PRELIMINARY DATA ON EFFECTS OF BEHAVIORAL AND LEVODOPA THERAPIES ON SPEECH-ACCOMPANYING GESTURE IN PARKINSON'S DISEASE

Susan Duncan
Psychology Department, University of Chicago and Laboratory for Cognitive Neuropsychology, National Yang Ming University, Taiwan
deng@uchicago.edu

ABSTRACT

Speakers spontaneously produce meaningful manual, bodily, and facial movements when engaged in interactive communication. This is universally true. Gestures serve as aids to communication and also as embodied representations of meanings, with a role in structuring connected discourse, linked with working memory. Given their communicative and cognitive significance in normal language use, it is important to study the alterations these behaviors undergo in language pathological conditions such as aphasia, right hemisphere communication disorders, and Parkinson’s disease (PD); also, to assess the effects of therapies for these disorders on gesture. Here we sketch the connections between (i) the role of gesture in language, (ii) research on the disabling effects of Parkinson’s disease on spoken communication, emphasizing voice, dysprosody, and flattened affect, (iii) the link between speech prosody and speech-accompanying gesture, and (iv) the spread of effects of Lee Silverman Voice Treatment® (LSVT) therapy beyond amelioration of voice deficits, possibly extending to speech-accompanying gestures. Preliminary analyses of narrative discourse data from four PD patients are summarized. Two of these patients were videotaped for comparison on and off Levodopa medications; two were videotaped pre- and post-LSVT.

1. INTRODUCTION AND OVERVIEW OF GESTURE RESEARCH

People gesticulate when they speak [1,2,3,4,5]. It is universally true that speakers spontaneously produce meaningful manual, bodily, and facial movements when they communicate interactively [6,7]. Results of close analyses of co-produced speech and gesture in audio-videotaped natural spoken language lead to the conclusion that these behaviors are “two aspects of the process of utterance” [2]. Speakers gesture iconically and metaphorically in accord with the semantic content of their speech, they gesture rhythmically in accord with the prosodic structure of their languages, and they use gesture space cohesively to ‘map’ the relations among the referents that figure in their discourse. Much gestuclaral behavior appears to be uniwting. Gestures are an integral part of language production and analysis of them opens a window onto the cognitive-semantic processes that language production involves.

Gestures are heterogenous in nature and serve several, non-mutually-exclusive functions. Since many gestures embody meanings—by virtue of their form, execution, and position in ‘gesture space’ in front of the speaker—they are aids to communication. Some features of gestures are transient and exist for the interval of a phrase or clause. Other features persevere or occur repeatedly, serving to highlight more comprehensive discourse structures and maintain discourse reference. As embodied meanings, they appear to function as supports to working memory in temporally, sequentially unfolding spoken communication [8]. In this overview, we discuss four ways that gesture may serve these functions.

(i) Gestures and synchronized elements of speech jointly highlight and thus emphasize emerging idea units in an evolving discourse, as each contributes similar semantic content to ongoing language production.

(ii) Peak prosodic emphasis in speech typically synchronizes with the meaningful phases of gesture production as well, moment-by-moment, thus further signaling the new focal elements of discourse.

(iii) Gestures can elaborate on and further specify meanings expressed in speech.

(iv) Gesture forms and locations in gesture space, over the course of an unfolding discourse, come to be associated with meanings. These endure, thereby serving as vehicles for the maintenance of discourse reference.

Each of the above can be understood as functional both from the perspective of the speaker and from that of the listener in face-to-face interaction. We claim that gestures support the speaker’s on-line, psycholinguistic processing in addition to supporting the listener’s comprehension of what the speaker is trying to communicate.

To see how gesture and speech serve jointly to highlight discourse semantic content, consider the following speech-plus-gesture production, taken from a videotaped narrative re-telling of a cartoon story:

(1) The cat [starts climbing up the drainpipe]

iconic gesture: both hands with fingers spread & palms down, flap alternatingly up & down on wrist pivots, while moving up.

he [gets up there]

iconic gesture: right hand index finger traces a path upward from chest-level to above head-level. ¹

In form and execution, these two gestures iconically represent portions of the content of the spoken utterance. The first one synchronizes with the verb-particle construction "climbing up" and is pantomimic of a cat’s paws’ upward climbing motion. The second gesture, synchronized with the word "up" in speech, is a simple trace of an upward path of motion. These are typical examples of the way speech and gesture often jointly highlight semantic content. It is easy to see how gesture of this sort may lend emphasis and clarity to communicative acts; make them more vivid and therefore more likely to capture and focus a listener’s attention, thus increasing the efficacy of communication [1].

