Evolution of Verb Meanings in Children and L2 Adult Learners Through Reorganization of an Entire Semantic Domain: The Case of Chinese Carry/Hold Verbs

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Evolution of Verb Meanings in Children and L2 Adult Learners Through Reorganization of an Entire Semantic Domain: The Case of Chinese Carry/Hold Verbs

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The meaning of a word is not acquired in isolation from other words. This article investigates how first-language (L1) and adult second-language (L2) learners of Chinese learn the meanings of verbs belonging to the same semantic domain, focusing on the semantic domain of "carrying/holding" in Chinese. Results revealed that the verb use of L2 adults is heavily influenced by their lexical knowledge of L1 and that their development of word meanings stops before they fully reach the adult native speakers' word meaning. L1 children in contrast tend to depend on perceptually visible features of actions at the initial stage of lexical acquisition and then gradually learn how their L1 categorizes the actions by verbs. We argue that L2 learners need to attain meta-knowledge about the mapping of the entire configuration of the corresponding lexical domain between L1 and L2 and discuss how reading inside and outside of the classroom could foster this process.

A good command of language is essential not only for communication but also for any human intellectual activity. In particular, having a good command of vocabulary (i.e., the ability to use words precisely but yet flexibly) is of critical importance for expressing oneself effectively and eloquently. But what is "a good command of vocabulary"? Vocabulary is most often talked about in terms of size. If someone is characterized as having "high level of vocabulary competence," we usually think that she or he knows a large number of words. However, what does "knowing a word" really mean?

There are different levels of knowledge of word meanings (Anderson & Nagy, 1991; Nation, 2001). At one level, a learner of English may know that *amble* refers to a sort of walking without knowing what kind of walking it is. She may be able to answer a question on multiple-choice test about this word correctly if the fillers include actions other than walking; however, at this level of knowledge, she will not be able to use this word appropriately. At another level, a learner can give a dictionary definition, "to walk at a slow relaxed speed," because she has learned the dictionary definition of this word, but she may not know how it is different from "saunter," the

dictionary definition of which is very similar ("to walk in a slow, relaxed way" in the *Oxford Advanced Learners' Dictionary* [Hornby, 2010]). At the highest level, a learner should be able to use the word appropriately.

As Anderson and Nagy (1991) put it, "really knowing a word always means being able to apply it flexibly but accurately in a range of new contexts and situations" (p.721). Then, what level of knowledge of word meanings do young children have? How about adult second language (L2) learners for words in the language they are learning?

Researchers have documented that children's word meanings are not quite the same as the meanings possessed by adults, though they often seem to "know" the words because they use them in limited contexts (Ameel, Malt, & Storms, 2008; Bowerman, 1982; Clark, 1997). For example, Schaefer (1979) reported that, in judging whether an event could be described as *cutting*, children gave inappropriate weight to the feature "presence of blades" and used the verb *cut* for an event in which a bottle was in fact *broken* by a blade.

Here, for the purpose of addressing our research questions, we loosely define "adult-like word meaning" as the representation that allows speakers to apply a word to a range of situations in about the same way that adult native speakers of the language do. Native speakers of a language "know" what entities (or what situations) a given word (for all word classes) can or cannot apply to. We assume that this knowledge is partly based on the *sense* of a word, but we assume that *connotation* or any other type of knowledge that affects the usage and application of a word in a range of contexts is also part of its meaning (Anderson & Ortony, 1975; Landauer & Dumais, 1997). For example, *animal*, *cat*, and *kitty* can all refer to the same object, but adult native speakers have a good intuition concerning which word would be most preferred in a given context. In any case, to the extent that children apply a word to different referents and/or in different situations than adults, we consider their word meaning representations to be different from those of adults.

Previous word learning studies mostly dealt with the learning of single words. But to understand the process of lexical acquisition in a larger context, we need to uncover not only how learners relate a newly learned word to other nearby words but also how the structure of the semantic domain as a whole is affected by the new word. In fact, early studies documenting young children's spontaneous production suggest that continuous reorganization of the lexicon takes place as children learn new words (Ameel et al., 2008; Clark, 1997; Haryu & Imai, 2002).

In the real world, learners (first-language [L1] children or L2 learners) usually encounter sets of words in specific semantic domains and thus need to delineate the boundaries among multiple words simultaneously. Here, we use the term *semantic domain* to mean *a paradigmatically and syntagmatically structured subset of the lexicon* (Lyons, 1977, p. 268; cf. Saussure, 1916/1983). To be able to use words like the adults in their language community, learners need to discover the relations among these words and grasp the boundaries between them. To understand how reorganization of word meanings takes place, then, it is important to understand how the representations of word meanings from the same domain *as a whole* start out, and how they evolve with development to converge onto those of adults.

That said, the lexical domain—or the subset of the lexicon—usually does not have a neat and clean structure: It is typically not divided to form mutually contrastive categories that are arranged into taxonomic hierarchies (Anderson & Nagy, 1991; Labov, 1973). Let us consider a set of verbs in Chinese denoting a set of actions that we call carrying/holding. Mandarin Chinese makes fine distinctions in terms of the manner in which the object is carried or held. There are roughly 20 verbs that would be translated into English as "to carry," and each of them refers to the

event of a person carrying an object in a distinct manner. For example, carrying/holding an object on one's head is denoted by *ding*(顶),[1] whereas carrying/holding an object on one's shoulder is *kang* (扛). Carrying/holding an object with two arms is denoted by *bao* (抱), but if the object is held with one arm at the side of the body, the action is called *jia* (夹). Several verbs like *na* (拿), *ti* (提), and *lin* (拎) refer to carrying/holding actions with one hand, and verb choice depends largely on the shape of the hand holding the object. These verbs are not necessarily all contrastive with clear gaps among them. Instead, one part of the semantic space is densely covered by several close synonyms with overlapping boundaries, whereas other parts of the space are only sparsely covered with clear gaps with other verbs.

