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Short Report

Semantic Expansion Based on Japanese University Students' Perceptions of Nonobjects

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Abstract

We aimed to investigate meaning expansion from the perception of unknown shapes-that is, nonobjects-among 82 Japanese university students and compare the results with a previous American study. Participants were shown 10 nonobjects and were required to indicate what the unknown shape looked like. The responses were grouped into categories, and the Japanese and American responses were compared. Although there were some differences in expressive forms and categories between languages, most of the semantic representations associated with the nonobjects belonged to the same category, indicating the relativity and universality of language.

1. Introduction

When children and adults acquire new knowledge, they need to constantly update their perception and memory and integrate events they have experienced in the past with the new information[1]. In other words, when we encounter a new word or the shape of an object, we recall a known word or shape. This associates the known semantic representations to the features of the new object[2].

The constraints on vocabulary acquisition include whole object constraint, taxonomic constraint[3], mutual exclusivity[4], and shape bias[5]. Shape bias originates from the symbolic nature of language, as described above[6]. According to Gershkoff-Stowe and Smith[7], paying attention to an object's shape can speed up noun acquisition in a child. Therefore, the effect of object shape on vocabulary acquisition was suggested to be significant.

Storkel and Adlof[8] conducted a study in which 82 English-speaking university students and 92 preschool children were presented with pictures of nonobjects (nonexistent objects) and asked what they looked like. They investigated the semantic neighbor and semantic set size of nonobjects by aggregating the words that participants associated with each nonobject and proposed applications for future studies on word learning and nonverbal memory. Studies have been conducted to investigate words learned and semantic representations using the size of passive vocabulary[9], a word-sense explanation task to explain the meaning of words[9], and a word recall task to list words belonging to a category[10]. However, there are no studies that

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have investigated semantic neighbors using semantically related representations among Japanese speakers. This study aimed to investigate the semantic neighborhood of Japanese university students in terms of their perception of unknown shapes (nonobjects), following Storkel and Adlof's method[8]. Furthermore, we examined differences in semantic representations across languages by considering the individual and cultural differences.

2. Methods

2.1 Participants

82 university students (23 men and 59 women) with a mean age of 21.1 years (SD 0.95) participated in the study.

2.2 Stimuli and procedure

The stimuli used in this study were the 10 nonobjects used by Storkel and Adlof[8] (Table 1), which are line drawings created by tracing and stitching together parts of real figures taken from the 88 nonobjects created by Kroll and Potter[11]. The participant was presented by the examiner (the first author) with a 13-cm long and 21-cm wide piece of paper on which a nonobject was drawn. They confirmed that they could see the nonobject clearly, and then were asked, "What does this look like? Please say the first word that comes to your mind." The participant's response to each stimulus was recorded by the examiner.

2.3. Data analysis

To investigate the semantic neighbor of each of the 10 nonobjects, we used the same analysis method as Storkel and Adlof[8]. Semantic neighbors of the nonobject were defined as words answered by two or more participants that were recollected. The number of semantic neighbors was counted for each nonobject, and the number of semantic neighbors was defined as the semantic set size, which indicates the extent of the meaning of the nonobject.

Since some of the words uttered by the participants had slightly different forms, similar words were merged by referring to Storkel and Adlof's procedure[8]. For example, "cash register machine" and "cash register" were combined as it was assumed that the imagined object was the same. To compare the semantic neighbor between this study and its English counterpart[8], it was necessary that the labels to be compared were the same. Since it is difficult to accurately translate English words into Japanese[12], we selected 11 categories from the semantic neighbors of both studies and defined category neighbors as superordinate concepts (1. General Tool, Equipment, Device, 2. A Living Thing, 3. Clothing, Accessories, Footwear, 4. Physical Structure and Function, 5. Art 6. Movement, Appearance, Sport, 7. Food and Drink, 8. Information (including letters), 9. Plant, The Four Elements, Landform, 10. Game, Toy, 11. Trash). The semantic neighbors associated with each nonobject were classified by category neighbors, and the number of category neighbors for each nonobject was defined as the category set size. Two speech-language pathologists (first and last authors) determined the categories to ensure the reliability. All the authors checked whether the classification and wording of the categories were appropriate. Any disagreements or doubts regarding the categorization or wording were resolved through discussion.

