages, and much easier to comprehend than those that violate conventional mapping principles; those that follow conventional mapping principles are also judged as more literal than those do not follow conventional directionality. The current study supports Conceptual Metaphor Model's claim that mapping principles are the underlying reasons for the source-target domain pairings in conceptual metaphors, and further sheds light on theoretical claims about the systematicity of conceptual mappings for linguistic synaesthesia.

Keywords: novel metaphors, linguistic synaesthesia, Conceptual Mapping Model, Conceptual Metaphor Theory

1 Introduction

Linguistic synaesthesia, which examines lexical meaning transfers between basic human senses (i.e., *vision, hearing, taste, smell,* and *touch*), associates two distinct sensory domains and gives rise to a conceptual mapping between two senses. In most cases, linguistic synaesthesia is realized when a sensory lexeme from one sensory domain describes another sensory lexeme from a different sensory domain. For example, in a phrase *sweet voice*, *sweet* is a concept originated in TASTE while *voice* is a HEARING concept; the auditory concept is thus depicted by the gustatory concept. Despite ongoing discussions about whether linguistic synaesthesia is metaphorical by nature (e.g., Rakova, 2003; Williams, 1976; Winter, 2019a, 2019b), the mapping tendency from one sensory domain to another in linguistic synaesthesia is similar to the embodied nature and transfer patterns found in conceptual metaphors (for example, in the phrase *sweet voice*, HEARING is the target domain, and TASTE is the source) (e.g., Strik Lievers, 2015, 2017; Ullmann, 1957; Zhao et al., 2019). To follow the tradition in previous linguistic synaesthesia studies, we likewise approach linguistic synaesthesia as

figurative speech and term the expressions examined hereinafter 'synaesthetic metaphors.'

One crucial, as well as an intriguing phenomenon in linguistic synaesthesia studies, is synaesthetic directionality. Similar to the typical pattern as agreed in the Conceptual Metaphor Theory (CMT), i.e., from a more concrete concept (e.g., MONEY) to a more abstract concept (e.g., TIME) (Lakoff & Johnson, 1980), synaesthetic directionality also follows a particular directional pattern, from a 'lower' sense (e.g., TOUCH) to a 'higher' sense (e.g., HEARING) (see Strik Lievers et al., 2021 for a summary). The differentiation of 'lower' and 'higher' senses primarily lies in involvement and closeness of bodily contact (Shen, 1997; Shen & Aisenman, 2008) as well as with reference to subjective and/or objective information (Popova, 2005). For instance, tactile (and gustatory) sense appearing at initial points of mapping to other senses (visual and auditory senses) can be explained by their substantial involvements of bodily contact and references to subjective feelings rather than objective information.

Recent studies of linguistic synaesthesia examining contemporary corpus data in both Indo-European (e.g., English and Italian) and non-Indo-European languages (e.g., Chinese) have proposed a more fine-grained mapping tendency based on the frequency of transfers (e.g., Strik Lievers, 2015; Zhao et al., 2019). As exhibited in the following figure, instead of simply mapping from one sense to another, Strik Lievers (2015) assigned a frequency percentage between two sensory domains according to the total number of synaesthetic cases analyzed in an English corpus.

As shown in Figure 1, sensory domains including TOUCH (49.3%), TASTE (25.7%), VISION (21.8%), predominantly act as source domains when they are compared to HEARING (3.0%) and SMELL (0.2%). On the contrary, HEARING (52.3%), VISION (28.0%), and SMELL (12.4%) far outnumber the frequency when TASTE (5.3%) and TOUCH (2.1%) are used as

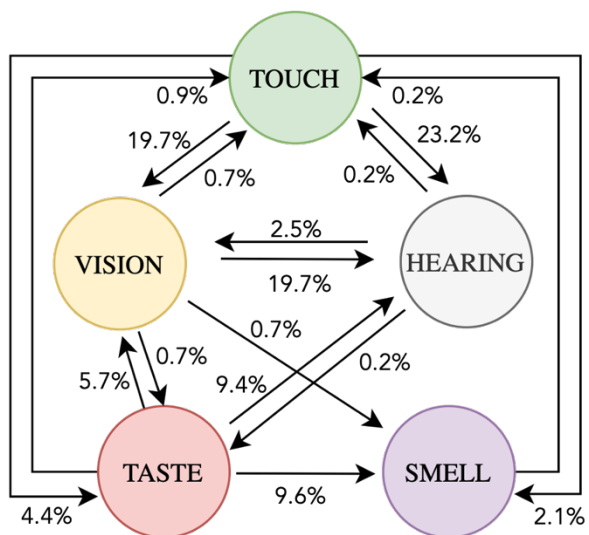target domains; therefore, they are the three major target domains.[1]

