Evaluation of Learning Potential of a Severe Aphasic Adult Through Analysis of Five Performance Variables Using Novel Pictorial Stimuli

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Introduction

Statement of the Problem. The aphasiologist concerned with learning potential of the aphasic adult asks: (1) can this individual learn? and (2) what are the optimal conditions for learning? We feel that a description of learning potential has direct implications for selecting treatment methodology and for stating a prognosis for response to treatment. Currently, learning potential of the aphasic adult is rarely evaluated in a systematic fashion.

Statement of the Purposes. The purposes of this paper are to: (1) describe the assumptions, goals and application of learning potential evaluation, (2) offer a rationale for use of novel pictorial stimuli for learning potential evaluation of the aphasic person, and (3) describe five performance variables pertinent to learning potential evaluation, using the performance of a severe aphasic adult as illustration. The learning performance variables include: trials to criterion, stimulability, response pattern, generalization across settings, and generalization across behaviors.

Rationale for Use of Novel Pictorial Stimuli. The visual and nonphonetic character of stimuli seems to lend itself to right-hemisphere processing. Traditionally, visual-spatial and nonverbal functions have been ascribed to the right hemisphere; auditory-verbal to the left hemisphere. The data from split-brain, dichotic listening, tachistoscopic, sodium amytal, hemispherectomy and aphasia research address this issue of functional organization. Collins (1976), Moscovitch (1976) and others (Whitaker, 1976; Krashen, 1977; Searleman, 1977; Meyers, 1978) offer excellent reviews. According to Smith (1966; 1971; 1977), Kinsbourne (1971) and others (Gazzaniga and Hillyard, 1971; Fromkin, Krashen, Curtiss, Rigler and Rigler, 1974; Heilman, Rothi, Campanella and Wolfson, 1979), the right hemisphere may perform a compensatory function in the language reacquisition process in the event of left hemisphere damage. West (1977) addressed this issue, as influenced by the work of Paivio (1971), stating, in short, that clinicians should tap the right hemisphere in aphasia therapy by using visual stimuli.

In addition, some intriguing observations with respect to the processing of novel stimuli by the left and right hemispheres have been made. Bradshaw and Gates (1978) investigated differences in magnitude of right visual field superiority of familiar vs. nonfamiliar (word vs. nonword) printed material. Their findings support the existence of an auxiliary right hemisphere mechanism for processing novel or unfamiliar material (cf. Critchley, 1962; Kimura, 1967). Thus, theories of lateralization of function, compensation and language learning ability, and processing of stimuli by the right hemisphere support the use of novel pictorial stimuli in the left hemisphere damaged aphasic person.

Another major advantage to using novel pictorial stimuli is that the clinician is providing the patient with the opportunity for new learning, a point on which we will elaborate in a moment.

Further advantages include: minimizing the memory load because of the inherent static character of visual stimuli; modifying impulsivity and concomitant noise buildup through increased visual scanning and analysis time (Rabinowitz and Robe, 1968);[1] increasing the opportunity for the patient to respond independently of the clinician's auditory-visual cues.

Finally, the use of novel pictorial stimuli increases data control. Novel stimuli and miniature artificial language systems (Wetherby, 1978) offer the advantage of increased data control because responses to novel stimuli are free of the effects of previous learning. This concept is not a new one in the field of speech pathology. In the context of articulation therapy, Van Riper (1947), Gerber (1973), Winitz (1969, 1975) recommended the use of nonsense objects and syllables in both the production and transfer stages of speech sound learning. The data of Winitz and Bellerose (1965) and more recently Mowrer and Scoville (1978) supported the following conclusions:

> The use of meaningful pictorial stimuli...may only serve to evoke incorrect articulation responses

due to a phenomenon described by Goldiamond (1958) as "learned response bias."

> By presenting a child with a nonsense syllable or object it may be possible to bypass the effects of prior experience. (p. 480)

In the area of language acquisition, the successful use of a nonspeech response mode employing arbitrary shapes or symbols has been reported by Premack (1971) with chimps, Carrier (1973) with mentally retarded children, McLean and McLean (1974) with autistic children, and Glass, Gazzaniga and Premack (1973) with severely impaired aphasic adults.

