

## Semantic Feature Analysis: Further Examination of Outcomes

Semantic Feature Analysis (SFA) has received considerable study over the past two decades as a word-retrieval treatment for aphasia (Boyle & Coelho, 1995; Lowell, Beeson, & Holland, 1995; Boyle, 2010; Wambaugh, Mauszycki, Cameron, Wright, & Nessler, 2013). SFA has been shown to have consistently positive acquisition effects (i.e., improvement of trained items), with generally positive but less predictable generalization effects (i.e., improvement in untrained items).

SFA was originally designed as a cognitive treatment for children and adolescents sustaining traumatic brain injury (TBI) (Haarbauer-Krupa, Moser, Smith, Sullivan & Szekeres, 1985). The therapy was designed as an “organizing process for thinking and verbal expression” (p.303).

Massaro and Tompkins (1994) operationalized SFA in a study with two participants with TBI. In keeping with the intentions of the original developers, Massaro and Tompkins measured SFA’s treatment effects in terms of increased production of semantically relevant content.

In the treatment of aphasia, the focus of SFA relative to outcomes has been naming accuracy. That is, SFA has been used as a means of systematically stimulating semantic networks to facilitate naming. Additionally, SFA has been considered to potentially serve as a mediating strategy for self-cuing accurate naming and/or a compensatory strategy for circumventing word-retrieval difficulties.

The current study was designed to elucidate the effects of SFA in aphasia treatment beyond naming accuracy. Given SFA was designed to improve verbal expression *in general* and may serve as a compensatory strategy, increased production of relevant content was of interest (after Tompkins & Massaro, 1994). In light of inconsistent generalization effects associated with SFA, the study was designed to explore its generalization effects relative to aspects of untreated items. Specifically, untreated items were controlled in terms of semantic relatedness, exposure in probing, and knowledge of phonological form.

## Method

### Participants

Four persons with chronic aphasia resulting from a single, left-hemisphere stroke (Table 1) served as participants. As seen in Table 2, participants were each diagnosed with a different aphasia type according to the *Western Aphasia Battery* (WAB; Kertesz, 1982).

### Experimental Stimuli

Three sets of picture stimuli were created for each participant. Sets 1 and 2 contained 32 items each, and Set 3 contained eight items (Appendix B). Each set represented two different semantic categories; one living and one non-living. Eight treatment items from Sets 1 and 2 were submitted to SFA during the designated treatment phase; the remaining items were used to measure generalization.

### Experimental Design

A multiple baseline design across behaviors and participants was utilized to examine the effects of treatment on naming and production of semantically appropriate information. Naming

of items used as treatment, generalization, and pre/post measures were probed repeatedly in the baseline phase. Three “information probes” were conducted prior to treatment to measure production of semantically relevant content. Treatment was then applied sequentially to two sets of experimental items.

#### **Baseline Phase**

Sixteen treatment items, 40 generalization items, and 16 pre/post items were probed during each baseline session. The number of baseline probes was extended across participants, with five as the minimum. Information probes contained two items from each list and category, totaling 36 items per probe. Three information probes were conducted in baseline.

#### **Treatment Phase**

Treatment probes were conducted at the beginning of each session prior to treatment. The eight treatment items were randomized and probed after every two treatment sessions. The sixteen generalization exposure control items were probed at the beginning of every other session when not probing treatment items. During the treatment phases, the second set of items (treatment and generalization items) was probed approximately half way through the first phase, and repeatedly prior to initiating the second phase.

Information probes were conducted at the end of each treatment phase.

#### **Maintenance and Follow-up Phases**

The previously treated set (treatment and generalization items) was probed half way, and at the end of the second treatment phase. Follow-up probes for all lists and items were conducted at two and six weeks after treatment ended.

### **Probe Procedures and Dependent Variable**

Probes were conducted repeatedly throughout all phases of the design in keeping with single-subject design conventions.

**Confrontation Naming Probes.** Performance on naming probes served as the basis for determining phase changes of the design. During baseline and treatment probes, each item was presented one at a time, for verbal naming in random order.

Naming responses were scored as correct or incorrect on the basis of the scoring system shown in Appendix C. Responses were judged on the first complete production within the allotted 20 seconds.

**Semantic Information Probes.** Semantic information probes were administered to examine amount of relevant semantic information provided about target items. The participant was allowed two minutes to respond. Words adding relevant and novel content to an item’s description were counted as semantic information units (SIUs). Task instructions were, “I’m going to show you pictures one at a time. Instead of naming the picture, think about the picture and tell me as much as you can about it.” Word counts were tabulated using Nicholas and Brookshire (1993) procedures. The SIU measure differed from Nicholas and Brookshire’s Correct Information Units (CIU) in that SIUs excluded articles, auxiliary verbs, and conjunctions. Example transcriptions with SIUs underlined are shown in Appendix D.

### **Treatment**

#### **Semantic Feature Analysis Task**

Treatment consisted of Semantic Feature Analysis as described by Boyle (2004). However, slight modifications to the SFA chart were made to accommodate living and nonliving categories.

