Lexical Pitch as a Measure of Word Choice in Narratives of Traumatically Brain Injured and Control Subjects

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The language abilities of individuals following traumatic brain injury (TBI) have been the topic of discussion for several years. In a 1982 discussion of this then relatively new topic, Holland (1982) said, "If the language problems seen in closed head injured patients don't look like aphasia, sound like aphasia, act like aphasia, feel, smell or taste like aphasia, then they aren't aphasia." True to our professional heritage, we have expended considerable effort since then attempting to label the language disorder associated with traumatic brain injury. Candidates for this label include latent aphasia, subclinical aphasia, and, more recently, cognitive communication disorders or cognitive language disorders (Kennedy & DeRuyter, 1991). Such labeling has partly been spurred by the need to distinguish the language performance of aphasic and TBI individuals.

Holland (1982) listed a number of features that distinguish aphasic patients from those with cognitive language disorders. These include the age of the population, the injury's diffuse nature, and vastly differing pragmatic skill levels. She also listed a number of similarities, including the problem of anomia. This study addresses this problem, specifically, word retrieval in high level TBI individuals. The concept of lexical pitch was applied to the assessment of word retrieval in narrative tasks. Lexical pitch, defined by Hayes (1988), describes variations in lexical choice based on lexical access and audience effect. The term *pitch* does not refer to fundamental frequency but describes the level at which a presentation is *pitched* to an audience. "He talked down to her" or "His doctor can't help talking over his head" are examples of presentations that are not *pitched* at the appropriate level.

Lexical access and audience effect are two factors that may contribute to word choice patterns. Lexical pitch seems especially applicable to the TBI population because for them both of these factors may be impaired. One could argue that reductions in lexical pitch are due to audience effect and to poor pragmatic skills that reduce the ability to select and maintain the appropriate lexical registers. We frequently see highly educated TBI patients who shift lexical registers dramatically even within a task. For example, we recently evaluated the narratives of a PhD candidate in mathematics who had experienced a severe brain injury. His description of the Cookie Theft Picture began on a high level. He talked of how adventurous the boy was and how he had put himself in a precarious position. By the end the sample, however, he had shifted to a different lexical register and said, "The kid over here must be kinda a brat or some kind of a jerk." On the other hand, one could also argue that changes in lexical pitch may reflect a lexical access problem. Lexical access may be reduced by general reduction in speed and efficiency of cognitive function. High level TBI patients report that they use a particular word not because it was the specific word they were seeking but because it was the only word that they could come up with.

This study attempted to answer the following questions: Does lexical pitch vary as a function of socio-economic status in control and/or TBI subjects, and are word choice patterns of individuals following TBI different from those of controls?

METHOD

Subjects

Control subjects included 45 non-neurologically impaired, native speakers of American English. These subjects were categorized according to the Hollingshead Four Factor Index of Social Status (Miller, 1983). The index takes into account education, occupation, gender, and marital status. See Table 1. Individuals in Group I (N = 12) mostly had graduate education and represented professions such as physicians or business executives. Individuals in Group II (N = 21) were college educated and worked in middle management positions, while individuals in Group III (N = 12) had a high school education with some technical training. Other demographic information regarding control subjects is summarized in Table 1.

Table 1 also contains information regarding TBI subjects. These subjects included 43 native speakers of American English. All were functioning at a high cognitive level at the time of testing, either level VII or VIII of the Ranchos Los Amigos Levels of Cognitive Functioning Scale (Hagen, 1984). Mean ages of TBI subjects were 34 and 38.9 years for individuals in Social Status Levels I-II and III, respectively, while the control subjects' mean

