Multimodal Communication Training in Aphasia: A Pilot Study

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Management of patients with aphasia often focuses on training nonverbal augmentative communication strategies; however, these strategies frequently do not generalize to natural situations. The limited success may be because training was not sufficient to produce an integrated multimodal semantic representation. The purpose of this study was to examine whether simultaneous training of stimuli in both verbal and nonverbal modalities would solidify the links within the semantic network and improve switching among modalities as needed in conversation. Two individuals with severe aphasia participated in 6 to 8 hours of Multimodal Communication Training (MCT), during which they conveyed a concept by verbalizing, gesturing, writing, and drawing. After practice with all modalities for a single concept, a new concept was introduced. Results showed that one participant increased conveyance of concepts on the functional communication task using a variety of modalities. Although some improvement was seen with the second participant, his overall performance remained poor, likely because of a greater impairment in semantic knowledge. After a brief period of semantic training, the second participant demonstrated additional gains. Thus, MCT may serve to increase switching among verbal and nonverbal modalities in individuals with intact semantic representations, thereby increasing the likelihood that individuals will use an alternative method to communicate.

INTRODUCTION

Management of severe aphasia often focuses on training nonverbal augmentative communication strategies such as the use of communication books, computerized systems, gestures, writing, or drawing. However, results of studies aimed at training these compensatory strategies have been less than optimal (Purdy, Duffy, & Coelho, 1994; Robson, Pring, Marshall, Morrison, & Chiat, 1998, Yoshihata, Watamori, Chujo, & Masuyama, 1998). Purdy et al. (1994) examined acquisition and use of three communication strategies—communication board, gesture, and naming—in 15 individuals with aphasia. Training began with identification of 20 pictures on a picture board named by the clinician. When criterion was met, participants were trained to provide a gesture for the same 20 targets. Training concluded with oral naming of the 20 targets. After achieving 80% with at least two of the strategies, use of these strategies was then examined during a referential communication task during which participants described pictures containing the trained targets to an unfamiliar

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partner. Results showed that participants typically attempted to verbally describe the picture on the first attempt; however, when this failed, they spontaneously switched to an alternative modality only 37% of the time. Yoshihata and colleagues (1998) studied mode interchange skills of three individuals with aphasia. They first trained participants to provide a gesture or drawing to represent 18 concepts. The acquisition phase was followed by a usage phase during which participants were required to request an object using the trained modalities. Results were inconsistent, and participants required additional training for generalization.

The current study differs from previous attempts to address this issue in that all modalities for a single stimulus are taught simultaneously, making the concept of switching among modalities more explicit. In addition, the treatment discussed is firmly rooted in computational linguistic theories about how verbal naming occurs (e.g., Dell, Lawler, Harris, & Gordon, 2004; Schwartz, Dell, Martin, Gahl, & Sobel, 2006). These models assume that naming involves a two-step process, which begins with the identification of the semantic features associated with the concept to be expressed. Feed-forward and feed-backward connections among features cause a particular semantic concept (i.e., a lemma) to become activated. At this point, the second stage of retrieval is initiated by a jolt of activation to the phonological features associated with the verbal expression of this word. Naming can occur when activation has propagated throughout the phonological features and settled, leaving a set of highly activated phonemes, constituting the verbal name for the semantic concept identified in stage one. On this account, failed naming attempts may occur if no semantic concept becomes sufficiently activated to initiate the phonological retrieval attempt or if the links between the active semantic concept and the phonological expression of that concept are underactivated. The primary focus in this study is on developing a training technique to remediate the latter deficit by creating automated connections between semantic concepts and alternative modes of expression. It is assumed that nonverbal expressions may—with sufficient training—be integrated alongside verbal expressions so that use of these modalities becomes as automatic as verbal expressions are for those who have not lost access to them (Figure 1). It is suggested that the key to developing