### **Exposure Control/Phonological Form Task**

Because repeated attempts at naming may result in improved naming in the absence of treatment (Howard, 2000) a set of items was presented for naming during the treatment session so that naming exposures were relatively equivalent; no feedback concerning naming accuracy was provided. In addition, improvements in semantic network access/organization may be masked by remaining phonological level processing deficits in some persons with aphasia. Consequently, another set of items was presented for naming during treatment and the correct name was provided in the event of inaccurate naming and feedback was provided for correct naming.

## **Results**

The data representing naming accuracy during probes are shown in Figures 1-4. Effect sizes (d-index; Bloom, Fischer, & Orme, 2003; Cohen, 1998) were calculated to measure the magnitude of change associated with treatment (Table 3). Based on Beeson and Robey (2006) benchmarks for interpreting effect sizes, trained items ranged from small effects, 4.04 to large effects, 14.52. Generalization items for which participants were exposed to the phonological forms, showed small to medium effects. Generalization items that did not have phonological exposure had small to medium effects, 7.51. Effect sizes for pre/post items were small showing limited generalization. Each participant increased the amount semantic information provided during information probes, as shown in Figure 5. Note: Participant 4 will complete the second phase of treatment within two weeks of this submission.

## **Discussion**

In this study, SFA facilitated increases in naming accuracy of treated items. Generalization to untreated items when controlled for semantic relatedness, exposure during probes, and knowledge of phonological form, was mixed and findings will be discussed further in relation to participant characteristics. Further use of SFA as a compensatory strategy to provide semantic information could be beneficial, in addition it's use as a naming treatment.

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Table 1.

Participant Characteristics

Characteristic	Participant 1	Participant 2	Participant 3	Participant 4
Age	62	54	30	53
Gender	female	male	male	female
MPO	11	30	23	384
CVA Location	LCVA	LMCA	LMCA	LMCA
Type	carotid dissection	ischemic	ischemic	ischemic
Years of Education	12	16	12	16
Race/Ethnicity	White non H/L	White non H/L	White non H/L	White non H/L
Handedness (premorbid)	right	right	right	right
Marital Status	married	single	married	married

L = left; R = right; MCA = middle cerebral artery; PCA= posterior cerebral artery; H/L = Hispanic/latino

Table 2.

## Pretreatment assessment results

Assessment	Participant 1	Participant 2	Participant 3	Participant 4
<b><i>TONI-4</i></b>				
Index Score	118	109	104	113
SEM	3	3	3	3
Percentile	88	73	61	81
<b><i>WAB</i></b>				
Aphasia Quotient	64.5	59.88	66.1	78.4
Aphasia Type	Conduction	Wernicke's	Broca's	Anomic
AQ Totals:				
Spontaneous speech	12	12	13	17
Comprehension	9.05	7.34	6.75	8.3
Repetition	5.2	5.2	6.2	5.5
Naming	6	5.4	7.1	8.4
<b><i>PICA</i></b>				
Overall Percentile	62 <sup>nd</sup>	53 <sup>rd</sup>	60 <sup>th</sup>	82 <sup>nd</sup>
Verbal Percentile	48 <sup>th</sup>	44 <sup>th</sup>	66 <sup>th</sup>	71 <sup>st</sup>
Auditory Percentile	89 <sup>th</sup>	36 <sup>th</sup>	53 <sup>rd</sup>	63 <sup>rd</sup>
<b>Nicholas and Brookshire (1993)-Discourse Task</b>				
Total time	23:30:00	24:12:00	21:42:00	17:10:00
Total # words	740	2992	217	2,535
Total # CIUs	335	572	174	1,043
<b><i>PPT</i></b> Total (3 picture)	51/52	47/52	50/52	50/52
<b><i>TAAWF</i></b>				
Total Raw Score	41	27	15	23
Comprehension	99%	97%	86%	93%
<b>Word Generation for Categories</b>				
Appliances	3	1	2	11
Body Parts	7	10	5	12

Fish	3	1	3	5
Insects	3	1	4	4
Transportation	3	3	4	4
Weapons	1	1	4	4
<b>Category Card Sort</b>	70/70	70/70	70/70	70/70
<b><i>OANB</i></b>				
Objects	60%	46%	65%	86%
Actions	78%	59%	54%	56%
<b><i>PALPA</i></b>				
<i>Spoken Word-Picture Matching</i>	39/40	40/40	37/40	40/40
<i>Written Word -Picture Matching</i>	40/40	40/40	37/40	40/40
<i>Auditory Synonym Judgments</i>	54/60	50/60	54/60	43/60
<i>Word Association</i>	24/30	22/30	10/30	21/30

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*TONI-4= Test of Nonverbal Intelligence-4 (Brown, Serbenou & Johnson, 2010); WAB-R= Western Aphasia Battery-R (Kertesz,1982); PICA= Porch Index of Communicative Ability (Porch, 2001); PPT= Pyramids and Palm Trees Test (Howard & Patterson, 1992); TAAWF= Test of Adolescent/Adult Word Finding (German, 1990); OANB= Object and Action Naming Battery (Drunks & Masterson, 2000); PALPA= Psycholinguistic Assessment of Language Processing in Aphasia (Kay, Lesser & Coltheart, 1992)*

Table 3.