TABLE 1. DEMOGRAPHIC INFORMATION FOR CONTROL AND TBI SUBJECTS

		Hollingshead Social Status Scale	
		LEVELS I-II	LEVEL III
Control Subjects (N=45)			
Age (years)	Mean	28	27
	SD	6	6.7
	Range	21–42	19–40
Education (years)	Mean	16.2	14.4
	SD	1.7	2
	Range	13–19	12–16
Gender (F/M)		17/16	6/6
TBI Subjects (N=43)			
Age (years)	Mean	34	38.9
	SD	10	8.5
	Range	19–56	20–57
Education (years)	Mean	16.2	12.6
	SD	3.1	1.2
	Range	12–27	10–14
Months post Onset	Mean	11.8	30.2
	SD	16.1	38.7
	Range	.5–75	.7–131
Severity of Initial Injury	Mild/Moderate	63%	56%
	Severe/Very Severe	37%	44%
Gender (F/M)		18/9	5/11

ages were 28 and 27 years for these two social status levels. Mean years of education for TBI subjects were 16.2 and 12.6 years for individuals in Social Status Levels I-II and III respectively, while years of education for the control subjects were 16.2 and 14.4 for these two social status levels. Sixty-three percent of Hollingshead Level I and II subjects were rated as having a mild or moderate initial injury, as were 56 percent of level III patients. These ratings are based on factors such as level of coma, initial Glasgow Coma Scale scores, length of post-traumatic amnesia, and positive or negative CT, MRI or EEG findings (Uomoto, 1991).

Narrative Tasks

Subjects were audio-recorded as they performed two narrative discourse tasks: (1) Picture description, in which subjects described what was happening in the Cookie Theft Picture from the Boston Diagnostic Aphasia

Examination (Goodglass & Kaplan, 1983), and (2) story retelling, in which subjects listened to a recording of a relatively unfamiliar Aesop's Fable, "Mice and Weasels" (Reeves, 1985). (The recording of this 219-word story is 80 seconds long.) Then the subjects re-told the story, making recordings that were timed, orthographically transcribed, and saved in a computer file appropriate for analysis of word choice.

Measurement of Lexical Pitch

All samples were placed into one large word-processing file. A word frequency analyzer program was used to generate a list of all the different words produced by either control or TBI subjects during both the picture description and story re-telling task. This list of words was reviewed by a five-member jury composed of three speech-language pathologists and two student technicians. Each word was rated as exhibiting low, neutral, or high lexical pitch for the narrative tasks.

For example, the words "kid," "boy," and "lad" all appeared in the list of different words generated as part of the Cookie Theft Picture description task. "Kid" was rated as low lexical pitch, "boy" as neutral and "lad" as high lexical pitch. Judges first rated the words independently, then disagreements were resolved by discussion. Low-pitched and high-pitched word lists were then compared with the words in each subject's sample, using custom software. Thus, the number of low-pitched and high-pitched words in each sample could be counted. A composite lexical pitch score for each subject was calculated by subtracting the number of low-pitched words used in a particular sample from the number of high-pitched words.

RESULTS

Univariate *F* tests were performed on three measures: number of low-pitched words (Low), number of high-pitched words (High), and the cumulative score (Cumulative). Because no significant difference in lexical pitch measures was found between Hollingshead Levels I and II, data were collapsed across these groups. Table 2 summarizes *F* and *p* values for this analysis. Figure 1 contains a schematic illustration of the statistically significant comparisons.

The first research question asked whether lexical pitch varied as a function of socio-economic status. These data suggest that more highly educated individuals tend to use more high-pitched words and fewer lower-pitched

TABLE 2. RESULTS OF ANALYSIS OF VARIANCE

Comparison	Lexical Pitch Measure Low	High	Cumulative
C I-II vs. C III	$F = 8.03$ $p = .007$	$F = 6.09$ $p = .018$	$F = 15.34$ $p = 000$
C I-II vs. TBI I-II	$F = 4.53$ $p = .037$	$F = 4.57$ $p = .037$	$F = 8.10$ $p = .006$
C I-II vs. TBI III	$F = 10.22$ $p = .002$	$F = 11.44$ $p = .001$	$F = 21.4$ $p = 000$
C III vs. TBI III	ns	ns	ns
C III vs. TBI I-II	ns	ns	ns
TBI I-II vs. TBI III	ns	$F = 5.20$ $p = .028$	$F = 4.16$ $p = .048$

Key: C = Control Group
TBI = Traumatically Brain Injured Group
I-II = Hollingshead Social Status Scale Levels I and II, (ns difference in lexical pitch between levels).
III = Hollingshead Social Status Scale Level III
ns = Non-significant

words than those individuals with less education. This trend is strong for the control subjects and significant for the TBI group.