Finally, to compare category neighbors between studies, the percentage of the total number of category neighbors obtained for all nonobjects was compared using Fisher's exact probability test with Holm's method adjusted for p-value.

Neighbor strength was calculated by dividing the number of respondents for each semantic neighbor by the total number of subjects (n = 82) in accordance with Storkel and Adlof[8]. This value indicates the percentage of participants who recalled the semantic neighbor. Spearman's correlation analysis was used to examine the correlation between the semantic set size and the first, second, third and fourth strongest neighbor for each nonobject.

2.4. Ethics statement

The research ethics committee of Kawasaki University of Medical Welfare (No. 18-107) approved the experimental procedures of this study in advance. Prior to the experiment, we obtained written informed

Table 1 Responses and classification of participants in the present study and Storkel and Adlof's study[8)]

non object (No.)	Present study (n = 82)			Storkel and Adlof (2009) (n = 82)		
	Category neighbor: number of participants [semantic neighbor: number of participants (%; neighbor strength)]	semantic set size	category set size	Category neighbor: number of participants [semantic neighbor: number of participants (%; neighbor strength)]	semantic set size	category set size
1 	Clothing, Accessories, Footwear: 58 [shoe: 54 (66%), socks: 2 (2%), slippers: 2 (2%)]	7	3	Clothing, Accessories, Footwear: 51 [shoe: 40 (49%), slippers: 7 (9%), footwear: 2 (2%), sandal: 2 (2%)]	7	3
	A Living Thing: 5 [butterfly: 3 (4%), fly: 2 (2%)]			Movement, Appearance, Sport: 10 [dance: 6 (7%), ballet: 4 (5%)]		
	General Tool, Equipment, Device: 4 [pacifier: 2 (2%), clip: 2 (2%)]			Physical Structure and Function: 5 [feet: 5 (6%)]		
2 	Physical Structure and Function: 32 [ear: 30 (37%), nail: 2 (2%)]	9	5	Physical Structure and Function: 28 [ear: 22 (27%), hear: 6 (7%)]	8	5
	Clothing, Accessories, Footwear: 18 [hairpin (hair clip, pin): 11 (13%), earrings for pierced ears (earring): 5 (6%), magatama: 2 (2%)]			Plant, The Four Elements, Landform: 5 [leaf: 3 (4%), tree: 2 (2%)]		
	Plant, The Four Elements, Landform: 9 [drop (including water drops): 9 (11%)]			General Tool, Equipment, Device: 5 [loop: 3 (4%), key: 2 (2%)]		
	General Tool, Equipment, Device: 3 [clip: 3 (4%)]			Clothing, Accessories, Footwear: 4 [ring: 4 (5%)]		
	Food and Drink: 4 [fried calamari: 2 (2%), Churros: 2 (2%)]			Information (include letter): 2 [o: 2 (2%)]		
3 	General Tool, Equipment, Device: 65 [clothespin: 24 (29%), spring shears: 18 (22 %), pliers: 8 (10%), scissors: 6 (7%), clip: 5 (6%), keyhole: 2 (2%), nipper: 2 (2%)]	7	1	General Tool, Equipment, Device: 32 [tool: 12 (15%), wrench: 6 (7%), pliers: 5 (6%), scissors: 5 (6%), key: 4 (5%)]	8	3
				Movement, Appearance, Sport: 6 [cut: 3 (4%), vice: 3 (4%)]		
				Game, Toy: 2 [maze: 2 (2%)]		

