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INTERFERENCE EFFECTS OF STROOP COLOR-WORD TEST IN CHILDHOOD, ADULTHOOD, AND AGING

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A. PURPOSE

The capacity of an individual to maintain a uniform course of action independent of intruding or interfering stimuli represents an important aspect of the functioning of the mature organism. The present study is devoted to uncovering differences on this aspect of behavioral functioning during ontogenesis and in old age. The test situation used to investigate this problem is a modified form of the Stroop color-word test. We make the assumption that performance on the Stroop test reflects the capacity to maintain a course of action in the face of intrusion by other stimuli. This critical part of the test involves interference between color naming and word reading. In this situation a color-word, such as "red," is printed in a color, e.g., green, different from the color word. The S has the task of naming the color of the ink (green) rather than pronouncing the word (red). Thus, a highly automatized activity (reading color-words) conflicts with the naming of a perceptual property (color). We assume then that carrying out the task of naming colors requires that the two functions (word reading and color naming) are differentiated from each other and, further, that word reading does not interfere, i.e., remain subordinate to color naming.

The basis for this analysis is grounded in a comparative-developmental framework, the most general principle of which states that development entails an increase in differentiation and hierarchic integration of functions. Application of this principle in the present study enables us to make certain predictions for the comparison of various groups. Given the assumption that less
mature organisms, children, are characterized by lesser differentiation and integration of function, we would expect that they would be less capable of successful performance on the Stroop test than adults. Similarly, if one views old age as involving a "regression" to a less differentiated and hierarchically integrated state, then less adequate performance should show up again at later ages.

B. METHOD

The modified Stroop test used in this study consisted of three kinds of material, printed on 9½" × 9½" cards, which S is instructed to read aloud as rapidly as possible. The first card (A) consists of 100 color words (RED, BLUE, and GREEN) which are printed in black ink and arranged in random order. The task is to read the words as quickly as possible. The second card (B) consists of 100 rectangular patches, 5/16 of an inch × 2/16 of an inch, of color (red, blue, and green) which are also arranged in random order. The task here is to correctly name the colors as fast as possible. The third card (C) presents, again in random order, 100 color-words (RED, BLUE, and GREEN) but these are printed in an ink whose actual color is different from the color designated by the word; e.g., the word "BLUE" might be printed in red ink, the word "GREEN" printed in blue ink, etc. On this card, the task is to name the color of the ink in which the word is printed as quickly as possible. The 100 items on each card comprised 10 lines with 10 items to a line. There is an additional practice line at the top of the page.

The three cards comprising the test were administered in the standard order - Card A, Card B, and Card C. The measure utilized was the total time taken for responding to the 100 items on each card.

C. SUBJECTS

A total of 235 Ss ranging from seven to 80 years of age were used. The subjects were divided into 11 age groups as shown in Table 1. Ss from ages seven to 13 were drawn from a grammar school; the 17-19-year-old subjects were undergraduate students; age groups 25-34 and 35-44 were drawn from an evening college; and the age group 65-80 were drawn from a community old age club.

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4 The lower age limit was set at 7 years of age because after preliminary testing of 5 and 6 year olds it was found that their reading activity was not sufficiently established as an automatized activity to serve as a potent factor of interference (also cf. 9).
TABLE 1

<table>
<thead>
<tr>
<th>Age</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>17-19</th>
<th>25-34</th>
<th>35-44</th>
<th>65-80</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24</td>
<td>20</td>
<td>20</td>
<td>25</td>
<td>29</td>
<td>25</td>
<td>29</td>
<td>18</td>
<td>14</td>
<td>16</td>
<td>15</td>
</tr>
</tbody>
</table>

D. Results

The over-all results are presented graphically in Figure 1. The graph plots the mean total time in seconds for each of the three cards for the various age groups. As expected the response time is least for reading color-words (Card A), longer for naming actual colors (Card B) and longest when there is interference (Card C); this general relationship holds for all the age groups studied here. However, in keeping with the main hypothesis of the study, the degree of interference differs depending on the age group; here, the pertinent measure for the interference effect is the difference in response time to Card C as compared to Card B. This time difference is greatest with the 7 year olds,
decreases with increasing age up to the 17-19-year-old level, remains constant
during middle years (25 to 45) and then increases again in the older group
(65-80). This developmental change is statistically significant; as shown in
Table 2 the interaction A × C (age by cards) is significant beyond the .01
level of confidence. Another finding, independent of interference effects,
pertains to Cards A and B: the response time for both activities, reading color-
words and naming colors, is greatest for the younger age group, decreases with
increasing age up to the 17-19 year olds, then remains relatively constant.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects (S)</td>
<td>224</td>
<td>3301.11</td>
<td>37.67</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Between Age Levels (A)</td>
<td>10</td>
<td>49616.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Ss within As</td>
<td>224</td>
<td>1317.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Subjects</td>
<td>470</td>
<td>3844.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Cards (C)</td>
<td>2</td>
<td>750034.74</td>
<td>1386.60</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>A × C</td>
<td>20</td>
<td>6431.89</td>
<td>16.18</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Pooled Ss × C</td>
<td>448</td>
<td>397.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>704</td>
<td>3969.33</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean Time (seconds)