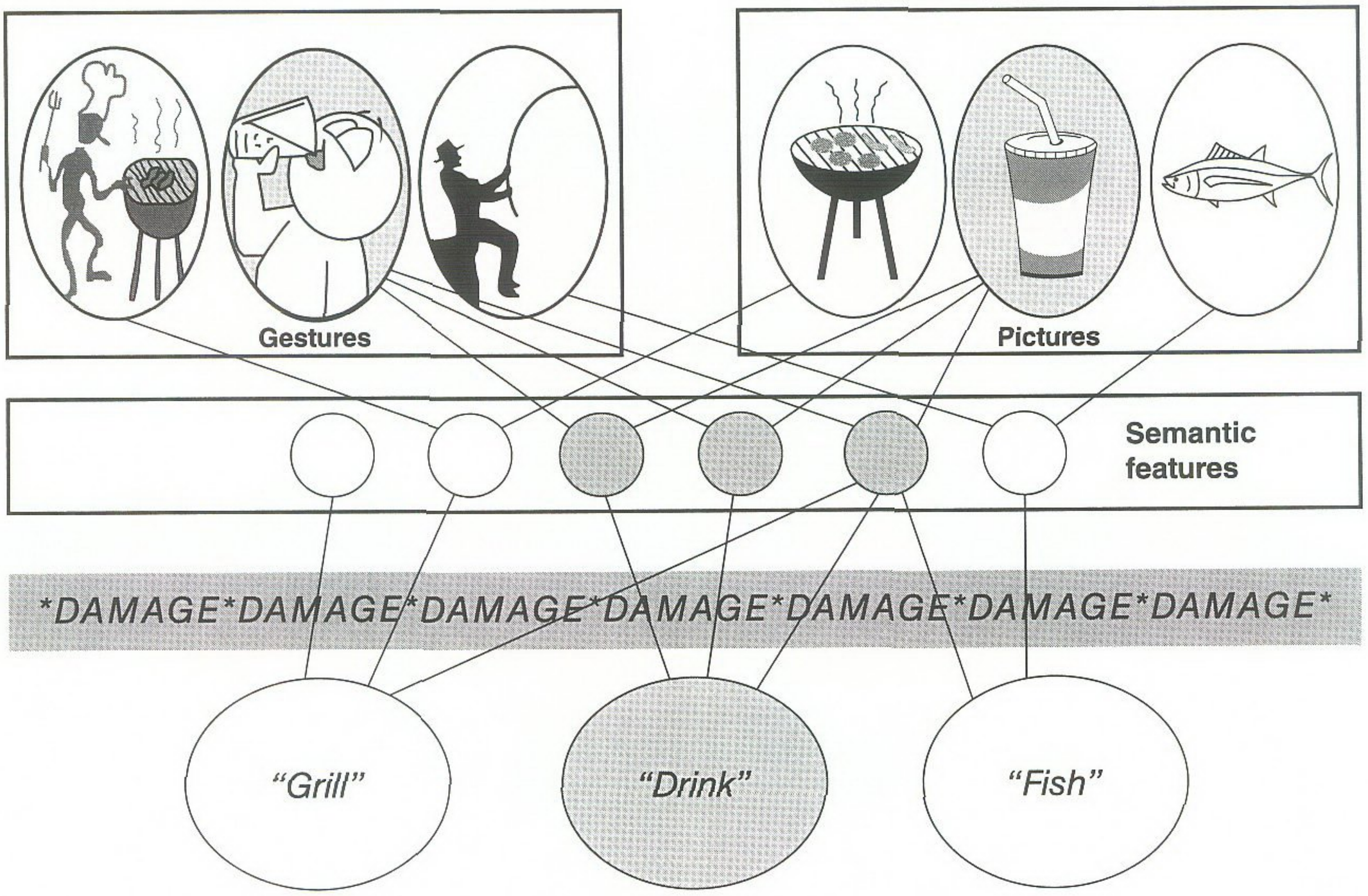

Figure 1. IA model extended to include nonverbal modalities.

