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Abstract

Research on cross-linguistic categorization reveals that there were universal principles constraining the categorization of motion events across languages, and variations only distributed in a limited range. However, this finding has not been widely verified across languages and semantic domains. In this paper, we will address whether the universal constraints exist in the cross-linguistic categorization of throwing events, with the data collected with a behavioral approach. We asked 79 adult native speakers of English (12 male, 17 female), Chinese (15 male, 15 female), and German (18 male, 12 female) to perform actions denoted by near-synonymous ‘throw’ verbs in their native languages. Then we coded the features of their actions and compared them across individuals and languages. The results support the finding of previous studies that event categorization is constrained across languages. In addition, the top-down approach we adopted in this study allowed us to capture the focal and extensional semantic range of each verb involved, which advanced our knowledge of event categories and different semantic representations of a class of near-synonyms.

Keywords: event categorization; verb semantics; near-synonyms, behavioral approach

1. Introduction

Speakers of different languages are believed to perceive the world differently. Based on the ways of encoding motion events into verb meanings, Leonard Talmy (1985) categorized languages into Verb-framed and Satellite-framed languages. Since then, many empirical studies have found that lexicalization patterns influence people's perception of motion events. Speakers of typologically different languages have tendencies of mentioning different motion aspects (Naigles, Eisenberg, Kako, Highter, & McGraw, 1998) or choosing Manner or Path verbs to describe a motion event (Papafragou, Massey, & Gleitman, 2002), and they may focus on different event components when predicting the meaning of a novel motion verb (Papafragou, Hulbert, & Trueswell, 2008; Papafragou, & Selimis, 2010; Trueswell, & Papafragou, 2010). Studies also found that even learning a typologically different language may change the pattern of path expression in L2 learners' first language (Hohenstein, 2005; Brown, & Gullberg, 2010; Aveledo, & Athanasopoulos, 2015), indicating that speakers' attention to event components could be influenced by the learning of a second language.

As empirical studies have gone finer and evidence has grown, whether typology membership can fully reflect how speakers perceive motion events has been questioned (e.g., Papafragou, Massey, & Gleitman, 2006).

First, despite the differences in lexicalization patterns between languages of different typologies, universal constraints/principles were found in the way of encoding event components into verb semantics cross languages of different typology categories (Bohnenmeyer et al., 2007). Asifa Majid and colleagues (2008) examined how event categorization by speakers of different languages was constrained by universal principles. They prepared sixty-one video clips depicting cutting/breaking events, and asked native speakers of twenty-eight languages to describe them. The results show that speakers across languages generally relied on the same event features as dimensions to distinguish cutting events and breaking events. Among all event features, biological parameters were believed to have constrained the lexicalization patterns across languages. Mila Vulchanova ~~and colleagues~~ et al. (2012) employed a free naming task to see how biological motion is encoded in the five languages: Bulgarian, Russian, English, Norwegian, and Italian. By analyzing the verbal production for twenty-nine motions performed by human and animals, similar patterns were observed across languages and thus were considered as a reflection of physical parameters. Similarly, Barbara Malt and colleagues (2008, 2014) asked native speakers of English, Dutch, Spanish, and Japanese to describe twenty-four video clips of human locomotion (running and walking). Their verb production and event features (speed and slope) were then analyzed categorically. The findings indicated that the speakers across languages generally followed the same dimension (the biomechanical discontinuity between running and walking) in categorizing the two actions.

Second, differences in encoding event components within typologically the same languages were discussed based on the examination of semantic granularity among

languages with the same typology membership. Asifa Majid ~~and colleagues~~et al. (2007) found that German, English, Swedish and Dutch have different numbers of categories describing cutting and breaking events, and the differences were also found in the boundaries of categories and the verb semantic relationships. Anetta Kopecka (2010) pointed out that although English and Polish are both satellite-framed languages, Polish does not rely on Manner verbs to express Manner information as much as English does. Moiken Jessen (2013) found that German motion verbs describe more fine-grained Manner distinctions than Danish, although they share the same typology membership. This evidence indicates that languages sharing the same typology membership could describe and represent motion events in different ways.