Figure 1. Frequency of synaesthetic transfers in English (adapted from Strik Lievers, 2015, p.80)

We can observe from recent studies that when synaesthetic directionality is examined in a more contemporary and larger dataset, it exhibits a more bidirectional pattern than a unidirectional tendency as found in earlier literary works (Ullmann, 1957) and dictionaries (Williams, 1976). Although the bidirectionality seems to have violated the unidirectional mapping from 'lower' to 'higher' senses, the bidirectional frequency shows that certain sensory domains are still more habitually served as source domains than the target, and vice versa. Zhao et al. (2019) further summarized that those unidirectional transfers between two sensory modalities obey a 'rule-based' directionality, while other biased-directionaland bidirectionaltransfers are mainly based on frequency.[2]

What is interesting to note is that synaesthetic directionality is presumedly mutable and fluid along with the creative use of language. In Zhong et al.'s (to appear) examining of gustatory vocabulary in Mandarin Chinese with a more recent corpus (i.e.,

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[1] The percentage in the parenthesis shows the sum of frequency when a sensory domain acts as a source domain or a target domain. For example, 23.2% of TOUCH transfers to HEARING, 19.7% to VISION, 4.4% to TASTE, and 2.1% to SMELL, which makes a total of 49.3% as the sum of frequency when TOUCH acts as a source domain.

[2] Biased-directional transfers are those transfers that occur in both directions, but the mapping from one sensory domain to

another has a much higher frequency than the mapping in the other way around. For example, the frequency of TOUCH to HEARING is much higher than that of HEARING to TOUCH, as shown in Figure 1 (23.2% vs. 0.2%). Bidirectional transfers are cross-mappings between two senses, but there is no obvious higher frequency from one to another; for example, TOUCH to SMELL (2.1%) and SMELL to TOUCH (0.2%), as shown in Figure 1.

corpus data from the web in 2017 [Kilgarriff et al., 2014]) than the data used in Zhao et al. (2019) (i.e., Sinica Corpus built in the 1990s [Chen et al., 1996]), it is observed that abstract concepts originated in the visual sense were frequently adopted to modify the more concrete domains, i.e., TASTE and SMELL.[3] Examples included 樸實[VISION/source]的味道[TASTE/target] *pǔshí_de_wèidào* 'simple taste', 清新活潑[VISION/source]的味道[TASTE/target] *qīngxīn_huópō_de_wèidào* 'fresh and lively taste', and 霸道[VISION/source]的味道[TASTE/target] *bàdào_de_wèidào* 'strong taste/smell.' This finding is consistent with the analysis of mouthfeel items used to describe desserts, in which words that stemmed mainly from impressions of personalities gained through social interactional contact were often used to illustrate the mouthfeel of desserts, and in turn, gave rise to a conceptual metaphor of TASTE IS PERSONALITY in Chinese (Zhong & Huang, 2018, 2020). Note that TASTE is deemed a source domain rather than a target domain, while VISION has very limited participation in TASTE, SMELL as well as TOUCH in most languages. This leads us to question if novelty, which is considered an important feature to distinguish different types of metaphors (i.e., conventional metaphors and novel metaphors), will also influence synaesthetic directionality to a certain extent.

2 Conceptual Mapping Model

Before delving into the central question of the interaction of novelty and synaesthetic directionality, we would like first to explore how easily people can understand novel synaesthetic metaphors.

Different views of metaphor processing saw metaphors understood by comparison (shared features of the metaphor vehicle and the topic [e.g., Gentner, 1983]), via categorization (shared category of the vehicle and the topic [e.g., Glucksberg et al., 1993; Glucksberg et al., 1997], or a combination of comparison and categorization but with a focus on the conventionality (a novel vehicle is understood by comparison, whereas a conventional metaphor is comprehended by categorization [e.g., Bowdle & Gentner, 2005]). However, none of the above

comprehension models seemed to consider embodied ground of the metaphors (Barsalou, 2008; Gibbs, 2006) or attempted to distinguish different types of novel metaphors.

