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Word Sound Retrieval Abilities in Japanese Children With Developmental Dyslexia - Report Based on the Use of Picture Naming Tasks in Discrete Condition

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Abstract

Developmental dyslexia (DD) is assumed to be partially caused by word sound retrieval difficulty. We analyzed the word sound retrieval abilities in Japanese children with DD with and without developmental language disorder (DLD) using picture naming tasks in discrete conditions. The participants in this study were 28 children with DD (9 with and 19 without DLD) and 18 children with typical development from third to eighth grades. All groups were matched for chronological age. We evaluated the number of correct responses and reaction time of picture naming tasks using 10 colors and 100 objects. Picture naming stimuli were selected from the Test of Lexical Processing in Aphasia (TLPA), Standard Language Test of Aphasia (SLTA) and Supplementary Tests for Standard Language Test of Aphasia (SLTA-ST). Children with DD and DLD, showed lower scores in the object naming task than those in children with typical development and with DD alone (p<.000). Children with only DD manifested scores in the normal range. Our results suggest that picture naming connects with spoken language development. Japanese children with DD without DLD have no problem in word sound retrieval abilities in discrete conditions.

Keywords: developmental dyslexia, developmental language disorder, picture naming task, vocabulary

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INTRODUCTION

A word sound retrieval deficit theory is hypothesized as a cause for cognitive disorders, which is a factor for developmental dyslexia (German, 1985; Fawcett & Nicolson, 1994; Korhonen, 1995; Swan & Goswami, 1997; Oishi, 1997; Oishi & Saito, 1999; Cohen, Morgan, & Vaughn, 1999; Faust & Sharfstein-Friedman, 2003; Hanly & Vandenberg, 2010). Many researchers have examined the word sound retrieval abilities of children with developmental dyslexia using object and color naming tasks in discrete conditions (Swan & Goswami, 1997; Oishi, 1997; Oishi & Saito, 1999; Faust & Sharfstein-Friedman, 2003; Hanly & Vandenberg, 2010). For children with developmental dyslexia, there is strong evidence that their reading difficulties are underpinned by weak phonological skills (Snowling, Van Wagtendonk, & Stafford, 1988; Snowling, 1991). The difficulty that children with developmental dyslexia experience when naming pictures has also been interpreted as a symptom of weak phonological skills.

It has been reported that in the task of naming an object or its color, children with developmental dyslexia showed a lower number of correct answers and longer reaction time compared to children with typical development (Swan & Goswami, 1997; Oishi, 1997; Oishi & Saito, 1999; Faust & Sharfstein-Friedman, 2003; Hanly & Vandenberg, 2010). For example, Swan and Goswami (1997) showed that children with developmental dyslexia were particularly poor at naming pictures that have long, phonologically complex and unusual names (e.g. protractor, harmonica, binoculars) in accuracy, even when compared with young children matched for reading age. Oishi & Saito (1999) conducted a color naming task with children with developmental dyslexia, and all of the children with developmental dyslexia showed lower scores in the color naming task compared to children with typical development in Japanese.

Faust & Sharfstein-Friedman (2003) used the ''tip-of-the-tongue'' (TOT) experimental paradigm in a picture-naming task to explore the naming deficits of adolescents with developmental dyslexia reading in Hebrew. In a TOT experience, the speaker is able to provide semantic information about the word but is unable to access the word's phonological representation and direct the assembly of the spoken word (Brown, 1991). As compared with a control group of typically developing readers, the adolescents with dyslexia had fewer correct responses and more TOT responses. However, previous studies have not sufficiently evaluated the vocabulary size of the children being studied (Swan & Goswami, 1997; Oishi, 1997; Oishi & Saito, 1999; Faust & Sharfstein-Friedman, 2003; Hanly & Vandenberg, 2010).

Furthermore, there have been reports of a co-existence of spoken language developmental disorder among children with developmental dyslexia (Oishi, 1997; Oishi & Saito, 1999). Studies about word sound retrieval abilities in children with developmental language disorder alone showed slower and more errorful performance, in comparison to age matched group, in discrete conditions (Menyuk, 1975; Wiig, Semel,

& Nystrom, 1982; Messer & Dockrell, 2006). Based on the above reports, the possibility that word sound retrieval abilities are involved in the development of spoken language in children with developmental dyslexia cannot be denied. Gotoh et al. (2016) analyzed word sound retrieval abilities in Japanese children with developmental dyslexia with and without developmental language disorder using word fluency tasks. As a result, the scores for word fluency tasks connected with spoken language development and were in the normal range in Japanese children with developmental dyslexia without developmental language disorder. Whereas, relationships between the word sound retrieval abilities and the picture naming tasks in Japanese children with developmental dyslexia with and without developmental language disorder has not been fully investigated yet.