such multi-modal representations is a training protocol that will transform these techniques from residing *outside* the linguistic system to being integrated within it. Thus, it could be suggested that successful nonverbal communication should not be *compensatory* but rather viewed as an *augmentation to* the existing linguistic system so that alternative modalities become a more salient means of expressing a particular message. From this perspective, limited success noted by Purdy et al. (1994) and Yoshihata et al. (1998) may be the result of training targets one modality at a time, which may not make sufficient contact with existing semantic and verbal representations to produce an integrated multi-modal representation. Consequently, these modalities are not accessed automatically, in the same way that phonological expressions, for instance, are accessed in neurologically healthy individuals. Even though patients may acquire the skill to point, draw, or gesture in order to communicate in structured situations, these forms of expression fail to generalize to spontaneous situations as they remain separate from the linguistic system. Their use requires conscious control, akin to task switching between two behaviors in which patients must explicitly inhibit the pre-potent tendency to invoke verbal modes of expression and switch to using alternative modalities. Indeed, patients who score highest on measures of executive function and cognitive flexibility are more likely to use sequentially trained nonverbal methods in spontaneous descriptions during unstructured referential communication tasks (Purdy, 1992).

To address this issue, the Multimodal Communicative Training (MCT) (Purdy & Cocchiola, 2006) was developed, which seeks to create integrated intermodal lexical representations via simultaneous, focused multimodal training that encourages patients to use nonverbal methods (i.e., gestures, drawing) in addition to verbal means to communicate their intended message. The concept of a multimodal lexical representation is an extension of the lexical representations used by the computational models referred to above (e.g., Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Schwartz et al., 2006) in which only phonological expressions are linked to semantic concepts. In non-impaired communication, the link between the semantic representation of a word and its phonological output form is intact and highly salient, making phonological production the most effortless means of expressing a message. However, when healthy individuals are put in a position in which conveying an intention verbally is not an option (e.g., in a noisy environment), they are able to gesture or draw the meaning of a sufficiently concrete word. Therefore, it appears that these modes of expression are already available. However, after brain damage, the links between these nonverbal signifiers and the semantic representation they signify may not be sufficiently automatized to be used with ease. MCT attempts to provide a structured learning context in which the salience of these alternative modes of expression can be increased.

MCT is based on the following assumptions: (1) each response (verbal or nonverbal) is a specific extension of the semantic representation of a concept, (2) successful training must make contact with an existing semantic representation of a concept, and (3) training must incorporate flexible movement among the verbal and nonverbal representations. MCT incorporates basic theories of learning and instruction during intensive practice of verbal and nonverbal representations of a single concept (e.g., Brown & Palincsar, 1989). A high degree of learning success is promoted through the use of a scaffolding technique in which clinicians provide initial models for participants to imitate but then fades the modeling as participants become more proficient with the alternative modalities. Thus, the hypothesis behind MCT is that systematic and intense training of both verbal and nonverbal modalities simultaneously will produce more automated links between a semantic concept and these alternative means of expression, making the alternative modality more available for use in spontaneous communication. This will reduce the need to invoke explicit task-switching behavior to use these alternative modalities, which may be difficult for patients with reduced executive functioning (Purdy, 1992, 2002). The purpose of this pilot study was to determine whether such training would improve aphasic individuals' use of multiple modalities on a functional communication task. Because of the link between semantic concepts and modes of expression, it was hypothesized that MCT would facilitate use of the alternate modalities in functional communication.

METHOD

Participants

Two men with moderate to severe aphasia consented to participate in this project after approval by the institutional review board at Southern

Connecticut State University. Both individuals sustained a single left hemisphere stroke, spoke English as their primary language, passed hearing and vision screenings, and were right-handed before their strokes.

BW is 56-year-old man, 4 years poststroke. He presented with a moderate Broca's aphasia as determined by his Western Aphasia Battery Aphasia Quotient (WAB-AQ) of 34.5 (Kertez, 2006), and severe apraxia of speech as determined by the *Apraxia Battery for Adults* (ABA) (Dabul, 2000). His speech was nonfluent and was characterized by one- and two-word utterances. His intelligibility was fair to good, depending on the listener's knowledge of the topic or context. He could comprehend conversation, respond reliably to concrete yes/no questions, and follow directions in context. His semantic knowledge was relatively good, demonstrated by his score of 88% (46 of 52) on the *Pyramids and Palm Trees Test—Picture version* (Howard & Patterson, 1992). BW has a right-sided hemiparesis and is a wheelchair user. He is married with one adult daughter. He resides in a skilled nursing facility but frequently returns to his home for brief visits. He has a high school education and was working as a transfer operator at the time of his stroke. BW had been receiving individual and group therapy at a university clinic once or twice a week for several months before initiation of this study. When this study began, he discontinued individual therapy but continued with group therapy once a week.