How do learners learn words in a complex structured semantic domain like these carry verbs in Chinese? When we say "learners," there are two different types of learners. One is of course children learning their native language (L1); the other type of learners are those who are learning the language as their non-native (second, third, etc.) language. For both types of learners, ongoing restructuring of the lexicon seems necessary in order to attain a mental representation that allows them to use words in the same way as adult native speakers of the language. However, intuitively, there is an obvious difference between children and adult L2 learners. L2 learners are required not only to restructure the semantic domain of the target L2 as their learning of the domain proceeds but also to adjust the structure of the semantic domain with respect to their L1 (Ijaz, 1986; Odlin, 1989).

LEXICAL DIVERSITY AND THE DIFFICULTY IN L2 ACQUISITION

Different languages often carve up the world differently (Gentner & Bowerman, 2009; Lyons, 1968; Malt, Sloman, & Gennari, 2003). For example, Japanese and Korean divide the carrying and holding events into five to seven verbs, and the naming patterns for these actions are clearly different from Chinese. Specifically, Japanese and Korean distinguish these types of actions to some degree, but much more coarsely than Chinese does. Both languages apply the most broad-covering verb (the general verb *motsu* in Japanese and *teulda* in Korean) to some of the actions that are typically denoted by narrow, specific verbs in Chinese. The pattern of division by verbs is also different across Japanese and Korean as well. Previous studies of L2 lexical acquisition indeed suggest that L2 learners have difficulty in adjusting the structure of the lexical domain in L2 when the corresponding lexical domain in L1 is structured differently (Ijaz, 1986; Jiang, 2002; Malt et al., 2003; Odlin, 1989). For example, Ijaz (1986) studied how L2 learners of English with different L1 backgrounds understand the relationships between the meanings of prepositions (*on, upon, unto, on top of, over,* and *above*) and found that native German speakers had difficulty in accepting the meaning of *on*, when *on* was used to represent a "nonvertical" relationship between objects in a sentence like "Jim nailed the plaque *on* the board," presumably reflecting that German preposition *auf* represents only "vertical" relationships between objects.

Thus, the process of restructuring a semantic domain as a connected system is necessary in order to obtain deeper, adult-like meanings of a set of related words, but this process seems to be

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[1]Throughout the article, to differentiate verbs and the actions denoted by the verbs, we italicized the verbs whereas the referent action for the verb was put in the double quotation marks.

quite challenging for both L1 and L2 learners. However, is the time course of the restructuring process and the trajectory of lexical development similar across child L1 and adult L2 learners? Do the two types of learners experience the same sort of difficulties?

PRESENT RESEARCH

In a previous study, we investigated the developmental trajectory through which Chinese children's representation of carrying/holding verbs evolves to converge to the adult representation (Saji et al., 2011). In the present study, we extended Saji et al.'s study to L2 learners of Chinese from two different language groups—Japanese and Korean— using the same stimuli and method as those used in Saji et al. (2011). We then compared the two types of learners—Chinese children learning their native language and adult L2 learners of Chinese—through a series of quantitative analyses in order to reveal commonalities and differences in the time course of the restructuring process.

As in Saji et al. (2011), we used the "carry" domain as the target. In addition to testing native Japanese-speaking or Korean-speaking L2 learners of Chinese, we elicited Japanese or Korean verbs for the stimuli from adult speakers of Japanese and Korean who have not learned Chinese. We obtained this data to see whether the lexical division of this semantic space in their L1 is related to the learners' application of Chinese verbs to these actions. The ways in which Japanese and Korean divide this lexical domain are somewhat in between the extremes of Chinese and English. Both Japanese and Korean tend to distinguish carrying/holding actions in which the object is supported by different body parts (e.g., shoulder vs. hands) but collapse the actions in which the object is held in the hands; however, the configuration of the semantic space is substantially different across Japanese and Korean. We report the detailed semantic analyses of the "carrying/holding" domain in Japanese and Korean in this article based on the actual production data from Korean and Japanese speakers (see Figure 3).

We analyzed the elicited production data from child L1 and adult L2 learners of the two language groups with respect to several points that are of theoretical importance for vocabulary development. As the first step, we examined how many verb types each group of learners produced, as this measure has been considered to reflect the learners' vocabulary size. However, as was already discussed, the number of produced words may not actually reveal the depth of the learners' word meaning representation. Saji et al. (2011) demonstrated that this is indeed the case for children who are learning Chinese as their L1. The average number of verbs that Chinese 3-, 5-, and 7- year-olds used for the stimulus videos was roughly the same, but when the entire pattern of production was compared to that of adult native speakers of Chinese, a steady developmental trend was found. Here, it would be interesting to see how L2 learners' pattern of verb use compares to that of Chinese children, and to see whether they attain the word meaning representations of adult native speakers of Chinese through the same developmental process that Chinese children go through, as their learning of Chinese progresses. Finally, we investigated which features the L1 and L2 learners use, and how they differentially weight these features, in applying verbs to the actions, and whether these features are different from the features that adult native speakers use.

METHOD

Participants

Four groups of Chinese speakers (3-, 5-, and 7-year-old children and adult), two groups of L2 learners (native Japanese and Korean) of Chinese, and two groups of native speakers other than Chinese (native Japanese and Korean) who had no experience of studying Chinese participated in the study. The Chinese speakers were the participants of Saji et al.'s (2011) study: There were 16 three-year olds, 20 five-year olds, and 21 seven-year olds and 21 university undergraduate all learning Mandarin Chinese as their L1. Chinese children, mostly from upper middle to upper class with college-educated parents, were recruited from several preschools and primary schools in Beijing, China.