In this study, a picture naming task was conducted to examine the word sound retrieval abilities of children with two types of developmental dyslexia, a typical Japanese speaking group with developmental dyslexia and a group with developmental dyslexia accompanied with developmental language disorder.

METHODS

Participants

Children with typical development

The participants with typical development comprised 18 children from third to eighth grades who attended a regular class [age: 10.4 ± 1.9 (mean ± standard deviation) years; age range: 8-13; 2 boys, 16 girls].

The participants with typical development scored at least -1 standard deviation (SD) or higher than the mean in all of the tests of Raven's Coloured Progressive Matrices (RCPM) (Raven, 1976), the Standardized Comprehension Test of Abstract Words (SCTAW) (Haruhara, Kaneko, & Uno, 2002), and the Kanji writing accuracy task in the Standardized Tests for Assessing the Reading and Writing (Spelling) Attainment of Japanese Children and Adolescents (STRAW-R) (Uno, Haruhara, Kaneko, & Wydell, 2017), and the children scored within +1 SD of the mean in the reading fluency tasks in the STRAW-R, showing that their general intelligence and spoken language development were within the normal range and they did not have any delay in reading and writing attainment levels.

Children with Developmental Dyslexia

The participants with developmental dyslexia comprised 28 students who visited an institution designated to providing support for children with learning disabilities, and ranged from third to eighth grades [age: 10.8 ± 1.6 (mean ± standard deviation) years; age range: 8-13; 23 boys, 5 girls; 27 right-handed, 1 left-handed]. The results of cognitive

Table 1

Results of Cognitive Tests and Tests Related With Reading and Spelling in the Children With Developmental Dyslexia (n=28)

		DD [a] (n=19)	DD +DLD [b] (n=9)
General intelligence tests			
Wechsler Intelligence Scale for Children-Third Edition (WISC-III) or Wechsler Intelligence Scale for Children-Fourth Edition (WISC-Ⅳ)		**mean ± SD**	**mean ± SD**
Verbal IQ (VIQ) or Verbal Comprehension Index (VCI)		104.0 ± 10.5	77.5 ± 4.64
Performance IQ (PIQ) or Perceptual Reasoning Index (PRI)		94.5 ± 13.1	96.0 ± 6.80
Full scale IQ (FIQ)		99.4 ± 10.9	88.3 ± 8.80
		mean z scores	**mean z scores**
Raven Coloured Progressive Matrices (RCPM)	(n = 36)	−0.40	−0.65
Vocabulary test			
Standardized Comprehension Test of Abstract words (SCTAW)	(n = 45)	0.61	−0.65
Reading and writing tests			
Standardized Tests for Assessing the Reading and Writing Attainment of Japanese Children and Adolescents (STRAW-R)			
Reading accuracy			
Hiragana words	(n = 20)	−0.30	0.14
Katakana words	(n = 20)	−0.62	−1.90
Kanji words	(n = 20)	−0.60	−2.70
Writing accuracy			
Hiragana words	(n = 20)	−0.40	−1.00
Katakana words	(n = 20)	−1.30	−1.70
Kanji words	(n = 20)	−2.00	−3.60
Reading fluency			
Hiragana words		2.57	3.56
Katakana words		2.73	3.46
Hiragana non-words		2.18	1.27
Katakana non-words		2.40	1.17
Paragraph		1.54	3.68
Phonological ability tests			
Nonword Repetition	(n = 10)	−0.57	−1.70
Word Repetition in Reverse Order			
Number of correct answers	(n = 20)	−1.01	−1.16
Duration (s)			
Three-morae words	(n = 10)	2.78	3.09
Four-morae words	(n = 10)	2.49	4.30
Visual cognitive ability tests			
Matching Familiar Figure Test (MFFT)			
Number of correct answers	(n = 12)	−0.33	−0.10
Number of errors		0.32	0.30
Reaction time (s)		0.61	1.21
Rey-Osterrieth Complex Figure Test (ROCFT)			
Copy drawing		−0.67	−1.44
Immediate recall		−0.74	−0.93
Delayed recall		−1.12	−1.16
Automatization test			
Rapid Automatized naming (RAN)			
Duration (s)		1.99	2.43

Note. WISC-ⅢorⅣ indicates mean±SD and all other tasks indicates mean z scores.

