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Semantic Feature Analysis: Application to Confrontation Naming of Actions in Aphasia

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Acknowledgement: This research was supported by the Department of Veteran Affairs, Rehabilitation Research and Development.

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Background: Despite advances in the development and testing of therapies for verb retrieval impairments in aphasia, generalization effects of treatment remain a challenge. Semantic Feature Analysis (SFA) is a word retrieval treatment that has been reported to result in generalized responding to untrained *object names* with persons with aphasia (Boyle, 2010). The theorized therapeutic mechanisms of SFA appeared to be appropriate for facilitating retrieval of trained and untrained *action names.*

Aims: This investigation was designed to extend pilot research in which SFA was applied to verb retrieval (Wambaugh & Ferguson, 2007). The primary purpose of the current study was to examine the acquisition and response generalization effects of SFA applied to action naming with four persons with chronic aphasia. Additional purposes were to examine changes in production of content in discourse and to explore the correspondence of accuracy of naming during treatment to probe performance.

Methods & Procedures: SFA was modified slightly to be appropriate for application to action naming as opposed to object naming; several feature categories were changed, but all other procedures were retained. Treatment was applied sequentially to two sets of action names in the context of multiple baseline designs across behaviors and participants. Accuracy of naming of trained and untrained actions in probes was measured repeatedly throughout all phases of the design. Production of correct information units (CIUs) in discourse was measured prior to and following treatment. The relationship of probe naming performance to naming performance during treatment sessions was examined using correlational analyses.

Outcomes & Results: Increased accuracy of naming of trained action names was associated with treatment for three of the four participants. The remaining participant did not demonstrate improvement in naming on probes despite some gains during treatment. Generalization to

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untrained action names did not occur for any of the participants. Increases in CIU production were observed for only one of the participants. For the participants with positive naming outcomes, probe performance correlated well with naming performance during treatment. For the participant who demonstrated some improvements in treatment, but did not show gains in naming on probes, weak correlations were obtained.

Conclusions: SFA appears to have potential for promoting improved action naming in aphasia. However, more research is warranted to explore treatment modifications to promote generalization. Correlational analyses indicated that gains in naming during treatment may not always be reflected in probe performance and thus, require verification through probing in non-treatment conditions.

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Word retrieval difficulties are a pervasive and defining feature of aphasia. These difficulties occur with all types of aphasia and are generally manifest across all content-word classes (e.g., verbs, nouns, adjectives). The majority of treatments addressing word retrieval in aphasia have been directed toward retrieval of object names. However, as knowledge has been gained concerning verb processing in aphasia, there has been an accompanying increase in reports of verb retrieval therapies.

The extant literature indicates that naming of actions can be improved by various treatments for verb retrieval (see Conroy, Sage, Lambon Ralph, 2006 and Webster & Whitworth, 2012 for reviews). Treatments for improving verb retrieval have been relatively diverse and have included semantic, syntactic, phonologic, visual observation, and gestural foci; positive outcomes have been reported across this range of approaches. In a comprehensive review of treatment studies for spoken verb retrieval, Webster and Whitworth (2012) examined treatment outcomes at various levels (e.g., naming of trained and untrained verbs and production of sentences and connected speech) relative to type of treatment paradigm (e.g., single word contexts and sentence contexts). The investigators concluded that "verb therapy, irrespective of whether verbs are treated within a single-word or sentence context, is effective in improving the retrieval of treated verbs, but with limited generalization to untreated verbs" (Webster & Whitworth, p. 619).

The lack of generalization to untrained items, despite strong improvements in trained items, has also been the typical pattern of response to most *noun* retrieval treatments (Nickels, 2002); however, a few notable exceptions exist (e.g., Boyle, 2004; Boyle & Coelho, 1995; Kiran & Thompson, 2003).

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Therapies that promote generalization to untrained object names may have the potential to promote generalization when applied to action names. However, it is widely recognized that verbs are more complex than nouns in terms of syntactic and morphological complexity (Druks, 2002). Therefore, a treatment that has robust effects in the treatment of object naming cannot be assumed to have similar effects when applied to action naming. The current investigation was designed to treat action naming using a word-retrieval treatment that has had positive effects in the treatment of object naming, namely Semantic Feature Analysis (SFA; Boyle, 2004; Boyle & Coelho, 1995; Lowell, Beeson, & Holland, 1995).

SFA has resulted in improved naming with individuals representing numerous aphasia types (see review by Boyle, 2010). Positive findings have also been found when SFA has been employed in group treatment (Antonucci, 2009) and in the context of discourse (Peach & Reuter, 2010). Increased accuracy of naming of treated items has been reported for the majority of participants who received SFA but generalization findings have differed across participants and studies (Boyle, 2010).

SFA involves guiding the person with aphasia (PWA) in the generation of semantic features of the target word and theoretically activates the semantic network surrounding the target word to aid in its retrieval (Boyle & Coelho, 1995). Additionally, by repeatedly and systematically requiring production of semantic features for treatment items, SFA may promote development of a feature generation strategy that facilitates naming of untrained items (Boyle, 2004; 2010). Although SFA has received a significant amount of study in terms of its effects on object naming, its effects on *action naming* have been examined in only one pilot investigation (Wambaugh & Ferguson, 2007).

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Wambaugh and Ferguson (2007) examined the effects of SFA applied to action naming with one participant with anomic aphasia. Treatment was applied sequentially to two sets of action names in a multiple baseline design. Increases in accuracy of naming of trained items were reported which were maintained at follow-up intervals. Substantial increases in production of correct information units (CIUs; Nicholas & Brookshire, 1993) and words in discourse were also found. Increases in naming accuracy that were variable were observed for an untrained set of actions that had been probed repeatedly as part of the experimental design. There were no changes in another untreated set of actions that had limited naming exposure (i.e., pre and post treatment measurement only) which suggested that the unstable increases were due to repeated exposure/naming attempts, as described by Nickels (2002).

Wambaugh and Ferguson speculated that the absence of generalization to untrained items may have stemmed from a lack of successful implementation or inability to independently employ the SFA feature generation strategy to facilitate naming. They also theorized that the relatively less constrained nature of the discourse task (in comparison to confrontation naming) may have allowed utilization of the semantic feature strategy or general gains in semantic processing abilities to be evident (i.e., possibly accounting for the seemingly paradoxical findings of treatment effects extending to discourse but not untrained items).

Wambaugh and Ferguson (2007) applied SFA to verbs using the procedures employed by Boyle and colleagues (Boyle, 2004; Boyle & Coelho, 1995) with the exception that the semantic feature categories were modified to be appropriate for generating features for actions. Semantic feature category labels have varied across object naming studies with the following categories having been used most frequently: "group", "use", "action", "properties", "location", and "association" (see Boyle, 2010, for a discussion of variations in SFA). Wambaugh and Ferguson

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eliminated category labels that did not pertain to actions and used the following category labels: "subject", "purpose of action", "part of body or tool used to carry out the action", "description", "usual location", and "associated objects or actions".

As discussed by Wambaugh and Ferguson (2007), thematic role information was considered in the selection of feature categories for SFA applied to action names. Research concerning the generation of expectancies has demonstrated that nouns typically associated with the thematic roles of "agent", "patient", "instrument", and "location" successfully primed verbs (McRae, Hare, Elman, & Ferretti, 2005). For example, "nun" (agent) primed "praying", "guitar" (patient) primed "strummed", "crayon" (instrument) primed "coloring", and "bedroom" (location) primed "sleeping" (McRae et al., 2005). In order to possibly take advantage of such activations, Wambaugh and Ferguson included several feature categories related to thematic roles (see Wambaugh & Ferguson, 2007 for further explanation). Although thematic roles were taken into consideration in developing the feature category labels, the purpose of treatment was *not* to elicit words to fill specific thematic roles (e.g., Edmonds, Nadeau, & Kiran, 2009). Instead, it was desired that the feature generation categories would elicit information that would strengthen associations for the target action name.