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15-19</th>
<th>25-34</th>
<th>35-44</th>
<th>45-65</th>
<th>65-80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Card A</td>
<td>89.8</td>
<td>77.6</td>
<td>68.5</td>
<td>62.3</td>
<td>55.6</td>
<td>59.3</td>
<td>54.1</td>
<td>40.5</td>
<td>39.4</td>
<td>42.6</td>
<td>45.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Card B</td>
<td>126.9</td>
<td>108.3</td>
<td>100.9</td>
<td>92.8</td>
<td>82.1</td>
<td>86.4</td>
<td>79.5</td>
<td>56.1</td>
<td>60.9</td>
<td>57.9</td>
<td>68.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Card C</td>
<td>264.7</td>
<td>208.3</td>
<td>191.4</td>
<td>184.3</td>
<td>160.8</td>
<td>157.9</td>
<td>147.6</td>
<td>103.0</td>
<td>106.2</td>
<td>109.9</td>
<td>165.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

E. DISCUSSION

In regard to the main problem of this study, i.e., ontogenetic changes in
degree of interference of color words on color naming, the following was
obtained: interference is greatest with young children, decreases with increasing
age to adulthood and increases again with older age.

5 Because of inhomogeneity of variance between age groups a non-parametric test
of significance was also employed in evaluating differences between age levels. A
Median Test employing difference scores (Card C—Card B) as the measure of inter-
ference showed the proportion of cases above and below median to differ signifi-
cantly among age groups. In addition it may be noted that an analysis of variance employing
ratio scores (Card C/Card B) as the measure of interference also showed significant
differences between age groups. In both supplementary analyses the same general find-
ing obtained: there is a decrease in interference effects from childhood to adulthood
with an increase in old age.

6 In the data obtained here as well as by other investigators (e.g., 8, 10) time to
respond to Card A (reading color-words) is faster than time to respond to Card B
(naming colors) from which we may assume that response to color is less dominant.
As indicated in the introduction, these age changes may be interpreted in terms of comparative developmental theory which formally analyzes such changes in terms of increase of differentiation and hierarchic integration. With respect to differentiation the Stroop task is predicated on the assumption that the two functions, word reading and color naming, are differentiated from each other; with respect to hierarchic integration the assumption is that word reading remain subordinate to color naming. This capacity to maintain color naming in the face of a tendency towards word reading is manifested by more rapid performance on the interference card. Developmentally, children are characterized by lesser differentiation and hierarchic integration of function; thus, our finding that children perform less efficiently on the interference task is in keeping with this conceptualization.

As to the oldest age group, 65-80, we have seen that the interference effect is increased again in comparison to the middle age adults. In this case, the developmental notion of “regression” may be employed for formally conceptualizing their behavior on the Stroop test; that is, “regression” implies a decrease in differentiation and hierarchic integration of functions. Such a notion has also been of value in studies concerned with psychopathology and drugs. For instance, on the assumption that schizophrenics represent a developmentally less mature group and that the pharmacological drug LSD-25 induces more primitive behavior, it has been demonstrated that on the Stroop test schizophrenics show differentially greater interference effects than normals; and that both normals and schizophrenics show greater interference effects under conditions of LSD as compared to placebo.

In order to show the significance of setting these facts within the conceptualization of regression we may point to other perceptual studies on old age where the interpretation of regression in terms of de-differentiation and de-hierarchization has proven to be fruitful. In one study dealing with the perception of verticality striking differences in effect of body tilt depending on age level were found: children (6-1.5) were found to locate the apparent vertical to the same side as body tilt whereas adults of middle age (18-50) located the apparent vertical to the opposite side of body tilt and older adults (65-80) again located the apparent vertical to the same side of body tilt. In another study parallel trends in development were found with two illusions: children and older adults showed greater susceptibility to the Muller-Lyer illusion than middle age groups and similarly children and older adults showed lesser susceptibility to the Titchener Circles illusion than middle age groups. In both studies the findings concerning the old age groups were interpreted in terms of a decrease in differentiation; one in terms of lack of differen-
tiation between self and object, the other in terms of lack of differentiation between part-whole relationships. Thus, the present study together with those mentioned point to the developmental notion of "regression" as of heuristic value in formally tying to the behavior of children such varied behavior as occurs in psychopathology, under drugs, and in the course of aging.

Lest the formal similarity between children and older adults be misunderstood, a word of caution may be added here. Although it has been demonstrated that achievements in terms of a time score for children and aged are similar, it should not be implied that the underlying operations leading to their achievements are identical. Some observations suggest that the means by which these achievements are reached differ in these two age groups. Thus, it was frequently observed that younger children in trying to maintain the task on Card C do so by pointing and rhythmically accentuating the material. In contrast to this concrete pointing the aged group sometimes utilized verbal "pointing," i.e., the S would precede each response with "that's a-," and in other cases S was verbally reminding himself of the task. This indicates the necessity of further investigation in terms of a process analysis rather than simply in terms of achievements.

F. Summary

The present study is devoted to uncovering differences during ontogenesis and in the process of aging concerning the capacity of an individual to maintain a uniform course of action independent of interfering stimuli. The test situation used to investigate this problem is a modified form of the Stroop color-word test. The critical part of this test involves interference of word reading with color naming.

The Stroop test was administered to a total of 235 Ss ranging from seven to 80 years of age. It was found that the degree of interference of color-words on color naming is greatest with young children, decreases with increasing age to adulthood and increases again with older ages. These changes with age are interpreted in terms of comparative developmental theory.

References


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