The exploration of universal principles of encoding event components across typologically diverse languages has deepened our understanding of the relationship between structures of world and their linguistic representations from a wider perspective. Meanwhile, looking into the variation of event encoding within languages of the same typology will lead us to the discovery of the causes of the variation. Both areas are worth examining to advance our knowledge in the understanding of how motion events are mentally represented in speakers of different languages. Thus, there is a need to widen the research scope and refine the research methodology. Our current study was designed to meet the need. We adopted a behavioral approach to investigate the categorization of throwing events ~~how by~~ speakers of English, Chinese and German ~~categorize throwing events~~.

2. This study

To widen the research scope, we selected throwing events as the semantic domain to verify the argument that event categorization by speakers across languages was constrained by universal principles. By choosing throwing events as our targeted semantic domain, we will be able to evaluate whether the theory of event categorization derived from boarder categories is applicable to narrower categories. Previous investigations of how speakers of different languages separate two event categories (walking versus running; cutting versus breaking) proposed that cross-linguistic categorization of action events was constrained by universal principles (Majid et al., 2008; Malt, et al., 2009). In the current study, we will verify whether the categorization process is still constrained by some universal principles when speakers of different languages distinguish sub-categories of throwing events. If the argument still holds, the theory derived from previous studies can be proven valid for more languages and more categories of different semantic domains and sizes.

To refine research methods, we adopted a behavioral approach to elicit speakers' understanding of action verbs, a way to looking into the categorization/encoding patterns in their native languages. Most previous studies on motion events encoding/categorization used visual stimuli to elicit verbal responses from speakers. Although justifications were given, the stimuli chosen may not be ideal or appropriate for the experiments of event categorization, since researchers' knowledge or assumptions could be involved. Hence, the responses by speakers may only reflect the speakers' understanding of the events captured by the video stimuli, and conclusions drawn from such studies should be handled with caution, since there is a risk of their inappropriate

application to cases or scopes beyond the studies. In other words, it is not advisable to select and investigate a few event representations and then yield a conclusion that applies to a larger scope. Since there has not been a general guideline for preparing visual stimuli for research of categorization, it is difficult for researchers to decide what visual stimuli should be chosen, which has actually discouraged empirical studies on event categorization. For example, the theoretical argument proposed more than ten years ago that event categorization by speakers across languages was constrained by universal principles, has not been widely addressed or verified across languages and semantic domains.

In a recent study conducted by Helena Gao, Wang, and Nicoladis (2016), behavioral experiments were applied to the investigation of the physical representations of ‘throw’ verbs in Mandarin Chinese. They asked native speakers of Mandarin Chinese to perform actions denoted by six ‘throw’ verbs in Chinese. By analyzing the physical features of the action performance, they distinguished the six near-synonymous verbs in terms of the prototypical representations and the extensional range of each verb. In the perceptual experiment in the same study, the representations elicited from native speakers in the behavioral experiment successfully initiated another group of native speakers’ oral production of the corresponding verbs. The behavioral approach was proven to be an effective research paradigm for specifying the lexical semantics of action verbs.

We believe that the behavioral approach to the study of event categorization is reasonable, because the ‘throw’ verbs are actually the labels of different sub-categories of throwing events. Partonomical structure, temporal order, and typicality structure have been considered as the nature of event category (Hanson & Hanson, 2005), and throwing

events denoted by any ‘throw’ verbs bear the three properties. Any single throwing action comprises a few simpler actions, such as holding an object, while moving one’s hand and arm (Gao, 2001). Besides, like any events, throwing events occupy time and the simple fractions of the actions of throwing events take place one after another in a fixed order. In addition, for the class of ‘throw’ verbs in Chinese, there exists a most representative one and a few others that are similar in one way or another (Gao et al., 2016). Therefore, to investigate how speakers distinguish near-synonymous ‘throw’ verbs in terms of physical representations, is actually to discover how people categorize throwing events in their native language.

3. Method

3.1 Targeted ‘throw’ verbs

We chose six most frequently used ‘throw’ verbs in English (throw, fling, chuck, cast, toss, hurl)¹, Chinese (扔 *rēng*, 丢 *diū*, 抛 *pāo*, 投 *tóu*, 摔 *shuāi*, 甩 *shuǎi*)², and German (*werfen*, *schmeissen*, *stossen*, *schleudern*, *pfeffern*, *schmettern*)³.

