

## **The University of Western Ontario Plurals Test v1.4**

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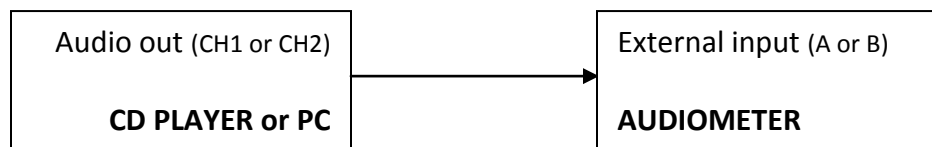
## Overview

The University of Western Ontario (UWO) Plurals Test is a measure of speech perception ability specific to English language plurality. This task requires the listener to identify the presence of word final fricatives, such as /s/ and /z/. Research suggests that this type of testing method may be sensitive to hearing aid bandwidth effects associated with perception of high-frequency speech sounds (Stelmachowicz, Pittman, Hoover, & Lewis, 2002). The UWO Plurals test can be used to evaluate hearing aid performance related to changes in high-frequency speech perception across hearing aid conditions or over time. This test has been used at UWO in a series of studies of nonlinear frequency compression hearing aids (Glista, Scollie, Bagatto, et al., 2009; Glista, Scollie, Polonenko, & Sulkers, 2009) and at other research sites (Wolfe et al., 2010). Details on the development and evaluation of this test have been published in the American Journal of Audiology (Glista & Scollie, 2012).

The items included in this test are spoken by a female talker and have been recorded in both singular & plural forms. All test items are provided as audio files corresponding to word lists for the following set of words: Ant, Balloon, Book, Butterfly, Crab, Crayon, Cup, Dog, Fly, Flower, Frog, Pig, Shoe, Skunk and Sock.

## Set-up and Calibration Procedure

This CD based test is meant to be administered in the sound field of a sound booth using a CD player/PC and a clinical audiometer. The CD is played through the CD player/PC and the sound is routed through the external inputs to the audiometer.



The tester must first adjust the VU meter on the audiometer using Track 1 (calibration tone) to zero. Presentation level can be determined using the following steps:

1. Play Track 2 (calibration noise) through the loudspeaker; this contains a noise which has been spectrally shaped to match naturally produced speech.
2. Measure the output level in dB (A-weighted) in sound field, using a sound level meter (SLM). For standard equipment set-ups (described above), a SLM reading of 60 dB(A) should result from a dial setting of 65 dB HL (tolerance =  $\pm 2$ ). If the measured level does not produce 60 dB(A) at 65 dB HL, adjust the HL dial setting until the correct output level is achieved. Fill in the adjusted dial level in dB HL on the chart below for "Normal-Raised" and calculate the corresponding "Soft" and "Loud" dial levels by adding and subtracting 10 dB.
3. The test is traditionally run at the level of soft speech. Use the dial on the audiometer to adjust the presentation level according to the following guideline (Olsen, 1998):

Presentation Level	Corresponding Dial Level (fill this in at time of calibration)	Approximate Speech Level (female speech)
50 dB(A)		Soft
60 dB(A)		Normal-Raised
70 dB(A)		Loud

The presentation level can be adjusted depending on the degree of hearing impairment of the listener. If the listener is having difficulty performing the test at a soft presentation level, the presentation level can be increased to a normal-raised speech level. Note: Chance performance is 50% on this test. If the listener is unable to perform at a level greater than chance performance, the tester should raise the presentation level.

4. Mark down the corresponding dial reading on the audiometer for the chosen level. This dB HL value can be used as the presentation level in subsequent testing to compare scores obtained for a given individual, across hearing aid conditions or over time.

This test is meant to be used with audiometric equipment that has been calibrated according to ANSI standards.

## Testing Instructions

Ten randomizations of the word lists are provided on the test CD. The same items are included in each randomization. A low level noise is included with each randomization; this will automatically play along with each word list at 20 dB SNR. To begin testing, choose a word list on the CD (tracks 3 through 12), and play it to the listener at the established presentation level. The listener's job is to indicate whether he/she heard the singular or plural form of each item. Instructions and scoring methods are provided below.