Feature generation has been used as a component of treatment in a few other investigations of verb treatment in aphasia. Faroqi-Shah and Graham (2011) applied treatment to verbs from specific semantic classes (e.g., "cut" and "contact" verbs) with two PWA. The participants were required to independently generate three semantic features about the target verb and also judge whether predetermined features belonged to the target verb. Additionally, treatment entailed naming attempts and sentence generation. Faroqi-Shah and Graham's findings revealed improved naming of trained verbs for one participant. The other participant did not

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demonstrate improved naming of trained verbs, and neither participant demonstrated generalization to untrained verbs.

Like Faroqi-Shah and Graham (2011), Webster, Morris and Franklin (2005) included a treatment task that required production of words to fill thematic roles or provide related information about target verbs (e.g., prompts: "where", "with what", "what to", "who"); the generated words were then used in a sentence generation task. The prompts used by Webster et al. were similar to several of the semantic feature prompts used by Wambaugh and Ferguson (2007). Webster et al.'s sentence generation task was only one component of their overall treatment which focused on improving predicate argument structure. The findings from Webster et al.'s case study indicated improved retrieval of trained verbs, but not of untrained verbs. Improvements in sentence production were reported along with an increased variety of argument structures in narratives.

As noted previously, Webster & Whitworth (2012) examined the effects of verb retrieval treatments on outcomes representing various levels of production. They concluded that "it remains uncertain as to whether therapies targeting single verb retrieval, verb retrieval in a sentence context and verb and argument structure production result in differential gains in sentence production and connected speech" (p. 635).

Changes in connected speech (i.e., production of content in discourse) has been associated with SFA applied to *object* names (e.g., Boyle, 2004). Wambaugh and Ferguson (2007) also reported substantial increases in number of words, number of CIUs, percent CIUs, and CIUs per minute following application of SFA to *action* naming. Explanations concerning the improvements in the production of content in discourse that have been observed with SFA are speculative. Theoretically, the semantic feature strategy could be applied spontaneously in

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discourse after having been learned/practiced with individual words. The strategy may result in increased generation of information about topics with or without promoting improved naming. Early applications of SFA with traumatically brain injured persons were focused on processing and/or generation of semantically relevant information rather than facilitation of naming (Massaro & Tompkins, 1992). Thus, the origins of SFA had a more general focus on improved communication, which may be considered to be consistent with improvements in discourse. Despite insufficient understanding of the therapeutic mechanisms of SFA, its feature generation strategy may have potential for promoting generalized responding to discourse and to untrained items.

In light of Wambaugh and Ferguson's (2007) somewhat promising, but preliminary findings of SFA applied to action names, the current investigation was designed as a replication of that study. Although SFA applied to object naming has a substantial data base supporting its application (Boyle, 2010), additional evidence is required to document the effects of SFA applied to verb retrieval. In particular, replications across persons with aphasia presenting with different aphasia types were desired.

A secondary purpose of the current study was to examine the correspondence of accuracy of naming during treatment to probe performance. This ad hoc, sub-investigation was included after the conclusion of the treatment portion of the present investigation because treatment performance did not appear to correspond to probe performance for one of the participants. Evidence-based practice necessitates the clinical utilization of treatment that has been demonstrated to be efficacious. Empirical examination of efficacy of aphasia treatment typically entails frequent measurement of performance during probes in which no treatment (including feedback) is provided. That is, repeated probing is necessary for implementation of single-

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subject experimental designs. However, repeated probing is not practical for clinical practice and clinicians may tend to rely on treatment performance to make decisions concerning treatment application. Limited information is available concerning the suitability of using treatment data to draw conclusions about treatment effects in the area of aphasia rehabilitation. As such, probe data were compared to performance in treatment.

In the current investigation, SFA was applied to action naming with four persons with chronic aphasia as a replication of the pilot investigation by Wambaugh and Ferguson (2007). Specific experimental questions were as follows:

1. What are the effects of treatment on accuracy of naming of trained action names?
2. What are the effects of treatment on accuracy of naming of untrained action names?
3. What are the effects of treatment on production of number of CIUs and words in discourse?
4. What is the strength of the relationship between accuracy of naming in treatment and accuracy of naming in probes as measured by correlations?

Method

Participants

Three men and one woman with chronic, stroke-induced aphasia served as participants. According to medical records, the participants were between 21 and 276 months post of a single episode stroke at the start of the investigation. They ranged from 48 to 60 years of age and were all native speakers of English. All participants passed a pure tone hearing screening at 500, 1000, and 2000 Hz at 40 dB and performed within normal limits on the *Coloured Progressive Matrices* (Raven, Raven, & Court, 1998). All reported negative histories of premorbid speech/language

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difficulties, alcohol/substance abuse, psychological disorders (other than medically-managed depression), or neurological conditions other than the stroke; self-reports were verified by medical records. None of the participants received any other speech/language therapy during the course of this study and had not previously received the treatment applied in this investigation. Descriptive participant characteristics are shown in Table 1.

INSERT TABLE 1

The *Western Aphasia Battery* (WAB; Kertesz, l982) and the *Porch Index of Communicative Ability* (PICA; Porch, 2001) were administered to determine presence and severity of aphasia. Overall PICA percentile scores ranged from the 48^{th} to 75^{th}. According to WAB classification criteria, aphasia types were as follows: Participant 1 – conduction aphasia, Participant 2 – anomic aphasia, and Participants 3 and 4 – Broca's aphasia.

As seen in Table 2, all of the participants demonstrated confrontation naming difficulties on the *Test of Adolescent/Adult Word Finding* (German, 1990) and the *Object and Action Naming Battery* (OANB; Druks & Masterson, 2000). As part of the process of selecting experimental stimuli for this investigation, both sets of action names from the OANB were administered twice on separate occasions. Naming errors occurred for object names and action names.

Because treatment was focused at the level of lexical semantic processing, additional testing was completed to detect and describe semantic processing difficulties as well as disruptions at other levels of processing. To that end, qualitative analyses of naming errors produced during administration of the OANB were completed and selected subtests of the *Psycholinguistic Assessment of Language Processing in Aphasia* (PALPA; Kay, Lesser, & Coltheart, 1992) were administered.

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As seen in Table 3, semantic paraphasias were the predominant error type for all of the participants. Semantic paraphasias included production of semantically related nouns, verbs, and descriptions. Performance on *PALPA* subtests revealed difficulties with semantic associations and comprehension of verbs and adjectives for all participants. These errors in combination with the large percentages of semantic paraphasias indicated that all of the participants had some degree of semantic processing deficit. All participants also had difficulties with rhyme judgments which suggested possible phonologic level deficits; however, phonemic paraphasias were rarely produced. Examples of pretreatment confrontation naming errors are shown in Supplemental Appendix A.

Due to the focus on action naming, the *Verb and Sentence Test* (VAST; Bastiaanse, Edwards, & Rispens, 2002) was administered to describe verb and sentence processing. All of the participants demonstrated errors on all subtests of the VAST (Table 2).

INSERT TABLES 2 & 3 ABOUT HERE

None of the participants presented with any type of dysarthria as described by Duffy (2005). Participants 3 and 4 demonstrated speech characteristics consistent with apraxia of speech (McNeil, Robin, & Schmidt, 2009). Word level speech intelligibility was at least 80% for all participants (Table 2) (Yorkston & Beukelman, 1981).

Experimental Design

Multiple baseline designs across behaviors and participants were utilized to examine the effects of treatment on accuracy of naming of trained and untrained actions. Naming performance was measured repeatedly in probes conducted during the baseline phase using four sets of experimental stimuli for each participant. A minimum of five baseline probes was deemed necessary prior to the initiation of the study to allow utilization of the Conservative Dual

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Criterion method (CDC; Fisher, Kelley, & Lomas, 2003) in data analysis. Probing continued until stability of performance was evident as determined by the following criteria: 1) no more than 10% fluctuation in response accuracy in at least 3 probes immediately preceding treatment (for the set designated for treatment), and 2) a non ascending trend or descending trend in accuracy of responding. In keeping with the requirements of the multiple baseline design across participants, the number of baseline probes was extended across participants.

Following baseline, treatment was applied to one set of experimental items and probing continued with treated and untreated sets. Treatment was administered with the first set until termination criteria were met (described in "Treatment") Treatment was then withdrawn from the first set and applied to the second set while probing continued with all items. Follow-up probes were completed with all sets at two and six weeks following completion of all treatment.