Ahrens (2010) proposed a framework of the Conceptual Mapping Model (CMM) in order to better understand the position and development of novel metaphors in the Conceptual Metaphor Theory. She adopted mapping principles to account for the source-target domain pairings. The mapping principles are generated from entities, quality, and functions of metaphorical expressions with reference to the source domain using a top-down approach, or are the frequent mapping patterns verified by corpus data via a bottom-up method (e.g., Ahrens et al., 2004). Mapping principles have been validated in both online and offline experiments at a sentence level (Ahrens, 2010) and a discourse level (Ahrens & Gong, 2021; Gong & Ahrens, 2007). According to CMM, novel metaphors differ in their compliance with mapping principles of the conceptual metaphors. In particular, there are two main types of novel metaphors: novel metaphors that adhere to mapping principles and novel metaphors that do not. CMM additionally predicts those novel metaphors following mapping principles are more acceptable and interpretable than those not following mapping principles, and therefore less cognitive effort is needed in the comprehension of the former type.

CMM is thus seen as an ideal comprehension model to test the understandability of novel linguistic synaesthetic metaphors. On the one hand, recent synaesthetic directionality has proposed frequent mapping principles based on the corpus data, as described in the above section; on the other hand, CMM can predict different types of novel metaphors with respect to their acceptability and interpretability. As the first study of novel synaesthetic metaphors, this paper asks two main questions:

1) Will the novel synaesthetic metaphors that follow conventional mappings differ from those that do not in terms of how they are comprehended?

2) Will the conventional mapping principles still hold when it comes to the

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[3] Two sensory modalities are considered because in Chinese, the word 味道 *wèidào* contains meanings from both gustatory

and olfactory senses, and most of time it is not possible to distinguish if the word refers to taste or smell.

comprehension of novel synaesthetic metaphors?

3 Method

This study adopts offline experiments to invite naive participants to judge novel synaesthetic metaphors in relation to comprehension of metaphors. Subjective ratings are valuable sources to operationalize how easily people understand the metaphorical expressions and how metaphorical the expressions are; the ratings also contribute to testing psycholinguistic theories of metaphor processing (e.g., whether metaphors are understood via comparison or categorization) (Thibodeau et al., 2018).

In previous research, several psycholinguistic dimensions have been suggested as possible indicators that can influence metaphor comprehension, for example, **conventionality (familiarity)**, **aptness**, **imageability**, **ease of interpretation**, and **metaphoricity** (Cardillo et al., 2010; Katz et al., 1988; Thibodeau et al., 2018). Among these dimensions, **conventionality (familiarity)** and **aptness** are the two prominent dimensions most related to metaphor processing fluency, and they are highly correlated with each other (Jones & Estes, 2006; Thibodeau & Durgin, 2011).

3.1 Stimuli

In synaesthetic metaphors, metaphor vehicles are typically represented by adjectives, while metaphor topics are frequently nouns. Therefore, in this study, we would like to start with testing a simple construction, i.e., Adjective[source] + Noun[target] phrase.

Following CMM, we have designed two types of novel synaesthetic metaphors:
1) **Novel_1**: novel synaesthetic metaphors that follow conventional synaesthetic mappings, but with a novel lexical item that is not usually used in that mapping.
2) **Novel_2**: novel synaesthetic metaphors that violate conventional synaesthetic mappings; the cross-domain pairing is also much less frequent than that in Novel_1, or there is no cross-domain pairing found in previous studies.

We further set a **literal control** condition, in which no metaphor vehicles are involved, or both the source and target domains are from the same sensory domain.

Conditions	Novel_1	Novel_2	Literal
Stimulus	***silky sound***	***fragrant sound***	*soothing sound*
Directionality	TOUCH to HEARING	SMELL to HEARING	--

Note. The bolded words are the metaphor vehicles, and 'sound' is the topic across three conditions.

Table 1. A sample of stimulus

3.1.1 Stimuli manipulation

First, we referred Strik Lievers' (2015) frequency of synaesthetic directionality in English to control the directionality across the conditions. For example, as shown in Table 1, TOUCH to HEARING is a conventional mapping as examined in her study (23.2%); and there is a conventional synaesthetic phrase *smooth sound* which follows this conventional mapping principle. In Novel_1, we used another metaphor vehicle, i.e., *silky*, to replace *smooth* in this conventional directionality. With the target domain (i.e., HEARING) and the topic (i.e., *sound*) unchanged, we chose another metaphor vehicle (i.e., *fragrant*) from another sensory domain (i.e., SMELL) to form a stimulus in Novel_2. The directionality in Novel_2 was further checked in Strik Lievers (2015) to make sure the directionality is novel or the frequency tendency is extremely low.