[a] The developmental dyslexia group

[b] The developmental dyslexia with developmental language disorder group

tests and tests related with reading and spelling observed from the first examination of the 28 children with developmental dyslexia are shown in Table 1.

The children in the developmental dyslexia group met the following three conditions:

(1) They scored 85 or above in the Verbal Intelligence Quotient (VIQ) or Performance Intelligence Quotient (PIQ) of WISC-Ⅲ (Wechsler Intelligence Scale for Children-Third Edition) or in the Verbal Comprehension Index (VCI) or Perceptual Reasoning Index (PRI) in WISC-Ⅳ (Wechsler Intelligence Scale for Children-Fourth Edition), or had a score of at least -1.5 SD in RCPM (Raven, 1976).

(2) They scored under -1.5 SD of the mean in reading or writing accuracy of any one of the Hiragana words, or Katakana words, or Kanji words, or had a duration time of longer than +1.5SD of the mean in reading either Hiragana and Katakana words or Hiragana and Katakana non-words or sentences in the reading fluency tasks in the STRAW-R (Uno et al., 2017).

(3) (a) They scored below -1.5 SD of the mean in the number of correct answers in the non-word repetition task or word repetition in reverse order, the time it took to correctly answer the word repetition in reverse order was +1.5 SD of the mean or longer, or
(b) the duration in the Rapid Automatized naming task (RAN) (Kaneko, Uno, & Haruhara, 2004) was +1.5SD or longer, or
(c) below -1.5SD in the number of correct answers or over +1.5SD in the number of errors and reaction times in the Matching Familiar Figures Test (MFFT) (Yokoi, Uno, Kaneko, & Kanbayashi, 2014), or they had a score of under -1.5 SD either in the copy task, immediate recall task, or 30-minute delayed recall task in the Rey-Osterrieth Complex Figure Test (ROCFT) (Osterrieth, 1993).

Nine out of the 28 children with developmental dyslexia (age: 10.8 ± 1.8 years; age range: 8-13; 8 boys, 1 girls; 9 right-handed) had a score of below 85 in the VIQ of WISC-Ⅲ or in the VCI of WISC-Ⅳ and/or a score of below -1.5SD of the mean in the number of correct answers in the Standardized Comprehension Test of Abstract Words (SCTAW) (Haruhara et al., 2002). Thus, this group was designated as the developmental dyslexia with developmental language disorder group.

There was no statistically significant difference in chronological age ($\chi^2 = .584$, $df = 2$, $p = .747$) among the typical development group (TD, n = 18, 10.4 ± 1.9 years), the developmental dyslexia group (DD, n = 19, 10.7 ± 1.6 years) and the developmental dyslexia with developmental language disorder group (DD+DLD, n = 9, 10.8 ± 1.8 years).

Procedure

In this study, the color naming task and object naming task were administered to the participants in discrete conditions.

Color naming task

Color naming had 10 tasks. 10 colors were selected from the Test of Lexical Processing in Aphasia; TLPA (Fujita et al., 2000) (see Appendix). The stimulus used was a Japan Color Enterprise colored paper with different tones and a size of 5 cm (length) × 6 cm (width). As a side note, preliminary research with 12 typically-developing children aged between 3 and 6 years was conducted in advance, with the mean correct response rate being 79.2%. The test implementation and scoring method followed TLPA (Fujita et al., 2000). We counted the number of correct answers within 10 seconds.

Object naming task

Object naming had 100 tasks. 20 nouns were used in the Standard Language Test of Aphasia; SLTA (Japan Society for Higher Brain Dysfunction, 1997) naming task and 80 words were used in the Supplementary Tests for Standard Language Test of Aphasia; SLTA-ST (Japan Society for Higher Brain Dysfunction, 1999) naming task (see Appendix). The stimuli were monochrome line drawings and its size was 10 cm (length) × 10 cm (width). The implementation and scoring method followed SLTA and SLTA-ST (Japan Society for Higher Brain Dysfunction, 1997, 1999). We counted the number of correct answers within 15 seconds.