This kind of meaningful gesture is observed to pattern with speech prosodic contouring. Many researchers have reported systematic temporal alignments between facial and bodily gestures and intervals of peak prosodic emphasis in

¹ Square brackets indicate onsets and offsets of a gesture ‘phrase’ in relation to co-occurring speech. This is the total gestural movement between the moments when the hand or hands move from rest position and then return to rest position. Bold font indicates the location of the gesture ‘stroke phase,’ or, the meaningful portion of the gesture phrase. Enlarged font indicates the interval of peak speech prosodic emphasis. The forward slash indicates an unfilled speech pause.
speech, of the sort illustrated in the example above [2,9,10,11]. The most dynamic phase of bodily gesture (the ‘stroke’ phase) tends strongly to synchronize with element(s) in the co-occurring speech stream that are prosodically emphasized. This is just one way in which bodily gesture appears to be linked with speech prosody. Gestures and speech prosody share semiotic characteristics as well; for example, much of speech prosody, like gesturing, patterns gradiently rather than categorically [9]. Further, speech prosodic contouring possesses iconic representational capabilities [12]. For example, consider a phrase such as, “it took sooo looong,” in which the forms of the categorially-contrastive vowel phonemes are perturbed, lengthened, in the process of generating an utterance that bears an iconic relationship to the concept (length of time) expressed.

In fact, Bolinger [9] considered speech prosody to be a kind of gesture, in the sense of vocal gesture, and recorded many observations of its uses in conveying affect and iconic depiction. An apt characterization of this is to say that gesture is bi-modal; that is, the manual-visual and vocal-auditory modalities share production (timings) and semiotic (gradience, iconicity) characteristics. These facts are suggestive of a functionally unified system that underlies ‘gestural’ patterning in both modalities, verbal (prosody) and nonverbal (gesture).

2. GESTURE IN PD

The research literature on the disabling effects of PD on communicative behavior emphasizes the issues of reduced voice volume and vocal quality [13,14], dysprosody [15,16,17,18,19], and flattened affect [20]. Anecdotal observation suggests this overall behavioral flattening extends to include reduced spontaneous gesturing during interactive communication. The latter, however, has not been systematically investigated prior to the current study. For the purposes of this study of gesture in PD, the facts linking speech prosody to gesture in the spoken communication of normals, outlined above, suggest we may sensibly tie explorations of gestural abilities of people with PD and any effects of therapy on these, to what is known concerning voice, dysprosody, and flattened affect in this population and the ameliorative effects of LSVT therapy on these [13,14,20]. Specifically, though LSVT therapy targets the voice variable of loudness, the effects of the therapy have been shown to spread to other aspects of language production. We can therefore predict improvements in speech-accompanying gesture as well.

Other findings from the PD research literature point to deficits in working memory [21,22,23], stuttering [24], and then once again on their levodopa medications. Another two male PD patients also participated twice, once just prior to and once just after a course of LSVT therapy. The latter two participants were on their medications at the time of both elicitations. They were participants in the LSVT trial, in part because they were in stable condition with their current drug therapy.

3. EXPLORATORY STUDY OF PILOT DATA ON GESTURE IN PD

Our purpose in performing the preliminary analyses of pilot data reported here was to garner an impression of how gesture is affected in PD, so as to determine what variables to focus on in larger samples to be collected subsequently.

3.1 Subjects.

Two male PD patients each participated in a natural language elicitation twice, once off and then once again on their levodopa medications. Another two male PD patients also participated twice, once just prior to and once just after a course of LSVT therapy. The latter two participants were on their medications at the time of both elicitations. They were participants in the LSVT trial, in part because they were in stable condition with their current drug therapy.

3.2 Method.

Unrehearsed, connected narrative discourse data was collected from each participant using a cartoon eliciting stimulus. Each participant watched the 6.5-minute animated cartoon about a cat and a bird twice on a video monitor and then was seated with a naïve listener in a room with lights and video camcorders. We instructed the speaker to tell the story of the cartoon to his listener in sufficient detail so that the listener, who had not seen it, would be able to re-tell the story afterward. The listener was instructed to be an active, engaged listener and to feel free to ask questions, laugh, and make comments. The goal of these instructions was to create as natural a discourse context as possible. The participants were told that their narratives were being videotaped because we planned to analyze all aspects of face-to-face communication, but they were not aware of any special interest in gestures.
The pair who were evaluated off and on medication arrived at their taping session in the morning, having not taken their medications since early the evening before. They did their first cartoon narration before taking their medications, then took their dose and did their second narration about an hour after that.

3.3 Analysis
The eight resulting videotaped narrations varied in length from about 4.5 to 7 minutes. The four narrations for the two participants who were evaluated on/off medication were transcribed entirely, while a representative subset only was transcribed for the participants who were evaluated pre-/post-LSVT therapy. The subsets in the latter cases comprised three of the cartoon episodes, which constituted approximately one-half of each narration.