Twenty native Japanese and 30 native Korean learners of Mandarin Chinese as an L2 participated in the study. The L2 learners of both groups were undergraduate students studying in the Mainland China. Although many of the learners had no experience of taking a standardized test of Chinese proficiency, they were able to comprehend and speak Chinese well enough to learn the required college-level class contents in Chinese (average learning experience was 39 months for the Korean group and 28 months for the Japanese group) and to communicate with the experimenter smoothly.

Finally, 16 native speakers of Japanese and 20 native speakers of Korean (who were not learners of Chinese) also participated in the study. They were also undergraduate students in Tokyo and Seoul, respectively.

Stimuli

A set of 26 videos of carrying and holding actions created by Saji et al. (2011) were used. In Saji et al., 13 representative carrying/holding verbs were selected, all of which were used by native Chinese speakers in everyday situations (see Table 1 for a list). Two video clips for each verb were prepared, one showing a carrying action and the other showing a holding action.

Procedure

The adult speakers of Chinese and L2 learners were presented with each video one at a time on a computer monitor and were instructed in Chinese to write the most appropriate *Chinese verb* for the video in the response window presented in the monitor. They could type the verb either in Chinese characters or in pinyin. The native speakers of Japanese or Korean who were not learners of Chinese were asked to type in the best verb for the video in their native language (Japanese or Korean) in the response window.

The Chinese children saw each video on a computer monitor, and the presentation order was controlled by the same program as that used for the adults. While they were watching the video, a female native Chinese speaker orally asked the children to say what the agent in the video was doing. The children's responses were recorded and transferred to a score sheet after the experiment by the experimenter.

TABLE 1
Stimuli Videos Used in the Pre- and Main Studies

Verb	Action	Object
抱 (bao4)	Carrying/holding an object in both arms	Stuffed animal
背 (bei1)	Carrying/holding an object on the back	Rucksack
顶 (ding3)	Carrying/holding an object on the top of head	Wooden bowl
端 (duan1)	Carrying/holding an object horizontally level with both hands	Glass bowl with water
夹 (jia1)	Carrying/holding an object under one arm	Square bag
举 (ju3)	Carrying/holding an object by lifting the obj over the head	Square box
扛 (kang2)	Carrying/holding an object on the shoulder	Pipe
挎 (kua4)	Carrying/holding an object, hanging it on the shoulder	Tote bag
拎 (lin1)	Carrying/holding an object, dangling it with one hand	Plastic bag
拿 (na2)	Carrying/holding an object with one hand	Plastic bottle
捧 (peng3)	Carrying/holding an object cautiously in both hands	Bouquet
提 (ti2)	Carrying/holding an object, dangling it around the arm	Handbag
托 (tuo1)	Carrying/holding an object in the palm(s)	Tray

ANALYSES AND RESULTS

How Many Verb Types Did Children and L2 Learners Produce Across the 26 Carrying/Holding Actions?

We first counted the number of verb types that each individual learner (children and L2 learners) produced across the 26 videos (13 actions, one moving and one standing still, representing carrying and holding actions, respectively). The adult Chinese native speakers on average produced 11.2 different verb types. The mean number of produced verb types for Chinese children were 7.25, 6.25, and 8.57 for 3-, 5- and 7-year-olds, respectively. The average number of produced verb types were not different among the three child groups (all $ps > .1$), Bonferroni corrected, but differed significantly between each of the child groups and the adult Chinese L1 group (all $ps < .01$). The mean number of produced verb types was 7.1 for the Japanese and 7.7 for Korean learners of Chinese. They were not significantly different (all $ps > .1$), Bonferroni corrected. The mean difference in the number of verb types between the L2 learners and the L1 speakers was significant for both the native Japanese and Korean groups (both $ps < .01$). These results show that the L2 learners of Chinese did not produce as many Chinese carrying/holding verbs as native speakers of Chinese, even though they were able to communicate in Chinese fairly well. The number of the verb types produced by the L2 learners was about the same as that produced by Chinese children.

How Does Learners' Use of the Verbs Converge With the Adult L1 Pattern?

To examine the learners' pattern of verb use quantitatively, we adopted the Multi-Dimensional Scaling (MDS) solutions as in Saji et al. (2011).[2] We first created a production matrix for each participant group. In each matrix, we tallied the number of verbs produced for each action. There were 13 rows representing the 13 actions in each matrix. The columns represented the verbs the participants had produced. The number of the participants producing the verb was tallied in each cell. We then calculated correlation values for all action-verb pairs (i.e., the number of verbs produced for each action) to create separate similarity matrices for each participant group. These matrices were fed into the MDS solution.

MDS provides a geometrical representation of patterns of similarity on dimensions that are extracted to maximize goodness of fit in such a way that interpoint distances on the multidimensional space correspond to dissimilarities between objects. In this study, MDS displays how speakers of each language categorize the 13 carrying/holding actions by the application of verbs. Two actions are closely located if many people apply the same verb to them and far apart if few people use the same verb for them.[3]

Figures 1 to 3 show the MDS solutions for each of the participant groups. The MDS configurations of the Chinese children and L2 learners show quite different patterns from those of the adult native speakers. The configuration for the adult speakers of Chinese group in Figure 1 was almost circular, which indicates that adult native speakers of Chinese used different verbs for each video. In contrast, in 3-year-old Chinese children's plots, the "na," "jia," and "peng" (捧) actions were completely overlapping, which indicates that they did not apply different verbs to these events, although they made distinctions among actions in other videos to some extent.

Interpreting the MDS configurations in light of the dominant verbs for each video (Table 2), we can see that the 3-year-olds applied the single verb *na*—the most general and broad-covering carrying/holding verb in Chinese—to three different actions—the "na," "jia," and "peng" actions, which adult native speakers clearly differentiated by the verbs *na*, *jia* and *peng*, respectively. This tendency was also observed but at a decreased rate for the 5- and 7-year-olds.