Analysis

In this study, the number of correct responses and reaction time (seconds) in the naming tasks were analyzed, with the number of correct responses and reaction time of each task being compared across the typical development (TD), developmental dyslexia (DD) and developmental dyslexia with developmental language disorder (DD+DLD) groups. For analysis, a one-way analysis of variance (one-way ANOVA) was used. Bonferroni's multiple comparison test was used when the main effect was found to be significant in a one-way ANOVA (IBM SPSS Statistics ver.23, Tokyo, Japan).

Ethics

Participation by subjects in this study was determined based on the informed consent of both the child and his/her parent or guardian. After explaining the outline of the study, the tasks were performed only if both the child and his/her parent or guardian gave their approval. Sufficient explanation was also provided regarding the fact that participants could drop out of the study at any time and that they would suffer no disadvantages by

doing so. This study was approved by the Research Ethics Committee of the Human Sciences at the University of Tsukuba (ID No.23-73).

RESULTS

Color naming task

There was no significant difference between either correct responses ($F(2,43)=2.238$, $p=.119$, $\eta^2=.09$) or reaction time ($F(2,43)=.097$, $p=.908$, $\eta^2=.01$) on the color naming task among the typical development (TD), children with developmental dyslexia (DD), and children with developmental dyslexia and developmental language disorder (DD+DLD) groups. In order to examine gender differences, two boys and 16 girls in the TD group were analyzed. There was no significant difference between either correct response ($F(1,16)=2.844$, $p=.111$, $\eta^2=.15$) or reaction time ($F(1,16)=.669$, $p=.425$, $\eta^2=.04$).

Furthermore, 15 boys and four girls in the DD group were analyzed. There was no significant difference between either correct response ($F(1,17)=.098$, $p=.758$, $\eta^2=.01$) or reaction time ($F(1,17)=.315$, $p=.582$, $\eta^2=.02$).

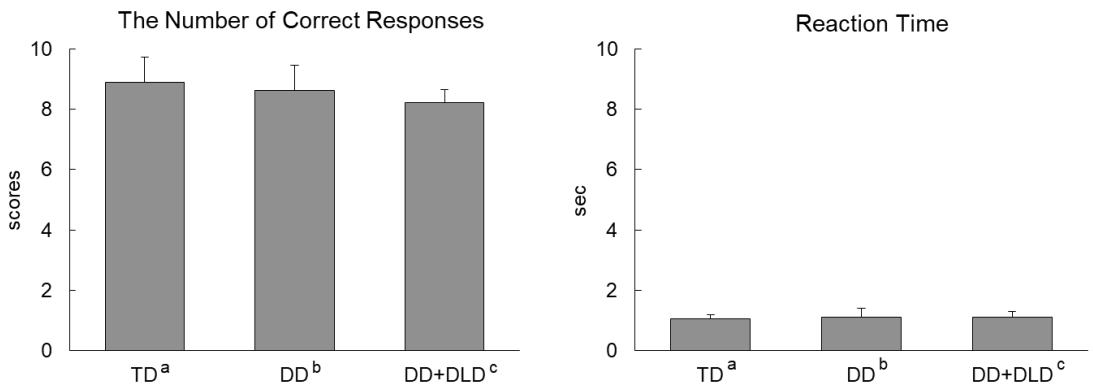

Figure 1. *Results of color naming task*

Note. [a] The typical development group; [b] The developmental dyslexia group; [c] The developmental dyslexia with developmental language disorder group

Object naming task

In the object naming task, a significant difference was found between the three groups ($F(2,43)=17.89$, $p<.000$, $\eta^2=.45$). When a multiple comparison was conducted to examine the difference between the groups, a significant difference was found between the TD and DD+DLD groups ($p<.000$, $r=.75$) and between the DD and DD+DLD groups ($p<.000$, $r=.71$). However, there was no significant difference between the three groups in terms of reaction time ($F(2,43)=.865$, $p=.428$, $\eta^2=.04$).

