The Dependence of Finger Tip Touch-Pressure upon the Condition of Braille Reading

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Since a French teacher, Louis Braille, invented a system of touch reading for blinds, this system has been widely used in blinds. In this system, now bearing his name, embossed dots and combinations of them stand for letters of the alphabet. In Japan a devise has been made to represent Japanese letters kanamoji with braille.

Blinds practice to read braille with their fingers gliding on the paper. It is known that the skill in braille reading is dependent on fine motions and touch sensation of fingers in regard to braille. Maxfield (1928), Burklen (1932) and Lowenfeld (1964) reported that blinds have a tendency to move the finger with a marked up-and-down motion, and to make the finger tip pressure firm on braille until they get skilled in braille reading. Kusajima (1952) observed the similar fact experimentally. These authors pointed out that blinds frequently reduce their sensation of the fingers by adding excessive pressure on braille. Few experiments, however, seem to have been made to clarify this problem.

In this paper the actions of finger were investigated by recording the pressure exerted by finger tips and its time process in relation to the conditions of braille reading.

METHODS

A force displacement transducer consisted of strain-gauges and springs was used in our experiments. A thin silver plate 4 x 6 mm in size was soldered horizontally on the top of a small rod connected to the strain-gauge, so that the plate was moved vertically by the addition of pressure, and it served as a pick-up to detect the pressure of a finger tip on braille.

A sheet of paper on which braille was embossed in a line was mounted on a lucite
plate with small hole in its center. The sheet of paper was so progressed by the hand of
the investigator that the selected braille came on the hole one by one. The transducer
was set up in such a way that the attached small silver plate was placed in the hole of the
lucite plate and in contact with the backside of the sheet. A finger coming on the braille
pushed down the plate and resulted electric changes were recorded with an ink-writing
recorder through a D.C.-amplifier.

The subjects of these experiments were 10 blinds. They were divided to two groups,
one was composed of 5 experienced readers and the other 5 beginners. The subjects were
directed to read braille arranged for the experimental aims, and resulted finger tip
pressure changes during reading one of the braille were recorded. The results were
compared between two groups and evaluated statistically.

RESULTS

Fig. 1 shows an example of the typical records of the finger tip pressure when
the subjects touched one of the braille while reading it. In Fig. 1, the upper
record was obtained from an experienced subject reading one of the braille in a
meaningful word, and the lower record from a beginner. The experienced blind
read with only one touch, but the beginner did with several touches, and a
longer time was needed to read. In this experiment two sheets of paper were
prepared. On one of them (denoted S₁) meaningful braille words were written in

![Fig. 1. Finger tip pressure on braille recorded from a experienced blind (upper record)
and from a beginner (lower record). Addition of pressure increase is represented by a
downward direction.](image)

![Fig. 2. Values of finger tip pressure obtained from 10 subjects who read individual 10
braille. Filled circles indicate values obtained from 5 experienced blinds, and open
circles from 5 beginners.](image)
Fig. 3. Values of time length during braille reading obtained from 10 subjects, 5 experienced blinds (filled circles), and 5 beginners (open circles).

10 lines, and on the other sheet (denoted S₂) meaningless words were written in a similar form. The finger tip pressure changes were recorded from the two groups of subjects during recording designated 1 braille in each of 10 meaningful and another 10 meaningless words. The values of pressure on meaningful words (S₁) measured at the peak of recorded pressure curve were illustrated in Fig. 2. And the time durations of pressure curves measured from their falling onset to their return to the base-line were illustrated in Fig. 3. In Figs. 2 and 3 filled circles indicate the values obtained from the 5 experienced readers, and open circles indicate the ones from the 5 beginners respectively. They were plotted separately on every braille. The values are scattered on some braille but fairly centered on another braille. The degree of scattering was not correlated between two groups. And in the identical group the pressure value was not correlative with the length of its time duration. They seemed to be within the extent of scattering. The results obtained with S₂ did not have a significant difference or a special feature as compared with those with S₁ except for the increased values of time and pressure. Therefore, the results give little support to the observation reported by Seo (1966) that some braille was easy to read but another was hard. The subjects in his experiments were beginners who began to practice touch reading. Therefore they seemed to be able to read only several braille. In our experiments, however, even the blinds classified into the beginner group got to read any braille. The disagreement in results of both experiments was probably caused by the different states of beginners.