To capture this trend more directly, we conducted correlation analyses, using the production matrices for the children and adults. We correlated children's production matrices of each age group with that of the adult Chinese native speakers (the procedure originated with Malt, Sloman, Gennari, Shi, & Wang, 1999, and was also used by Ameel et al., 2008, and adopted by Saji et al., 2011, for further use). The correlation between 3-year-olds and adults was only .29. Convergence with the adult pattern increases linearly from 3 to 7 years (5-year-olds = .46; 7-year-olds = .58).[4] The significant difference in the correlation values was detected between 3-year-olds and 5-year-olds ($p < .05$) but not between other age groups. The results of the correlation analyses together

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[2]However, in Saji et al. (2011), the matrices were created only from the carrying videos to simplify the analyses on the ground that the two matrices created for the carrying videos and holding videos were very highly correlated. Here, we decided to create the matrices that aggregated the responses from the carrying and holding videos to increase data points.

[3]We employed the two dimension solutions for all groups, as the stress value can be considered to be acceptable (.04, .03, .06, .08 for 3-, 5-, 7-year-old children and adults; .02 and. 01 for Japanese and Korean learners; .04 and .01 for native speakers of Japanese and Korean, respectively) for all.

[4]These correlation values are slightly different from what have been reported in Saji et al. (2011) because the responses for the carrying and holding videos were aggregated for the carrying (moving) and holding (nonmoving) actions here, whereas Saji et al. used only the responses from the carrying video.
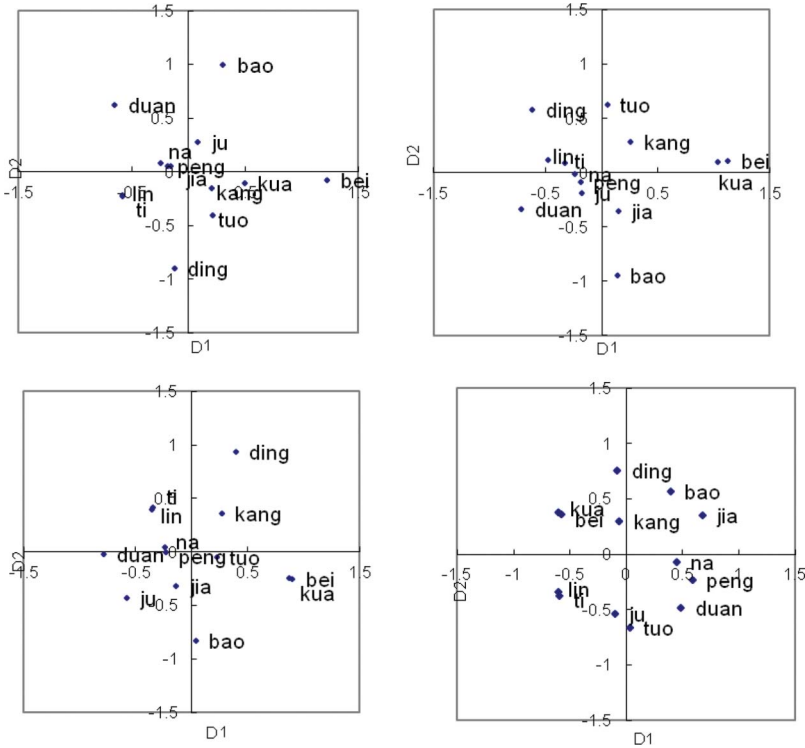
FIGURE 1   Multi-Dimensional Scaling solutions for the native speakers of Chinese: Chinese 3-year-old children (upper left); Chinese 5-year-old children (upper right); Chinese 7-year-old children (lower left); native speakers of Chinese (lower right). (Color figure available online.)
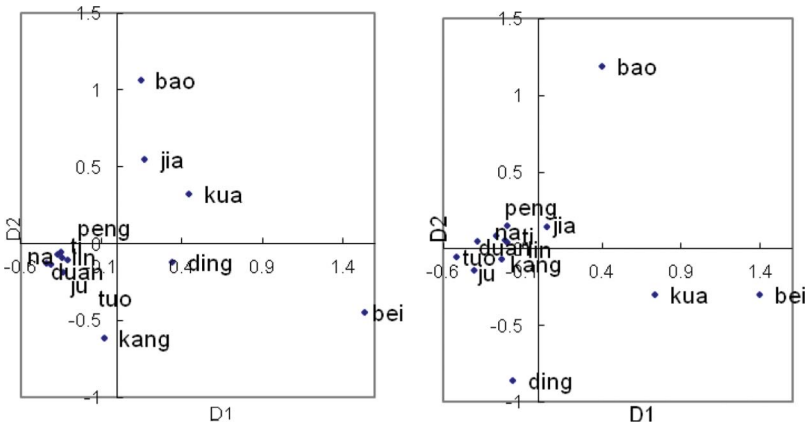

FIGURE 2   Multi-Dimensional Scaling solutions for the L2 learners: native Japanese-speaking L2 learners of Chinese (left); native Korean-speaking L2 learners of Chinese (right). (Color figure available online.)
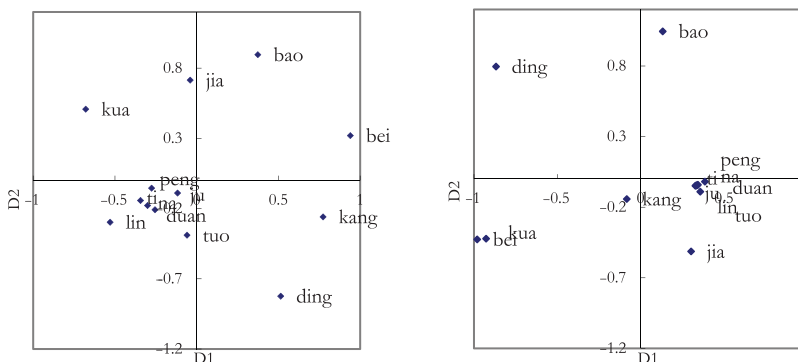
FIGURE 3   Multi-Dimensional Scaling solutions for the native speakers of Japanese and Korean who are not the learners of Chinese: native speakers of Japanese (left); native speakers of Korean (right). (Color figure available online.)