¹ [The selection was](#) based on *The Corpus of Contemporary American English* (Davies, 2011)

² [The selection was](#) based on *Lexicon of Common Words in Contemporary in Chinese* (National Committee of Chinese Language, 2008)

³ [The selection was](#) based on *Deutsche Referenzkorpus* (Institut für Deutsche Sprache, 2012)

3.2 Participants

Thirty native speakers of Mandarin Chinese (15 male, 15 female, Mean Age = 20.15, SD = 1.01) recruited in northern China, 30 native speakers of German (18 male, 12 female, Mean Age = 22.02, SD = 1.83) recruited in Germany, and 29 native speakers of English (12 male, 17 female, Mean Age = 21.89, SD = 1.56) recruited in Singapore and Berlin participated in this study. All of the English speakers were exchange undergraduate students from English speaking countries⁴. They had lived in Singapore and Berlin for less than a year before participating in the study. All the participants only spoke their native languages in their daily life.

3.3 Procedure

Participants were not informed of the study in detail in advance. They each took the experiment individually. First, the experimenter showed the six ‘throw’ verbs to the participant in his/her native language, and then asked him/her to stand with his/her left body next to a wall and hold a novel object (palm size, made from a coke can, which was not able to be identified or named by any of the participant.) in his/her right hand. Two digital cameras were set in the front and at the right side of the participant. The participant was told to perform actions according to the instructions orally administered by the experimenter: ‘Please V it’ in English, ‘*Qǐng V zhè ge dōngxi* (请 V 这个东西)’ in Chinese, or ‘*Können Sie das bitte V*’ in German. ‘V’ is one of the six

⁴ USA (N=16), England (N=6), Scotland (N=1), Ireland (N=2), Canada (N=2), Australia (N=2).

‘throw’ verbs in each language. When the participant completed each action, he/she picked up the object and returned to the initial position.

In this way, each participant performed six actions corresponding to the six ‘throw’ verbs in a random order. To ensure that the participants were consistent with their performances and to minimize random errors, we repeated the experiment procedure for each participant right after he/she completed the first round. That is, each participant performed twelve actions in total with two actions for each verb. All the actions were videotaped from front and side angles.

3.4 Data Transcription

3.4.1 Coding Criteria. We transcribed the recorded actions of the participants’ throwing by coding the observable components into numerical values.

FORCE was coded on a five-point scale (5 = very strong; 4 = strong; 3 = medium; 2 = weak; 1 = very weak).

Initial Arm Pose (henceforth ARM) and Initial Hand Height (henceforth HAND) were the features of physical position before the action was performed. According to Gao (2001), the hand contact of the object is the precondition of an throwing action and the agent keeps the position for a short while before the action. Our observations in the experiment showed that ARM and HAND varied across participants and verbs. We assumed that they might also be the variables that could distinguish the ‘throw’ verbs. The initial arm pose was observable and objective (coded as 1=straight; 0=bend), but the absolute height of hand was correlated to the absolute height of the participant. So we

used relative height to code HAND (0 = ground level; 10 = participant height; 11 = one unit above participant height; 12 = two units above the participant height; etc.)

Based on the video recordings from the front and the side perspectives, we coded the value of the trajectory of the hand movement, namely Vertical Direction of Hand Movement (henceforth VD, 1 = downward; 0 = upward) and Horizontal Direction of Hand Movement (henceforth HD, 1 = forward; 0 = sidewise).

3.4.2 Coders. The data transcription was done by two coders (one was a PhD student in linguistics, and the other was a PhD student in psychology). Following the coding criteria, each coder coded all variables for all video recordings. The overall inter-coder reliability is high (Cohen's Kappa= 0.74).

To combine the transcribed data from two coders, we took the mean value of the two continuous variables (FORCE and HAND). For the categorical variables (VD, HD and ARM), we excluded a few minor inconsistent values caused by participants' ambiguous performances and took only the agreed ones for data analysis.

4. Results

For each 'throw' verb, we collected data from two rounds of participants' action performance and compared them with Pair sample T-test and Chi Squared Analysis for continuous variables and categorical variables respectively. No significant difference was found in any variables between the two rounds of action performance, which indicates that the actions performed by the participants were consistent. We chose to use the data from the first round for data analysis, as the data from the second round might be affected

by the participants' experience from the first round. Table 1 shows the descriptive statistics of the five action features characteristic of all 'throw' verbs in the study. For the categorical variables, the frequencies of both values were provided in the table.