Experimental Stimuli

As described previously, the participants were asked to name 100 line drawings depicting actions using the OANB (Druks & Masterson, 2000) on two separate occasions. Items that were named inaccurately on both administrations were utilized to select experimental stimuli. Forty action names were chosen for each participant which were then divided into four sets of 10 items. The sets were balanced as closely as possible (within participant) for the following factors: word frequency, age of acquisition, familiarity, number of syllables, number of phonemes, and argument structure. In order to facilitate balancing of sets, a subset of items was used to supplement the OANB items (Fiez & Tranel, 1997); these items were also named incorrectly on two occasions prior to selecting experimental stimuli (stimuli are listd in Supplemental Appendix B and balancing information is provided in Supplemental Appendix C).

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The action names that were selected on the basis of OANB performance were depicted by line drawings prepared by a graphic artist (i.e., the OANB drawings were not utilized as experimental stimuli). Ten non-brain-damaged adults (5 men and 5 women ages 41-70, mean age of 57.6 years) were asked to provide a one word response that best depicted the action in each drawing; all elicited the desired target response or an acceptable alternative response. The action names that were derived from Fiez and Tranel (1997) were depicted by stimuli that were developed and validated by those investigators.

Two of the sets of items were designated for treatment (Sets 1 and 2) and Sets 3 and 4 remained untrained. The trained and untrained sets of items were used to measure acquisition effects and response generalization effects of treatment, respectively. The two trained sets (Sets 1 and 2) and one untrained set (Set 3) were probed continually throughout all phases of the design. Set 4 was designed to be measured at pre- and post- treatment only to control the number of naming attempts for these items. Repeated exposure of items has been associated with improved naming without any treatment (Nickels, 2002). Set 4 was designed to serve as a control so that the possible effects of repeated exposure would not be misinterpreted as the effects of treatment. Unfortunately, Set 4 was mistakenly probed repeatedly by Participant 1's speech-language therapist; probing occurred as planned for the remaining participants.

The experimental sets of actions were not controlled in terms of semantic relatedness. Boyle (2004) indicated that the generalization effects of SFA derive in part from "accessing items from a variety of semantic categories in a structured, methodical way over and over again" (p. 246). Wambaugh et al. (2013) found no generalization to untrained items when SFA was applied to carefully constrained semantic categories and speculated that acquisition of the SFA feature generation strategy may depend upon application *across* semantic categories. That is,

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generation of features for a "variety" of semantic categories may be necessary for the generalization effects of SFA to be manifest. Relatedly, Faroqi-Shah and Graham (2011) reported no generalized responding with carefully controlled verb classes with a treatment that included semantic feature identification and generation (i.e., a variant of SFA). In the interest of applying the semantic feature generation strategy across a variety of semantic categories and adhering to a treatment protocol that was similar to previous SFA research (Boyle, 2010), semantic category membership was not constrained.

Dependent Variables and Probe Procedures

Confrontation Naming. The primary dependent variable was accuracy of naming of the experimental items in probes. Each of the pictured 40 experimental items was presented one at a time in random order and the participant was instructed to "use an action word to describe each picture". A 15 second response time was allowed for each picture. If the participant produced a noun response (e.g.. "horse" for "riding"), he/she was prompted to supply a verb (e.g., "tell me what is happening". Prompting was provided a maximum of three times per probe session. No feedback concerning accuracy was provided during probes; only general encouragers were given. Probe procedures were identical across all phases of the investigation. During treatment phases, probes were conducted at the start of the day's session, prior to treatment. Consequently, probe data reflected short-term maintenance effects of treatment (i.e., probes followed treatment by at least one full day).

All responses were orthographically transcribed on-line and were audio recorded (recordings were used to verify the on-line transcriptions). Responses were scored as accurate if the target action name (or acceptable alternative) was produced within 15 seconds. Acceptable alternatives responses were those that were determined by the participant's therapist to be an

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appropriate response or were provided by non-brain-damaged speakers. Self-corrected responses were allowed if the correction occurred within the allocated time. Uninflected or incorrectly inflected forms of the target verb were were scored as correct (e.g, target = "weighing"; acceptable responses = "weighing", "weigh", "weighed"). All other responses were scored as incorrect. Scoring was completed by the speech-language pathologist (SLP) who conducted the probe.

Percent accuracy for each of the experimental sets was calculated separately for each probe.

Production of Content in Discourse. Discourse samples were elicited using procedures described by Nicholas and Brookshire (1993) prior to the first treatment phase and following the last treatment phase. This procedure requires production of 10 discrete discourse samples which are then analyzed as one corpus: six picture descriptions, two procedural descriptions, and two descriptions of personal information.

Discourse samples were audio recorded and transcribed orthographically. Number of correct information units (CIUs), number of words, and percent of words that were CIUs (% CIUs) were calculated. CIUs are a measure of production of content in discourse and are words that are intelligible, "accurate, relevant, and informative relative to the eliciting stimulus. Words (do) not have to be used in a grammatically accurate manner to be counted as CIUs" (Nicholas & Brookshire, p. 340).

Treatment

SFA entails guiding the participant through the process of generating semantic features of the target item. A feature chart is used in therapy; the pictured target item is placed in the center of the chart and feature category labels are displayed above and below the pictured item. The

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therapist uses the chart to systematically elicit semantic features specific to the target item as well as to request naming responses. The SFA procedures employed by Boyle and colleagues (Boyle, 2004; Boyle & Coelho, 1995) were used in the current investigation with the exception of modification of the feature categories. The feature categories and corresponding elicitation prompts are shown in the Appendix.

For each treatment session, each of the 10 target action names was submitted one at a time, in random order, to the SFA procedure. The depicted action was displayed in the SFA feature chart and the SLP asked the participant to provide a name for the action. Regardless of naming accuracy, the participant was guided through the process of verbally producing features about the target action. The feature category labels and corresponding questions/statements were used to elicit responses. The order in which the category features were addressed always proceeded in the same order, moving from left to right in the top row and then the bottom row. The therapist wrote the participant's responses in the corresponding feature boxes as the responses were produced. After all of the feature categories were completed, the therapist again requested a naming response. If the response was incorrect, the features were reviewed again. The complete, operationalized treatment protocol is shown in Supplemental Appendix D.

Treatment was provided three times per week by an ASHA certified SLP (i.e., laboratory staff members). SFA was applied sequentially to two sets of experimental items. With each set, treatment continued until the following criteria were met: 90% accurate naming of trained items in two of three consecutive probes, ***or*** 12 treatment sessions were completed.

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Analysis of Treatment Performance in Relation to Probe Performance

Naming accuracy during treatment was compared to naming accuracy during probes. These analyses were conducted in the interest of determining if treatment performance could predict probe performance which could be helpful for clinicians who cannot perform frequent probes.

Two naming attempts were always required for each item during treatment: upon presentation of the target picture (first naming attempt) and following generation of semantic features (second naming attempt). For the group of 10 treatment items, the overall accuracy for the first and second naming attempts of the session was calculated separately for use in the analyses.

Because probes were conducted at the start of a treatment session, performance reflected maintenance of gains achieved in *prior* treatment sessions. Therefore, probe performance was compared to naming in the treatment session immediately preceding the probe (e.g., Friday's probe may have been compared to Wednesday's treatment).

It was speculated that probe performance might align closely with treatment that occurred on the same day as the probe. Consequently, probe performance was also compared to performance in the subsequent treatment session. For the example above, Friday's probe was also compared to Friday's treatment.

Correlational analyses were performed using percent accuracy for the 10 items in the treated set during probes and percent accuracy for the same 10 items during treatment. All probe and treatment sessions for each participant for the treated set of items were used for the correlations. Separate analyses were completed for the following data sets for each participant: 1) probe versus first naming attempt from previous therapy session; 2) probe versus second treatment

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naming attempt from previous therapy session; 3) probe versus first naming attempt from same day therapy session; and 4) probe versus second naming attempt from same day therapy session.

Reliability

Twenty-five percent of all probes were randomly selected for each participant to determine reliability of scoring of the primary dependent variable. An investigator who had not completed the original scoring used audio recordings to rescore the probes. The reliability scorer transcribed the productions from the audiotape and calculated response time. The responses were rescored using the operational definition of a correct response. Point-to-point agreement for scoring of correct and incorrect responses was calculated for each probe. Agreement ranged from 95% to 100% (average: 99%).

