The effects of elimination of hand gestures and of verbal codability on speech performance*

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Abstract

Subjects were required to describe line drawings of two-dimensional shapes at two levels of verbal codability, with and without using hand gestures. Elimination of gesture affected speech performance by changing the semantic content of utterances and the proportion of speaking time spent pausing; numbers of words, numbers of pauses, mean pause length and semantic content were found to be related to the verbal codability of the stimulus material; and the number of hesitations was related to both gesture and level of codability.

Introduction

Graham and Argyle (1975) showed that eliminating hand gestures had a detrimental effect on the communication of two-dimensional shapes to subjects having to reproduce them. The implications of this study are that gestures are carrying information about the shapes and that subjects can decode such information. An early experiment by Dobroga'ev (reported by Schlauch, 1936), however, suggests that eliminating hand gestures has marked effects on speech performance itself, indicated by decreases in fluency, articulation skill and vocabulary size.

From the work of Kendon (1970a, 1970b), showing the close relations between physical movements of the body and the structure of speech (not only for speakers but also for listeners) we might predict that elimination of at least one degree of freedom in body movement during speech (hand movements) would lead to disruptions of the speech process itself. Moscovici (1967) reported differences in the proportions of

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different classes of words (functors, nouns and verbs) under circumstances in which speakers and listeners cannot see each other. However, he continues: 'The elimination of purely gesticulative or mimic elements from a communication channel is not enough to cause modification of syntactic organisation.'

The early work of Brown and Lenneberg (1954) and Lantz and Stefflre (1964) had indicated that the number of words used to encode an object was an index of its codability and that in general the variance in length of name of a referent is a function of the class of referents from which it must be distinguished. Some suggestions as to the effects of codability on speech performance itself have been more closely tapped in experiments by Reynolds and Paivio (1968) who reported that the number of long pauses increased when speakers attempted to define 'abstract' as opposed to 'concrete' words and by Goldman-Eisler (1968) who showed that the cognitive complexity of a task (e.g., interpreting, as opposed to describing, a cartoon drawing) increased the length of time spent pausing.

The present experiment was conducted to see whether elimination of gestures, and level of verbal codability, affected speech performance, measured both in terms of semantic content and in terms of temporal patterning.

Method

Six male students from Oxford University were each individually required to describe two sets of twelve line drawings to an audience whose task was to draw them. The stimulus material used was that used by Graham and Argyle (1975). Briefly, it was a set of 24 abstract line drawings in Indian ink on white cards; half the drawings were of high verbal codability and half were of low verbal codability. The set of 24 was subdivided into two subsets (A and B) of twelve drawings, each containing six drawings of both low and high codability. The development of this material is described in detail by Graham and Argyle. Verbal codability was defined in terms of independent ratings of ease of description of the drawings; mean scores for performance on a production task (drawing the pictures while an encoder described them) indicated that the pictures did, in fact, differentiate between low and high verbal codability ($t = 7.67, p < 0.001$).

The experiment was in two parts; for half the subjects the first part was to describe set A to an audience without using hand gestures. Gestures were eliminated by instructing the subjects to keep their arms folded throughout the experiment. The second part required the subject to describe set B to the same audience with hand gestures permitted. For the other half of the subjects the task was reversed, i.e., set A was described first using gesture, followed by set B without gesture. Subjects were allowed 30 seconds to describe each picture, and the order of presentation of the pictures was

randomized. All the verbal descriptions were tape-recorded, and these tape-recordings were subsequently analyzed, to examine the effects of gesture and codability on speech performance.

Thirteen measures of speech performance were used for five speakers. Data for one encoder was not analyzable. The measures were:

1. Total number of words;
2. total length of time spent speaking (in seconds);
3. mean rate of utterance (1 divided by 2);
4. absolute numbers of hesitations (e.g. 'um', 'er', and incomplete words);
5. the number of hesitations expressed as a proportion of the total number of words uttered;
6. the number of noun and verb phrases directly describing elements of the drawings (excluding those included in number 7, below), expressed as a proportion of the total number of words uttered;
7. the number of words or phrases denoting spatial relations within the picture (e.g., spatial prepositions, 'to the left of', 'on the right-hand side'), expressed as a proportion of the total number of words uttered.
8. the number of demonstratives (e.g., 'there', 'like this', 'like so'), expressed as a proportion of the total number of words uttered;
9. the total time spent pausing (in seconds);
10. the proportion of the total speaking time spent pausing, excluding pauses immediately following demonstratives;
11. the total number of pauses;
12. the total number of pauses, excluding pauses immediately following demonstratives;
13. mean length of pauses for each picture, excluding pauses following demonstratives (in milliseconds).