Effect Sizes: d-Index Values for Treatment and Follow-Up Phases Interpreted Relative to Robey and Beeson's (2006) Benchmarks

Participant/ Experimental Set	Baseline - Treatment	Baseline - Follow-up
Participant 1		
Treatment Set 1	4.04 (small)	2.68 (small)
Generalization-Name	3.26	2.11
Generalization-No Name	7.51 (medium)	4.24
Pre/Post	na	.72
Treatment Set 2	3.15	2.27
Generalization-Name	1.37	3.67
Generalization-No Name	6.99 (small)	6.97 (small)
Pre/Post	na	1.99
Generalization Set 3	na	2.66
Participant 2		
Treatment Set 1	1.43	2.39
Generalization-Name	1.62	2.48
Generalization-No Name	2.88	2.00
Pre/Post	na	.22
Treatment Set 2	4.32	3.47
Generalization-Name	3.45	3.61
Generalization-No Name	1.31	2.83
Pre/Post	na	.50
Generalization Set 3	na	1.41
Participant 3		
Treatment Set 1	11.24 (large)	14.52 (large)
Generalization-Name	4.78	6.02
Generalization-No Name	3.69	3.44
Pre/Post	na	1.97
Treatment Set 2	6.45	4.55
Generalization-Name	5.0	7.64 (medium)
Generalization-No Name	2.83	3.62
Pre/Post	na	.08
Generalization Set 3	na	1.59
Participant 4		
Treatment Set 1	3.18 (small)	na
Generalization-Name	4.49	na
Generalization-No Name	5.82	na
Pre/Post	na	na
Treatment Set 2	na	na
Generalization-Name	na	na



Generalization-No Name	na	na
Pre/Post	na	na
Generalization Set 3	na	na

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## Figure Captions 1-4

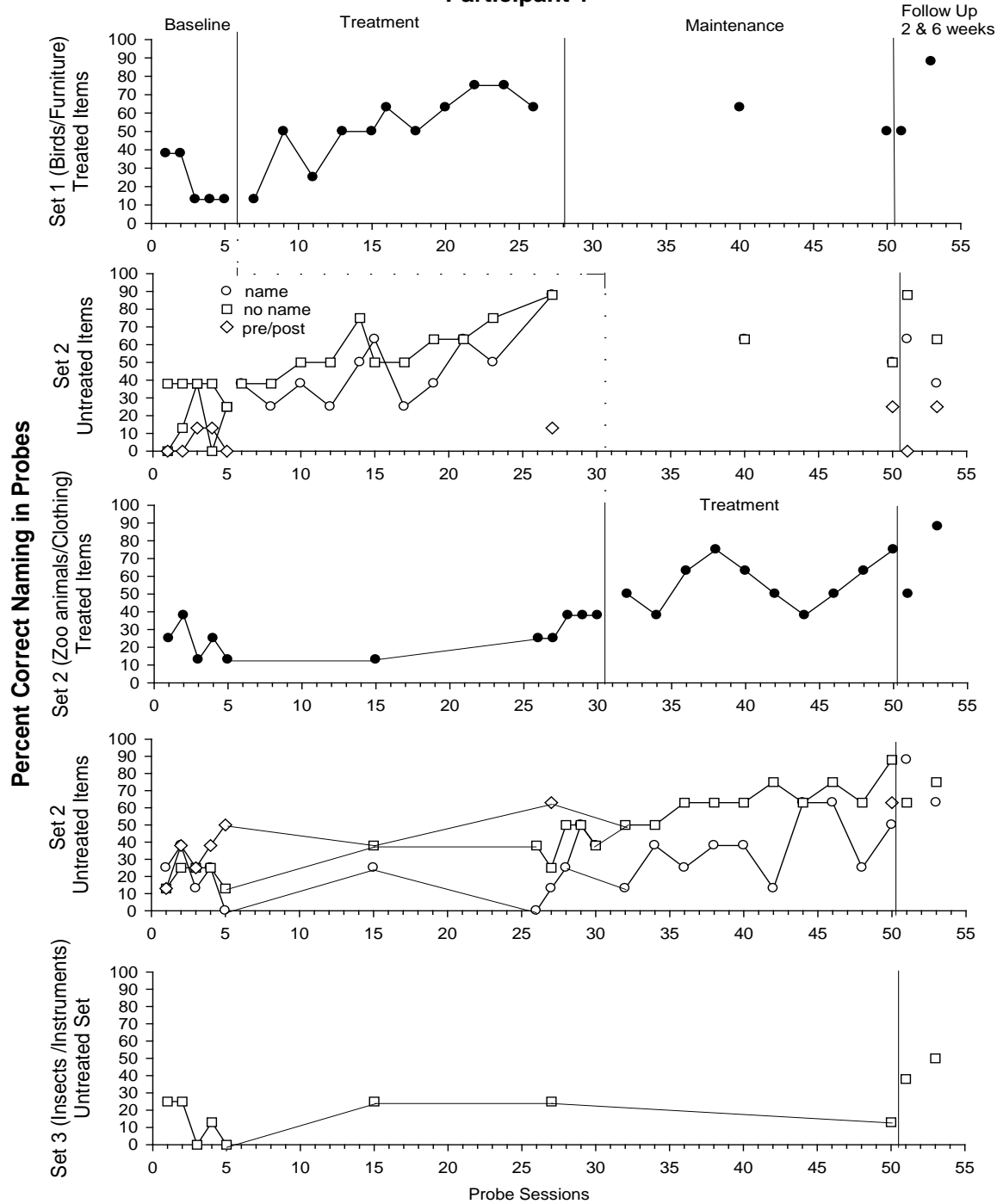
Figure 1: Accuracy of naming of experimental probes for Participant 1