Twenty percent of the pre treatment – post treatment discourse samples (Nicholas & Brookshire, 1993) were randomly selected and rescored for each participant for number of words and CIUs. Two of the 10 discourse samples that comprised the entire corpus from each sampling time were selected. Point-to-point agreement averaged 96% and 99% for CIUs and words, respectively.

Results

Data representing accuracy of naming of actions during probes are shown in Figures 1 – 4 for Participants 1 – 4, respectively.

The CDC method was used to aid in determination of treatment effects (Fisher, et al. 2003). Application of the CDC method requires creation of a trend line and a mean line for each set of data using the baseline data. The lines were adjusted upwards in the direction of the expected treatment effect by 0.25 standard deviations and extended into each corresponding treatment phase (Fisher et al.). In Figures 1-4, the mean line is represented by long-dashed lines

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and the trend line is represented by short-dashed lines. Interpretation of positive treatment effects is dependent upon a pre specified number of data points falling above *both* lines (see Fisher et al. for required numbers)

To indicate magnitude of change associated with treatment, effect sizes (d-index; Bloom, Fischer, & Orme, 2003; Cohen, 1988) were calculated and are shown on the individual graphs and in Table 4. Effect sizes were calculated separately for treatment phases and follow-up phases which reflect short-term maintenance and longer-term maintenance effects, respectively. To calculate effect sizes, baseline probe values and the last two probe values in the treatment phase or the two follow-up probe values were utilized. Beeson and Robey (2006) suggested the following benchmarks for interpreting the magnitude of calculated effect sizes for lexical retrieval treatments for aphasia: 4.0 (small), 7.0 (medium), and 10.1 (large).

INSERT TABLE 4

Participant 1. Participant 1 demonstrated relatively stable naming performance during the baseline phase, with accuracy levels ranging from 0% to 40% across the experimental sets (Figure 1). With application of treatment to Set 1, accuracy of naming increased for trained items, reaching a maximum of 80% correct. When treatment was applied to Set 2 items, the performance criterion of 90% over two of three probes was reached within five treatment sessions.

Generalization to untrained items was minimal (Sets 3 and 4); increases of only10% above maximum baseline accuracy levels were observed. Set 4 had been intended to serve as a control for naming exposure, but had been mistakenly probed repeatedly. Because exposure did not appear to contribute to improved naming, this error in design implementation did not limit

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data interpretation. Improvements in naming for Sets 1 and 2 were maintained at levels well above baseline at the two and six week follow-up probes.

As seen in Figure 1, all of the 12 probe values for Set 1 fell above both CDC lines in the treatment phase (top graph, second phase), indicating that systematic change occurred with treatment. For Set 2, because of the limited number of probe values for the second phase of treatment, the CDC lines were extended through the follow-up phase. All probe values except the first probe in the treatment phase fell above both criterion lines, supporting interpretation of systematic change associated with treatment.

A medium effect size of 7.0 and small effect size of 5.75 were obtained for Set 1 for the treatment and follow-up phases, respectively. A large effect size of 10.78 for treatment and medium effect size of 7.99 for follow-up were obtained for Set 2.

INSERT FIGURE 1

Participant 2. Participant 2 demonstrated stable naming performance across the six baseline sessions (Figure 2). Accuracy of naming ranged from 0% to 40% correct across the four experimental sets. Performance criterion was reached for Sets 1 and 2 within five and three treatment sessions, respectively. No changes in naming accuracy were evident for the untreated sets. Maintenance effects were strong for both treated sets with naming accuracy remaining at high levels.

All probe data points in both treatment phases fell above the CDC lines indicating systematic behavioral change associated with both treatment applications. Large effect sizes were found for all treatment and follow up phases (10.69-17.0).

INSERT FIGURE 2

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Participant 3. As seen in Figure 3, negligible changes occurred with application of treatment for both treated sets. No changes were observed with untreated sets as well. The CDC method confirmed a systematic lack of behavioral change with treatment. Effect sizes were negligible.

INSERT FIGURE 3

Participant 4. Following stable performance ranging from 10% to 20% accuracy for Set 1, Participant 4 demonstrated large increases in naming accuracy with application of treatment. Performance criterion was reached with Set 1 following seven treatment sessions. Baseline performance was initially more variable with Set 2 (ranging from 0% to 50% correct) but stabilized with extended probing. Performance criterion was reached within five treatment sessions with Set 2. Gains in accuracy of naming trained items were maintained at levels well above baseline at both follow-up intervals. No increases in accuracy of naming of untrained items occurred.

All of the probe data points fell above both CDC lines for both treatment phases, indicating systematic change associated with treatment. For Set 1, d-Index values of 7.7 and 12.62 reflected medium and large effects for the treatment and follow-up phases, respectively. Small effect sizes were obtained for the treatment (4.7) and follow-up phases (4.43) for Set 2.

INSERT FIGURE 4

Probe Performance Compared to Treatment Performance

Pearson product-moment correlation coefficients are shown in Table 5. For Participants 1, 2, and 4 the correlations for the two treated sets are shown as one value; separate correlations were found to be highly similar, so the sets were combined for a single analysis. For Participant

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3, the correlations are displayed separately for each set because differential performance across sets in treatment resulted in correlations that varied by set.

For Participants 1, 2, and 4, overall naming accuracy during therapy *conducted the same day as the probe* was relatively highly correlated with probe performance; values of at least r=.80 were obtained for first and second naming trials (Table 5). There was also a strong, positive relationship between probe performance and naming accuracy in the preceding treatment session.

For Participant 3, probe performance did not appear to be strongly related to naming accuracy in treatment, with the exception of the first naming attempt for Set 2 during therapy and probe performance that same day (this was not seen for Set 1). Figure 5 displays Participant 3's probe data along with data representing accuracy of naming during treatment. (Note: Figures depicting probe versus treatment performance are not provided for the other participants because their treatment performance closely mirrored probe performance.) Whereas Participant 3 failed to show gains in naming accuracy during probes, he showed some improvements in naming during therapy, particularly for Set 2 following feature generation. His first naming attempts in therapy for Set 2 did not demonstrate improvements; thus, the correlation was relatively high for that condition.

INSERT TABLE 5 & FIGURE 5

CIU Production

Pre and post treatment results for CIU and word production in narrative and procedural discourse (Nicholas & Brookshire, 1993) are shown in Table 6. With the exception of Participant 1, treatment did not appear to be associated with increases in CIU production. As seen in Table 6, Participant 1 demonstrated increases in total word and CIU production, but not % CIUs.

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INSERT TABLE 6

Discussion

For three of the four participants, SFA applied to action naming resulted in improved naming of trained items which was maintained at two and six weeks following treatment. For all participants, generalization to untrained action names did not occur. Lack of response generalization was observed with items that were repeatedly probed and items that were measured at pre and post treatment intervals only. Increases in production of CIUs and words in discourse were found for Participant 1, but not for the other participants. Strong correspondence of treatment to probe data was found for the participants who demonstrated improved naming in probes (Participants 1, 2, and 4). However, probe performance was not strongly correlated with treatment performance for Participant 3; improvements were seen in treatment for one set of items which was not reflected in probes.

Acquisition Effects of Treatment

Wambaugh and Ferguson (2007) also found increased accuracy of naming of trained action names for their participant with anomic aphasia. The current study provides replications of the positive acquisition effects of SFA applied to action names and extends findings to participants with additional aphasia types.

Most participants across SFA *object* naming investigations have demonstrated improvements in naming of trained items (16 of 17 participants) (Boyle, 2010). Aphasia severity and poor nonverbal cognitive skills were suggested as factors for the participant who did not improve (Lowell et al. (1995). However, as noted by Boyle (2010), there have been other participants with more severe aphasia who have had positive responses to SFA treatment. Faroqi-Shah and Graham (2011; not included in Boyle's 2010 review) reported lack of improvement in

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naming of trained items for one of two participants who received verb training using procedures similar to SFA. Faroqi-Shah and Graham suggested that phonological difficulties and unfamiliarity with stimuli may have contributed to the lack of improvement.

