Role of Surface and Base Structure in the Perception of Sentences

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The Ss in this study listened to groups of ten syntactically homogeneous sentences mixed with white noise. An anomalous test sentence followed each group of ten. Perception scores for the test sentences showed that changes in both surface structure and base structure can significantly disrupt perception. Changes in surface structure have the stronger effect. These findings provide evidence for the psychological reality of some abstract properties of stimuli.

In this study we have tried to assess the psychological reality of two linguistic constructs which have proved very useful in descriptions of language: surface structure and base structure. Surface structure is similar in many respects to the parsing of a sentence. Consider the following sentences:

1. They are forecasting cyclones.
2. They are conflicting desires.

In (1), for example, we know that are forecasting is a unit, whereas forecasting cyclones is not. In (2), on the other hand, are conflicting clearly does not form a unit, whereas conflicting desires does. In linguistics, tree-structure diagrams, or F-markers, are often used to illustrate graphically the relations among the units of surface structure. A detailed tree-structure diagram, however, often does not depict all our intuitive syntactic knowledge about a sentence. For example, sentences (3) and (4):

3. They are delightful to embrace.
4. They are hesitant to travel.

are characterized by tree structures of identical shape, but we know that in (3) they is basically the direct object of embrace, whereas in (4), they is the subject of travel. Furthermore, sentence (3) may be paraphrased as It is delightful to embrace them, but one may not say It is hesitant to travel them. Since the syntactic difference between (3) and (4) is not represented in the surface structure, these sentences are said to differ on the level of base structure.3 Such differences were negligible.

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3 Sentence types of uniform surface structure differed insignificantly in base structure, and vice versa. Such differences were negligible.
boundaries of the sentences. Our aim in this study has been to confirm the hypothesis that in processing sentences Ss make use of both surface structure and base structure. Our reasoning has been that if we could demonstrate that a S's expectation of a certain base or surface structure impeded the perception of sentences with different structures, we would have at least partially achieved our goal.

METHOD

Subjects. Twenty-three Harvard and Radcliffe students served as listeners in Group A, and twenty-two different Harvard and Radcliffe students were listeners in Group B.

Materials. Forty sentences of four syntactic types were used in the experiment. Ten contained the surface structure of (1), and ten the structure of (2). These sentences were employed to assess the importance of surface structure in perception. The other two groups of ten sentences were equivalent in base structure to (3) and (4), and were used to test the hypothesis that base structure can influence perception. The syntactic uniformity of each group of ten sentences was designed to induce a set for the common structure. A syntactically different test sentence followed each group of ten homogeneous sentences. For the group of sentences sharing the surface structure of They are forecasting cyclones, the test sentence was They are recurring mistakes, a sentence of type (2). They are describing events—a type (1) sentence—was the test sentence following the ten sentences sharing the surface structure of They are describing desires.

The following materials were used to test the role of base structure in the perception of sentences: the test sentence They are reluctant to consent, a type (4) sentence, followed the ten sentences having the base structure of They are delightful to embrace. The test sentence They are troublesome to employ, a sentence of type (3), followed the sentences possessing the base structure of They are hesitant to travel.

Had there been no controls for the test sentences, it would have been difficult to determine the extent to which perception scores reflected purely syntactic processes rather than artificial acoustic cues. Since the test sentence They are recurring mistakes also appeared as the last of the ten set-inducing sentences of type (2), and the sentence They are describing events appeared as the last of the set-inducing sentences of type (1), it was possible to control for all non-syntactic factors. The controls for changes in base structure paralleled those for surface structure. Perception scores were thereby obtained for each test sentence in control position and in test position.

Procedure. The recording of the sentences was made by a native speaker of American English. The master tape was made in an acoustic chamber on an Ampex Model 601 monaural recorder, which ran at 7½ ips. In order to eliminate international cues to syntactic structure, sentences were pronounced at a normal rate but in a monotone appropriate to no sentence in English. The master recording containing all the experimental materials was prepared in a single sitting, and the maximum meter deflection for the recurring words they are was made uniform for every sentence. Numerous practice tapes were made before one was judged sufficiently uniform in monotone, rate of speech production, and maximum loudness. Pauses of 13 sec duration separated the sentences, and the beginnings and ends of the sections were marked by loud signals.