## Instructions for the Listener

"You will hear a woman's voice saying different words. You will also hear a little bit of noise. Some of these words will end in /s/, and some will not. It's your job to listen to the word, and decide whether the word matches the picture with one object or the picture with many objects. If you're not sure what you heard, it's ok to guess. Some of the word endings may be very hard to hear, so be sure to listen carefully. Do you have any questions?"

## Scoring

One testing session includes administration and scoring of two word lists, for a total of 60 items. This test is meant to be implemented using a closed set of response choices. Pairs of pictures (i.e., the singular and plural version of the target root word) appear on spiral bound cards, which have been pre-arranged in testing order according to each word list. The listener must choose from each picture pair, which picture best describes what they heard. The listener or tester will then advance to the next picture pair and listen for the next word. To aid the tester, printable score sheets are provided below; these correspond to each word list track on the CD.

*When are two scores different?*

A critical difference table is provided below describing when two test scores are statistically different. The values in this table have been derived using the binomial theorem (Thornton & Raffin, 1978). This table can be used as a supplement to the scoring sheet provided.

Instructions on how to use the critical difference table:

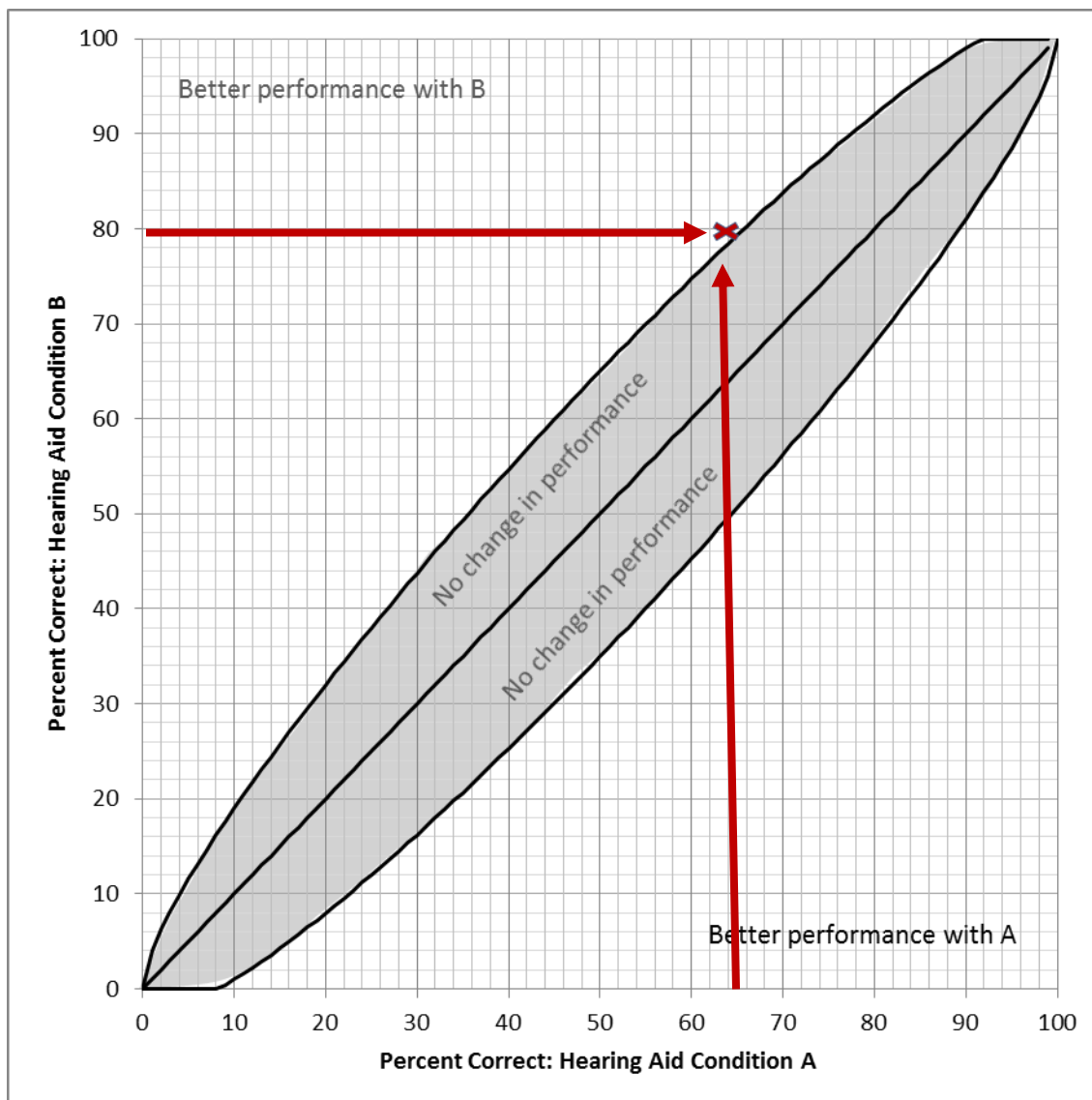
1. In the first column, isolate the row corresponding to the lower of the two scores you are comparing.
2. Then choose the columns corresponding to the number of items administered to achieve the scores.
3. The chosen row and column will intersect to reveal the value by which the two scores must differ (i.e., the critical difference at the 90% level) and the percent correct score that the higher score must be equal to or greater than.