Table 1: The descriptive statistics of action features for 'throw' verbs

Chinese 'throw' verbs	FORCE		HAND		ARM		HD		VD	
	Mean	SD	Mean	SD	bend	straight	forward	sidewise	upward	downward
<i>rēng</i> 扔	3.05	0.51	5.43	1.82	11	18	21	8	21	8
<i>diū</i> 丢	2.33	0.83	4.63	1.08	6	24	16	12	23	5
<i>pāo</i> 抛	3.16	0.45	6.65	2.52	14	15	29	1	30	0
<i>tóu</i> 投	3.21	0.52	9.13	0.79	30	0	30	0	29	1
<i>shuāi</i> 摔	4.55	0.56	8.51	1.11	29	0	25	4	0	29
<i>shuǎi</i> 甩	3.74	0.68	6.27	1.49	21	8	9	20	14	15
English 'throw' verbs'	FORCE		HAND		ARM		HD		VD	
	Mean	SD	Mean	SD	bend	straight	forward	sidewise	upward	downward
throw	3.62	0.64	8.58	1.91	24	5	29	0	26	3
fling	3.44	0.70	6.41	1.62	17	11	25	4	27	2
chuck	3.91	0.68	7.06	2.18	19	10	27	2	21	8
cast	3.01	0.47	6.18	2.30	15	14	27	2	28	1
hurl	4.39	0.74	8	2.07	21	8	28	1	24	5
toss	3.01	0.22	4.5	1.63	3	26	29	0	29	0
German 'throw' verbs'	FORCE		HAND		ARM		HD		VD	
	Mean	SD	Mean	SD	bend	straight	forward	sidewise	upward	downward
<i>werfen</i>	3.25	0.47	8.41	1.76	26	4	30	0	30	0
<i>stossen</i>	3.42	0.65	7.51	0.95	27	1	28	0	24	4
<i>schleudern</i>	4.1	0.62	7.38	1.87	21	8	30	0	22	8
<i>schmeissen</i>	3.81	0.74	8.3	1.70	27	3	30	0	20	10
<i>schmettern</i>	4.79	0.40	9.72	1.36	25	3	29	0	4	25
<i>pfeffern</i>	4.41	0.76	8.61	1.48	29	1	30	0	6	24

4.1 Continuous dimensions for categorization

To find out the dimensions for semantic categorization of throwing events, we examined whether the value of each variable differed across the six verbs in each language.

We performed one-way repeated measure ANOVA for continuous variables. The results with a Greenhouse-Geisser correction are shown in Table 2.

Table 2: Differences among the six verbs in FORCE and HAND in the three languages

	English			Chinese			German		
	sig.	Partial Eta Square	F	sig.	Partial Eta Square	F	sig.	Partial Eta Square	F
FORCE	***	.554	34.8	***	.682	60.11	***	.508	26.81
HAND	***	.375	16.8	***	.605	42.84	***	.202	6.325

Note: *p<.05; **p<.01; ***p<.001

The results showed that there were significant differences in FORCE and HAND mean values among the verbs in each language, which means FORCE and HAND were shared dimensions for encoding throwing events in English, Chinese, and German. However, post hoc pair-wise comparison using the Bonferroni correction (see results in Table 3 and 4) revealed that the semantic granularity of ‘throw’ verbs in FORCE and HAND varies across languages.

Table 3: Pairwise comparison of ‘throw’ verbs in FORCE value

	<i>rēng</i> 扔	<i>diū</i> 丢	<i>pāo</i> 抛	<i>tóu</i> 投	<i>shuāi</i> 摔	<i>shuǎi</i> 甩
<i>diū</i> 丢	**					
<i>pāo</i> 抛		***				
<i>tóu</i> 投		***				
<i>shuāi</i> 摔	***	***	***	***		
<i>shuǎi</i> 甩	*	***	**	*	***	

	throw	fling	chuck	cast	hurl	toss
fling						
chuck		*				
cast	**	*	***			
hurl	***	***	**	***		
toss	***	**	***		***	
	<i>werfen</i>	<i>stossen</i>	<i>schluedern</i>	<i>schmeissen</i>	<i>schmettern</i>	<i>pfeffern</i>
<i>stossen</i>						
<i>schluedern</i>	***	***				
<i>schmeissen</i>						
<i>schmettern</i>	***	***	**	***		
<i>pfeffern</i>	***	***				