Gesture-annotated speech transcripts were created for each narration, according to published guidelines [5,26]. In brief: speech is transcribed in detail, including all unfilled and filled pauses, breath pauses, self-interruptions, self-corrections, repetitions, restarts, dysfluencies, and mispronunciations. Listener contributions are transcribed as well. Detailed annotations are then made to the speech transcripts, indicating the synchrony of gesture phrases with segments of the speech stream. Use of professional grade Sony Hi-8 VCRs (model EVO-9850) makes possible slow-motion and frame-by-frame playback of video with audio, thus permitting assessments of speech-gesture synchrony to a within-syllable degree of precision.

The total numbers of words and of gestures produced in each narration were tallied. The form and execution of each gesture is described in exacting detail, as is its meaning in relation to the co-occurring speech, together with any referential value it shares with other gestures (as determined by shared features or location in space) or intervals of speech in the preceding discourse. This last category of recorded observation allows us to determine whether participants are able to use gesture forms and locations perseveratively to build larger discourse structures and discourse cohesion; also, to catch instances in which PD gestures synchronizes with speech differently from what we know to be typical of normals.

3.4 Results
3.4.1 Quantitative results
Word totals were divided by gesture totals for each narration, to learn whether one effect of behavioral or drug therapy is to increase the overall incidence of speech-accompanying gesture.

Table 1 shows that LSVT behavioral therapy had the effect of increasing the overall proportion of gestures in relation to speech in one of the two participants; whereas in both participants in the medication group an effect of being on medication was an increase in gestural activity. In the case of participant B4, the effect appears to have been quite large. Off medications he produced one gesture for every 22.55 words while on he produced one every 10.41 words.

3.4.2 Qualitative results
Following up on the figures on words/gestures ratios reported in Table 1, we note a peculiarity about the gesturing of participant B5. This is the participant who showed the lesser increase in gesture production when on medication. Very noticeable in this participant, was a tendency in his first narration (off medication) to produce gestures well in advance of the intervals of speech with which they seemed to share referential content. Typically, these 'pre-posed' gestures synchronized with an interval of a pause in speech, sometimes multiple clauses in advance of co-expressive speech. This pattern of gesture-speech asynchrony is markedly different from anything seen in normals, who typically show very tight synchrony of meaning in the two modalities, as illustrated in (1), above. B5’s pre-posed gestures seemed to associate with intervals in his narration when he was having difficulty organizing the next large unit of discourse. It was sometimes as though gesture looked ahead to the ‘punchline’ of one of the cartoon sequences. The other participant in the medication group exhibited such pre-posed gesturing in only one of his many speech-gesture combinations, while the two participants in the LSVT treatment group seemed never to.

There appeared to be a tendency across all the participants who showed an increase in gesture from pre- to post-, most noticeable in B4, toward more perseverative use of gesture space, as a reflection of maintenance of reference to discourse entities. Increases in gesture seem associated with increases in speech dysfluency. Rather than lending an impression of disordered speech however, the dysfluencies associated with increased gesturing in these cases actually made the communicative behavior seem more ‘normal’; less cautious and flattened.

There seems to be a tendency toward greater differentiation and greater complexity of gesture forms post-LSVT and on-medication. An example of this would be the difference between a gesture in which the handshape was just a hand held loosely, with no particular shape suggested by the positioning of the fingers or configuration of the palm, versus a handshape where the fingers are spread, curved, and tensed; for example, specifically suggesting the shape of a round object to which speech and gesture jointly refer.

Finally, an anecdotal result in the form of the same unsolicited observation from each of three participants in the on-off medication comparison (only the two reported here have so far been analyzed). After the second (on medication)
taping, each of the three was asked to compare their own communicative performances. None had anything specifically to say about their speech output and all claimed no awareness of having gestured. (This is typical of normals also.) But all three commented that, when narrating while on medication, they were able to think more clearly and thereby remember more detail.

4. CONCLUSION

It seems reasonable to conclude that effects of any therapy, pharmacological or behavioral, that ameliorates the core deficits of PD, dysprosody and flattened affect may spread such that speech-accompanying gesture will be enhanced and become more like that of normals. In regard to the final anecdotal qualitative result just mentioned, it is suggestive of the hypothesized role of gesture as a support for cognitive processes during speaking, that the medication group participants, instead of recalling the fact of increased communicative gesturing, each retained simply the impression of generally clearer thought processes. In general, given the communicative and cognitive significance of gestures in normal language use, it is important to study the alterations these behaviors undergo in language pathological conditions such as those resulting from PD; also, to assess the effects of therapies on these behaviors.

5. ACKNOWLEDGMENTS

The data on which this discussion is based were collected with Lorraine Ramig of the University of Colorado at Boulder, Jennifer Spielman and Angela Halpern of the Wilbur James Gould Voice Center, Denver Center for the Performing Arts, and Dr. Melanie Brandabur of the University of Illinois at Chicago Hospitals.

6. REFERENCES