TABLE 2
Dominant Verbs for Each Action Produced by L1 and L2 Learners of Chinese

Video	3 Years (16)	5 Years (20)	7 Years (21)	Adults (21)	Japanese Learners (n = 20)	Korean Leaners (n = 30)
bao	bao (.66)	bao (.70)	bao (.88)	bao (.76)	bao (.55)	bao (.78)
bei	bei (.91)	bei (.90)	bei (1.0.)	bei (.98)	bei (.85)	bei (.77)
ding	ding (.44)	ding (.40)	ding (.55)	ding (.93)	dai (.28)	ding (.23)
duan	duan (.34)	duan (.55)	duan (.64)	duan (.45)	na (.55)	na (.67)
jia	na (.63)	na (.35)	na (.38)	ja (.69)	dai (.41)	na (.39)
ju	ju/na (.38)	ju (.43)	ju (.36)	ju (.88)	na (.49)	na (.36)
kang	kang (.44)	kang (.40)	kang (.55)	kang (.90)	kang/na (.23)	na (.40)
kua	kua (.28)	bei (.70)	bei (.83)	kua (.50)	dai (.56)	dai (.47)
lin	ti (.47)	na (.43)	na (.38)	lin (.69)	na (.58)	na (.69)
na	na (.72)	na (.98)	na (.95)	na (.52)	na (.73)	na (.69)
peng	na (.81)	na (.80)	na (.83)	peng (.55)	na (.70)	na (.62)
ti	ti (.41)	na (.55)	na (.38)	ti (.52)	na (.59)	na (.60)
tuo	kang (.22)	na (.30)	tuo (.43)	tuo (.57)	na (.49)	na (.43)

Note. Each number for the verb indicates the proportion for whole token of produced verb.

with the MDS analyses suggest that it takes a long time for children to adjust their word meanings after the initial mapping of words to meanings.

We now turn to the L2 learners. Figure 2 shows that the MDS configurations of the native Japanese and native Korean learners of Chinese. The pattern of verb application by the L2 learners also greatly differed from that by adult native speakers of Chinese seen in Figure 1. As Figure 2 shows, the native Japanese learners differentiated the "bao," "jia," "kua" (挎), "ding," "bei" (背), and "kang" actions but not others. The Korean learners distinguished the "ding," "bao," "kua," and "bei" actions but not others. The actions that were collapsed in a large cluster were labeled by the verb *na* (i.e., the most broad-covering and general verb).

As we previously noted, this tendency to overextend the general verb *na* was also seen in the naming pattern of Chinese children. However, the pattern of the overuse of the verb *na* was

somewhat different across the Chinese children and the L2 learners. It is important to note that the influence of the lexical knowledge of L1 on the learning process of the L2 was clearly apparent in the naming pattern of the L2 learners: When we compare the configurations of the 13 actions for the native Japanese or native Korean learners to the configurations obtained from the Japanese or Korean speakers for the Japanese or Korean language (see Figures 2 and 3), we clearly see that the configuration for the L2 learners was very similar to the configuration for the learners' native language for both the Japanese and Korean groups. Specifically, the actions the learners could distinguish by Chinese verbs mostly corresponded to the actions to which their native languages, Japanese or Korean, distinguished by different verbs.

In fact, as seen in Table 3, which shows the dominant verbs produced by Japanese and Korean, the actions to which Japanese and Korean learners applied the verb *na* corresponded exactly to the actions to which native speakers of Japanese or Korean applied the general carrying/holding verbs in their own language (Japanese: *motsu* and Korean: *teulda*. See Table 2 for the dominant verbs produced by native speakers). In contrast, Japanese and Korean learners distinguished the actions when their native language has specific verbs for them. For example, Korean learners distinguished the "bei" and "kua" actions, which roughly correspond to the Korean verb *meda* [carrying/holding an object with belt-like object], whereas Japanese learners distinguished the "kang" action, which is denoted by the Japanese verb *katsugu* [carrying an object on the shoulder].

To examine these observations quantitatively, we correlated the production matrices of the two L2 groups with the matrix of the native Chinese speakers. The correlation between the native Japanese learners and the adult Chinese speakers was .19, and the correlation between the native Korean learners and the adult Chinese speakers was .25. We then correlated each of the two L2 group matrices with its corresponding L1 naming matrix. Not surprisingly, the L2 learners' naming patterns in Chinese was highly correlated to the pattern in which the learners' L1 labeled these actions (Japanese, $r = .81$; Korean, $r = .86$). This suggests that lexical categorization of the semantic space in L1 strongly affects how L2 learners learn the meanings of words in their target

TABLE 3
Dominant Verbs for Each of the 13 Actions Produced by Japanese and Korean

Video Name	Korean Native Speakers (n = 20)	Japanese Native Speakers (n = 16)
bao	antta (.83)	daku (.47)
bei	meda (.98)	seou (.91)
ding	ida (.98)	noseru (.78)
duan	teulda (.95)	motsu (.53)
jia	kkida (.48)	kakaeru (.66)
ju	teulda (1.0)	motsu (.50)
kang	teulda (.35)	katsugu (.59)
kua	meda (.95)	kakeru (.59)
lin	teulda (.95)	motsu (.41)
na	teulda (.68)	motsu (.75)
peng	teulda (.88)	motsu (.50)
ti	teulda (.88)	motsu (.63)
tuo	teulda (.65)	motsu (.34)

Note. Each number for the verb indicates the proportion for whole token of produced verb.

L2: They have a strong tendency to divide the semantic space in L2 exactly in the same way as they do in their L1.