Note: *p<.05; **p<.01; ***p<.001

Table 4: Pairwise comparison of ‘throw’ verbs in HAND value

	<i>rēng</i> 扔	<i>diū</i> 丢	<i>pāo</i> 抛	<i>tóu</i> 投	<i>shuāi</i> 摔	<i>shuǎi</i> 甩
<i>diū</i> 丢						
<i>pāo</i> 抛		**				
<i>tóu</i> 投	***	***	***			
<i>shuāi</i> 摔	***	***	*			
<i>shuǎi</i> 甩		***		***	***	
	throw	Fling	chuck	Cast	Hurl	toss
fling	**					
chuck						
cast	**					
hurl				*		
toss	***	**	***	*	***	
	<i>werfen</i>	<i>stossen</i>	<i>schluedern</i>	<i>schmeissen</i>	<i>schmettern</i>	<i>pfeffern</i>
<i>stossen</i>						
<i>schluedern</i>						
<i>schmeissen</i>						
<i>schmettern</i>		***	**			
<i>pfeffern</i>						

Note: *p<.05; **p<.01; ***p<.001

As can be seen in Table 3, there are 12 pairs of ‘throw’ verbs significantly different in the FORCE value encoded in their meanings respectively in both Chinese and English, whereas only 8 pairs were found in German. In terms of significance level, the differences in FORCE value in Chinese ‘throw’ verbs are bigger than those in the English verbs. The results show that a wider range of FORCE values were captured and encoded

in the lexical semantics in Chinese ‘throw’ verbs, as compared to that in the English and German verbs.

Similar patterns were observed for the event components of HAND. Ten pairs of ‘throw’ verbs were found significantly different in the HAND value encoded in their meanings, whereas 8 pairs in English and only 2 pairs in German. The results indicate that the Chinese ‘throw’ verbs were more specifically discriminated with the hand height at the starting point of throwing events, which was found less so in the English and German ‘throw’ verbs.

In sum, a wider range of different throwing events were captured by Chinese ‘throw’ verbs, in terms of FORCE and HAND, though the two components are specifically encoded in the lexical meanings of ‘throw’ verbs in all the three languages.

4.2 Binomial Dimensions for Categorization

Based on the data in Table 1, we applied one-way Chi Square analysis to categorical (binomial) variables to understand whether the value of a certain action feature was typical for a certain verb. Take ‘throw’ as an example, the result showed that the performances with an upward (frequency = 21, as shown in Table 1) hand movement were many more than the ones with a downward (frequency = 8) hand movement ($p < .001$), so we regarded upward as the typical value of VD for throw. Table 3 shows the typical values of VD, HD and ARM for the ‘throw’ verbs in the three languages.

Table 3: Typical values of VD, HD, and ARM for ‘throw’ verbs

‘throw’ verbs	Vertical Direction of Hand Movement (VD)	Horizontal Hand Movement (HD)	Initial Arm Pose (ARM)
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	value	sig.	effect size	value	sig.	effect size	value	sig.	effect size
<i>rēng</i> 扔	upward	*	.390	forward	**	.390	N.A.		
<i>diū</i> 丢	upward	***	.600	forward	*	.267	straight	***	.567
<i>pāo</i> 抛	upward	all		forward	***	.967	N.A.		
<i>tóu</i> 投	upward	***	.933	forward	all		bend	***	.967
<i>shuāi</i> 摔	downward	all		forward	***	.593	bend	all	
<i>shuǎi</i> 甩	N.A.			sidewise	**	.356	bend	***	.593
throw	upward	***	.793	forward	all		bend	***	.607
fling	upward	***	.862	forward	***	.828	bend	*	.350
chuck	upward	***	.655	forward	***	.862	bend	**	.434
cast	upward	***	.931	forward	***	.828	N.A.		
hurl	upward	***	.621	forward	***	.931	bend	***	.509
toss	upward	***	.966	forward	all		straight	***	.759
<i>werfen</i>	upward	***	.932	forward	all		bend	***	.767
<i>stossen</i>	upward	***	.500	forward	all		bend	***	.928
<i>schleudern</i>	upward	***	.600	forward	all		bend	***	.481
<i>schmeissen</i>	upward	**	.400	forward	all		bend	***	.800
<i>schmettern</i>	downward	***	.684	forward	all		bend	***	.960
<i>pfeffern</i>	downward	**	.433	forward	all		bend	***	.966

Note: *p<.05; **p<.01; ***p<.001

As can be seen in Table 5, almost all the verbs had a typical action associated with each of these three dimensions. The only exceptions were the Vertical Direction of Hand Movement for *shuǎi* and the value of Initial Arm Pose for *rēng*, *pāo* and cast⁵.