LK is a 73-year-old man, 8 years after left hemisphere stroke. His WAB-AQ score of 25.8 indicated a Wernicke's aphasia. His verbal output was characterized by word-finding problems and paraphasic errors (semantic, phonemic, and neologistic), with islands of fluent, appropriate phrases and short sentences. He comprehended familiar conversation, responded reliably to yes/no questions, and followed directions in context. He demonstrated impaired semantic knowledge, evidenced by his score of 67% (35 of 52) on the *Pyramids and Palm Trees* test. He is ambulatory, has mildly reduced sensation in his right hand, and has a mild limb apraxia. LK is married and lives at home with his wife. He completed high school and 2 years of trade school and was working as an electrician at the time of his stroke. LK also had been receiving individual and group therapy at a university clinic once or twice a week for several semesters. Individual therapy was discontinued when the current study was initiated, and he continued with group therapy once a week.

Design and Stimuli

Participants were seen in a university clinic for one to two, 1-hour sessions per week over a period of 5 weeks. A single-subject AB design (baseline and treatment) was used to document changes in performance. Twenty targets were drawn from the Communicative Activities in Daily Living-2 (CADL-2) and consisted of seven nouns (boy, car, tire, gas, shoelace, fan, and pencil), seven verbs (move, push, break, hit, smoke, stop, and hurt), four adjectives (flat, mad, blind, and cold), and two adverbs (fast and slow). One set of pictorial representations of each target was used for baseline and probes. Three other sets of pictures were used for training to emphasize that a single concept

TABLE 1. Participant Characteristics

	BW	LK
WAB AQ	34.5	25.8
Pyramids and Palm Trees test	46/52 (89%)	35/52 (67%)
Age and gender	56-year-old man	73-year-old man
Time after stroke	4 years	8 years
Comorbidities	Moderate to severe verbal apraxia	Moderate limb apraxia
Motor status	Right hemiparesis	Decreased right hand sensation
Ambulation	Wheelchair user	Ambulatory
Education	High school graduate	High school graduate
Occupation	Transfer operator	Retired electrician

WAB AQ = Western Aphasia Battery Aphasia *Quotient*.

could be represented many ways (e.g., "car" was represented by a station wagon, a convertible, and a sedan). Two baseline and three or four treatment probes (every-other session) were taken. During probes, the participant was shown a picture and asked to "tell me and show me all the ways you could let me know what is in this picture." No cues or assistance was provided during probes. Participants were given up to 3 minutes to respond. All communicative attempts and the modalities used were recorded.

Baseline Assessment

Functional Communication Testing

Functional communication was determined using the CADL-2 (Holland, Frattali, & Fromm, 1999) and a referential communication task. For this latter task, 15 action pictures, each containing two or three of the targets to be trained during MCT, were presented to the participants to describe to their communication partner, an unfamiliar graduate student, who was blinded to the target picture. The partner was asked to select the appropriate picture from four semantically similar choices based on information provided by the participant. A pencil, a paper notebook, and a picture board containing representations of the concepts were placed on the table, and participants were instructed to use whatever means necessary to describe the picture. The CADL-2 and the Referential Communication Task were videotaped, and all verbal and nonverbal communication attempts were transcribed and analyzed. The mode of response (verbal, gestural, pointing, drawing) was noted for each of the targets to be trained. A cognitive flexibility score was calculated from the transcripts. This score represents participant's modality-switching behavior (compensatory strategy usage) and was derived by dividing the number of opportunities to switch (e.g., a failed attempt to communicate a trained target) by the number of successful modality shifts (Purdy & Cocchiola, 2006; Purdy & Koch, 2006). Point-to-point reliability for scoring of opportunities and modality switches was 93%. All discrepancies were resolved before the final analysis.