4 	General Tool, Equipment, Device: 51 [computer (sideways computer, computer): 10 (12%), radio (radio cassette recorder, old radio cassette recorder, audio, stereo): 9 (11%), clip: 5 (6%), speaker: 5 (6%), chair (sideways chair, sofa): 4 (5%), scissors: 4 (5%), glasses: 4 (5%), binoculars: 2 (2%), handcuffs: 2 (2%), drink holder: 2 (2%), brass knuckles: 2 (2%), cash register: 2 (2%)]	14	2	Information (include letter): 20 [book: 13 (16%), read: 4 (5%), knowledge: 2 (2%)]	8	3
	Information (include letter): 7 [book: 5 (6%), pop-up book: 2 (2%)]			General Tool, Equipment, Device: 19 [computer: 9 (11%), keyboard: 7 (9%), glasses: 2 (2%), radio: 2 (2%)]		
				Movement, Appearance, Sport: 8 [type: 8 (10%)]		
5 	A Living Thing: 35 [butterfly (half of ～, other side of ～): 12 (15%), butterfly (wings of ～, one wing of ～): 6 (7%), amoeba: 6 (7%), sea slug: 5 (6%), microorganism: 4 (5%), coral: 2 (2%)]	13	3	Food and Drink: 12 [food: 6 (7%), pea: 4 (5%), pie: 2 (2%)]	8	5
	Physical Structure and Function: 16 [cell: 5 (6%), mouth (when laughing): 4 (5%), ear: 3 (4%), good: 2 (2%), profile (human profile): 2 (2%)]			Physical Structure and Function: 11 [ear: 11 (13%)]		
	Food and Drink: 6 [pot sticker: 3 (4%), meat (raw meat, section of meat): 3 (4%)]			General Tool, Equipment, Device: 6 [bowl: 4 (5%), vase: 2 (2%)]		
				A Living Thing: 4 [butterfly: 4 (5%)]		
				Game, Toy: 7 [marble: 2 (2%)]		
6 	General Tool, Equipment, Device: 46 [cup: 10 (12%), empty can (including can): 9 (11%), mailbox: 6 (7%), flashlight: 4 (5%), water jugs: 3 (4%), pipe, pole: 3 (4%), light (spotlight): 3 (4%), chimney: 2 (2%), mug: 2 (2%), trash can: 2 (2%), cork (wine cork): 2 (2%)]	14	4	General Tool, Equipment, Device: 37 [can: 21 (26%), mug: 6 (7%), can opener: 3 (4%), cup: 3 (4%), pot: 2 (2%), trash can: 2 (2%)]	12	5
	Plant, The Four Elements, Landform: 10 [bamboo (bamboo light): 10 (12%)]			Movement, Appearance, Sport: 8 [open: 6 (7%), turn: 2 (2%)]		

	Food and Drink: 3 [Vienna coffee: 3 (4%)] Art: 2 [clarinet fitting: 2 (2%)]			Food and Drink: 6 [coffee: 4 (5%), soda: 2 (2%)] Trash: 4 [trash: 4 (5%)] Art: 2 [drum: 2 (2%)]		
7 	A Living Thing: 63 [insect: 10 (12%), animal (attracted～, weird～): 7 (9%), wild boar: 5 (6%), dinosaur: 5 (6%), goldfish: 5 (6%), mouse: 5 (6%), dog (dog with wings): 4 (5%), rabbit: 4 (5%), platypus: 4 (5%), fly: 4 (5%), bird: 3 (4%), mole: 3 (4%), creature: 2 (2%), pig: 2 (2%)] Food and Drink: 4 [carrots: 4 (5%)]	15	2	A Living Thing: 52 [animal: 14 (17%), rabbit: 13 (16%), kangaroo: 7 (9%), bug: 4 (5%), dinosaur: 4 (5%), beaver: 3 (4%), squirrel: 3 (4%), fly: 2 (2%), insect: 2 (2%)] Movement, Appearance, Sport: 4 [run: 4 (5%)] Plant, The Four Elements, Landform: 2 [Australia: 2 (2%)]	11	3
8 	General Tool, Equipment, Device: 47 [vacuum cleaner: 20 (24%), lighting desk lamp, stand light, lamp, light, indirect light): 20 (24%), fan: 3 (4%), shower: 2 (2%), stethoscope: 2 (2%)] Art: 23 [horn (alto horn): 16 (20%), trumpet (bugle): 7 (9%)]	7	2	General Tool, Equipment, Device: 28 [lump: 13 (16%), light: 4 (5%), instrument: 3 (4%), band: 2 (2%), loop: 2 (2%), shower: 2 (2%), vacuum: 2 (2%)] A Living Thing: 9 [horn: 9 (11%)] Movement, Appearance, Sport: 4 [clean: 2 (2%), play: 2 (2%)] Art: 3 [music: 3 (4%)] Plant, The Four Elements, Landform: 2 [water: 2 (2%)]	12	5
9 	Physical Structure and Function: 16 [bone (skeleton, skull, skeletonized body, dinosaur fossils: 16 (20%)] General Tool, Equipment, Device: 14 [key (bunch of keys, about 3 keys): 6 (7%), pallet: 4 (5%), clip: 2 (2%), chopsticks (disposable chopsticks): 2 (2%)]	15	7	Art: 15 [trumpet: 6 (7%), music: 5 (6%), horn: 4 (5%)] General Tool, Equipment, Device: 14 [instrument: 5 (6%), tool: 3 (4%), band: 2 (2%), gun: 2 (2%), stick: 2 (2%)]	12	4