In the current investigation, the non responsive participant (P3) presented with the greatest degree of aphasia and word retrieval deficits. In addition to semantic processing difficulties, he displayed some degree of phonological processing difficulty. Analysis of error responses revealed a much high percentage of “no responses” for Participant 3, suggesting a lack of, or inability to access or select semantic or phonologic information concerning the target actions. Beyond language factors, there were additional characteristics that distinguished Participant 3. Notably, he was premorbidly left handed and his aphasia resulted from a right hemisphere stroke.

As discussed by Wambaugh and colleagues (2013), different profiles of language/memory/cognition may be associated with different responses to SFA. Additional attention to neuropsychological abilities as well as characteristics such as neuroradiological findings and motivation is required to predict response to SFA.

Response Generalization Effects of Treatment

Another crucial component of treatment efficacy is generalization to untrained items. The lack of response generalization for all participants was disappointing, but consistent with Wambaugh and Ferguson’s (2007) findings. These negative response generalization results are in keeping with the majority of verb retrieval naming treatments (Conroy, Sage, & Lambon Ralph, 2006; Webster & Whitworth, 2012).

SFA has the potential to promote response generalization through at least two different therapeutic mechanisms: stimulation of semantic networks and implementation of feature

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generation as a strategy. Because semantic relatedness was not controlled across sets of items in this investigation, it was not expected that generalization to untrained items would necessarily result from stimulation of semantic networks. In contrast, Faroqi-Shah and Graham (2011) used a variant of SFA with carefully controlled, semantically related verb classes (e.g., cut and contact verbs). Despite trained and untrained items being very similar, Faroqi-Shah and Graham found no response generalization for both participants. They speculated that the features specific to each verb may need to be associated with the verb's label to improve naming. Additionally, they theorized that SFA (a modified version) may not have emphasized the important semantic features of the verbs sufficiently. Faroqi-Shah and Graham's suggested explanations for lack of response generalization may apply to the findings of the current investigation.

The other SFA mechanism that may facilitate generalized responding is utilization of semantic feature generation as a strategy. It appears that the participants in this investigation may not have used SFA as a strategy to facilitate naming of untrained items. If they did attempt to apply semantic feature generation as a strategy with untrained items, then the strategy was unsuccessful in promoting name retrieval.

For Participants 2 and 4, the length of treatment may have been a factor in lack of development of strategy use. These participants reached performance criterion levels within relatively few treatment sessions and consequently, had limited opportunities for practicing feature generation.

Generalization to untrained items has often been reported when SFA has been applied to object naming. However, as noted by Boyle, purported generalization may have been the result of repeated naming attempts rather than a result of treatment (except see Lowell et al., 1995). That is, the majority of SFA investigations have not controlled for repeated exposure of

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untrained items. Therefore, the lack of generalization found with SFA applied to action naming may not necessarily indicate that generalization outcomes are different than SFA applied to object naming.

Changes in Discourse

In the current investigation, increases in production of CIUs and words in discourse were evident for only Participant 1; findings for this participant were similar to those reported by Wambaugh and Ferguson (2007).

Participant 1 had notably better performance on the sentence production subtest of the VAST than the other participants. Wambaugh and Ferguson’s participant (2007) also was able to generate sentences on the VAST sentence production subtest. It is possible that a minimum level of sentence production (or general language production) abilities is necessary for generalization of the semantic feature strategy to discourse. If Participant 1 was able to implement the SFA feature generation strategy, increases in word production would be predicted in discourse and this was the case. Increased feature generation could conceivably result in relevant or non relevant feature production (as pointed out by an anonymous reviewer). Participant 1’s results indicate that she produced more related information (increased number of CIUs) as well as unrelated words (increased number of words without increased % CIUs). The lack of increases in word and CIU production for Participants 2, 3, and 4 suggest that they did not attempt to implement the strategy in discourse.

The findings of increased production of content in discourse and negative response generalization for Participant 1 and the participant studied by Wambaugh and Ferguson (2007) may seem incongruous. However, SFA was originally designed to increase the amount of semantically relevant information and naming accuracy was not a goal of treatment (e.g.,

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Massaro & Tompkins, 1992). Even if a participant was not successful in using the SFA strategy to facilitate naming, application of the strategy in discourse could result in increased production of content. That is, increased generation of semantic features, regardless of naming success, could result in increases in CIUs if the features were relevant to the context. Determination of whether participants actually engage in feature generation beyond the confines of treatment may be useful in future SFA investigations.

Treatment Performance Compared to Probe Performance

For the participants who demonstrated improved naming on probes (Participants 1, 2, and 4) accuracy of naming during treatment was highly correlated to accuracy of naming during probes. In contrast, Participant 3 demonstrated no improvements in naming on probes but some improvements in naming during treatment for one set of items. Consequently, his treatment performance was not highly correlated with probe performance

The lack of a strong correlation between treatment and probe data for Participant 3 highlights the need for clinicians to ascertain that gains during treatment sessions are manifest under non treatment conditions. Although repeated probing may not be feasible clinically, verification of improvements as measured under non treatment conditions would appear to be warranted prior to termination of treatment.

Summary and Future Directions

The results of this investigation indicate that SFA may have potential to promote improved naming of trained actions for persons with aphasia. Given the lack of response generalization, further research is needed to explore methods for extending treatment effects to untrained items. Similarly, additional study is required to promote consistent gains in discourse.

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Organization or selection of treatment stimuli may be deserving of attention. Determination of optimal ways by which to group actions for treatment and measurement of generalization may be challenging. As discussed by Faroqi-Shah and colleagues (Faroqi-Shah & Graham,2011; Faroqi-Shah, Wood, & Gassert, 2010), consideration of the motor effector used in completion of the action (e.g., hand action, foot action) may have potential for promoting generalization. Semantic relatedness may be another consideration in the structuring of treatment, although preliminary findings by Faroqi-Shah and Graham (2011) were not encouraging. Additionally, research concerning the neural substrates of action as they relate to language (Watson & Chatterjee, 2011) may be pertinent in the organization of treatment.

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Acknowledgements

This research was supported by the Department of Veterans Affairs, Rehabilitation Research and

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Development.

Thanks are extended to Rosalea Cameron and Kelly Eatchel for their assistance with this project.

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Table 1

Participant Characteristics

Characteristic	Participant 1	Participant 2	Participant 3	Participant 4
Age	48	53	55	60
Gender	Female	Male	Male	Male
MPO	276	66	79	21
CVA Location Type	L MCA & L PCA occlusive	L temporal occlusive	R MCA occlusive	L MCA occlusive
Years of Education	16	12	14	11
Race/Ethnicity	White non H/L	White non H/L	White non H/L	White non H/L
Handedness (premorbid)	right	right	left	right
Marital Status	married	single	single	widowed

Note: L = left; R = right; MCA = middle cerebral artery; PCA – posterior cerebral artery; H/L = Hispanic/Latino; Handedness determined by self-report in response to questions from the Edinburgh Inventory (Oldfield, 1971)

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Table 2

Pretreatment Assessment Results

Measure	Participant 1	Participant 2	Participant 3	Participant 4
WAB				
Aphasia Quotient	77.4	83.4	52.9	66.9
Classification	Conduction	Anomic	Broca's	Broca's
PICA				
Overall	12.89	12.17	10.72	11.75
Percentile	75	65	48	60
TAAWF				
Raw Score (107 Possible)	18%	43%	15%	22%
Comprehension	97%	97%	90%	99%
OANB				
Nouns (Objects A) (81 Possible)	88%	78%	47%	60%
Verbs (Actions A & B) - Time 1	53%	49%	47%	22%
Verbs (Actions A & B) - Time 2 (100 Possible)	62%	55%	48%	37%
PALPA				
Word Rhyme (60 Possible on each)				
Auditory	82%	77%	72%	83%
Written	75%	60%	48%	57%
Word Semantic Association (15 Possible on each)				
High Imageability	73%	73%	73%	73%
Low Imageability	53%	60%	47%	27%
Auditory Comprehension Verbs/Adjectives (41 Possible)	85%	80%	73%	76%
VAST				
Verb Comprehension	95%	90%	73%	98%
Sentence Comprehension	50%	35%	55%	70%
Grammaticality Judgment	58%	78%	83%	80%
Action Naming (40 Possible on each)	50%	40%	30%	18%
Filling in Finite Verbs	70%	30%	0%	20%
Filling in Infinitives	80%	70%	0%	40%