McLean and McLean (1974) reported two goals of training nonspeech systems: (1) to attain an initial expressive repertoire, and (2) to assess prelinguistic readiness...for symbolic representation and syntactic constructions. (p. 192)

Thus, novel symbol systems allow one to train communication in a mode other than in the vocal-verbal channel, which may have been ineffective previously, and learning data are relatively free of the effects of prior experience.

<u>Learning Potential Evaluation</u>. This brings us to the question of the evaluation of learning potential. The exciting work of Corman and Budoff (1974), who have used this approach with mentally retarded children relative to nonverbal problem solving, and Dwyer (1978), who discusses learning potential evaluation in the context of aptitude-treatment interaction research, may be useful sources of additional information.

[1] In the case to be described, dramatically decreased impulsivity occurred in the first training sessions until the novelty of the pictorial stimuli wore off.

Two broad questions in learning potential evaluation include: (1) can this person learn? and (2) what are the optimal conditions for learning? These questions are particularly applicable to the severely involved aphasic person, and hence the reason for our interest.

Measurable Performance Variables. Specific measurable performance variables are: trials to criterion, or rate of learning; stimulability, which implies the best response of the patient to given cues or prompts; response pattern, including stability over time and stability across treatment conditions; carryover from treatment to home; and, generalization to untrained items (in other words, generalization across settings and behaviors). There may be others which also have value for predicting learning, but these at least may serve as a point of departure. The following is a case in point, and illustrates the application of these concepts to our management of a person who is severely aphasic.

CASE HISTORY

Patient JY, a former college dean, is a 58-year old male who suffered two left hemisphere cerebral vascular accidents. A CT scan performed at Duke University Medical Center in December 1977 showed:

> ...an extensive area of low density in the left frontal, parietal and occipital regions...This area involves Wernicke's and Broca's areas consistent with the clinical symptoms.

JY was initially described as "globally" aphasic. His aphasia was characterized by stereotyped verbal utterances and nonfunctional auditory comprehension and severe oral, verbal and limb apraxia. Treatment goals included; increasing his oral-verbal repertoire and auditory comprehension, at the single word and multi-word levels. At the time of presentation of novel symbols (10 months post onset), auditory comprehension was functional using a pointing or yes/no response, and the patient presented an oral-verbal repertoire of approximately 25 words. JY's learning characteristics and performance on standardized tests, including scores from the Porch Index of Communicative Ability, are shown in Appendix B.

The significant expressive problem was JY's inability to initiate and produce the "available" vocabulary without cueing by the clinician. Speech was stimulable but not spontaneous.

The goals of treatment at ten months post onset, and the rationale for presenting novel symbols for learning were to: (1) facilitate reorganization of language by pairing of verbal lexical items with novel pictorial stimuli so that residual vocabulary, however limited, would be available for communication, and (2) increase verbal selection and retrieval behaviors independently of the clinician.[2]

Novel Pictorial Stimuli. The novel pictorial stimuli used in this study were adapted from the Blissymbolic system (Bliss, 1965), which is a nonverbal communication system conveying meaning via 100 visual-pictographic signs without phonetic associations. Bliss symbols reportedly have been used with speech/language disordered individuals to replace or supplement verbal

[2]Nonspeech (pointing) responses were not used because of JY's adamant preference for oral-verbal responding.

communication or to stimulate receptive and expressive language (Archer, 1977). The final set of novel stimuli are shown in Figure 1. The lexicon included: sleep, coffee, shirt, what? and TV.

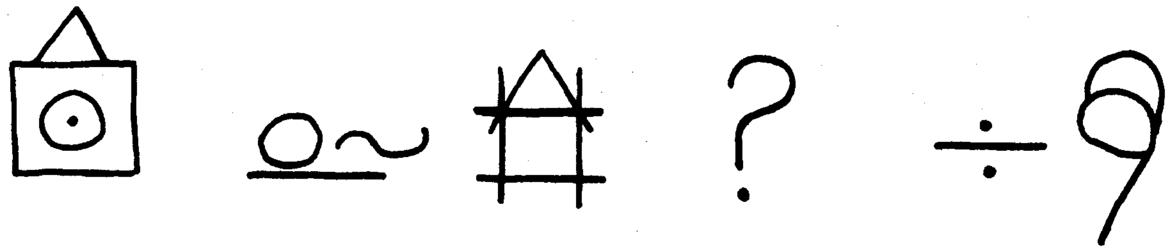

Figure 1. Novel pictorial stimuli.