Treatment

During the first training session, the clinician explained the purpose of the training and the expectations of the participant. Specifically, the participant was instructed to provide four methods for communicating a pictured concept. The researcher then demonstrated the expected response by presenting a picture, stating the name, writing the name, gesturing its function, and pointing to a corresponding picture on an 8.5 × 11 inch picture board containing black-and-white drawings of the 20 trained targets. The participant imitated each behavior. Direct input and feedback (e.g., oral directions, hand-over-hand guidance) were provided to elicit a correct production in each modality. The participant was given multiple opportunities to practice providing a response in all modalities, and assistance or cueing was gradually faded. When all target responses were elicited without a model, a new picture was introduced, and the process of demonstration and imitation was repeated. The order of modality usage was varied randomly (e.g., name, gesture, write, point; gesture, name, point, write). In subsequent sessions, pictures were presented, and the participant was asked to demonstrate the different ways the concept could be conveyed without a model. If all modalities were not elicited, a general request was made ("What else could you do to get your point across?"). If the target responses were still not elicited, a specific request would be made (e.g., "Gesture it"). If errors in production occurred, correct responses were demonstrated for the participant to imitate. The three sets of 20 pictures were practiced during each session.

Posttreatment Assessment

After treatment, the functional communication testing (CALD-2 and Referential Communication task) were repeated using the same procedure described above.

RESULTS

BW Acquisition

The total number of responses increased during treatment, indicating that BW used multiple modalities more frequently after treatment (e.g., 31, 45, 39 total responses) compared with baseline performance (24, 23 responses) (Figure 2). The specific concepts and modes of response varied among probe sessions. BW used the verbal modality most frequently. A slight increase was seen over time with his spontaneous provision of a gesture, and he more readily pointed to the corresponding