Figure 2: Accuracy of naming of experimental probes for Participant 2

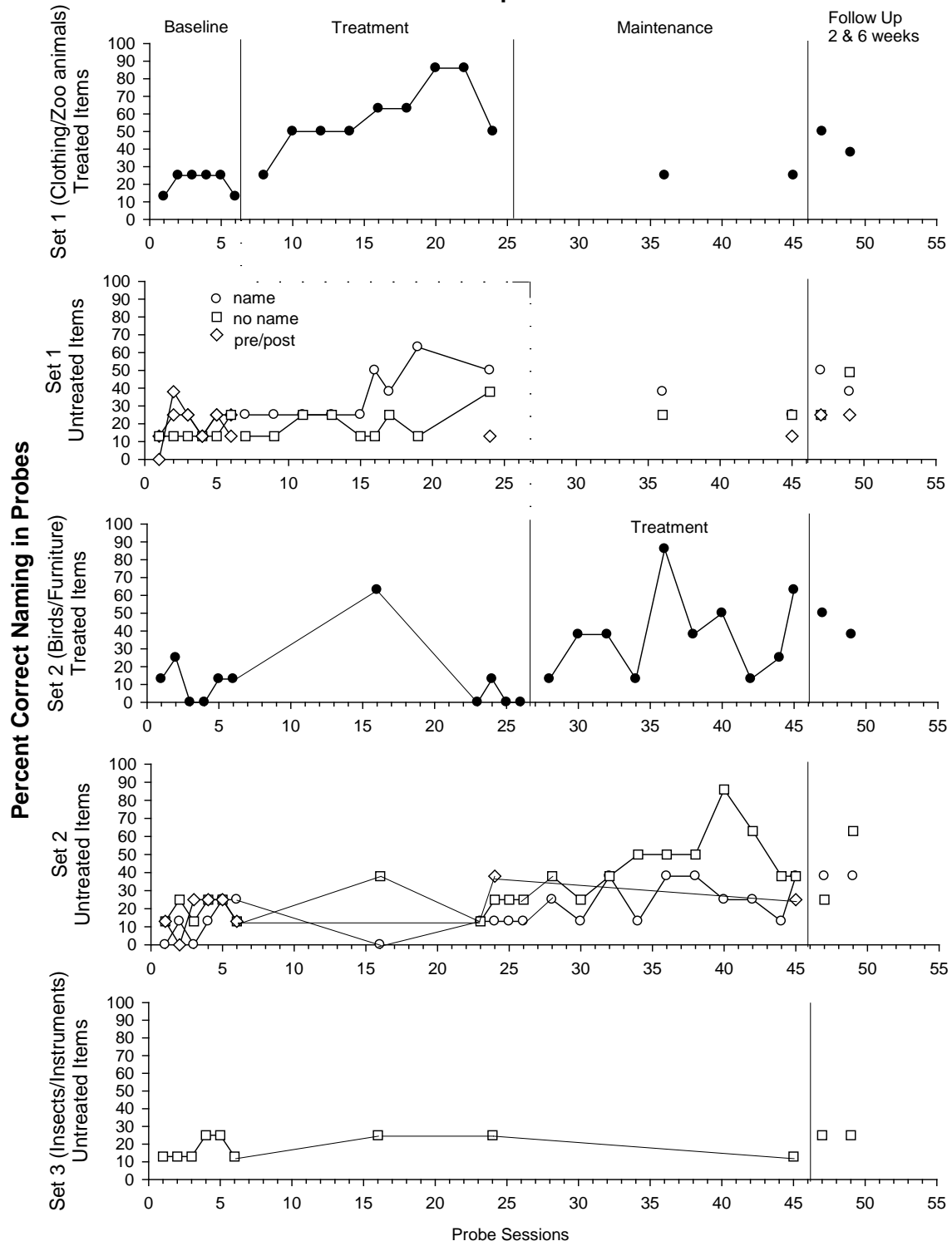
Figure 3: Accuracy of naming of experimental probes for Participant 3