Instructions on how to use the scoring sheet:

1. Plot the intersection of the two scores obtained:
  - a. The x-axis value corresponds to the score measured in hearing aid condition A.
  - b. The y-axis value corresponds to the score measured in hearing aid condition B.
2. Interpretation:
  - a. If the plotted value falls within the shaded region, the two scores should be judged as “the same” (you cannot conclude that they are statistically different).
  - b. If the plotted score falls above the shaded region, the listener performed better with treatment B.
  - c. If the plotted score falls below the shaded region, the listener performed better with treatment A.

## Illustrative Case Example

Jill achieved a score of 64% in hearing aid condition A compared to a score of 79% in hearing aid condition B. The scores were obtained using 60 items. According to the critical difference table, a critical difference value of 14 is needed to determine if the lower score is significantly different than the higher score. Because the higher score (79%) exceeds that of the lower score (64%) by more than the critical difference ( $79 - 64 = 15\%$ ,  $15\% > 14\%$ ), we can assume the two scores are different. Therefore, Jill's performance is significantly better in hearing aid condition B when compared to hearing aid condition A. Based on the scoring example provided below, the plotted value (red X) falls above the shaded region. Therefore, the tester should conclude that the listener was able to detect word final plurality better in hearing aid condition B.



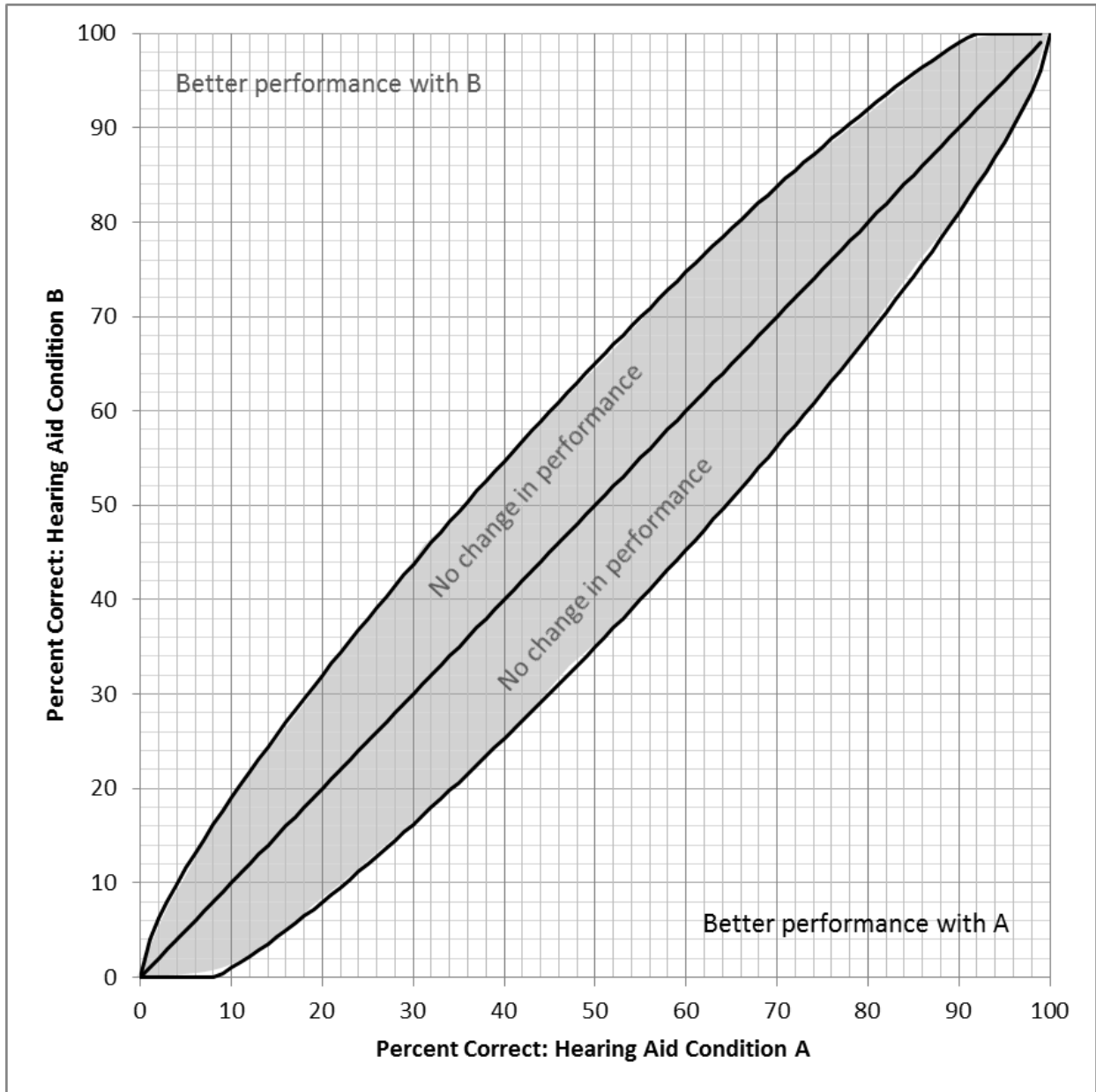
## Critical Difference Table

The lower of the two scores	30 items					60 items						
	Critical difference	The higher score must be equal to or higher than the bolded value				Critical difference	The higher score must be equal to or higher than the bolded value					
40	21	40	+	21	=	<b>61</b>	15	40	+	15	=	<b>55</b>
41	21	41	+	21	=	<b>62</b>	15	41	+	15	=	<b>56</b>
42	21	42	+	21	=	<b>63</b>	15	42	+	15	=	<b>57</b>
43	21	43	+	21	=	<b>64</b>	15	43	+	15	=	<b>58</b>
44	21	44	+	21	=	<b>65</b>	15	44	+	15	=	<b>59</b>
45	21	45	+	21	=	<b>66</b>	15	45	+	15	=	<b>60</b>
46	21	46	+	21	=	<b>67</b>	15	46	+	15	=	<b>61</b>
47	21	47	+	21	=	<b>68</b>	15	47	+	15	=	<b>62</b>
48	21	48	+	21	=	<b>69</b>	15	48	+	15	=	<b>63</b>
49	21	49	+	21	=	<b>70</b>	15	49	+	15	=	<b>64</b>
50	21	50	+	21	=	<b>71</b>	15	50	+	15	=	<b>65</b>
51	21	51	+	21	=	<b>72</b>	15	51	+	15	=	<b>66</b>
52	21	52	+	21	=	<b>73</b>	15	52	+	15	=	<b>67</b>
53	21	53	+	21	=	<b>74</b>	15	53	+	15	=	<b>68</b>
54	21	54	+	21	=	<b>75</b>	15	54	+	15	=	<b>69</b>
55	21	55	+	21	=	<b>76</b>	15	55	+	15	=	<b>70</b>
56	21	56	+	21	=	<b>77</b>	15	56	+	15	=	<b>71</b>
57	21	57	+	21	=	<b>78</b>	15	57	+	15	=	<b>72</b>
58	21	58	+	21	=	<b>79</b>	15	58	+	15	=	<b>73</b>
59	21	59	+	21	=	<b>80</b>	15	59	+	15	=	<b>74</b>
60	21	60	+	21	=	<b>81</b>	15	60	+	15	=	<b>75</b>
61	21	61	+	21	=	<b>82</b>	15	61	+	15	=	<b>76</b>
62	21	62	+	21	=	<b>83</b>	15	62	+	15	=	<b>77</b>
63	21	63	+	21	=	<b>84</b>	15	63	+	15	=	<b>78</b>
64	20	64	+	20	=	<b>84</b>	14	64	+	14	=	<b>78</b>
65	20	65	+	20	=	<b>85</b>	14	65	+	14	=	<b>79</b>