The selection of metaphor vehicles pertaining to a specific sensory domain is not random either—Lynott et al.'s (2019) sensorimotor norms were used to check if the chosen sensory domain is dominant in that metaphor vehicle. Their study invited native speakers of English to rate words with respect to each of the sensory modality on a scale from 0 to 5. For example, *silky* received a rating of 4.64 in the tactile, 2.86 in the visual, 0.79 in the auditory, 0.29 in the gustatory, and 0.07 in the olfactory sense; so that we can confirm that *silky* is mainly relevant to TOUCH, given that tactile sense is the dominant modality for this word.

In addition, all the metaphor vehicles used in Novel_1 and Novel_2 and the adjectives used in literal condition were controlled for their concreteness according to the ratings in Brysbaert et al. (2013) and emotional valence (positive/negative) based on the ratings in Warriner et al. (2013). The frequencies of phrases in the three conditions were further checked in the *Sketch Engine* (Kilgarriff et

al., 2014) using the English Web 2020 (en TenTen20) corpus data.[4] The frequency for the phrases in Novel_1 ranged from 0 to 13, with an average frequency of 4.6; Novel_2 conditions contained phrases with 0 to 3 instances in the corpus data, averagely 0.5. That is to say, all the phrases are fairly 'novel' and seldom be heard or used in daily life.

3.2 Procedure

We designed 10 phrases for each condition, i.e., 30 in total. The 30 stimuli were randomized and presented on a survey platform SurveyMonkey (www.surveymonkey.com) to collect responses from the naive participants.

According to the dimensions relevant to metaphor comprehension, we revised to four measurements that befitted our stimuli; and we invited participants to rate on a 7-point Likert scale. Four measurements included:

1) **Degree of commonness**: 1 = *very uncommon expression* to 7 = *very common expression*;
2) **Degree of appropriateness**: 1 = *very inappropriate usage* to 7 = *very appropriate usage;*
3) **Degree of understandability**: 1 = *very easy to understand* to 7 = *very hard to understand*;
4) **Degree of figurativeness**: 1 = *very literal expression* to 7 = very figurative expression.

3.3 Participants

A total of 432 participants (108 per measurement) were recruited on Amazon's Mechanical Turk (http://www.mturk.com). Each participant was rewarded with US$0.80 in exchange for participation. We used Mechanical Turk's inclusion function to ensure that the participants were located in the United States, had a HIT approval rate greater than 95%,[5] and had never participated in any of our similar studies.

Apart from screening to ensure that all the participants should be native speakers of English (i.e., English was the ONLY language that they grew up speaking), we also set two criteria to control the quality of results. One criterion is that the mean score for the literal phrases in the measurements of commonness and appropriateness should be larger than 5 (i.e., these literal phrases are supposedly considered common expressions and appropriate usages). The other is that the mean score for the literal phrases in the measurements of understandability and figurativeness should be less than 3 (i.e., these literal phrases are supposedly considered easy to understand and literal expressions).

308 participants remained after data screening: 72 for the measurement of commonness (female = 25 [34.7%], male = 47 [65.3%]; M_{age} = 39.3 years old, SD_{age} = 11.1, $range_{age}$ = 18 ~ 74); 78 for appropriateness (female = 34 [43.6%], male = 44 [56.4%]; M_{age} = 39 years old, SD_{age} = 10, $range_{age}$ = 23 ~ 69); 80 for understandability (female = 47 [58.8%], male = 33 [41.3%]; M_{age} = 37.7 years old, SD_{age} = 11.7, $range_{age}$ = 20 ~ 68); 78 for figurativeness (female = 33 [42.3%], male = 45 [57.7%]; M_{age} = 39.8 years old, SD_{age} = 11.6, $range_{age}$ = 22 ~ 69).
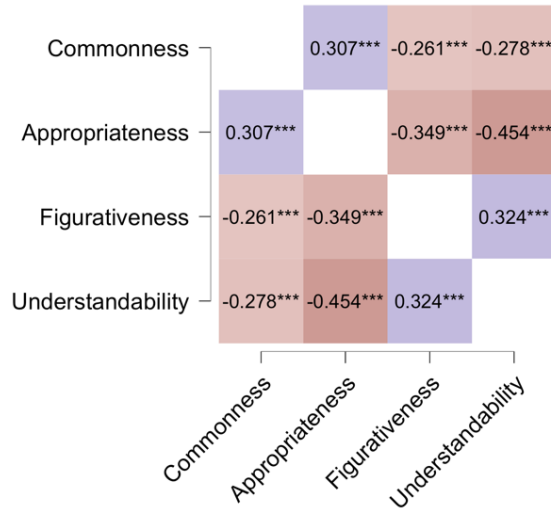
4 Results