The Ss were told that they would hear short, ordinary English sentences mixed with noise. They were instructed to listen to each sentence carefully, then to write it down in the interval before the next sentence. They were informed that the first two words in every sentence would be they are. Guessing was encouraged.

During experimental trials the sentences were played on a single channel of a VM stereo recorder. The recorded material was mixed with the output of a Grason-Stadler Model 455 noise generator, which produced white noise at the steady level of 10 db below 1.5 volts. The Ss used earphones and heard the mixture of signal and noise in each ear. To facilitate the development of a set for the syntactic regularities, the first five sentences of each type were played at a signal-to-noise ratio of +2 db. To allow for the possibility of errors, the signal strength was attenuated for the five remaining sentences and the test sentence. These last six sentences were heard at a signal-to-noise ratio of -4 db, a level which preliminary experiments defined as the 50%–correct level.

The 23 Ss of Group A heard the sentences of types (1) and (4) and their test sentences. The 22 Ss of group B heard types (2) and (3) and their test sentences. Sentences occurring in test position for group A occurred in control position for group B, and vice versa. Precise control was
possible by cutting out the critical sentences from group A's tape and splicing them into appropriate positions in group B's tape.

Results and Discussion

Table 1 contains the total scores for each of the four test sentences in control position and in test position. The score in control position for *They are recurring mistakes* is significantly higher than the score in test position, one-tailed $\chi^2(1) = 17.32$, $p < .001$. For *They are describing events*, the control position score is also significantly higher, $\chi^2(1) = 10.70$, $p < .005$. These results demonstrate that a sentence that differed in surface structure from the structure of the ten preceding sentences was perceived significantly less accurately than when it followed other sentences of its own type. These results, therefore, support the view that in the perception of sentences, surface structure plays an important part. Furthermore, the analysis of errors for the sentence in test position reveals that many such errors tended in the direction of the structure of the preceding sentences.

From Table 1 it can be seen that the score for *They are troublesome to employ* is slightly higher in control position than in test position, one-tailed $\chi^2(1) = 1.07$, $p = .15$. The frequency with which the word *troublesome* is correctly reported is higher in the control position, whereas the frequency with which it is incorrectly reported is higher in test position. This difference, in fact, is significant with two-tailed $\chi^2 = 4.00$, $p < .05$. Consequently, we may conclude that the perception of a sentence whose base structure is different from that of the ten preceding sentences may be hindered.

It should have been possible to use the scores for *They are reluctant to consent* as a further test of the influence of base structure in perception. Unfortunately, this was not possible since as Table 1 shows, there was a large error rate for this sentence in both positions. The score for *They are reluctant to consent* in the control position is only 31%, whereas the lowest score for any other sentence in the control position was 56%. *They are reluctant to consent* was, therefore, inherently difficult to perceive, and this difficulty severely restricted the possibility of observing a syntactic effect in test position. Since the error rate in the control position

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Control</th>
<th>Test</th>
</tr>
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<tbody>
<tr>
<td>They are recurring mistakes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>Wrong</td>
<td>7</td>
<td>22</td>
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<tr>
<td>They are describing events.</td>
<td></td>
<td></td>
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<tr>
<td>Right</td>
<td>21</td>
<td>9</td>
</tr>
<tr>
<td>Wrong</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>They are reluctant to consent.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Wrong</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>They are troublesome to employ.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Wrong</td>
<td>10</td>
<td>15</td>
</tr>
</tbody>
</table>
was high, according to the "principle of availability," the likelihood of observing a further decrease in the performance in the test position was small. In fact, the score was observed to decrease from 31% to 23%, and, as expected, this was not significant.

The results show that in perceiving test sentences, Ss take only partial cognizance of the actual sounds of the recording. When a S makes an error, he often selects words that are compatible with the syntactic set rather than words that are phonetically close to the stimulus.

These experiments show that sets for specified types of deep and surface structures can be induced in Ss. Such findings are consonant with the view that representations of sentences that are abstractly related to their physical realization play a role in speech perception.

**References**


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