Figure 4: Accuracy of naming of experimental probes for Participant 4

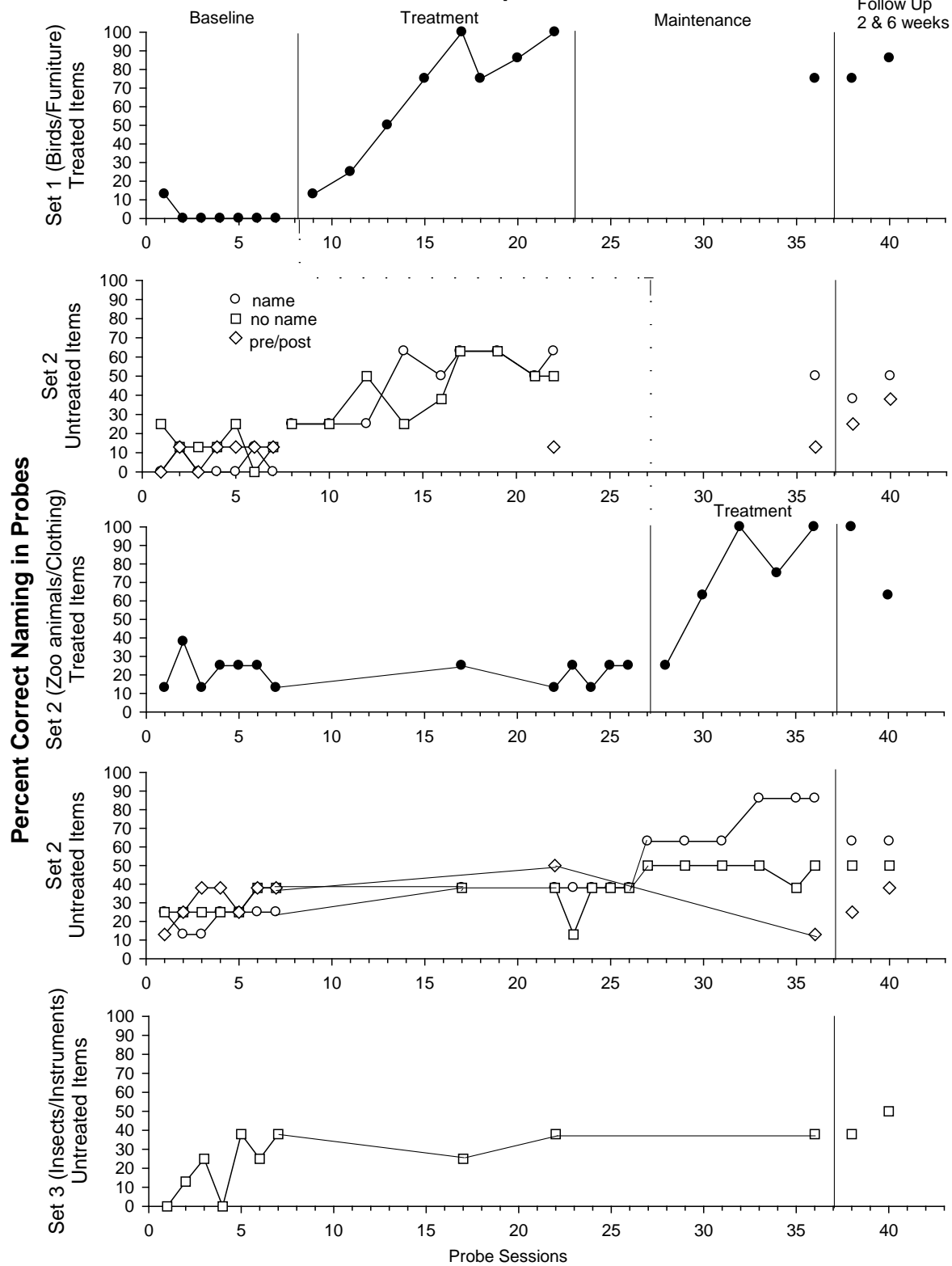
### Participant 1



## Participant 2



### Participant 3



### Participant 4

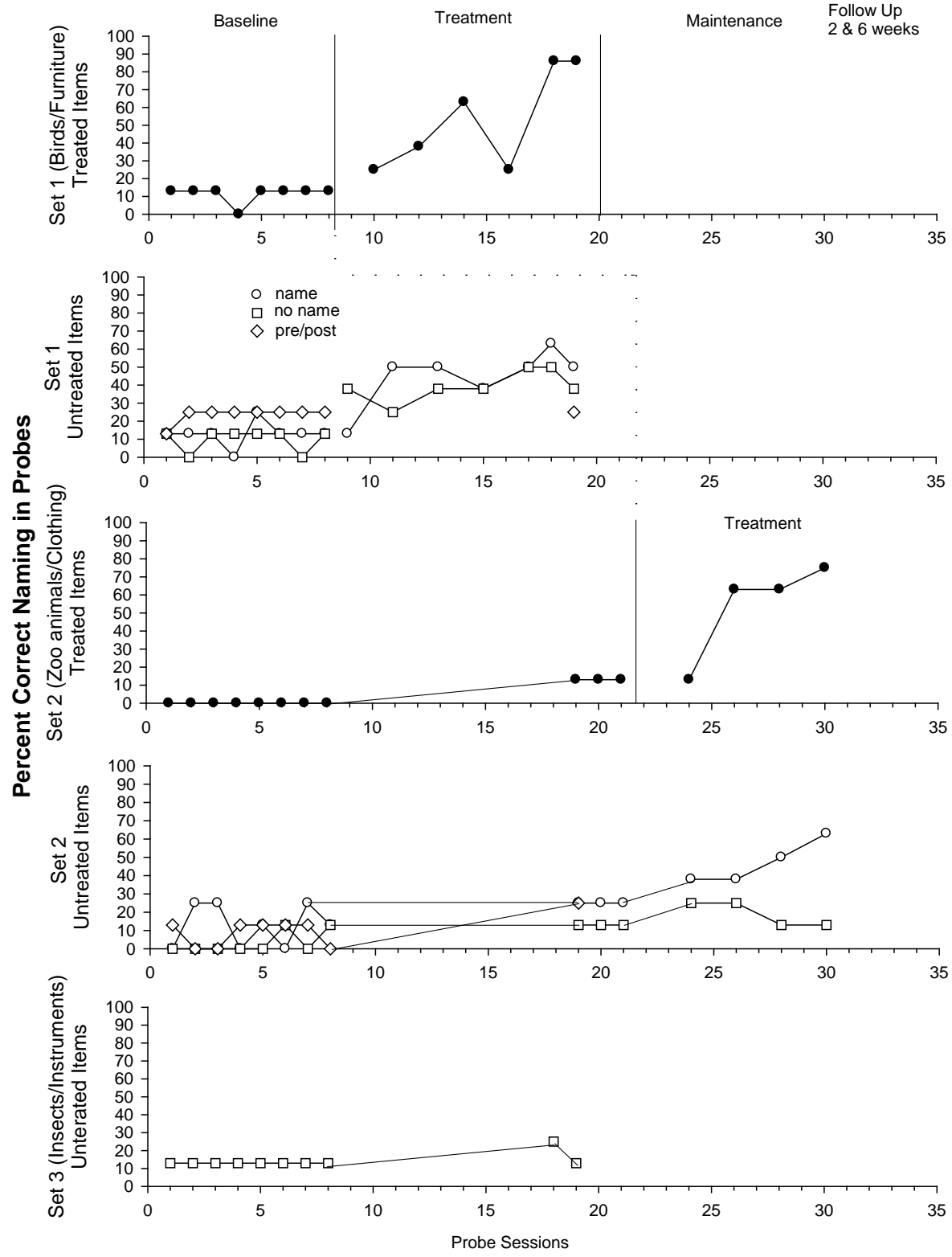


Figure 5

*Semantic Information Units*

Participant	Pre Treatment SIU/Words	Percentage	Post Treatment SIU/Words	Percentage
Participant 1	168/780	22%	159/477	33%
Participant 2	295/4,928	6%	345/4,553	8%
Participant 3	131/209	63%	163/245	67%
Participant 4	804/5,558	14%	na	na

Appendix A

Examples of Naming Errors for Each Participant: Responses from Baseline Probes

**Participant 1**

<u>Target</u>	<u>Response</u>
magpie	bagpie
puffin	I don't know
pigeon	penguin
flamingo	fabingo
coatrack	coarag
stool	skool
crib	cwib
recliner	recider
alligator	crosadile
antelope	deer
zebra	sebu
hippo	hislapot
sombrero	soburu
nightgown	gown something
earmuffs	muff something

**Participant 2**

<u>Target</u>	<u>Response</u>
goose	go over all the time
cardinal	it's the redder for the
parrot	pakaw
hummingbird	hippie or a
lamp	lamper
dresser	I don't know
bookcase	berbrek
wastebasket	bavewood
bat	bat
beaver	bavie
panther	liger
hyena	hasvena
belt	bess
mittens	muffs
nightgown	night time

**Participant 3**

<u>Target</u>	<u>Response</u>
puffin	bird
pigeon	bird
flamingo	f something
magpie	bird
coatrack	I don't know
stool	stool
crib	baby bedroom
recliner	chair
zebra	zeba
antelope	deer
panther	bobcat
skunk	stinky
bathrobe	towel
blouse	sweater

**Participant 4**

<u>Target</u>	<u>Response</u>
puffin	bird
pigeon	green bird
magpie	mapie
flamingo	flounders
coatrack	hangers
stool	stool
credenza	furniture put radio in there
recliner	swing chair
anteater	I don't know
panther	pander
skunk	skun
bathrobe	robe
nightgown	sleeping dress
leotard	leo