Several sessions were devoted to stimulus selection and familiarization of the patient with the stimuli and the task of symbol selection. Learning data reported in this paper were obtained from two consecutive half-hour sessions, twice per week for a total of 14 sessions.

Task Events. Task events were as follows (Table 1): the 5 symbols were presented on 5 x 7 " cards in a standard order. The patient selected a symbol in any order and placed it in front of him on the table. He was encouraged to say the word associated with the symbol. Because of the novelty of the stimuli, initial trials yielded no appropriate speech. However, JY quickly learned that specific consequent events would be available to him following any attempt by him to respond. The criterion response was JY's spontaneous production of the one word associated with the symbol.

Table 1. Novel Pictorial Stimuli: Task Events

ANTECEDENT	RESPONSE	CONSEQUENT
Five Bliss Symbols, standard layout, patient selects	Patient labels symbol with one word (oral-verbal)	Consequent 1: Specified visual, auditory, and/or gestural feedback. (Immediate, single cue.)
		Consequent 2: Clinician presents multiple cues as needed to elicit maximal oral-verbal response

Following his attempt to verbally label the symbol, the clinician would provide specified consequences. The first consequent event was an immediate single cue—a spoken word or a gesture. Let's take the symbol for "coffee" as an example. In the verbal treatment condition, the clinician would say the word and JY would repeat it. In the gesture treatment condition, the clinician would gesture the Amerind sign for "drink" and thereby elicit the word coffee. The second consequent event consisted of multi-modality and repeated cues in order to elicit the intended one-word response associated with the selected symbol.

In each session, 6 consecutive trials, consisting of five responses each, were elicited. In all conditions, the first spontaneous response on each trial was scored, and immediately followed by specified cues by way of reinforcement, stimulation or corrective feedback. If JY responded incorrectly on spontaneous naming, consequent cues served as corrective feedback and stimulation. If JY responded correctly on spontaneous naming, the consequent cues served as reinforcement and the opportunity to practice the correct response.

This series of task events—spontaneous response followed by consequent 1 and consequent 2—was followed so that each novel symbol-word association was stimulated equally throughout the program.

Learning Data

Trials to Criterion. How quickly did JY learn these symbol-word associations? Figure 2 shows the number of trials to the first instance of correct spontaneous naming of the symbol. The first occasion on which the spoken response "TV" was correctly produced following selection of the symbol for "TV" occurred after only 3 trials; "coffee" after 6 trials; "shirt" after 12; "sleep" after 20. The word "What?" was never spontaneously uttered after selection of the symbol (?) during the 14 training sessions.[3]

Figure 3 illustrates the discrepancy between stimulability for the 5 selected words and spontaneous naming of the symbols. The first 5 (of a possible 30) trials on days 1-12 are shown. The important things in this figure are as follows. (1) Spontaneous naming of the 5 novel symbols was poor. Actual performance did not reach the expected level of attainment. (2) Stimulability following presentation of consequent 1, a single immediate cue, was highly variable. (3) Stimulability following presentation of consequent 2, maximal cues, was good, but carryover across days to spontaneous performance was negligible.

[3] It may be significant that the symbol for what (?)—a question mark—was the only stimulus in the program not meeting the criterion of novelty. On a supplementary receptive (auditory - point to symbol) task, JY's pointing to (?) was virtually error free. On followup (2 months status post discharge from therapy), the patient spontaneously and appropriately used the gesture for (?), i.e., a waving action, appropriately and functionally to ask about his return appointment. The patient's wife had not observed this at home during the treatment-followup interval.