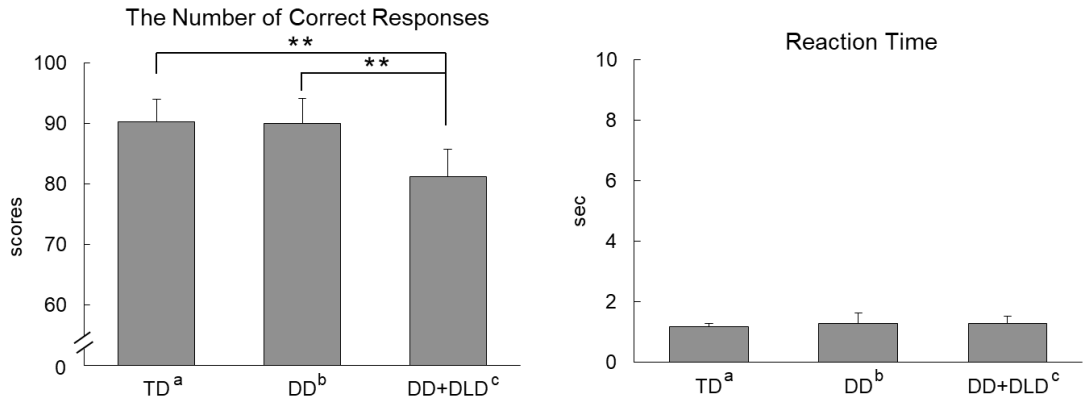

Figure 2. *Results of object naming task*

Note. [a] The typical development group; [b] The developmental dyslexia group; [c] The developmental dyslexia with developmental language disorder group
**$p < .01$

In order to examine gender differences, two boys and 16 girls in the TD group were analyzed. There was no significant difference between neither correct response ($F(1,16) = 2.659$, $p = .122$, $\eta^2 = .14$) nor reaction time ($F(1,16) = .252$, $p = .622$, $\eta^2 = .01$). Furthermore, 15 boys and four girls in the DD group were analyzed. There was no significant difference between neither correct response ($F(1,17) = 3.451$, $p = .081$, $\eta^2 = .17$) nor reaction time ($F(1,17) = .845$, $p = .371$, $\eta^2 = .05$).

DISCUSSION

Word sound retrieval deficit hypothesis in Japanese children with developmental dyslexia

In this study, the typical developmental dyslexia group (DD) did not show a lower score in either the color or object naming tasks. This supported the results of the study by Gotoh et al. (2016) that the scores for word fluency tasks did not decrease in DD and DD did not cause issues in word sound retrieval abilities.

Previous studies have consistently reported that the number of correct responses in the object naming task was lower among children with DD compared to children with typical development (Swan & Goswami, 1997; Faust & Sharfstein-Friedman, 2003; Hanly & Vandenberg, 2010). Snowling et al. (1988) pointed out the deficit with the activation of phonological representation toward pictures as a cause for this. In our study, the DD showed a phonological disorder in the results of the non-word repetition task and word repetition in reverse order, although they did not show lower scores in the color naming or object naming tasks. On the other hand, the developmental dyslexia with

developmental language disorder group (DD+DLD) showed lower scores in the object naming task. Gotoh et al. (2016) examined the word sound retrieval abilities of children with DD in a verbal fluency task (alliteration fluency tasks with a given sound / a / and / ka /) and stated that spoken language development was involved with the verbal fluency task scores. In this study, the score of the object naming task is likely to be related with the development of spoken language. Issues with the development of spoken language, in particular with vocabulary, are believed to impact the decline in the word sound retrieval abilities of the DD+DLD group.

Oishi & Saito (1999) conducted a color naming task with seven Japanese children with developmental dyslexia, and all of the children with developmental dyslexia showed lower scores in the color naming task compared to children with typical development. Oishi (1997) hypothesized that the degree to which the semantic network is accessed in the color naming task is lower than that in the object naming task, and that the phonological representation had to be retrieved directly from the phonological lexicon. Therefore, it was assumed that children with developmental dyslexia with word sound retrieval disorder have lower scores in the color naming task. In our study, DD and DD+DLD showed normal scores in the color naming task. Oishi & Saito (1999) conducted a naming task with 10 colors including the basic and intermediate colors, and the mean correct response rate of 10 typically-developing children aged five years was 70.0%. On the other hand, in this study, eight out of 10 colors were composed of the basic colors, and the only intermediate colors were beige and navy blue. Also, preliminary research with 12 typically-developing children aged between three and six years was conducted in advance, with the mean correct response rate being 79.2%. In our study, DD and DD+DLD did not show lower scores in the color naming task, which was different from the results of Oishi & Saito (1999); it was suggested that the stimuli used in the color naming task were different, and the difficulty of the color naming task might be lower than that of Oishi & Saito (1999).