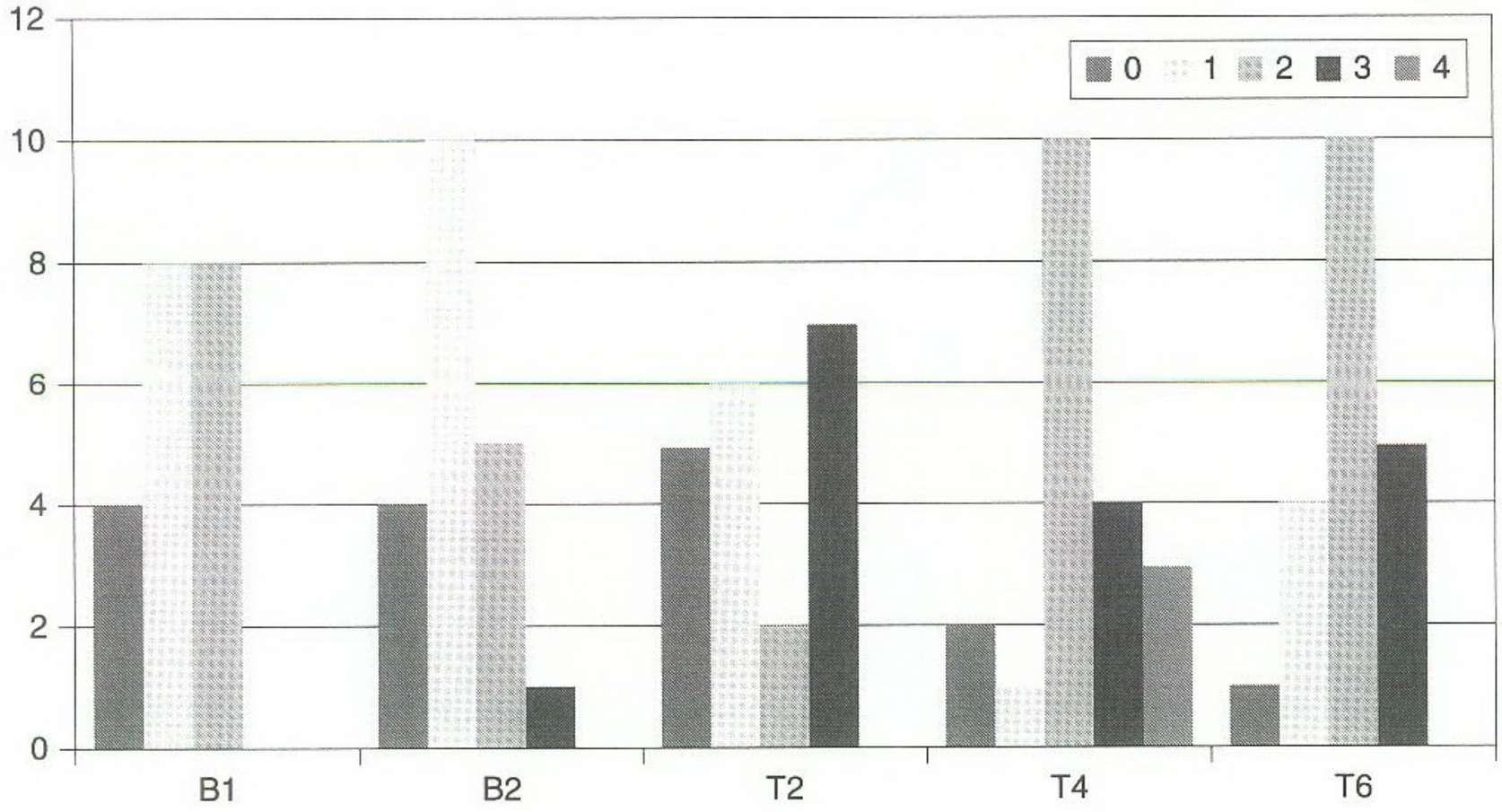

Figure 2. Number of modalities (0, 1, 2, 3, or 4) used by BW for expression of a single concept (n = 20) during baseline (B) and Multimodal Communication Training treatment (T) probes.

picture on the picture board. Minimal changes were seen with writing.

BW Usage

After training, BW switched to another modality when his first communicative attempt failed 71% of the time on the CADL-2 (increased from 28%) and 62% of the time on the referential communication task (increased from 37%) (Table 2). He routinely attempted a verbal response initially and most frequently used gesture to repair unintelligible, perseverative, inaccurate, or absent verbal communicative attempts.

LK Acquisition

LK required frequent demonstrations and cues throughout the training program. By his eighth session, he still did not spontaneously provide a response for almost half of the concepts (Figure 3). When he did respond, he used the verbal modality most frequently. He spontaneously switched to pointing to a picture on the picture board with increasing frequency. LK seldom switched to using gesture drawing or writing. He provided a representation of the concept in two or more of modalities for an average of only six concepts, which varied among probe sessions.

TABLE 2. Results for BW: Number of Opportunities to Switch*, Number of Successful Modality Switches, and Cognitive Flexibility Score†

	CADL			Referential Communication Task		
	Number of Opportunities to Switch	Number of Successful Switches	Cognitive Flexibility	Number of Opportunities to Switch	Number of Successful Switches	Cognitive Flexibility
Before training	14	4	28	27	10	37
After training	14	10	71	24	15	62

*Number of failed verbal attempts.
†Number of successful switches divided by opportunities to switch.
CADL = Communicative Activities in Daily Living-2.