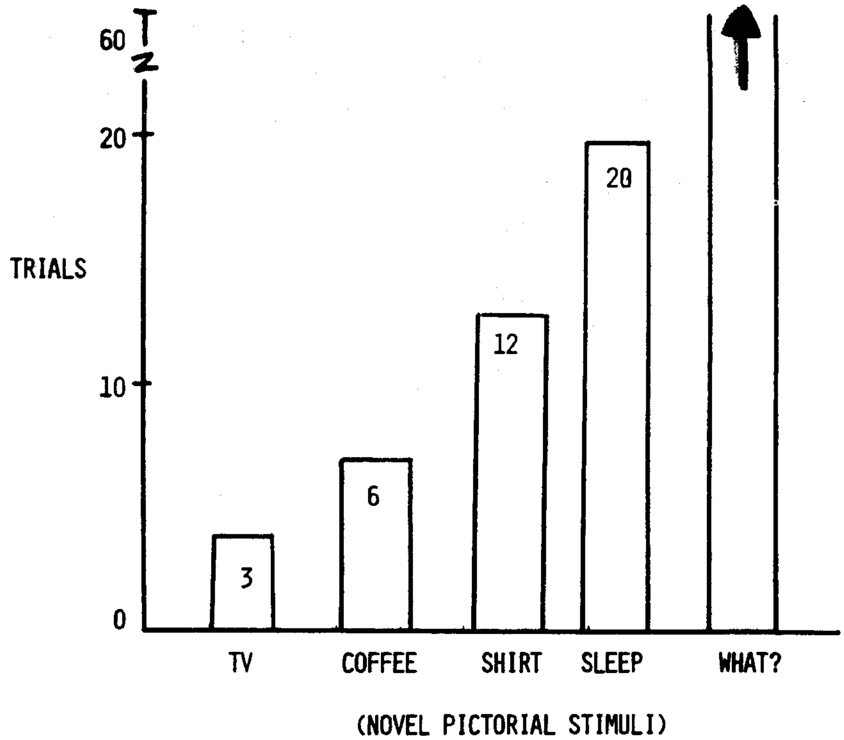

Figure 2. Trials to criterion task: Spontaneous naming of novel pictorial stimuli.

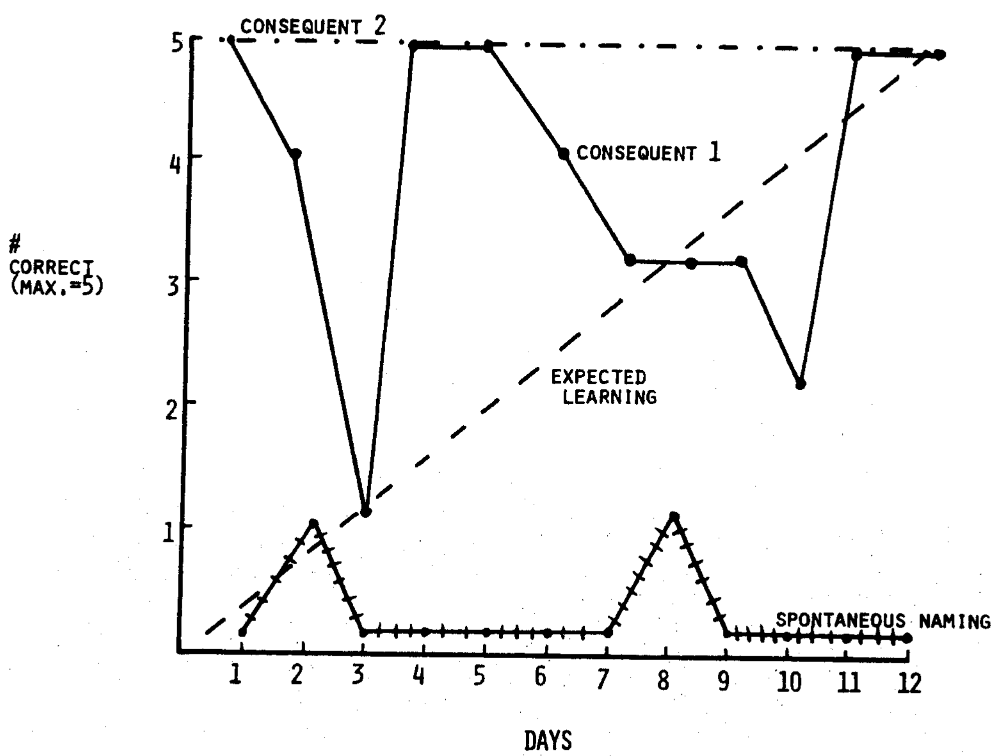

Figure 3. Stimulability vs. learning.

Trials to Criterion vs. Response Stability. The rank order of novel stimuli with respect to trials to criterion and response stability over time were compared. On the criterion measure, spontaneous naming, the stimuli were rank ordered from fewest trials to most trials as follows: TV, coffee, shirt, sleep, what? Response stability, from most stable (and accurate) to least stable was as follows: coffee, TV, shirt, sleep, what? The consistency between these two measures suggests that rate of acquisition of a given response may be reflected in retention and relative availability of a given response on subsequent trials. As we might expect, if a response is easier to learn, it is likely to be more stable.