66	20	66	+	20	=	<b>86</b>	14	66	+	14	=	<b>80</b>
67	20	67	+	20	=	<b>87</b>	14	67	+	14	=	<b>81</b>
68	20	68	+	20	=	<b>88</b>	14	68	+	14	=	<b>82</b>
69	20	69	+	20	=	<b>89</b>	14	69	+	14	=	<b>83</b>
70	19	70	+	19	=	<b>89</b>	14	70	+	14	=	<b>84</b>
71	19	71	+	19	=	<b>90</b>	14	71	+	14	=	<b>85</b>
72	19	72	+	19	=	<b>91</b>	13	72	+	13	=	<b>85</b>
73	19	73	+	19	=	<b>92</b>	13	73	+	13	=	<b>86</b>
74	19	74	+	19	=	<b>93</b>	13	74	+	13	=	<b>87</b>
75	18	75	+	18	=	<b>93</b>	13	75	+	13	=	<b>88</b>
76	18	76	+	18	=	<b>94</b>	13	76	+	13	=	<b>89</b>
77	18	77	+	18	=	<b>95</b>	13	77	+	13	=	<b>90</b>
78	18	78	+	18	=	<b>96</b>	12	78	+	12	=	<b>90</b>
79	17	79	+	17	=	<b>96</b>	12	79	+	12	=	<b>91</b>

<b>80</b>	17	80	+	17	=	<b>97</b>	12	80	+	12	=	<b>92</b>
<b>81</b>	17	81	+	17	=	<b>98</b>	12	81	+	12	=	<b>93</b>
<b>82</b>	16	82	+	16	=	<b>98</b>	12	82	+	12	=	<b>94</b>
<b>83</b>	16	83	+	16	=	<b>99</b>	11	83	+	11	=	<b>94</b>
<b>84</b>	16	84	+	16	=	<b>100</b>	11	84	+	11	=	<b>95</b>
<b>85</b>	15	85	+	15	=	<b>100</b>	11	85	+	11	=	<b>96</b>
<b>86</b>							10	86	+	10	=	<b>96</b>
<b>87</b>							10	87	+	10	=	<b>97</b>
<b>88</b>							10	88	+	10	=	<b>98</b>
<b>89</b>							9	89	+	9	=	<b>98</b>
<b>90</b>							9	90	+	9	=	<b>99</b>
<b>91</b>							9	91	+	9	=	<b>100</b>
<b>92</b>							8	92	+	8	=	<b>100</b>
<b>93</b>							<p>Comparisons made in this region are not statistically significant (Even if the second score is 100%).</p>					
<b>94</b>												
<b>95</b>												
<b>96</b>												
<b>97</b>												
<b>98</b>												
<b>99</b>												