Number and length of pauses were measured with a specially constructed electronic pause analyzer coupled with a 10-millisecond cumulative digital time-counter (Advance Instruments, SC3).

The independent variables being manipulated in this experiment, therefore, are mode of communication (gestures or no gestures) and level of codability of the pictorial stimulus material. The dependent variables are the thirteen measures of speech performance described above.

Results

Three-way analyses of variance, with repeated measures across two factors, were

carried out on thirteen measures of speech content and performance. These are summarized in Table 1 with the relevant F ratios and significance levels. Table 2 lists for each condition the mean values per picture on each of the thirteen dependent measures.

Table 1. *F ratios and significance levels for measures of speech performance in two conditions*

Measure	Gesture/no gesture	Low/high codability	Interaction
1. Total number of words	2.72	21.35**	0.20
2. Total speaking time	0.85	0.088	1.67
3. Mean rate of utterance	1.00	1.00	1.00
4. Absolute number of hesitations	4.28	0.77	13.73*
5. Proportion of total words that are hesitations	4.42	0.001	3.31
6. Number of descriptive noun and verb phrases	1.24	13.12*	0.03
7. Number of words and phrases denoting spatial relations	9.66*	14.75*	0.08
8. Number of demonstratives	36.07**	17.51*	0.001
9. Total time spent pausing	4.53	6.03	1.12
10. Proportion of total speaking time spent pausing, excluding demonstrative pauses	22.82**	4.71	0.02
11. Total number of pauses	0.08	11.93*	0.04
12. Total number of pauses excluding demonstrative pauses	0.01	11.32*	0.02
13. Mean pause length per picture excluding demonstrative pauses	0.149	8.00**	0.006

* $p < 0.05$
** $p < 0.01$

Seven of the thirteen measures distinguished between material of low and high codability. Low-codability material elicited more words, including a higher proportion of demonstratives and utterances denoting spatial relations within the picture being described; however, there were fewer descriptive noun and verb phrases. Low-codability material also led to an increased number of pauses, both absolutely and when those pauses following demonstratives (i.e., those accompanying gestures) were excluded. Furthermore, mean pause length per picture, excluding demonstrative pauses, was shorter. More gestures were used, as indicated by an increase in the use of demonstratives. A seventh measure, the total time spent pausing showed a strong tendency to differentiate between low- and high-codability material; more time was spent pausing with low-codability material.

Table 2. *Mean values per picture of measures of speech performance in the four conditions*

Measure	Gesture	No gesture	Low codability	High codability
1. Total number of words	63.46	58.33	70.47	51.33
2. Total speaking time (in seconds)	25.91	24.38	27.89	22.40
3. Mean rate of utterance (in words per second)	2.41	2.54	2.52	2.42
4. Absolute number of hesitations	1.70	3.68	2.47	2.97
5. Proportion of total words that are hesitations	0.027	0.046	0.034	0.039
6. Proportion of total words that are descriptive noun and verb phrases	0.315	0.330	0.305	0.340
7. Proportion of words that are denoting spatial relations	0.097	0.111	0.122	0.086
8. Proportion of words that are demonstratives	0.07	0.014	0.025	0.017
9. Total time spent pausing (in seconds)	16.10	14.45	16.77	13.78
10. Proportion of total speaking time spent pausing, excluding demonstrative pauses	0.56	0.595	0.57	0.585
11. Total number of pauses	62.0	61.235	70.4	52.83
12. Total number of pauses excluding demonstrative pauses	61.33	61.235	70.18	52.38
13. Mean pause length per picture excluding demonstrative pauses (in milliseconds)	0.248	0.245	0.231	0.263

Only three of the measures differentiated between the gestural and no-gestural conditions, and two of these involved changes in the content of speech. The elimination of gestures led to a significant increase in the use of phrases or words describing spatial relations within the picture but to decreased use of demonstratives. In addition, the proportion of total speech time spent pausing, excluding time spent pausing after demonstratives, was significantly increased in the no-gestural condition. There was no difference between the gestural and no-gestural conditions on any of the other measures of fluency.