Response Pattern. Now let's take a look at the response pattern. Figure 4 illustrates correct spontaneous naming performance on Day 13. The data points show spontaneous performance, with the effects of the consequent cues, which were provided systematically after each spontaneous naming effort as described earlier, reflecting in the changing face of the graph. In session 1, verbal imitation was the primary cue; in session 2, visual-gesture was the primary cue.

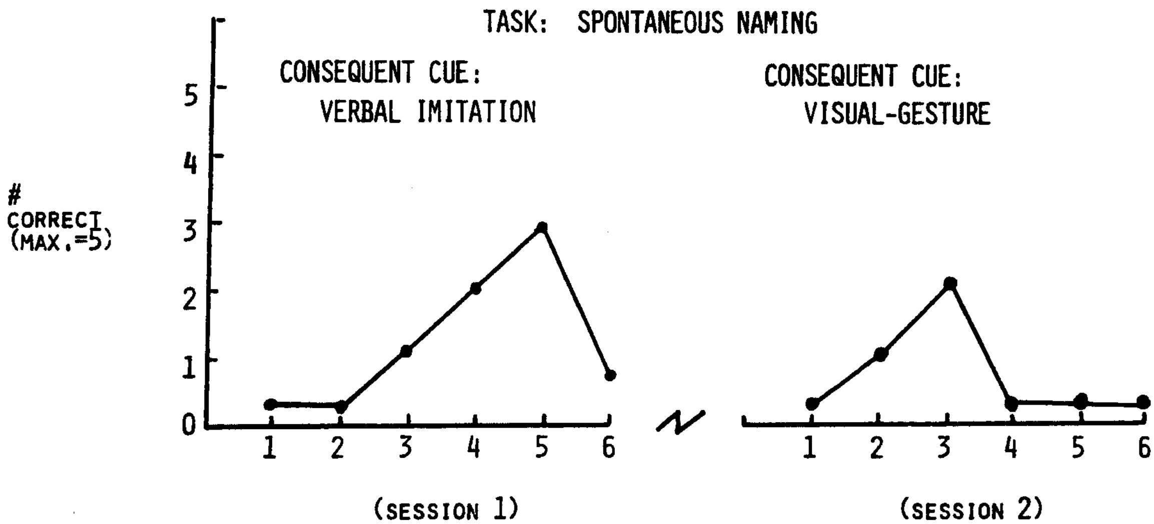

Figure 4. Response pattern across conditions and sessions: Day 13.

We would like to highlight the similarity in the two graphs. First, JY responded to repeated stimulation, with improved performance within each session. Second, there does not appear to be a clinically significant difference in the overall accuracy of spontaneous responses between sessions or treatment conditions. Third, in both treatments, the sawtooth pattern reflects response variability, while the final dip in both conditions may be evidence of noise buildup.

Figure 5 shows data from the first 6 trials from Days 13 and 14, respectively. The two conditions are verbal imitation and verbal imitation with an imposed 10-second inter-trial pause. On the right-hand graph, one can see that noise buildup was alleviated with the introduction of inter-trial pauses, with an increase in the stability of accurate spontaneous naming.[4]

[4] Attempts to train the patient to self-impose an inter-trial pause were unsuccessful.