*Appendix B*  
**Participant Stimuli**

**Participant 1 Stimuli**

Set 1: Birds & Furniture

- |   |  |
|---|--|
| 1. SFA treatment items                    | 2. Naming control items                  |
| magpie                                    | goose                                    |
| puffin                                    | roadrunner                               |
| pigeon                                    | cardinal                                 |
| flamingo                                  | hummingbird                              |
| crib                                      | playpen                                  |
| stool                                     | frame                                    |
| coatrack                                  | dresser                                  |
| recliner                                  | wastebasket                              |
|   |  |
| 3. Generalization-repeated exposure items | 4. Generalization-limited exposure items |
| canary                                    | ostrich                                  |
| hawk                                      | swan                                     |
| seagull                                   | vulture                                  |
| bluebird                                  | woodpecker                               |
| cot                                       | hutch                                    |
| throne                                    | futon                                    |
| hammock                                   | nightstand                               |
| chandelier                                | ottoman                                  |

Set 2: Zoo Animals & Clothing

- |   |  |
|---|--|
| 1. SFA treatment items                    | 2. Naming control items                  |
| zebra                                     | panther                                  |
| hippo                                     | beaver                                   |
| antelope                                  | hyena                                    |
| alligator                                 | koala                                    |
| blouse                                    | bonnet                                   |
| nightgown                                 | tracksuit                                |
| earmuffs                                  | miniskirt                                |
| sombrero                                  | pajamas                                  |
|   |  |
| 3. Generalization-repeated exposure items | 4. Generalization-limited exposure items |
| skunk                                     | wolf                                     |
| rhino                                     | panda                                    |
| giraffe                                   | raccoon                                  |
| kangaroo                                  | porcupine                                |
| robe                                      | scarf                                    |
| blazer                                    | bowtie                                   |
| overalls                                  | corset                                   |
| cardigan                                  | tuxedo                                   |

Set 3: Insects and Musical Instruments

1. Generalization-repeated exposure items

moth  
cockroach  
dragonfly  
wasp  
drum  
flute  
banjo  
accordion

**Participant 2 Stimuli**

Set 1: Zoo Animals & Clothing

1. SFA treatment items

bat  
beaver  
panther  
hyena  
belt  
socks  
mittens  
nightgown

2. Naming control items

seal  
goat  
kangaroo  
giraffe  
vest  
boots  
shorts  
suspenders

3. Generalization-repeated exposure items

hippo  
zebra  
elephant  
porcupine  
jacket  
blouse  
bathrobe  
earmuffs

4. Generalization-limited exposure items

wolf  
tiger  
cougar  
lion  
purse  
scarf  
tuxedo  
sandals

Set 2: Birds & Furniture

1. SFA treatment items

goose  
cardinal  
parrot  
hummingbird  
lamp  
dresser  
bookcase  
wastebasket

2. Naming control items

eagle  
swan  
vulture  
woodpecker  
stool  
chair  
curtain  
recliner

3. Generalization-repeated exposure items

hawk  
owl  
crow  
bluebird  
pillow  
crib  
hammock  
chandelier

4. Generalization-limited exposure items

turkey  
dove  
flamingo  
magpie  
frame  
rug  
nightstand  
ottoman

Set 3: Insects and Musical Instruments

1. Generalization-repeated exposure items

spider  
butterfly  
ant  
cockroach  
guitar  
drum  
banjo  
flute

**Participant 3 Stimuli**

Set 1: Birds & Furniture

2. SFA treatment items

magpie  
puffin  
pigeon  
flamingo  
crib  
stool  
coatrack  
recliner

2. Naming control items

goose  
roadrunner  
cardinal  
hummingbird  
playpen  
frame  
dresser  
wastebasket

3. Generalization-repeated exposure items

canary  
hawk  
seagull  
bluebird  
cot  
throne  
hammock  
chandelier

4. Generalization-limited exposure items

ostrich  
swan  
vulture  
woodpecker  
hutch  
futon  
nightstand  
ottoman

Set 2: Zoo Animals & Clothing

2. SFA treatment items

2. Naming control items

zebra  
hippo  
antelope  
alligator  
blouse  
nightgown  
earmuffs  
sombrero

panther  
beaver  
hyena  
koala  
bonnet  
tracksuit  
miniskirt  
pajamas

3. Generalization-repeated exposure items

skunk  
rhino  
giraffe  
kangaroo  
robe  
blazer  
overalls  
cardigan

4. Generalization-limited exposure items

wolf  
panda  
raccoon  
porcupine  
scarf  
bowtie  
corset  
tuxedo

Set 3: Insects and Musical Instruments

1. Generalization-repeated exposure items

moth  
cockroach  
dragonfly  
wasp  
drum  
flute  
banjo  
accordion

**Participant 4 Stimuli**

Set 1: Birds & Furniture

3. SFA treatment items

puffin  
pigeon  
flamingo  
magpie  
coatrack  
stool  
credenza  
recliner

2. Naming control items

goose  
cardinal  
roadrunner  
ostrich  
playpen  
shutters  
dresser  
wastebasket