Results from the repeated measures ANOVA showed that a statistically significant difference suggested in all the four measurements. First, we found a main effect of **degree of commonness**: $F(2, 2157)$ = 239, $p < .001$, η^2p = .181. Pairwise comparisons with Bonferroni corrections demonstrated that Novel_1 (M = 4.24, SD = 2.04) and Novel_2 (M = 3.62, SD = 2.19) were more uncommon expressions than the literal condition (M = 5.74, SD = 1.34, $p < .001$); Novel_1 was more common than Novel_2, $p < .001$. With regard to the effect of **degree of appropriateness**: $F(2, 2337)$ = 514, $p < .001$, η^2p = .305. Post hoc comparisons suggested that Novel_1 (M = 4.56, SD = 1.85) and Novel_2 (M = 3.38, SD = 2.09) were less appropriate usage when compared to the literal (M = 6.22, SD = 1.20, $p < .001$); moreover, Novel_1 was more appropriate than Novel_2, $p < .001$. In terms of the **degree of understandability**: $F(2, 2397)$ = 865, $p < .001$, η^2p = .419. Pairwise comparisons showed that Novel_1 (M = 3.49, SD = 1.87) and Novel_2 (M = 4.79, SD = 1.89) were much harder to understand than the literal (M = 1.44, SD = 0.92, $p < .001$); but Novel_1 was easier to

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[4] This is a corpus consists of 38 billion words and is made up of texts collected from the Internet between 2019 and 2021.

[5] A HIT approval rate means the proportion of completed tasks that are approved by requesters.

understand than Novel_2, $p < .001$. Last but not least, a main effect of **degree of figurativeness** was also suggested: $F(2, 2337) = 355$, $p < .001$, $\eta^2 p = .233$. Novel_1 ($M = 4.71$, $SD = 1.91$) and Novel_2 ($M = 5.21$, $SD = 1.80$) were much more figurative than the literal ($M = 2.87$, $SD = 1.77$, $p < .001$); however, Novel_1 was less figurative than Novel_2 at a significance level of 0.001.

We further computed the correlation among the four measurements, as shown in Figure 2:

Note. * p < .05, ** p < .01, *** p < .001

Figure 2. Correlation matrix of the four measurements

The correlation results demonstrated that **commonness** and **appropriateness** were positively correlated: $r = 0.31$, $p < .001$, while **figurativeness** and **understandability** were positively correlated: $r = 0.32$, $p < .001$. In addition, **figurativeness** was negatively correlated to **commonness** ($r = -.26$, $p < .001$) and to **appropriateness** ($r = -.35$, $p < .001$); **understandability** was also negatively correlated to **commonness** ($r = -.28$, $p < .001$) and **appropriateness** ($r = -.45$, $p < .001$). However, all of the correlations are rather weak or moderate.

5 Discussion

From the results, we can observe that those novel synaesthetic metaphors that follow conventional mappings principles differ significantly from those that do not in terms of how they are comprehended. More specifically, novel synaesthetic metaphors that follow conventional mappings were judged to be more common, more appropriate, and much easier to understand than those that violate conventional mappings. They are also less

metaphorical compared to those novel synaesthetic metaphors that do not follow mapping principles.

One possible explanation is the structural similarity between Novel_1 and conventional synaesthetic metaphors. The metaphor vehicles used in Novel_1 are presumably analogous to those in the conventional synaesthetic phrase; for example, to compare *sharp*[conventional] *voice* and *prickly*[novel_1] *voice*; *sweet*[conventional] *perfume* and *savory*[novel_1] *perfume*; *thick*[conventional] *taste* and *rubbery*[novel_1] *taste*. On the contrary, the vehicles in Novel_2 are from a different category (i.e., a different sensory domain from the source domain used in the conventional mapping), the analogical reasoning did not take effect in comprehension of these novel metaphors anymore; for instance, to consider *sharp*[conventional] *voice* and *smelly*[novel_2] *voice*; *sweet*[conventional] *perfume* and *rhythmic*[novel_2] *perfume*; *thick*[conventional] *taste* and *hoarse*[novel_2] *taste*. In other words, comprehension of novel synaesthetic metaphors that follow conventional constructions possibly evoke an analogical comparison, which is similar to the comprehension of novel metaphorical expressions as hypothesized by the Career of Metaphor Model (Bowdle & Gentner, 2005). However, such comparison is made between the similar lexical items used in conventional and novel synaesthetic metaphors instead of between the source and target domains in the novel metaphor per se. Yet, without interpretation of the novel expressions, it is not readily apparent that people will reach the same meaning as that of the conventional metaphors.