The relationship between the reaction time of the picture naming task and RAN (Rapid Automatized Naming)

In previous studies, it was reported that children with developmental dyslexia showed a longer reaction time in a single picture naming task, compared to children with typical development (German, 1985; Fawcett & Nicolson, 1994; Oishi, 1997). However, the children with DD and DD+DLD showed no significant extension in reaction time in either the color nor object naming tasks. On the other hand, the children with DD and DD+DLD who were examined in this study showed longer duration in Rapid Automatized Naming (RAN).

There are serial conditions and discrete conditions in the format of the naming tasks. In previous studies, only serial RAN is related to reading because both involve serial processing and oral production of the names of the stimuli (Bowers & Swanson, 1991;

Chiappe, Stringer, Siegel, & Stanovich, 2002; Georgiou, Parrila, Cui, & Papadopoulos, 2013). Additionally, increasing the number of items to be accessed and produced in a RAN task in object and digit naming resulted in an increase in the difference in duration between normal readers and children with developmental dyslexia (Di Filippo, Zoccolotti, & Ziegler, 2008). Therefore, we suppose that the reaction time of the picture naming task was influenced by the type of format of the naming task and DD and DD+DLD did not show a longer reaction time in the picture naming tasks in discrete conditions. We discussed the results of this study from an educational point of view. Children with developmental dyslexia showed longer duration in the picture naming task in the serial condition. Therefore, it was thought that picture naming training in the serial condition focusing on fluency might improve word sound retrieval abilities in children with developmental dyslexia.

LIMITATION

The participants of this study were 18 in the TD group, 19 in the DD group, and nine in the DD+DLD group. Since the sample size is not large, a larger sample size may be needed in the future.

CONCLUSION

In this study, picture naming tasks in discrete conditions were conducted to examine the word sound retrieval abilities of Japanese children with developmental dyslexia. It is likely that object naming connects with spoken language development. Japanese children with typical developmental dyslexia without developmental language disorder may not show a lower score in the picture naming tasks in discrete conditions.

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APPENDIX : STIMULUS LIST USED IN THE PICTURE NAMING TASKS

Colors (n=10)

1	green	6	white
2	yellow	7	blue
3	black	8	yellow-green
4	purple	9	beige
5	red	10	navy blue

Objects (n=100)

1	book	35	refrigerator	69	cup
2	pencil	36	key	70	cake
3	dog	37	meat	71	pot
4	clock	38	bowl	72	bag
5	rice	39	milk	73	mouth
6	spinning top	40	scissors	74	slippers
7	mountain	41	chair	75	mirror
8	newspaper	42	pants	76	Shamisen
9	airplane	43	pillow	77	lighthouse
10	goldfish	44	egg	78	inkstone
11	medicine	45	foot	79	Go
12	drum	46	handkerchief	80	guitar
13	desk	47	apple	81	Tabi
14	crocodile	48	calendar	82	Sumo ring
15	lantern	49	fish	83	chicken
16	Tori-i	50	house	84	butterfly
17	bamboo shoot	51	coffee	85	folding fan
18	deer	52	briefs	86	paints
19	Fusuma	53	glasses	87	sandals
20	pine decoration	54	stairs	88	shoehorn
21	television	55	beer	89	Shogi
22	money	56	spoon	90	boat
23	phone	57	Udon	91	abacus
24	bath	58	umbrella	92	telephone pole
25	shoes	59	tangerine	93	glove
26	wallet	60	nose	94	racket
27	toilet	61	notebook	95	swing
28	nurse	62	Sushi	96	fire extinguisher
29	car	63	curtain	97	bench
30	chopsticks	64	rice ball	98	Bonsai
31	socks	65	ear	99	candle
32	Futon	66	nail clipper	100	thumbtack
33	bread	67	dish		
34	window	68	towel		