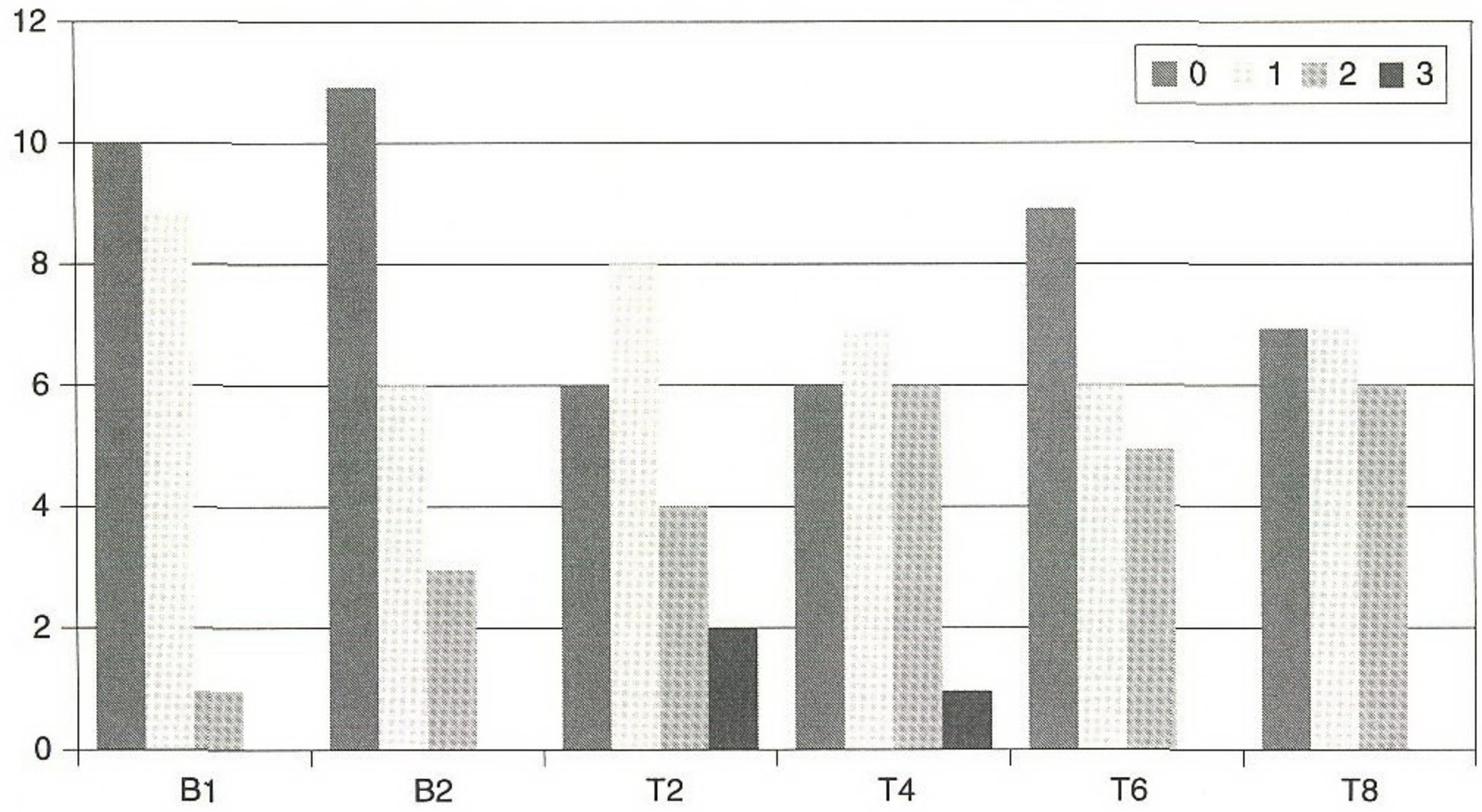

Figure 3. Number of modalities used (0, 1, 2, 3, 4) by LK for expression of a single concept (n = 20) during baseline (B) and Multimodal Communication Training treatment (T) probes.

LK Usage

LK's switched to another modality when his initial attempt failed on 45% of the opportunities presented on the CADL-2 (increased from 6%) and switched on 28% of the opportunities presented on the referential communication task (increased from 5%) (Table 3). Although MCT produced noticeable improvement for LK, his overall scores remained poor. This, combined with his poor performance on the *Pyramids and Palm Trees* test, suggested that his improvement may have been limited by generally poor semantic representations. As predicted by the lexical access models, if the appropriate semantic lemma cannot be activated, then naming failures will occur. Moreover, MCT will have limited success because training in alternative modalities could not make contact with sufficiently active semantic representations. To ameliorate this, a semantic treatment program was initiated, which aimed at increasing the salience of relevant features. It was hypothesized that semantic treatment may enhance semantic representations, allowing better access to verbal naming. If oral naming improves, there is less need to switch modalities.