3. Generalization-repeated exposure items

canary

4. Generalization-limited exposure items

hummingbird

hawk  
seagull  
bluebird  
cot  
throne  
futon  
chandelier

swan  
vulture  
woodpecker  
hutch  
hammock  
nightstand  
ottoman

Set 2: Zoo Animals & Clothing

3. SFA treatment items

anteater  
antelope  
panther  
sloth  
bathrobe  
sombrero  
leotard  
earnuff

2. Naming control items

skunk  
rhino  
armadillo  
gekko  
nightgown  
miniskirt  
tracksuit  
fedora

3. Generalization-repeated exposure items

otter  
lemur  
alligator  
warthog  
bonnet  
blazer  
overalls  
cardigan

4. Generalization-limited exposure items

panda  
koala  
hyena  
porcupine  
bowtie  
corset  
poncho  
tuxedo

Set 3: Insects and Musical Instruments

1. Generalization-repeated exposure items

dragonfly  
praying mantis  
cockroach  
moth  
accordion  
saxophone  
banjo  
tambourine

*Appendix C*  
**Multidimensional Scoring System**

*Responses scored as 7-9 were scored as "correct"*

*Responses scored as 0-6 were scored as "incorrect"*

<u>Score</u>	<u>Description</u>
9	Accurate, immediate (<5 seconds)
8	Accurate delayed (correct response within 6 to 20 seconds)
7	Incorrect plural or singular form
6	Phonemic paraphasia (i.e., single phoneme substitution or recognizable word with more than one sound substitution; at least 50% of sounds correct)
5	Semantic paraphasia (semantically related word)
4.5	Semantic paraphasia containing phonemic paraphasia
3	Circumlocution
2	Neologism or unintelligible word
1	Perseveration (response that was used for a previously presented item)
0	No response or "I don't know"

*Appendix D*  
**Example transcriptions with SIUs underlined**

Participant 1

1. Zebra-um he has four xx legs um he has um force he has um ze no white and black um xxx xx has kail a tail and something
2. Rhino- um he has four um legs he has um gray and its whsl wasl stum rough on du on du sides and um he's dut corn two forms on um two ears two hears horns das it horns
3. Tracksuit- warm warm things um a pants about uh dat has lastic on dis front and um uh button nu um zipper on du thing on whatever it's black on du arms and red on du the tings I don't know it and uh uh zipper on the front um

Participant 2

1. Wastebasket- and this is a they're called they're in your bedroom or in your be or in your house put them on in your kitchen or wh or the're bathroom floor or bathroom the baste for a basket a base a basebasket uh I can't say the namebas bask xx bascar they call them you bath your kitchen they're bathroom they call em they call em other sorts of things I can't say
2. Hippo - this one too is a himpo hippo it's a hippo it's himpio I can't say himipa I can't say it's full name casue it's too big a word hip hippo it's hippo and they live in Africa and they have lots of x they h they usually have lots of they live they they live inside they don't live in on them in the water but they hang in it all the time and then they'll sleep outside they'll go out the around there with the um hi like the hipir oh now I can't think or their name again hi hippo hip he's a hippo hipia yeah ok and um they just eat they usually just eat the food that they er this jus they usually just eat um what uh food er uh what kinds of things can't think iof the name how to feed them anyway ok

3. Belt- these are they're called they're called for th they are called for a bek you wear them on your clothes you put them on your pants to hold them up and you call em they are called they er ba I can't say their name they're um you hold em with their with your be your bre your bleaks I can't think of the name though

#### Participant 3

1. Cot- army tent sleeping
2. Woodpecker- bird uh worms scared of man and woman
3. Tracksuit- mens sweatpants and sweatshirt training weights fitness

#### Participant 4

1. Bathrobe- ok this um is a bathrub uh bathrobe and this is um you put like you put in your either before or after just sleep or just sleep before and after sleep and makes ya um like you have a shower nice and warmer or or when you get up put ya nice and warm when you get your breakfast or whatever x x warm at the time
2. Panda- ok this is a um panda and um it's white and black well it the face looks like looks like a bear it big and fat and um small ears and um the face the face is all white but the ears and eyes are black and the little nose is black and then it then it's face like white and black with the middle part er the legs are all black and the back part is white and um it's um it's from at the zoo or it's from I can't think what it's from um it's a different country now I can't remember exactly where the country though
3. Dragonfly- this is like a um like a butterfly but it's not a butterfly but it's but um but it flies uh he's got four um it's like a butterfly I don't know what it's called though but it flies on that or it can walks and it's kinda on the on the um um I don't know what these are called though but it's not the arms though anyway but it's clear but the face is green and the body is really long and thin and it's kinda blue