	Art: 10 [trumpet (bugle): 7 (9%), violin: 3 (4%)]			A Living Thing: 5 [ghost: 3 (4%), butterfly: 2 (2%)]		
	A Living Thing: 10 [ghost, zombie, monster: 6 (7%), frog: 4 (5%)]			Movement, Appearance, Sport: 5 [twist: 3 (4%), stuck: 2 (2%)]		
	Movement, Appearance, Sport: 7 [food (cabbage, lotus root) with chopsticks: 4 (5%), holding a branch, scroll, something: 3 (4%)]					
	Clothing, Accessories, Footwear: 5 [hair ornaments: 3 (4%), ornamental hairpins: 2 (2%)]					
	Food and Drink: 5 [lotus root: 3 (4%), mushrooms: 2 (2%)]					
10 	Art: 31 [drum: 17 (21%), folk instrument (djembe, like sitting and beating, drum, bongo, drum...samba type, beating instrument): 10 (12%), musical instrument: 2 (2%), drum "tsuzumi" (shoulder-beating instrument): 2 (2%)]	14	6	General Tool, Equipment, Device: 18 [can: 6 (7%), rope: 6 (7%), instrument: 2 (2%), trap: 2 (2%), vase: 2 (2%)]	12	6
	General Tool, Equipment, Device: 10 [sewing thread: 6 (7%), empty can (...crushed flat): 2 (2%), chair: 2 (2%)]			Movement, Appearance, Sport: 5 [scar: 3 (4%), detach: 2 (2%)]		
	Food and Drink: 7 [mushroom: 3 (4%), elingi mushroom: 2 (2%), pizza: 2 (2%)]			Physical Structure and Function: 4 [jaw: 2 (2%), neck: 2 (2%)]		
	Clothing, Accessories, Footwear: 5 [muffler (neck warmer): 3 (4%), baggy socks: 2 (2%)]			Plant, The Four Elements, Landform: 3 [fire: 3 (4%)]		
	Movement, Appearance, Sport: 3 [apple core (dregs, leftover): 3 (4%)]			Clothing, Accessories, Footwear: 2 [dress: 2 (2%)]		
	A Living Thing: 2 [sea anemone: 2 (2%)]			Art: 2 [art: 2 (2%)]		

consent from each participant after informing them of the study purpose, methodology, risks, handling of personal information, benefit of the study's results, rights to withdraw, and voluntary participation.

3. Results

The category neighbors, semantic neighbors, neighbor strength, semantic set size, and category set size for the 10 nonobjects are shown in Table 1. The categories associated with each nonobject are shown in each row, and the semantic neighbors, the number of respondents, and neighbor strength are shown in parentheses in the "Category Neighbors" column. The average number of recollections for each nonobject was 11.5 ± 3.5 (range 7-15) in this study, and 9.8 ± 2.1 (range 7-12) in Storkel and Adlof[8].

The relationship between the semantic set size of each nonobject and the neighbor strength was significantly negatively correlated only with the first strongest neighbor (r = -.75, p = .011). The second, third, and fourth strongest neighbor did not show any significant correlation with semantic set size (second: r = -.35, p = .320; third: r = -.31, p = .386; fourth: r = -.05, p = .893).