Within the languages, some dimensions were featured with unique values, while other dimensions (shaded in grey in Table 3) included two different values. For example, all

⁵ The typical action representation of *shuǎi*, *rēng* and *pāo* were specified by a follow-up perceptual experiment (see Gao et al., 2016)

the six English ‘throw’ verbs denote throwing actions with an upward hand movement. As a contrast, both upward and downward movements were encoded in the meanings of the ‘throw’ verbs in Chinese and German.

Across languages, Chinese ‘throw’ verbs were distinguished in all the three dimensions, but the English and German ones only differed in one of the feature dimensions. For the English near-synonyms, it is ARM that distinguishes the near-synonyms, while for German it is VD.

4.3 *A Comparison of the value distribution differences among the three languages*

Table 6 shows the dimensions in which ‘throw’ verbs were differentiated within each language. The most fine-grained delineation of the throwing domain was observed in Chinese. As a comparison, the action features depicted by the ‘throw’ verbs in English and German were differed within a fewer semantic dimensions.

Table 6: Dimensions for semantic categorization of throwing actions in three languages

	FORCE	HAND	ARM	HD	VD
English	√	√	√		
Chinese	√	√	√	√	√
German	√	√			√

The overall comparison among the three languages shows that all the ‘throw’ verbs in the three languages are semantically categorized based on multi-dimensional features. The verbs in Chinese are more distinctively identified by the vertical direction of hand movement (VD), the horizontal hand movement (HD), and the initial arm pose (ARM) than the ones in English and German.

4.4 Translation equivalents across languages

Since the semantics of ‘throw’ Verbs in the three languages were specified as values in five action dimensions, we are able to identify a few pairs of translation equivalents across languages. We summarize in Table 5 the verbs across languages that were matched on all of these dimensions. Note that out of the 18 verbs included in the present study, very few of them were translation equivalents by this method of categorization.

Table 7: Translation equivalents of ‘throw’ verbs across languages

	FORCE	HAND	ARM	HD	VD
toss- <i>diū</i>	Light	low	straight	forward	upward
throw- <i>tóu-werfen</i>	Medium	high	bend	forward	upward
<i>shuāi-schmenttern-pfeffen</i>	Strong	high	bend	forward	downward

It should be noted that the above identification of translation equivalents is only based on the features of the actions denoted by the verbs. These verbs may differ from each other from other aspects, such as connotational meaning, syntactic behavior, and pragmatic characteristics. A future study can test how the lexical semantics of these verbs interacts with other variables in people’s understanding of ‘throw’ verbs.

5. Discussion

The above results of data analysis show both similarities and cross-language differences in the process of throwing event categorization and in the representations of throwing verbs.

5.1 *Partly Shared Dimensions across Languages*

As shown in Table 4, the dimensions for semantic categorization of throwing events were partly shared by all the three languages. FORCE and HAND were used in all three languages to distinguish near-synonyms. For HAND, upward and forward were the most common features in performances for all three languages (see Table 2). Only two backward hand movements were spotted in our experiments, which indicates that native speakers of different languages uniformly resisted backward as a semantic component of ‘throw’ verbs, although it is within the physical capability of human beings and actually happens in reality. According to the anthropological findings, the development of throwing capability in early hominids was motivated by the needs of defense (Fifer, 1987) and hunting (Calvin, 1983) which generally required a far forward throwing action, and the upward hand movement increased the forward journey that the object travelled. Therefore, it is fair to deduce that upward and forward hand movements are universally more common in throwing actions.