Semantic Treatment

LK participated in four 1-hour semantic treatment sessions over 2 weeks. The treatment incorporated both semantic feature analysis and categorization tasks. LK was provided with six picture cards that could be sorted into two groups of three based on a variety of concrete and abstract semantic features (e.g., red vs. yellow; animals vs. vehicles; air vs. ground). LK and the clinician began by jointly completing a semantic feature analysis chart, which identified perceptual (e.g., color, size, shape) and semantic (e.g., superordinate category, use, location) features of each picture. Similarities and differences among the pictures were discussed. Training then proceeded to the categorization task, during which LK was to sort the picture cards into as many groups as possible. Initially, the clinician specified the categories (e.g., fruits and vegetables; red and yellow), and LK sorted the pictures accordingly. Then LK initiated the sorts. Two different sets of six cards were presented during each session.

Results of Semantic Training

During baseline, LK spontaneously completed one sort (subordinate categories: fruits/vegetables). Over the course of treatment, he independently completed up to three different sorts (subordinate category, color, size). After semantic treatment, he demonstrated improvement on the *Pyramids and Palm Trees* test, and the accuracy of his oral output improved, demonstrated by a reduction in the number of opportunities to switch modalities on the referential communication task. However, little change was seen with his cognitive flexibility because he only switched during four of 12 opportunities (see Table 3).

TABLE 3. Results for LK: Number of Opportunities to Switch,* Number of Successful Modality Switches, and Cognitive Flexibility Score†

	CADL			Referential Communication Task			*Pyramids and Palm Trees* Test
	Number of Opportunities to Switch	Number of Successful Switches	Cognitive Flexibility	Number of Opportunities to Switch	Number of Successful Switches	Cognitive Flexibility	
Before cognitive flexibility training	15	1	6	19	1	5	34/52 (65%)
After cognitive flexibility training	11	5	45	21	6	28	35/52 (67%)
After semantic training	9	4	44	12	4	33	46/52 (89%)

*Number of failed verbal attempts.
†Number of successful switches divided by opportunities to switch.

DISCUSSION

It was hypothesized that MCT may enhance communication in individuals with aphasia through facilitation of switching among communicative modalities. Although it is understood that little can be concluded on the basis of two individuals, the fact that after only eight training sessions using the integrated multimodal technique BW's performance on these tasks exceeded that of all 15 participants in an earlier study that did not use the integrated approach (Purdy et al., 1994) suggests that the integrated training approach may foster increased use of nonverbal modalities when verbal expressions are unavailable. It may be that MCT served to reduce the demand on executive processes by creating nonverbal expressions of the trained semantic concepts that could be accessed more automatically.

A particularly significant outcome of this pilot study is the finding that the participant with more disrupted semantic representations did not fare as well with the training and subsequent functional communication task. This is consistent with the theoretical foundation of MCT, which aims to connect newly acquired nonverbal expressions to existing semantic representations. If such representations are themselves faulty, then there will be only a weak conceptual anchor to support acquisition of new expressions and training will necessarily have limited success. This result suggests that individuals with impaired lexical semantic knowledge may not benefit as much from this approach. A more compelling argument for this hypothesis could be made if LK participated in another course of MCT after the semantic treatment. Unfortunately, he did not, making that a limitation of this study.

The current work joins a number of other studies that have linked high proportions of nonresponses in naming tasks to weak semantic representations (e.g., Bormann, Kulke, Wallesch, & Blanken, 2008; Lambdon Ralph, Moriarty, Sage, & The York Speech Therapy Interest Group, 2002; Schwartz et al., 2006). Taken together, these findings highlight the clinical importance of identifying which patients have sufficiently intact semantic representations to support the acquisition of alternative communication modalities. Thus, an issue that is equally as important as that of how to best train patients to use nonverbal modalities to communicate is which patients are likely to respond to such training in the first place. Because augmentative communication strategies can be costly and time consuming to implement, it would be particularly helpful if clinicians could more precisely match these therapies to patients who could benefit from them. Consequently, this is a highly fruitful area for future research.

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