Across 10 nonobjects, we compared the proportions of types of category neighbors between this study and Storkel and Adlof's study[8], and significant differences were found among all nonobjects (p < .05). Next, we compared the total number of categories represented in this study and in Storkel and Adlof's study[8]. As shown in Figure 1, there was a significant difference between some of the pairs (p < .001～.05). In particular, "Movement, Appearance, Sport" and "Information (including letters)" were associated with English-speaking participants significantly more frequently than most other categories. On the other hand, there was no significant difference between the categories expressed in English and Japanese for the other pair combinations.

4. Discussion

In the present study, we examined the expansion of meanings associated with the first visual stimuli (nonobject) in different linguistic regions, referring to the work of Storkel and Adlof[8]. In this study, as well as in Storkel and Adlof's study[8], we found a significant negative correlation between the size of the semantic set and the first strongest neighbor. In other words, the larger the semantic set size, the weaker was the neighbor strength of the word and vice-versa. Therefore, nonobjects with a large semantic set size were seen differently among participants, suggesting that a variety of words are associated with these nonobjects. On the contrary, the smaller the semantic set size of a nonobject is, the less likely it is that its associated meaning will be broadened, and the more likely it is that many people will imagine an approximation to an unknown object. In addition, the second, third, and fourth strongest neighbors were not correlated with the semantic set size. This suggests that nonobjects with a large semantic set size are more likely to be associated with many words, while words that are associated with the second or subsequent strongest neighbors are less likely to be affected by the semantic set size, which means that these nonobject stimuli are suitable for examining the semantic neighbor of the subject, since they are less sensitive to semantic set size and can measure word recall ability.

The category neighbors for each nonobject differed between the Japanese and the American studies[8]. It is suggested that the words associated with the 10 nonobject stimuli reflect the participants' past experiences[1] and the influence of the participants' culture. It is also possible that different groups of these objects had different perspectives regarding nonobjects. Malt[13] states that the role of our intrinsic cognitive abilities becomes more influential when the surrounding environment does not present us with perceptually and cognitively obvious chunks of information. The nonobject has no obvious coherence and therefore has few environmental cues. Thus, the responses associated with this task may reflect human cognitive abilities, including individual and culture-specific views. On the other hand, when we look at the total percentage of categories represented by the 10 nonobjects (Figure 1), we see that Storkel and Adlof[8] found that two categories, "Movement, Appearance, Sport" and "Information (including letters)," were associated with a higher percentage of nonobjects than in the present study. However, there was no difference in the