Five of the thirteen measures failed to distinguish between either gestural or no-gestural, or between low- and high-codability conditions; but of these five, one, the absolute number of hesitations, showed a significant interaction between availability of gesture and codability. Eliminating gesture led to an increase in number of hesitations for low-codability material whereas, when gestures were allowed, low-

codability material produced fewer hesitations than did the high-codability material.

Discussion

We have shown that the level of codability (determined by the ease of verbal description) of pictorial material not only affects the information that can be transmitted about it (Graham and Argyle, 1975) but also has marked effects on the speech performance of the subjects trying to describe it. This finding is in accord with earlier results on cognitive complexity (Goldman-Eisler, 1968) and abstractness (Reynolds and Paivio, 1968) where length of pauses was found to increase with more difficult speech tasks. However, in this experiment two-dimensional drawings that are independently rated as difficult to encode lead to an increase in the number of pauses made but a decrease in their mean length. They are also described in more words overall (thus confirming the earlier finding of Brown and Lenneberg, 1954), including a higher number of phrases concerned with spatial relations and a higher number of demonstratives, suggesting an increased dependence on gesture. In those cases where the use of gesture is not available, low-codability material leads to an increase in the number of hesitations as well.

Eliminating gesture by itself shifts the content of speech in a similar fashion by increasing the use of expressions denoting spatial relations and by reducing the use of demonstratives, thus disconfirming the claim of Moscovici (1967) quoted in the introduction. In addition, it leads to an increase in the proportion of speech time spent pausing. As Graham and Argyle (1975) have shown, elimination of gesture also reduces the communication efficiency of subjects describing two-dimensional drawings.

These results do not suggest that in the context of this experiment elimination of gesture has particularly marked effects on speech performance. This result is in contradiction to that found by Dobroga'ev (reported by Schlauch, 1936) who claimed to have found decreased fluency, impaired articulation and reduced vocabulary size as a consequence of elimination of gesture. (However, the increase in the proportion of time spent pausing does suggest that subjects find speaking without gestures a more difficult performance task.) The results of Graham and Argyle indicate that elimination of gesture is detrimental to communication skill in circumstances in which gesture is conveying not affective information but semantic information. That conclusion is supported by the results of this study, in which elimination of gesture is accompanied by an increased reliance on verbal means of conveying spatial relations. Gestures are, of course, well fitted to convey such spatial information.

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Résumé

On a demandé aux sujets de décrire des dessins linéaires de formes à deux dimensions, et ce à deux niveaux de codabilité verbale, avec et sans la permission d'utiliser des gestes de mains. L'élimination des gestes affecta la performance verbale en changeant le contenu sémantique des paroles et la proportion de temps passé en pauses entre les phrases. On trouva une relation entre le nombre de mots, le nombre de pauses, la durée moyenne de pause et le contenu sémantique d'une part et la codabilité verbale du matériel servant de stimulus d'autre part; et le nombre d'hésitations, fut-il aussi observé, était relié tant aux gestes qu'au niveau de codabilité.

Zusammenfassung

Die Vpn wurden gebeten, zweidimensionale, gezeichnete Formen zu beschreiben, die bezüglich des Grades der verbalen Kodifizierbarkeit in zwei Gruppen fallen. Die Beschreibung sollte einmal mit und einmal ohne Einsatz von Handgesten erfolgen. Die Eliminierung der Gestik beeinflußte die Sprechleistung durch die Veränderung des semantischen Gehaltes der Äußerungen und des Anteils der Pausen an der Sprechzeit. Zwischen der Anzahl der Worte, der Anzahl der Pausen, der mittleren Pausenlänge und dem semantischen Gehalt fand sich eine Beziehung zur verbalen Kodifizierbarkeit des Stimulusmaterials. Die Anzahl der Verzögerungen stand sowohl zur Gestik als auch zum Grad der Kodifizierbarkeit in Beziehung.