## Scoring Sheet



## Word Lists

List 1	List 2	List 3	List 4	List 5
Skunks	Flowers	Skunks	Shoe	Balloon
Crayon	Skunk	Crayon	Socks	Socks
Flies	Dogs	Dog	Crab	Flower
Flower	Crabs	Butterfly	Crabs	Frog
Book	Butterflies	Butterflies	Sock	Pigs
Shoe	Cups	Pigs	Flowers	Crab
Ants	Crab	Crayons	Cup	Crabs
Shoes	Flower	Book	Ant	Shoe
Butterflies	Frog	Cup	Flower	Skunk
Frogs	Crayons	Balloons	Crayons	Book
Flowers	Book	Frogs	Frog	Dog
Skunk	Ant	Crab	Fly	Balloons
Balloon	Flies	Flower	Book	Pig
Dogs	Crayon	Frog	Balloon	Ants
Balloons	Shoes	Ant	Books	Ant
Crab	Pigs	Dogs	Pigs	Shoes
Crayons	Cup	Ants	Ants	Cup
Ant	Books	Sock	Cups	Books
Fly	Balloon	Crabs	Shoes	Crayon
Frog	Dog	Shoes	Butterfly	Sock
Sock	Balloons	Cups	Dog	Dogs
Pig	Pig	Fly	Butterflies	Fly
Pigs	Shoe	Balloon	Balloons	Butterflies
Crabs	Butterfly	Socks	Skunks	Skunks
Cups	Skunks	Shoe	Skunk	Flies
Dog	Frogs	Books	Crayon	Frogs
Cup	Sock	Pig	Dogs	Flowers
Books	Socks	Flowers	Pig	Cups
Butterfly	Fly	Skunk	Flies	Butterfly
Socks	Ants	Flies	Frogs	Crayons
<b>TOTAL</b>	<b>TOTAL</b>	<b>TOTAL</b>	<b>TOTAL</b>	<b>TOTAL</b>

**List 6**

Flower	
Crabs	
Socks	
Flies	
Crab	
Dog	
Skunks	
Sock	
Book	
Crayons	
Crayon	
Shoes	
Fly	
Shoe	
Balloons	
Butterfly	
Dogs	
Skunk	
Flowers	
Frog	
Butterflies	
Pig	
Cup	
Ant	
Cups	
Frogs	
Balloon	
Books	
Ants	
Pigs	
<b>TOTAL</b>	

**List 7**

Skunk	
Frogs	
Crayon	
Socks	
Shoe	
Crab	
Fly	
Skunks	
Flower	
Dog	
Butterflies	
Pig	
Crabs	
Ants	
Books	
Flowers	
Cup	
Flies	
Frog	
Book	
Crayons	
Ant	
Balloons	
Cups	
Balloon	
Butterfly	
Shoes	
Dogs	
Sock	
Pigs	
<b>TOTAL</b>	

**List 8**

Flower	
Socks	
Book	
Ant	
Balloon	
Crayon	
Crab	
Crabs	
Butterflies	
Flowers	
Skunks	
Sock	
Dogs	
Shoes	
Books	
Balloons	
Pigs	
Cup	
Ants	
Frogs	
Butterfly	
Frog	
Crayons	
Flies	
Fly	
Skunk	
Pig	
Dog	
Shoe	
Cups	
<b>TOTAL</b>	

**List 9**

Ants	
Butterfly	
Crayon	
Frogs	
Frog	
Shoe	
Flies	
Skunk	
Fly	
Sock	
Dogs	
Cups	
Books	
Ant	
Crayons	
Crab	
Flower	
Book	
Pig	
Butterflies	
Crabs	
Dog	
Socks	
Shoes	
Balloon	
Flowers	
Cup	
Skunks	
Balloons	
Pigs	
<b>TOTAL</b>	

**List 10**

Books	
Flowers	
Frog	
Crab	
Sock	
Pigs	
Balloons	
Frogs	
Pig	
Crayon	
Crabs	
Dog	
Fly	
Shoes	
Cups	
Flies	
Crayons	
Socks	
Butterfly	
Skunks	
Ants	
Dogs	
Butterflies	
Cup	
Ant	
Skunk	
Flower	
Book	
Shoe	
Balloon	
<b>TOTAL</b>	

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