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(10 Possible on each)				
Sentence Construction (20 Possible)	80%	0%	0%	0%
AIDS				
Word Level Intelligibility (transcription)	92%	80%	84%	94%
CPM				
Overall (36 Possible)	92%	86%	72%	92%

WAB = *Western Aphasia Battery* (Kertesz, 1982); *PICA* = *Porch Index of Communicative Ability* (Porch, 2001); *TAAWF* = *Test of Adolescent/Adult Word Finding* (German, 1990); *OANB* = *Object and Action Naming Battery* (Druks & Masterson, 2000); *PALPA* = *Psycholinguistic Assessment of Language Processing in Aphasia* (Kay, Lesser, & Coltheart, 1992); *VAST* = Verb and Sentence Test (Bastiaanse, Edwards, & Rispens 2002); *AIDS* = *Assessment of Intelligibility of Dysarthric Speech* (Yorkston & Beukelman, 1981) ; *CPM* = *Coloured Progressive Matrices (Raven, Raven, & Court, 1998)*

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Table 3

Number of Errors and Percentages of Error Types during Confrontation Naming of Actions: Pre Treatment Performance on the OANB

Number of Errors Error Type	Participant 1 Pre Treatment Time 1	 Time 2	Participant 2 Pre Treatment Time 1	 Time 2	Participant 3 Pre Treatment Time 1	 Time 2	Participant 4 Pre Treatment Time 1	 Time 2
Total Number of Errors (100 possible)	47	38	51	45	53	52	78	63
% Semantic Paraphasias	96%	89%	100%	100%	68%	67%	85%	49%
% Phonemic Paraphasias		8%			2%	2%	2.5%	3%
% Mixed Paraphasias						2%		
% Unrelated Paraphasias					2%	2%	2.5%	
% Perseverations						4%		
% No response	4%	3%			28%	23%	9%	48%
% Other							1%	

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Table 4

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
Participant1		
Treatment Set 1	7.0 (medium)	5.75 (small)
Treatment Set 2	10.78 (large)	7.99 (medium)
Exposure Set 3	na	2.45 (<small)
Exposure Set 4	na	3.0 (<small)
Participant 2		
Treatment Set 1	17.0 (large)	15.59 (large)
Treatment Set 2	12.29 (large)	10.69 (large)
Exposure Set 3	na	1.0 (<small)
Pre/Post Set 4	na	1.0 (<small)
Participant 3		
Treatment Set 1	2.89 (<small)	2.89 (<small)
Treatment Set 2	3.13 (<small)	-0.27(<small)
Exposure Set 3	na	0.78 (<small)
Pre/Post Set 4	na	-0.59 (<small)
Participant 4		
Treatment Set 1	7.7 (medium)	12.62 (large)
Treatment Set 2	4.7 (small)	4.43 (small)
Exposure Set 3	na	0.39 (<small)
Pre/Post Set 4	na	1.12(<small)

4.0 (small), 7.0 (medium), and 10.1 (large).

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Table 5

Correlations Between Probe and Treatment Performance

Participant		1st Tx. Trial Previous Session	2nd Tx. Trial Previous Session	1st Tx. Trial Same Day	2nd Tx. Trial Same Day
P1		.69*	.85*	.88*	.82*
P2		.82*	.72*	.91*	.90*
P3	Set 1	.20	.28	.40	.57
	Set 2	-.10	-.22	.74*	-.43
P4		.65*	.72*	.80*	.80*

*Statistically significant at $p<.05$

Tx. = Treatment

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Table 6

Discourse Performance: Pre and Post Treatment CIU and Word Production Values

Measure	Participant 1		Participant 2		Participant 3		Participant 4	
	Pre Tx	Post Tx	Pre Tx	Post Tx	Pre Tx	Post Tx	Pre Tx	Post Tx
Total CIUs	765	1043	543	422	59	53	345	184
Total Words	1628	2145	832	738	144	81	671	426
% CIUs	46.9%	48.6%	65.3%	57.2%	40.9%	65.4%	51.4%	43.2%

Tx = treatment

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Figure Captions

Figure 1. Accuracy of naming of experimental items in probes for Participant 1. Each graph represents responding to a set of items. The top two graphs show treated sets and the bottom two graphs show untreated sets.

Figure 2. Accuracy of naming of experimental items in probes for Participant 2. Each graph represents responding to a set of items. The top two graphs show treated sets and the bottom two graphs show untreated sets.

Figure 3. Accuracy of naming of experimental items in probes for Participant 3. Each graph represents responding to a set of items. The top two graphs show treated sets and the bottom two graphs show untreated sets.

Figure 4. Accuracy of naming of experimental items in probes for Participant 4. Each graph represents responding to a set of items. The top two graphs show treated sets and the bottom two graphs show untreated sets.

Figure 5. Accuracy of naming of experimental items in probes compared to naming in therapy for Participant 3

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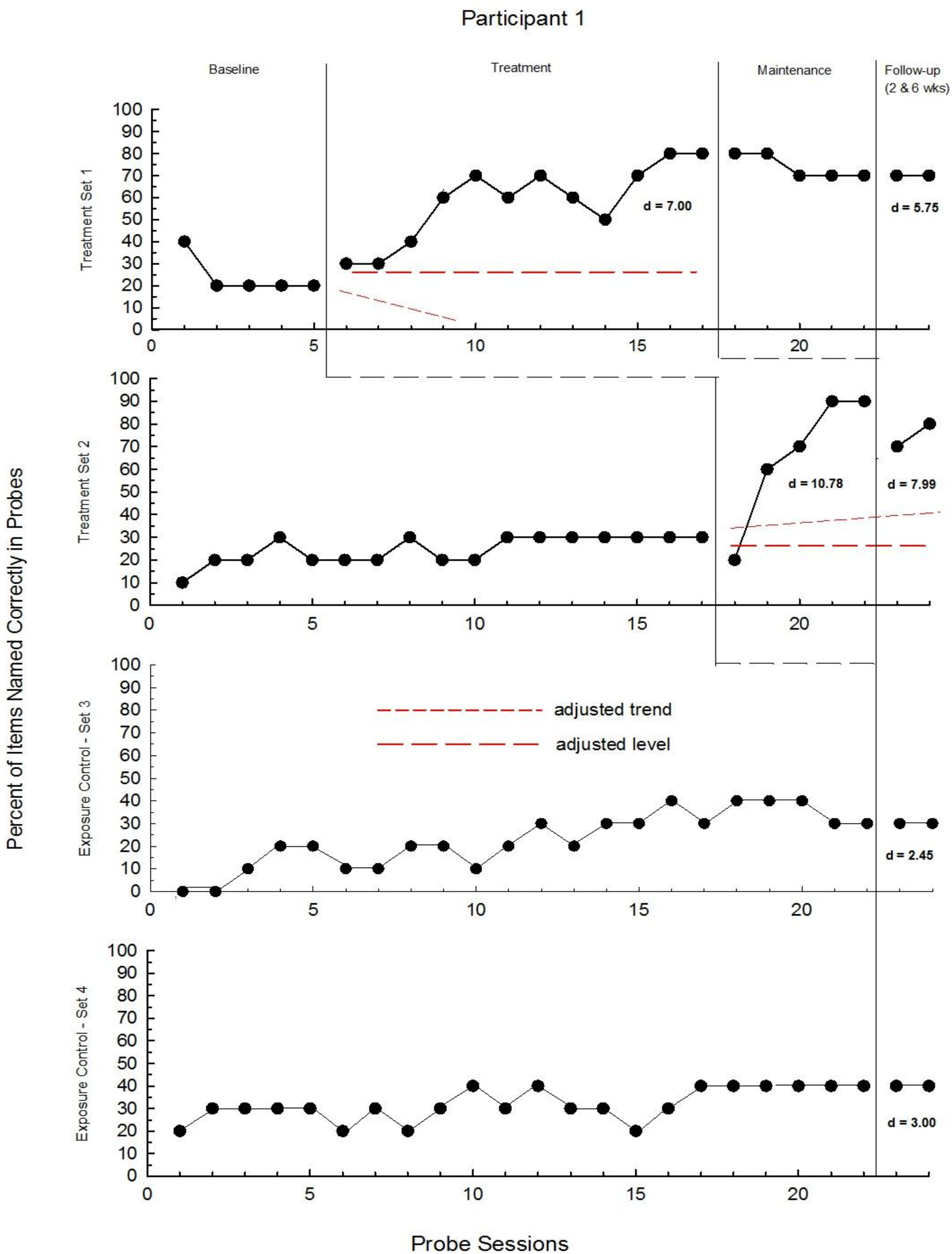