Do L1 Children and L2 Adults Categorize the Semantic Space of Verbs Using Different Criteria?

The MDS analyses for individual groups suggest that the L1 children and the L2 adults labeled the carrying/holding actions using different criteria. In our final analysis, we quantitatively examined this possibility using the INDSCAL (INDividual SCALing) analysis, a version of the MDS technique developed for evaluating group differences in a multidimensional space common across groups (Carroll & Chang, 1970). In the current study, INDSCAL would reveal the semantic dimensions that are shared across the five groups of learners (Chinese learning 3-, 5-, and 7-year-olds and Japanese or Korean native L2 learners) and the three groups of the native speakers (Chinese, Japanese, and Korean) in the *common space*. The *individual space* shows how each group of learners weighted each dimension with respect to the three groups of native speakers.

The eight production matrices were fed into INDSCAL. We employed the three-dimension solutions with the stress value of .16. Figure 4 shows the *common space* constituted of three dimensions, each of which reflects one semantic feature distinguishing the 13 actions. Figure 5 shows the *individual space*, showing how each group weighted the semantic features represented by each dimension.

The distribution of the actions along the first dimension (Dimension 1) suggests that this dimension may reflect the lexicalization pattern of Chinese, along which the actions were placed by the manner by which the object was held or supported. Here, the "bei" action [carrying/holding an object on the back] and "kua" action [hanging an object on the shoulder or back side of the body] were placed closely together and separated from most other actions on one end, whereas the "ding" action was placed on the other end. The actions in which the object
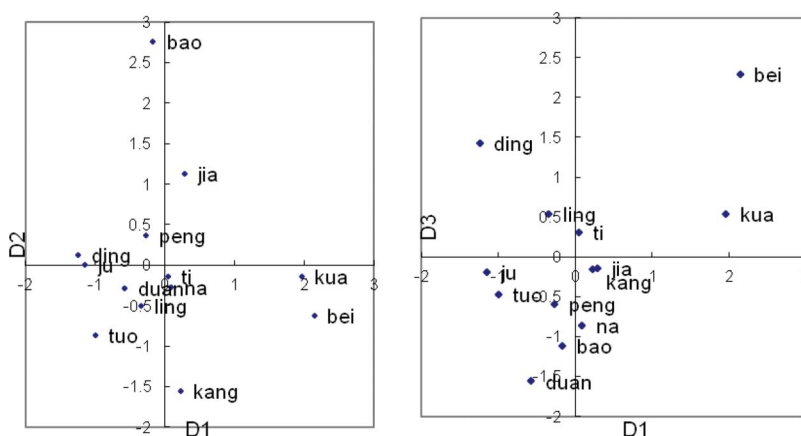

FIGURE 4   A common space extracted in an INDSCAL solution: Dimension1 and Dimension2 (left); Dimension1 and Dimension3 (right). (Color figure available online.)
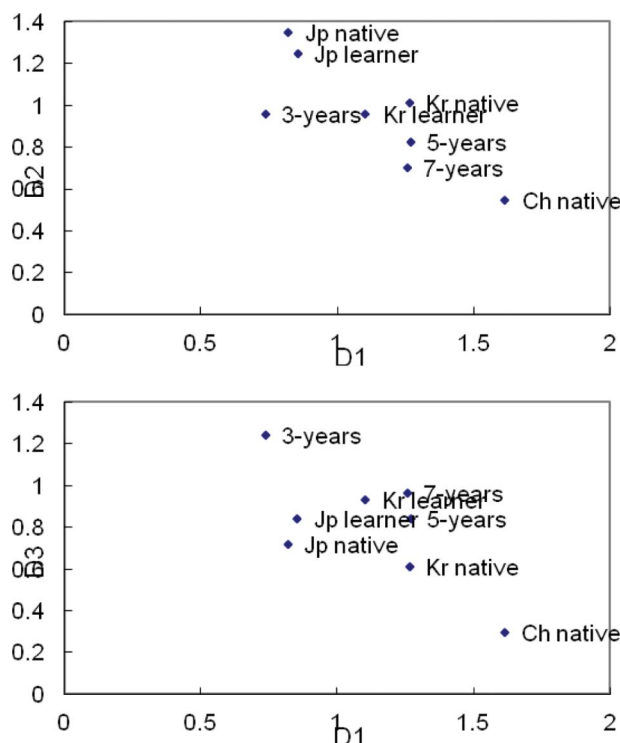
FIGURE 5   An individual space extracted in an INDSCAL model: Dimension1 and Dimension2 (upper); Dimension1 and Dimension3 (lower). (Color figure available online.)

was held with arms or a hand are seen around the center. Thus, Dimension 1 seems to reflect the *manner* of holding the object, which was found to be the semantic criterion that adult native speakers of Chinese relied on in Saji et al. (2011). When looking at the *individual space*, the adult native Chinese group indeed put the heaviest the weight on this dimension in this study as well.

The second dimension (Dimension 2) separates the "bao" [carrying/holding an object in both arms] and "jia" [carrying/holding an object under the arm] actions in the positive direction and the "kang" [carrying/holding an object on the shoulder] action in the negative direction. This dimension appears to reflect the lexicalization pattern in Japanese. The extension of the Japanese verb *kakaeru* includes both the "bao" and the "jia" actions, but these actions were distinguished by different verbs in Chinese and Korean (*antta* and *kkida* in Korean). On the other hand, Japanese has a very specific verb for the "kang" (holding an object on the shoulder) action. Consistent with this linguistic analysis, the native Japanese speaker group as well as the native Japanese L2 group put the heaviest weight on this dimension (see Figure 5). Thus, Dimension 2 seems to be reflecting the pattern of semantic division in Japanese.[5]

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[5]Some readers may wonder why the produced verbs by Korean and Japanese learners were very similar in Table 3, though they were different in Figure 5A and 5B. This is because the results of MDS reflect the entire response matrices, whereas Table 3 shows a single verb that was produced most frequently.