In contrast, ARM was used in Chinese and English but not German. VD was used in Chinese and German but not English. And HD was used only in Chinese. The reason for these differences could be due to cultural and historical differences between these three languages. If so, then these differences would contrast with the forces that shape the

naming patterns of running and walking events, namely the universally experienced biomechanical discontinuity between the two actions (Malt, et al., 2008, 2014). The semantic differences among ‘throw’ verbs are not direct reflections of any natural distinctions in the physical world, instead, among infinite ways of throwing actions, languages selected some dimensions and their values as verb meanings and ignored other existing ones (e.g. backward path), so that the verbs could optimally represent the most practiced/perceived throwing actions. The sidewise throwing actions might be commonly practiced in Chinese speaking society when ‘throw’ verbs originated, as a result, the sidewise hand movement, as a semantic component, was coded in at least two ‘throw’ verbs (*diū* and *shuǎi*) in Chinese. Studies exploring the usage of these verbs could test this interpretation.

5.2 Multi-dimensional Semantic Distribution

Rappaport Hovav and Levin (2008, p.135) stated that what distinguishes throw-type verbs is “how the force is imparted.” John Beavers (2011) claimed that nearly all throw-type verbs encoded simple manners. The results of our study show that the semantics of ‘throw’ verbs were underspecified in the previous studies. Our findings show that the differences among the ‘throw’ verbs were not restricted in the force of action. Instead, the physical representation of a ‘throw’ verb can be featured in five action dimensions. The native speakers in the study relied on at least two of them to distinguish the near-synonymous ‘throw’ Verbs in any of the three languages studied.

To show the language-specific patterns of the semantic distributions of ‘throw’ verbs, we transformed the raw values of all variables for each of the verbs in five dimensions into percentage and plotted them in Figure 1 to 3⁶.

Figure 1: The semantic distribution of English ‘throw’ verbs on five action features

⁶ The FORCE Percentage = (FORCE/5)100%, 5 is the maximum degree of FORCE; the HAND percentage = (HAND/12)100%, 12 is the maximum possible value of HAND; the ARM percentage = (bend-armed frequency/straight-armed frequency) x 100%; the HD percentage = (forward frequency/sidewise frequency)/100%; the VD percentage = (upward frequency/downward frequency)/100%.

Figure 2: The semantic distribution of Chinese 'throw' verbs on five action features

Figure 3: The semantic distribution of German 'throw' verbs on five action features

The conversion to percentages allows us to visualize the variability in native speakers' production of each dimension. For example, although ARM was not a dimension for distinguishing 'throw' verbs in German (the typical value of ARM for all

the six German ‘throw’ verbs was bend), straight-arm actions for *schleudern* were also observed, indicating that they are not unacceptable.

The semantic features of the Chinese ‘throw’ verbs were widely distributed in all dimensions (Figure 2), covering the majority area of the throwing domain. The English verbs showed a similar distribution pattern but within a narrower range (Figure 1). As a contrast, the German ones were distributed only in four dimensions and also within an even narrower range than English (Figure 3). The wide distribution of the Chinese verbs in continuous variables can be interpreted as an indication of the distinct differences among the verbs, while their wide distribution in categorical variables may imply the ambiguity of the verb meanings in these dimensions. For example, the typical value of VD for *shuǎi* and HD for *pāo* and *rēng* could not be decided, which reflects that both values of the dimensions were equally acceptable by native speakers. Following this line of thinking, German ‘throw’ verbs were most clear-cut in semantic features, and the English ones stood in between the Chinese and German ones.

6. Conclusion

In this study, we analyzed action representations of ‘throw’ verbs elicited from native speakers of English, Chinese and German. The findings show that FORCE and HAND position at the onset of throwing are dimensions used in all three languages to differentiate near-synonyms. There were also differences between the three languages: English and Chinese also used ARM position at the onset of throwing, German and Chinese also used the Vertical Direction of the movement, and Chinese also used the Horizontal Direction of the movement.

These results support the argument that the dimensions for event categorization were constrained, and the variations distributed in a limited range.

These language-specific distinctions are likely to be linked to historical and cultural factors related to usage.

As compared with the stimulus-based perceptual approach, the behavioral approach allows us to know more of category information in terms of prototypical representation and extensional range of a certain event category. More importantly, the top-down approach relies less on researchers' subjective decision in the experimental design, and only minimum adaptation is needed for future research on other event categories.

In terms of language typology, this study tested three satellite-framed languages: English, Chinese and German, which all emphasize manner of motion (Talmy, 1985, 2000). Do FORCE and HAND universally function as distinctive dimensions for categorizing throwing events? Is the behavioral approach effective and reliable for the research of event categorization in verb-framed languages, such as Japanese or Spanish? To answer questions like these, more languages, especially typologically different languages, must be incorporated in future research.

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