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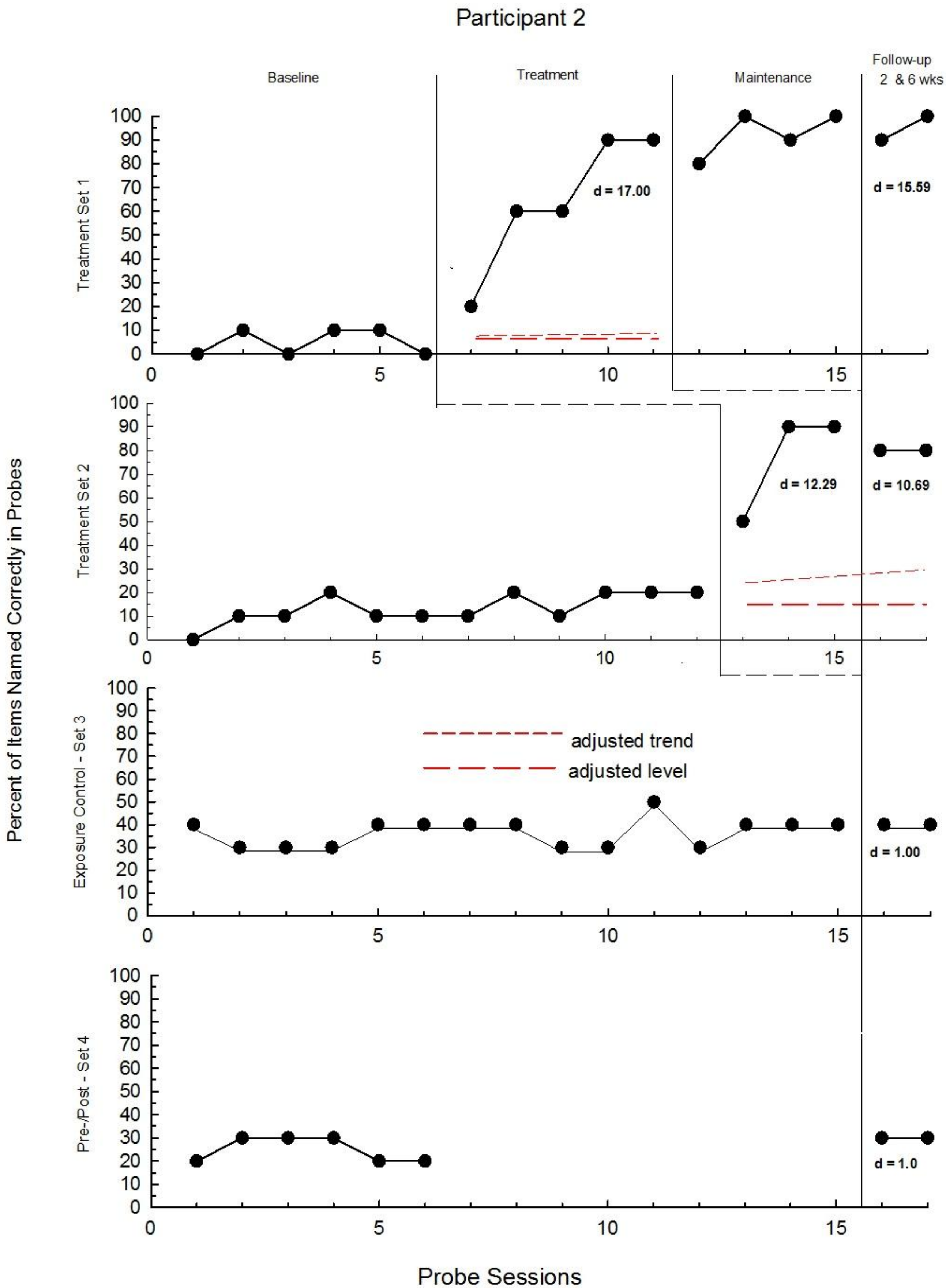

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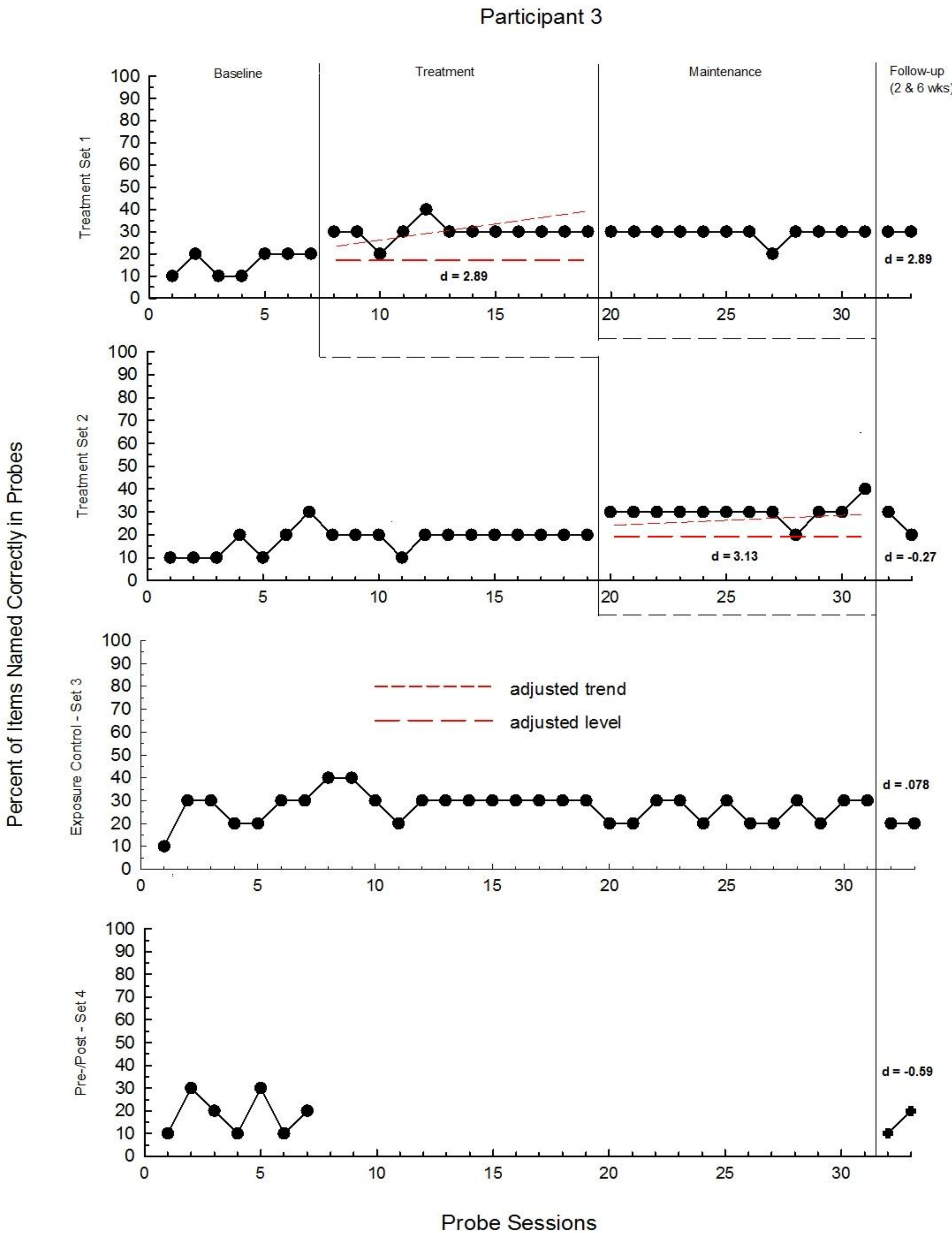