Dimension 3 seems to reflect a different type of semantic criterion (see Figure 5) from those for the first two dimensions. The actions located in the negative direction were those supporting the object on the front side of the body—for example, "duan" (端), "bao," "na," "peng," and so on—whereas the actions in the positive direction were those in which the object was supported on the back or on the head (e.g., "bei," "ding," "kua," and "lin"). Perhaps Dimension 3 concerns the place of the object with respect to the body, especially whether it is held in front of the body or not. The group that put the heaviest weight on this dimension was Chinese children, the 3-year-old group in particular (see Figure 5). Perhaps, then, this dimension reflects the perceptual saliency of the action events, as this object position is perceptually salient and easy to detect without fine perceptual discriminations.

Figure 5 displays how each of the eight groups placed weights on each of the three dimensions extracted for the *common space*. Two noteworthy trends were found. On each dimension, each L2 group was positioned very closely to their corresponding native speaker group (see the points of "Jp native" and "Jp learner," "Kr native" and "Kr learner" in Figure 5). This implies that the criteria L2 learners adopted were similar to (or even the same as) those of their native language. Furthermore, along with Dimension 1 and Dimension 2, which appear to be reflecting the difference in the lexicalization patterns of Chinese and Japanese, respectively, the adult Chinese group and Japanese group were relatively far apart, with the native Korean group in between (see Figure 5). The 3-year-olds acquiring Chinese placed a heavy weight on Dimension 3 and were far apart from the adult native Chinese group. However, the 5- and 7-year-old groups were positioned more closely to the adult Chinese group, with decreased weights on Dimension 3 and increased weights on Dimension 1.

The INDSCAL analysis revealed that L1 children and L2 adults adopt different criteria in naming actions. L2 adults are heavily influenced by the semantic division of the domain in their L1, whereas L1 children tend to depend on the perceptually visible features of actions at the initial stage of lexical acquisition, and then gradually learn how their native language categorizes the actions by verbs.

These results suggest complex patterns of commonalities and differences across L1 and L2 vocabulary learning. Children learning their L1 and adults learning an L2 are similar in that they both tend to overuse broad-covering general verbs. This may be a strategy both L1 and L2 language learners commonly use when they need to talk about a thing or an event for which they do not have rich repertoire of words with deep knowledge of meaning. Both L1 and L2 also require a restructuring of the semantic domain order to attain the same meanings as those of adult L1 speakers; however, L2 vocabulary learning may face an additional challenge in this restructuring in that they have a strong bias to retain the original division of the conceptual space for their L1. In the General Discussion section, we discuss the implications we can draw for vocabulary learning in both L1 and L2.

GENERAL DISCUSSION

How L2 Word Meaning Acquisition Is Different From L2 Acquisition

Words do not stand on their own. They belong to a lexical domain, and the meaning of a word is in a large part determined by its relationship to other words in the same lexical domain. Further,

close neighbors in the same lexical domain usually do not have clean boundaries. To learn the full meaning of a word thus entails learning the meanings of all neighboring words and delineating the boundaries among them. In this research, we used the semantic domain of "carrying/holding" as a test case.

It has been agreed that meanings of words cannot be directly taught to children by adults through dictionary definitions; dictionary definitions are given by words, and thus cannot be understood without knowing meanings of words that are used in the definitions (Nagy & Anderson, 1984). In fact, even for older children, it is extremely difficult to attain the right meaning (at least to the level at which they can *use* the correctly word in context) from a dictionary meaning alone (Ameel et al., 2008; Bowerman, 1982; Nagy & Anderson, 1984). Children thus have to learn word meanings by inferring them on their own, as they observe words used in contexts. Here, they face the well-known problem—the so-called Gavagai problem (Quine, 1960)—that it is logically impossible to determine the correct meaning of a word based on the observation of only a limited number of exemplars. However, in the real world, children handle this problem very well. Guided by a set of constraints or biases (e.g., the whole object bias, the shape bias, and the mutual exclusivity bias for object names and syntactic bootstrapping for verbs), in many cases children are able to map a newly heard word to its rough meaning instantly (Carey & Bartlett, 1978; Haryu & Imai, 2002; Imai, Gentner, & Uchida, 1994; Markman, 1989).

Although this is an important first step for developing the lexicon, researchers have often overestimated what can be obtained by this initial mapping, even saying that children can attain the "adultlike" meaning on the first encounter to a word. This research demonstrated that this is not the case. On the contrary, children's initial word meaning attained by fast-mapping is very limited (see also Bowerman, 2005; Clark, 1995; Imai et al., 2008, for this point) and is very distant from adultlike word meanings, once we define "adultlike" word meanings as the representation that allows children to apply the word in the same way as adult native speakers do in the face of other words with similar meanings.

This article added to our previous article (Saji et al., 2011) in that it underscores the importance of the restructuring process not only for children learning L1 but also for adults learning an L2. Saji et al. (2011) provided a comprehensive picture about this long process of lexical development. Verbs that are likely to be included in children's early lexicons tend to be those that they hear most frequently. Words that are frequently used by adults are likely to be used broadly and polysemously as is the case with Chinese verb *na*, or with many English verbs such as *go*, *make*, or *run*. Children thus start to use these verbs early and to apply them to broad range of events. When these frequent and broad-covering verbs have close neighbors that cover a relatively narrow range of referents, the more frequently used verbs may tend to be overextended to cover actions that adults would denote with a less frequent but more specific verb. As children's lexical knowledge of the domain develops with inclusion of more verbs in the domain and with experience of using them, the boundary of the originally overextended verb is gradually modified.