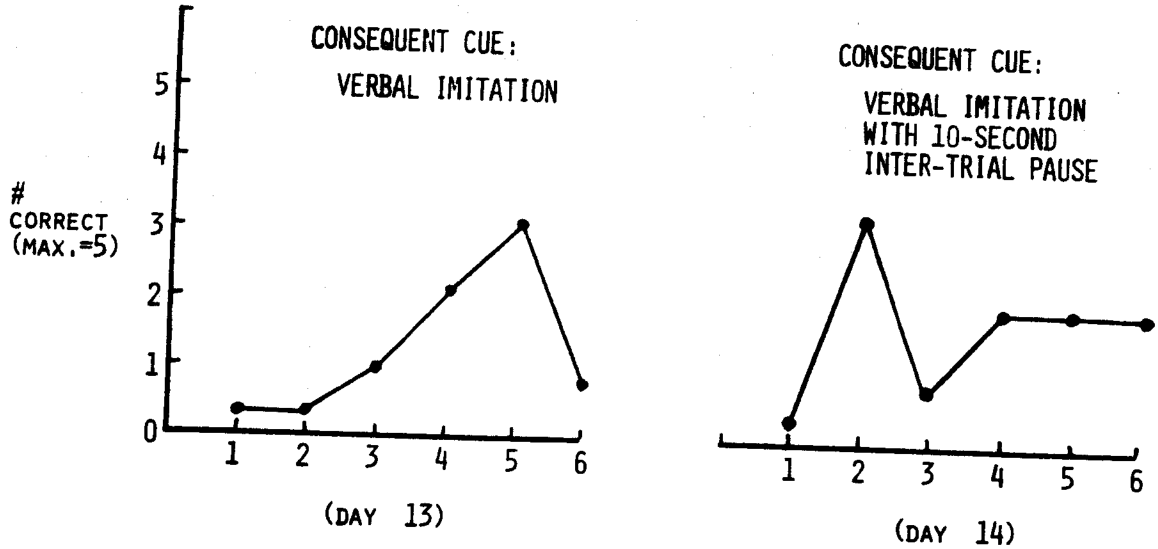

Figure 5. Response pattern across conditions and days.

These data, on Day 14, represent JY's best performance on any 6 consecutive trials in the program. This level of performance was below our expectations, especially when put in the context of the total opportunities for verbal responding in the 14-day program. The total number of trials or opportunities to respond verbally to novel pictorial stimuli was computed as follows: 5 symbols x 6 trials per session x 1 spontaneous naming attempt x 2 sessions per day x 14 days, yielding a total of 840 opportunities for spontaneous verbalization, and an additional 1680 elicited verbalizations for a grand total of 2520. Of this grand total, only 54 utterances were spontaneously correct.

Carryover. Carryover of the 5-word vocabulary to consistent and functionally appropriate usage at home was virtually nil. As an indicator of the ability to learn to use available vocabulary for functional communication, these data are not impressive. However, if one is interested in describing and measuring learning potential for the purpose of cost-effective treatment planning and for predicting treatment outcomes, these types of data are potentially very useful to the language clinician.

Generalization. Generalization across behaviors, the final performance variable in the learning potential evaluation model, could not be measured in this study. JY did not advance to the point where generalization to untrained stimuli could be tested. In novel-symbol-to-word association learning, generalization is not expected; if the novel stimuli were part of a rule-based generative system, such as a natural language or a miniature artificial language (Wetherby, 1978), then generalization would be an important learning potential evaluation variable, though the potency of generalization as a predictor remains to be studied. In future learning potential studies, generalization across behaviors, across treatments, and across settings should probably be carefully differentiated as measures of learning, and evaluated with careful consideration for the severity of aphasia and individual treatment goals. The severely involved person's ability to rote memorize and functionally use a limited set of utterances or gestures may be no less valid than the less severely involved person's ability to learn and apply strategies in order to communicate at or near premorbid levels. For both, the quality of life may be significantly altered through language treatment though their learning potential and achievement levels may differ markedly.

Summary

In summary, we have described the learning potential of a severe aphasic adult in a program using novel pictorial stimuli to elicit speech. Trials to criterion, stimulability, response pattern over time, response pattern across treatment conditions and generalization were described.

Which of these variables was predictive of JY's overall learning potential?

Stimulability was probably the least predictive variable. JY was stimulable but proved to be unable to learn and maintain performance on the task at hand. The remaining performance variables consistently reflect poor learning potential.

In 1968, Carson, Carson and Tikofsky suggested that aphasic persons might best be described in terms of learning characteristics. A learning model has, we feel, potent and direct implications for treatment planning. It allows the clinician to (1) describe an individual's learning characteristics, and (2) evaluate the efficacy of specific treatments. We suggest that routine and periodic evaluation of learning potential through measurement of specified performance variables might have predictive value for an aphasic individual's response to treatment and to eventual recovery. Description of "learning potential" of the aphasic person, particularly at the time of initial evaluation, may eventually strengthen our prognostic statements and enhance treatment planning.