This leads to the second question of mapping principles in the comprehension of novel synaesthetic metaphors. We propose that the directionality of conventional synesthetic metaphors still holds when it comes to the comprehension of novel synaesthetic metaphors, given that people more accept expressions that strictly follow the directionality of conventional synesthetic metaphors, even though these phrases are also rarely heard or used. The present results are in line with Ahrens' (2010) and Ahrens and Gong's (2021) studies on comprehension of novel metaphors at sentential and discoursal levels, with a consistent finding showing that processing of novel synaesthetic phrases that violate conventional mapping principles are judged as much harder to process than those that follow mapping principles. This study also provides additional support for

CMM, i.e., mapping principles are the underlying reasons for the source-target domain pairings in conceptual metaphors.

One more thing to note is that figurativeness is also correlated to the processing of novel synaesthetic metaphors. In particular, when a synaesthetic mapping is considered more metaphorical, this expression will be harder to comprehend. Furthermore, figurativeness also distinguishes novel mappings from conventional mappings, even though all the lexical items in Novel_1 and Novel_2 are fairly concrete (i.e., average concreteness rating for Novel_1 vehicles is 3.55; while the mean score of concreteness of Novel_2 is 3.20; 1 = *very abstract*; 5 = *very concrete*) and embodied (all the lexical items in Novel_1 and Novel_2 are strongly related to one particular sensory domain).

This study opens another window to look at synaesthetic directionality and linguistic synaesthesia from the perspective of comprehension of novel synaesthetic metaphors. The pivotal position of mapping principles in linguistic synaesthesia has been attested in novel expressions. Overall speaking, linguistic synaesthesia seems to provide a joint mechanism for conventional and novel synaesthetic metaphors; the underlying principle of synaesthetic directionality, i.e., low-to-high mapping as discussed previously, is considered solid and sound in comprehending creative expressions. In addition, we have also associated metaphoricity with the novelty of directionality in this study. We hypothesize that linguistic synaesthesia is metaphorical in a sense that it is not a single lexical item used in a cross-sensory pairing that contains or triggers a metaphorical meaning (e.g., if *sweet* is metaphorical or not), it is rather the conflicting *post hoc* meaning that the cross-sensory pairing evokes makes the expression metaphorical. Yet, how metaphoricity interacts with mapping principles of linguistic synaesthesia still awaits further investigation.

6 Conclusion

This empirical study of comprehension of novel synaesthetic metaphors examined how two types of novel metaphors differ in terms of the degree of commonness, appropriateness, understandability and figurativeness. We found that novel synaesthetic metaphors that follow conventional mapping principles are more common expressions, more appropriate usages, and much easier to comprehend than those that violate conventional mappings; they are also considered more literal when compared to those that do not follow mapping principles. We propose that, firstly, semantic similarity of lexical items may elicit a conventional mapping that is frequently used in the language; secondly, only when this conventional mapping is in force, comprehension of novel synaesthetic metaphors will be stimulated. These findings reaffirmed the modulating effect of conventional directionality in comprehending novel expressions. In other words, mapping principles of linguistic synaesthesia may facilitate processing and comprehension of novel synaesthetic metaphors, but they only take effect when the source and target sensory domains are congruent and systematic with the conventional mappings.

Note that due to space limit, the underlying perceptual and cognitive motivations for the synaesthetic directionality are not discussed in this study. Future work will increase the number of stimuli and to compare specific sensory domains in a mapping to further test the systematicity of synaesthesia directionality; for example, if the mapping from HEARING to SMELL is more comprehensible and/or more figurative than HEARING to VISION. It is also worth collecting people's interpretations of two types of novel synaesthetic metaphors to better understand how they reason about linguistic synaesthesia.

Acknowledgments

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