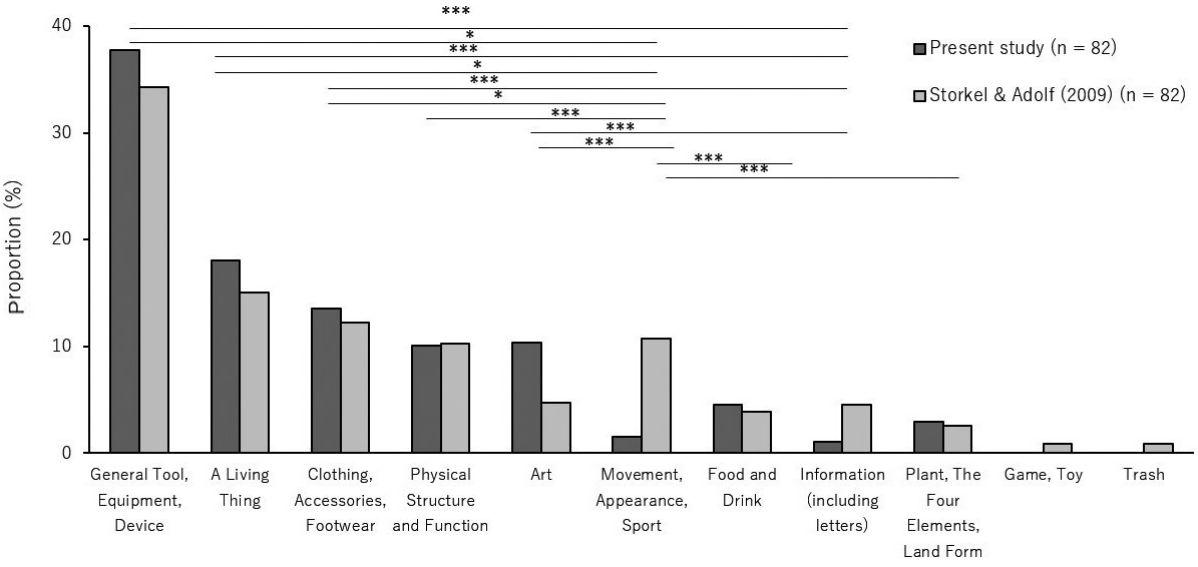

Figure 1 Comparison between categories in the present study and Storkel and Adlof's study[8)]

frequency of associations between the studies in the other categories. Therefore, the overall perception of the expansion of meaning associated with the perception of nonobjects might be universal in a similar age group, regardless of cultural differences.

The target population of this study was limited to university students; the age range was narrow. Therefore, the difference in semantic expansion by age was well controlled. In terms of gender, however, this study had a large proportion of women (72%) compared to men (28%), whereas Storkel and Adlof's study[8)] had a nearly equal proportion of men (48%) and women (52%). Thus, future studies need to consider the impact of gender differences.

5. Conclusion

In this study, we examined the semantic neighbors associated with nonobjects and compared them across languages, referring to the work of Storkel and Adlof[8)]. The semantic neighbor (the form of expression recalled by the participants) was found to be diverse among languages, indicating the individuality of each language, while the category neighbor (the macro rather than the micro level) suggested that a few non-overlapping and many overlapping expressions belonging to universal categories were associated.

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References

1. Samuelson LK and Smith LB : Grounding development in cognitive processes. *Child Development*, 71, 98-106, 2000.
2. Storkel HL, Armbrüster J and Hogan TP : Differentiating phonotactic probability and neighborhood density in adult word learning. *Journal of Speech, Language, and Hearing Research*, 49, 1175-1192, 2006.
3. Markman EM and Hutchinson JE : Children's sensitivity to constraints on word meaning: Taxonomic versus thematic relations. *Cognitive Psychology*, 16, 1-27, 1984.
4. Markman EM and Wachtel GF : Children's use of mutual exclusivity to constrain the meanings of words. *Cognitive Psychology*, 20, 121-157, 1988.
5. Imai M, Gentner D and Uchida N : Children's theories of word meaning: The role of shape similarity in early acquisition. *Cognitive Development*, 9, 45-75, 1994.

6. Imai M: *The paradox of language learning*. Kyoritsu Shuppan, Tokyo, 1997. (in Japanese, translated by the author of this article)
7. Gershkoff-Stowe L and Smith LB : Shape and the first hundred nouns. *Child Development*, 75, 1098-1114, 2004.
8. Storkel HL and Adlof SM : Adult and child semantic neighbors of the Kroll and Potter (1984) nonobjects. *Journal of Speech, Language, and Hearing Research*, 52, 289-305, 2009.
9. McGregor KK, Berns AJ, Owen AJ, Michels SA, Duff D, Bahnsen AJ and Lloyd M : Associations between syntax and the lexicon among children with or without ASD and language impairment. *Journal of Autism and Developmental Disorders*, 42, 35-47, 2012.
10. Yoshibashi Y, Fujita C, Kawakami M and Tsujii M : The characteristic of the structure of semantic networks of childhood high function pervasive developmental disorder: the experimental examination using linguistic associational paradigm. *Pediatric Psychiatry and Neurology*, 49, 149-161, 2009. (in Japanese)
11. Kroll JF and Potter MC : Recognizing words, pictures, and concepts: A comparison of lexical, object, and reality decisions. *Journal of Verbal Learning and Verbal Behavior*, 23, 39-66, 1984.
12. Kojima Y : *Meaning in Japanese, meaning in English*. Nanun-Do Publishing, Tokyo, 1997. (in Japanese, translated by the author of this article)
13. Malt BC : Category coherence in cross-cultural perspective. *Cognitive Psychology*, 29, 85-148, 1995.