Future research will help us (1) define the interaction of learning potential with severity and type of aphasia, (2) specify the types of stimuli and tasks which should be used in learning potential evaluation, and (3) discover which performance variables are the best predictors of language recovery.

Appendix A

Learning Potential Evaluation

ASSUMPTIONS:

The processes involved in learning can be isolated, manipulated and explained by changing the nature of the learning task. (Wetherby, 1978)

Individuals are meaningfully different...these differences can be used in selecting treatments...

Individuals learn from the treatment to the extent that their aptitudes enable them to interact with the materials. (Dwyer, 1978)

QUESTIONS:

Can this person learn?

What are the optimal conditions of learning?

GOAL:

To achieve controlled behavior change through analysis of individual aptitudes, treatment methods, and aptitude-treatment interactions.

METHOD:

Describe:

Learner characteristics (aptitudes, preferences, strategies)

Teaching Method variables

Clinician characteristics (aptitudes, preferences, strategies + knowledge and clinical expertise)

Measure:

Trials to criterion (rate of learning)

Stimulability (best response to cues)

Response pattern/stability (over time; across treatments)

Generalization (across settings; across behaviors)

APPLICATION:

State a prognosis

Determine amount and duration of treatment

Select specific treatment methods

Horner (1979)

Appendix B

JY: Learner Characteristics

Novel symbol learning introduced at 10 months post onset.

Role Preference:	Spectator; Respondent
Modality Preference:	Oral-verbal
Stimulus Preference:	AV_1 (Listen & watch clinician)
Cognitive Tempo:	Impulsive
Accuracy/Error Payoff:	Fair-good error awareness; poor self-correction ability; noise buildup following correct and incorrect responses
Behavior:	Easily frustrated
Motivation:	High
Premorbid intellect:	Above average learning ability and achievement

Nonverbal aptitude:	Raven's Coloured Progressive Matrices 14 / 36
Verbal aptitude:	Severely aphasic, all modalities, with resolving auditory comprehension

PICA Overall %-ile

Test 1	3 mpo	11th
Test 4	9 mpo	16th
Test 5	11 mpo	21st

Peabody Picture Vocabulary Test

Test 1	8 mpo	12
Test 2	10 mpo	56

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Discussion

Q: You suggested that the failure of your patient to acquire the appropriate response to the (?) symbol was because it was the only sumbol which was not novel. Do you think the pragmatic function, the meaning, the arbitrary and abstract nature of the (?) symbol as distinct from the other symbols might account for this difference?

A: Yes. I think abstractness, pragmatic function and other perceptual and linguistic variables for which we did not control—in addition to the novelty feature—could account for the difference in learning of the (?).

Q: Is the task and method you used applicable to other types of aphasia and other severity levels?

A: Yes. Describing the approach of presenting a new task—giving the patient the opportunity to show how dynamic his system is—was the main purpose of this paper. This case-study is illustrative of an approach which can, we think, be used with a wide variety of types of patients and at different levels of severity.

Q: Do you think the low learning scores achieved by your patient may have been confounded by his severely involved verbal expressive abilities?

A: Yes. I think a better approach would be to use a completely nonverbal system, more consistent with those used by Premack, Carrier and others. The reason we chose verbalization as the output modality was that JY's modality preference for responding was definitely oral-verbal. He was not willing (or able) to simply point to the symbols.

Q: What are your conclusions about the learning potential of this patient?

A: The area of lesion was extensive in this patient and the learning potential turned out to be poor—definitely. However, Figure 2 shows the symbol-word association for "TV" was learned after 3 associations (response opportunities), which to me was very exciting in a patient of this severity level. We think that is evidence of plasticity in the system. I think our patient did show some learning potential, though this didn't carry over to the criterion measure as we had operationally defined it.

Q: Available literature has described that aphasic persons can learn. What does the learning potential model you described add to what we already know about learning ability in aphasic persons?

A: In the proposed learning potential model, the general question "can this person learn?" should be further specified as follows: "how does he learn (learner characteristics); how well (rate, stability, generalization) and what are the optimal conditions of learning (which treatment methods work best?)?" The learning potential model assumes that aptitudes differ for each individual patient and that the clinician's appreciation for aptitude treatment interactions is critical to treatment outcomes.

Acknowledgment

I would like to acknowledge the assistance of Mary Ann Berry, M.A., who helped treat JY during both the traditional and novel symbol programs.