It is important to consider how word meanings develop for adult L2 learners, especially in light of how it is different from what L1 children go through. We identified some commonalities across child L1 and adult L2 learners. The number of produced verb types was about the same, and the correlation values to the adult pattern of usage were similar across the child L1 and adult L2 learners. The L1 and L2 learners were also similar in their tendency to overextend broad-covering verbs. However, the results from this research suggest that a different mechanism may underlie this seeming similarity. The L2 learners' overextension may have arisen simply because

their own language happens to have a general verb that roughly (though only in part) corresponds to the Chinese verb *na*. In other words, if the verb that (seemingly) corresponds to *na* in their L1 covers a narrower range than Chinese with specific surrounding verbs, the L2 learners may not overextend *na* so much.

In fact, this possibility is supported by the difference in the range of application of the verb *na* to non-"na" actions by the native Japanese and Korean L2 learners. The Japanese L2 learners rarely overextended the verb *na* to the *kang* (carrying object on the shoulder) action, whereas Korean speakers did so very often. Of interest, Japanese has a specific verb for the action of holding an object on the shoulder (*katsugu*), whereas Korean general verb *teulda* includes this action in its extension. This suggests that L2 learners' overextension of *na* may reflect the modification of the semantic space in L2 to their L1 rather than the kind of overextension seen in children.

In any case, the way adult L2 learners learn word meanings is apparently different from the way children learn their L1. Unlike children, adult L2 learners often learn L2 words through dictionaries in which the definition of the L2 target word is given by corresponding words or phrases in their L1. Dependence on dictionaries is likely to bias L2 learners to think that the target L2 word is equivalent to the word in L1 and lead them to assume that the two words are used in the same argument structure, have the same collocational properties, and have the same boundary of extension. L1 children, steadily, though slowly, modify their word meanings through the restructuring process with development and eventually converge onto the word meanings shared by adults in their language community. In contrast, L2 learners' development of word meanings may stop well before they fully reach the adult native speakers' word meaning representation. In casual everyday discourse, L2 learners are in most cases able to make themselves understood even when their use of verbs are imprecise: As long as they use synonyms which are "close enough," L1 hearers often do not bother to correct L2 speakers in this situation. The false assumption that there is a one-to-one correspondence between L1 and L2 both at the level of each lexical word and at the level of the configuration of the lexical domain (i.e., how the semantic domain is divided into lexical categories) is thus very difficult to overcome.

Questions for Future Research

Many important questions concerning L2 word meaning acquisition are still left open. First, it is important to see whether the strong L1 influence is seen in other semantic domains, especially when the L2 semantic domain is not as complex as the Chinese "carry" domain. As we discussed, in Japanese and Korean, the structure of "carry" semantic domain seems to be simpler than in Chinese, with fewer verbs. English seems to have an even simpler structure, with only two verbs (i.e., *carry* and *hold*). It needs to be empirically examined whether L2 learners are still influenced by their L1 when the L2 semantic domain is simple.

Second, from a pedagogical perspective, it is extremely important to examine whether and how L2 learners can eventually overcome the influence of their L1 and attain an accurate adult native-like word meaning representation. There are people who start learning an L2 fairly late (after puberty) but who still attain native-like fluency both in speaking and writing. However, it has not really been investigated whether these people—extremely proficient late-starting L2 learners— use words exactly the same way as native speakers or early bilinguals. Ameel, Storms, Malt, and Sloman (2005) compared early bilinguals of French and Dutch and monolingual speakers of those languages to examine whether early bilinguals use nouns denoting various containers

in exactly the same ways as monolingual French or Dutch speakers. They found that the pattern of word use of early bilinguals was in between French monolinguals and Dutch monolinguals, indicating that their meanings of French words were influenced by their knowledge of Dutch and vice versa. Given this finding, it is possible that the word-meaning representation of even advanced L2 learners who speak the target language very fluently are still influenced by their L1 (see Malt & Sloman, 2003, for similar findings). In any case, further study of high-proficiency L2 learners is needed to shed further light on L2 learners' vocabulary acquisition, especially with respect to how deep and native-like their word meanings can become and what factors matter most in attaining a native level understanding of word meanings.

Implications for Vocabulary Education

The findings from the present research strongly suggest that knowledge of vocabulary should be considered not only in terms of the vocabulary size but also in terms of the depth of word meanings. Vocabulary knowledge should be determined in light of the ability to apply words precisely but creatively. An important aspect of this ability is the knowledge of how words in the same lexical domain are related to one another, how boundaries among them are delineated, and how the lexical domain as a whole is structured. This research demonstrated that this ability develops only gradually for L1 children. Our research also suggests that adult L2 learners may not fully attain this knowledge even when they have studied L2 for years, unless they understand that there are differences in the way L1 and L2 divide the world differently across many (or most) conceptual domains and pay consistent conscious attention to this fact as they learn and use L2 words. Reliance on dictionary definitions (particularly those given in the L2–L1 translation dictionaries) may enhance the bias to think that there is one-to-one mapping both for individual words and for the configuration of the lexical domain as a whole.

To overcome this problem, first, learners need to experience a given word in many different contexts. Reading inside and outside of the classroom may provide excellent opportunities for this. However, learners further need to attain meta-knowledge about the mapping of the entire configuration of the corresponding lexical domain between L1 and L2. This takes explicit awareness that the structure of a lexical domain in L2 is not equivalent to the structure of the corresponding lexical domain in L1 and continuous effort to discover the differences across the two languages. Careful attention to word use during reading is again very important. However, reading alone may not be sufficient, as paying too much attention to word meanings of individual words may disturb the comprehension of the text. So it may be useful to teach a set of words in the same lexical domain at one time and have L2 learners analyze the meanings of the words in light of how these words contrast in terms of usage and meanings, and how these words differ from the corresponding words in their L1. Practicing using the words in speaking and writing while obtaining feedback from native speakers also seems to be needed in order to fully attain the word meanings shared by adult native speakers.

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