Next, we asked whether lexical pitch varied with the occurrence of TBI. The data suggest that lexical pitch is affected by TBI for the more highly educated group, but not for the less educated group. Further, the data support the idea that using an inappropriate control group may lead to errors of over-interpretation. Note that differences exist between highly educated control subjects (Social Status Scales I & II) and both groups of TBI subjects. However, if less educated TBI subjects are compared with controls of similar educational backgrounds, no difference between groups is apparent.

Discussion

Caution is warranted in interpreting the results of discourse analysis in the TBI population. To understand the complex communication deficits in this population, we must use tasks that are more demanding than those traditionally found on aphasia tests. However, more difficult tasks may lead to less perfect and more variable performance of non-impaired controls, causing a tendency to over-interpret our data and misinterpret any deviation from flawlessness as being a consequence of the brain injury.

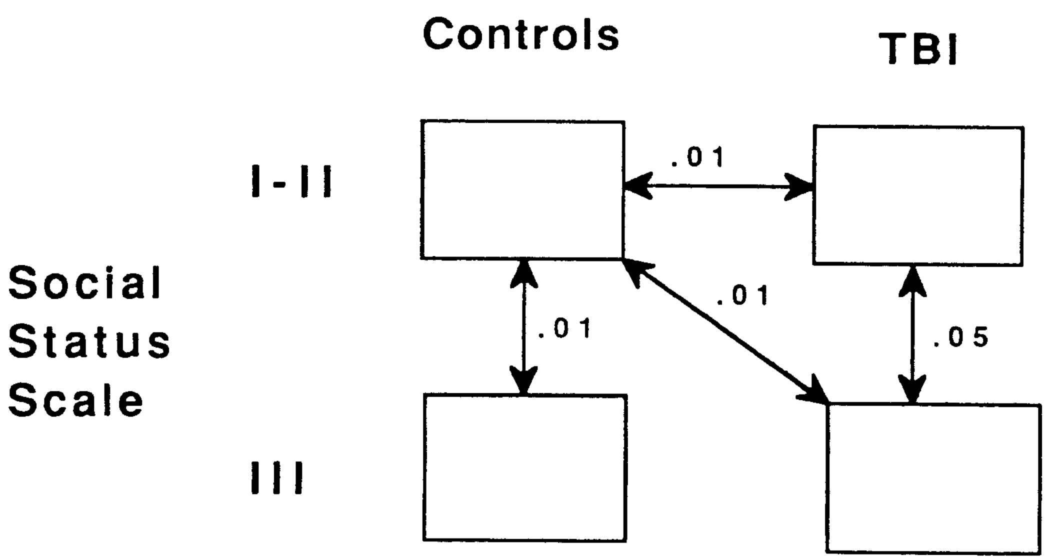

Figure 1. A schematic representation of the statistically significant comparisons for the cumulative measure of lexical pitch.

Another methodological concern is that control groups must be carefully selected (Dikmen & Temkin, 1987). TBI individuals are not a cross section of the total population. About two-thirds of brain-injured patients are male, and there is an over-representation of poor education and other pre-existing conditions. It is becoming increasingly difficult to defend the practice of using college students or college graduates as a standard population against which to compare the TBI population, many of whom have a lower level of education. Use of inappropriate controls may seriously overestimate the linguistic deficits associated with TBI.

With these cautions in mind, let us reconsider the model of lexical pitch. Hayes (1988) described at least two factors that may contribute to the level of lexical pitch: audience effect and lexical access. Our data suggest that lexical pitch may be affected by traumatic brain injury. The specific cause of this effect is not clear. However, Hayes' model may help us explain the results. The concept of lexical access is particularly pertinent in explaining the data presented here. It depends on at least two factors—the size of the lexicon and word retrieval abilities. Lexicon size (or the number of words available to a speaker) at least partially depends on education level. Our results confirm this relationship. For both control and TBI subjects, lexical pitch was higher for the more highly educated subjects. Our data suggest that lexical pitch is affected for the highly educated TBI subjects but not the less educated. This may be explained by lexicon size. Highly educated individuals have a large pool of words from which to draw. This larger word pool, combined with changes in word retrieval efficiency, may cause changes in word selection patterns or lexical pitch. Thus, the consequence of traumatic brain injury may be less apparent in subjects with less education and a smaller lexical pool from which to draw.