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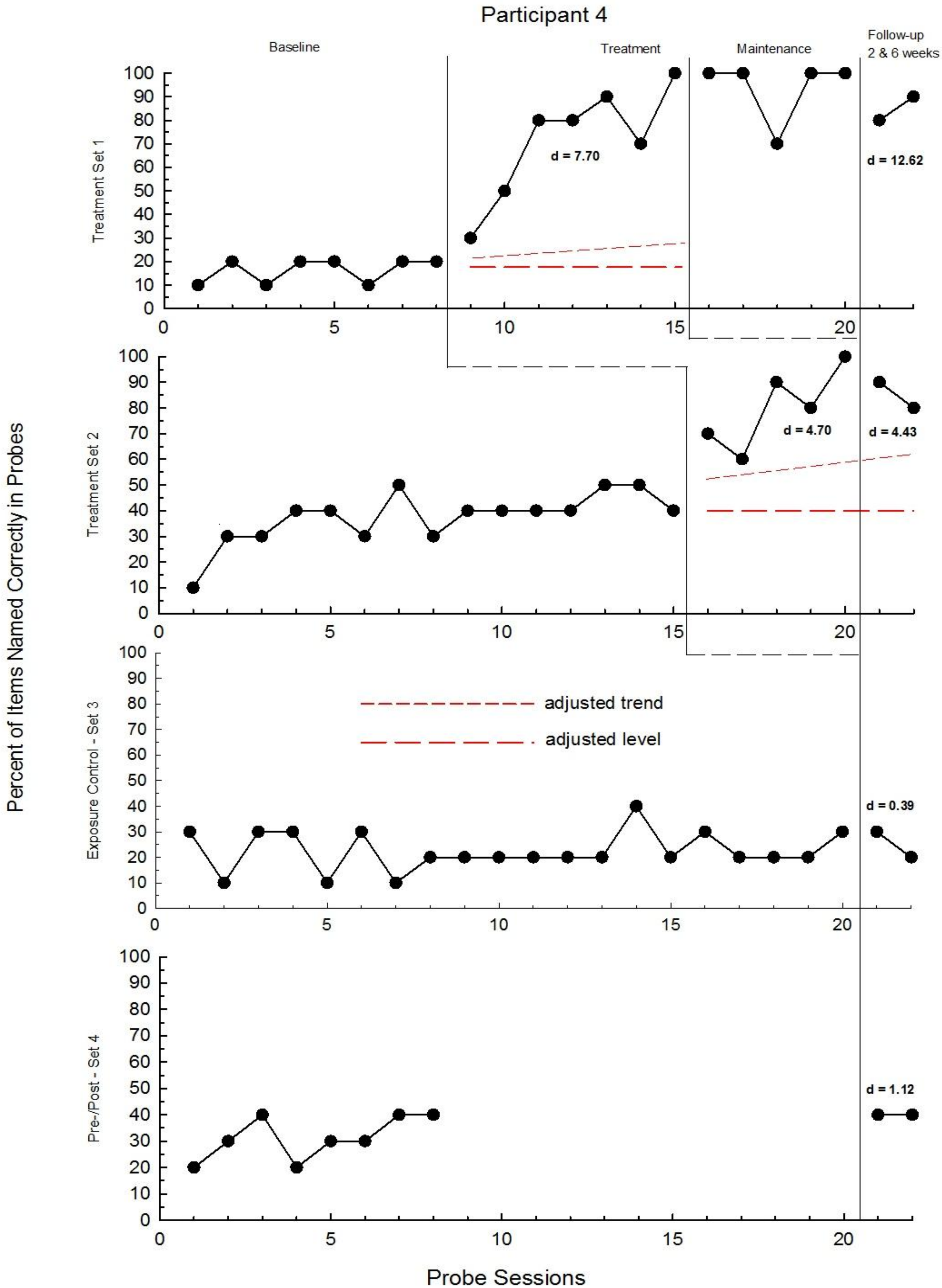

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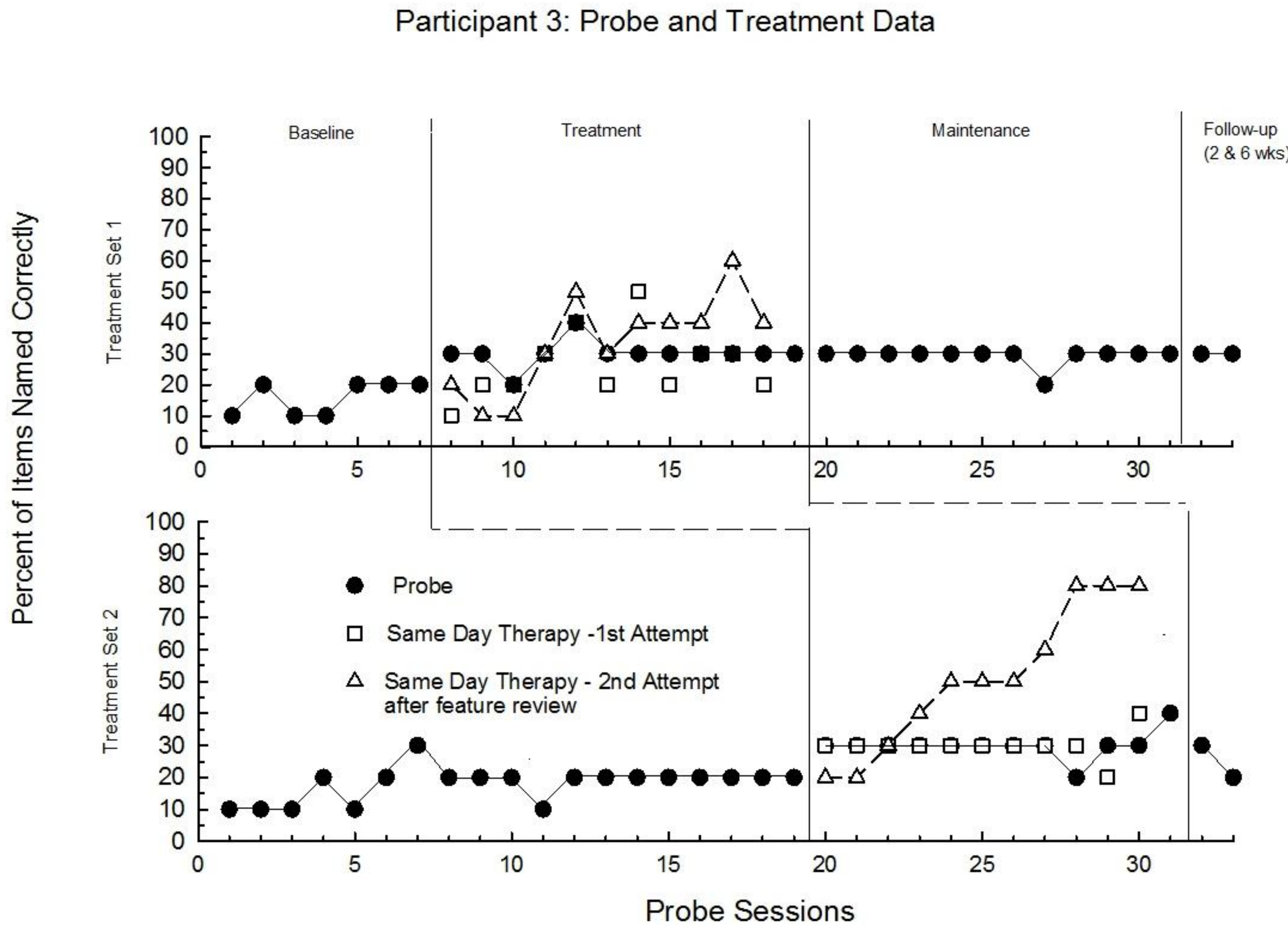

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Appendix

SFA Treatment Chart

SUBJECT

PURPOSE of ACTION

HOW

Who usually does this?

Why does this happen?

What part of the body/or what tool is used to make this happen?

INSERT PICTURE HERE

Tell me what it looks like.

Where does this action usually take place?

What does it make you think of?

DESCRIPTION OF PHYSICAL PROPERTIES

LOCATION

RELATED OBJECTS or ACTIONS

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