The mean values of every fifty measurements are illustrated in Table 1. In this Table P₁ and T₁ denote the mean values of pressure and its time duration obtained from the experimental set S₁, while P₂ and T₂ from S₂. The statistical test shows that the difference of mean values of P and T between two groups are both significant at 0.1% level. And the difference of P₁ from P₂ is significant only in the experienced blind group, while the difference of T₁ from T₂ is significant in
TABLE 1. Mean values of pressure (g) and time (sec) on experimental sets S₁ and S₂

<table>
<thead>
<tr>
<th></th>
<th>Pressure</th>
<th>Time</th>
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<tbody>
<tr>
<td></td>
<td>P₁</td>
<td>P₂</td>
</tr>
<tr>
<td>Beginner</td>
<td>8.7</td>
<td>9.2</td>
</tr>
<tr>
<td></td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>Experienced b.</td>
<td>6.3</td>
<td>7.3</td>
</tr>
<tr>
<td></td>
<td>p&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>2.4</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>p&lt;0.001</td>
<td>p&lt;0.001</td>
</tr>
</tbody>
</table>

TABLE 2. Mean values of pressure (g) and time (sec) on top and end of words

<table>
<thead>
<tr>
<th></th>
<th>Pressure</th>
<th>Time</th>
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<tbody>
<tr>
<td></td>
<td>P₁</td>
<td>Pₑ</td>
</tr>
<tr>
<td>Beginner</td>
<td>8.7</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>Experienced b.</td>
<td>7.8</td>
<td>4.8</td>
</tr>
<tr>
<td></td>
<td>p&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>0.9</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>n.s.</td>
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</table>

both groups at 0.1% level. These observations mean that the subjects in both groups could read meaningful words in shorter time than meaningless ones, and the experienced readers read meaningful words with a light touch, but the beginners slided their fingers always with a firm pressure. Even the experienced readers pressed down the braille more strongly when he felt difficulty to distinguish the dots in the meaningless word.

In another experiments, the finger tip pressures were recorded on the top braille of meaningful words and again on the end braille. The obtained results showed that the experienced readers pressed the braille more strongly to read at the top of words than at the end. In this experiment the given words were all meaningful. The mean values of measurements are illustrated in Table 2, in which P₁ and T₁ indicate the mean values of pressure and time duration at the top of words, and Pₑ and Tₑ at the end of words. The statistical test shows that the difference of pressure and time duration between the experienced readers and beginners are significant at the level of 0.1% except for the pressure values at the top of the words, and the difference between the top and end of words are significant at 0.1-5% levels except for the pressures of beginners.

DISCUSSION

The experimental results showed that the decreased reading time was parallel with the decrease in the force to press the braille. This indicates that blinds
become to read braille with a light pressure when they become skilled. On the meaningful words or on the end of words the experienced reader can conjecture next coming braille by aid of understanding the meaning of words. While, the beginner seems to touch any braille so carefully one by one with firm pressure without catching the meaning that he can not read any braille with decreased pressure even on the meaningful words.

Increased pressure given to the meaningless words or to the top of words indicates that careful reading caused a considerable increase in pressure. Therefore, the increased pressure does not seem to hinder the braille reading, but seems to contribute to careful reading. This suggests that the tactile sensibility of finger tip is accelerated by the addition of pressure. Guilford and Lovewell (1936) reported that the number of effectual touch sensory spots contracting the braille increased with the addition of light pressure. On the other hand Maxfield (1928) told that increased pressure might momentarily intensify the sensation of touch but continued pressure would dull it. And Hines (1931) presumed that the local anemia in the finger tip resulted from firm pressure might make the touch sensation dull. But the finger leaves up from a sheet of paper always at the exchange to next line and the finger tip may scarcely have an opportunity to keep the pressure increased. So it is not likely that the touch sensibility of finger tip is weakened by the addition of pressure.

References