Any exploration of the underlying cause of lexical pitch changes in TBI would be speculative at this time. However, research is underway that may provide insight into whether a problem with lexical access exists in the TBI population. The pausal structure of these and other narrative tasks is being analyzed in detail. Among the factors being measured is the location of pauses: Do they occur at primary or secondary syntactic boundaries or are they lexically related? More lexical pauses in the TBI population than in normal controls would support the argument that lexical access contributes to the subtle word retrieval problems characteristic of the TBI population. For now we will continue to speculate that lexical pitch changes are related to both pragmatic and word retrieval problems and that they are most prominent in highly educated individuals.

Many researchers (Kennedy & DeRuyter, 1991; Liles, Coehlo, Duffy, & Zalagens, 1989; Mentis & Prutting, 1987; Milton, Prutting, & Binder, 1984) study narratives to examine the common ground between language and cognition in the TBI population. In addition to measures of organization such as cohesiveness, measures of grammatical complexity such as t-unit analysis, and measures of content such as propositional analysis, narrative samples may also be an appropriate vehicle for measurement of word selection. Studying narrative discourse yields understanding of the subtle but important changes in word selection abilities in the TBI population.

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REFERENCES

Dikmen, S., & Temkin, N. (1987). Determination of the effects of head injury and recovery in behavioral research. In Levin, Grafman, & Eisenberg (Eds.), *Neurobehavioral recovery from head injury* (pp. 73–87). Oxford: Oxford University Press.

Goodglass, H., and Kaplan, E. (1983). *The assessment of aphasia and related disorders* (2nd ed.). Philadelphia, PA: Lea & Febiger.

Hagen, C. (1984). Language disorders in head trauma. In A. Holland (Ed.), *Language disorders in adults: Recent advances.* Austin, TX: PRO-ED.

Hayes, D. P. (1988). Speaking and writing: Distinct patterns of word choice. *Journal of Memory and Language, 27,* 572–585.

Holland, A. L. (1982). When is aphasia aphasia? The problem of closed head injury. In R. H. Brookshire, (Ed.), *Clinical Aphasiology* (Vol. 12, pp. 345–349). Minneapolis, MN: BRK Publishers.

Kennedy, M. R. T., & DeRuyter, F. (1991). Cognitive and language bases for communication disorders. In D. R. Beukelman, & K. M. Yorkston (Eds.), *Communication disorders following traumatic brain injury: Management of cognitive, language, and motor impairment.* Austin, TX: PRO-ED.

Liles, B. Z., Coehlo, C. A., Duffy, R. J., & Zalagens, M. R. (1989). Effects of elicitation procedures on the narratives of normal and closed head-injured adults. *Journal of Speech and Hearing Disorders, 54,* 356–365.

Mentis, M., & Prutting, C. (1987). Cohesion in the discourse of normal and head injured adults. *Journal of Speech & Hearing Research, 30,* 88–97.

Miller, D. C. (1983). *Handbook of research design and social measurement.* New York: Longman.

Milton, S. B., Prutting, C. A., & Binder, G. M. (1984). Appraisal of communicative competence in head injured adults. In R. H. Brookshire (Ed.), *Clinical Aphasiology Conference Proceedings* (Vol. 14, pp. 114–123). Minneapolis, MN: BRK Publishers.

Reeves, J. (1985). Mice and Weasels. *Fables from Aesop* (pp. 30–32). New York: Peter Bedrick Books.

Uomoto, J. M. (1991). Evaluation of neuropsychological status after traumatic brain injury. In D. R. Beukelman, & K. M. Yorkston (Eds.), *Communication disorders following traumatic brain injury: Management of cognitive, language, and motor impairment.* Austin, TX: PRO-ED.