SEMANTIC ATTRIBUTE ENCODING, INTERFERENCE, AND RECALL: AN INVESTIGATION OF THE STROOP COLOR EFFECT

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TABLE OF CONTENTS

LIST OF TABLES

Semantic Attribute Encoding, Interference, and Recall: An Investigation of the Stroop Color Effect

The idea that word meaning is the accumulation of attributes along many dimensions is a viable one. The encoding of words by attributes is an area presently being investigated by a number of researchers. One technique that is useful in the study of meaning is the PI release paradigm which deals with the automatic encoding of words along semantic dimensions. Wickens (1970) has shown that the interference is specific to one dimension and the shift to another dimension produces the release from proactive inhibition. Another tool used to study the interference or inhibition produced by one dimension--color--is the traditional Stroop Test (Stroop, 1935).

The Stroop Test emphasized the importance of the effect of the encoding dimension of color. The task was to name the color of color-words like RED and GREEN printed in different and incongruously colored inks. Stroop (1935) found it was more difficult to name the color of the inks of these words than naming the colors of nonmeaningful material. The word RED and the other items on the test are encoded almost totally in the color dimension. When RED is written in blue ink and the S has to name the color of the ink, there is direct interference with the color attribute of the written word. A question to be answered is whether this interference is due to automatically encoding the wrong attribute.

The earliest explainations of the color-word interference were in terms of response interference. In that framework, the two perceptual dimensions of the color-word evoke incompatible responses. The more dominant and more habitual response is the naming of the word and this must be suppressed in order to name the ink color. This suppression causes the delay in reading time. Pritchatt (1968) studied the verbalizing component using color-words. For some groups instead of having the subject say the correct color, he has the subject match the color of the ink to a color patch on a response key. He hypothesized that this would minimize the conflict. His stimuli were words like RED and BROWN. For other groups the response was also on a response key, but the colors were spelled out. He found that responding using color patches was quicker than if words were on the response key. Also, he included two incongruent groups such that for one group the response was to name the color and for the other the response was to read the word. For these two groups, the response time difference was not significant when color patches on a response key were used. Thus, the response dimension--verbal or nonverbal--can contribute greatly to the interference. Sichel and Chandler (1969) also investigated how the response required of the subject could be manipulated to effect the degree of interference. They looked at response suppression by using series of word pairs such as RED (printed in green) followed by GREEN (printed in red). Their idea was that suppression of the reading response to the first would decrease its availability as a color-naming response to the second. Also, the color-naming response to the first word would have to be suppressed for the second word in the pair. These pairs produced the greatest color-naming difficulty over pairs of words which were incongruent but were not so arranged.

However, the Stroop Test involves more than response interference; coding is intrinsically involved. Schiebe, Shaver, and Carrier (1967) provide an elaboration of the response suppression theory with a mediation theory. They assume that each word has some color association value, and this is the strength of the connections of the stimulus to their color attribute. Those words with a high association value will cause greater interference than words with a low value. After establishing color association norms, he used high value words (red, blue, etc.) medium value words (scarlet, sky, grass), and low value words (car, paint, reason). He found a high correspondence between color association values and interference scores. Langer and Rosenberg (1966) support the mediation hypothesis when they found that nonsense syllables produced interference effects if they had color associations and were printed in the wrong color. The symbols used had been matched by a normative group to particular colors like ZAH = red and OOM = blue. Also, some symbols were printed in a congruent color. The Ss took longer and had more variation on the incongruent syllables than the congruent ones, and they also could not say why they were having more difficulty.

Klein's theory (1964) encorporates aspects of the two previous points of view in his semantic gradient explaination of interference: (a) color coding, (b) linguistic-motor responses, and (c) the word's semantic structure--its meaning (encoded attributes) and how closely they are related to the color naming response (associative value). Klein used lists that differed intuitively in their degree of semantic relatedness: (1) names of colors, (2) names of unusual colors, (3) color associated words, (4) common words, (5) rare words, (6) nonsense syllables, and (7) asterisks. He found that interference decreased (going from one to seven) following a gradient determined by semantic relationship.

Other investigators have also looked at the effects of the variables Klein has emphasized. For example, Bakan and Alperson (1967) manipulated the motor response variable by varying pronouncibility and the semantic structure variable by varying meaning. They found that meaningful words produced more interference despite equal pronouncibility and that the ordering of interference corresponds to the ordering of pronouncibility. Ellison and Lambert (1968) also concentrated on the semantic structure variable, meaning. Previously they found that with continuous repetition the repeated words decrease in meaning (Lambert and Jakobovits, 1960). Subsequently they used the regular Stroop Test card and also a revised card in which the interfering words never had the identical color attributes of the color of the inks being used (i.e., RED in pink, BLUE in grey). They hypothesized that if the repeated words belonged to the incorrect response class, then a decrease in their meaning or availability would facilitate performance. They reasoned that the incorrect word would be less available as a response. In their study, each subject named the colors from the interference card and then rated the color-words on six semantic differential scales. After this the subject repeated each word for fifteen seconds, rated the word on one scale, and then repeated this procedure for all scales. Then the second color-naming test was given. They found that for the regular card a decrease in meaning did not improve performance on the second testing. However, on the revised card where the colors were not the words used, a decrease in meaning produced the most improvement on the second test. This last finding supported their hypotheses.

Morton (1969), however, claims that Klein's semantic gradient explaination is both incomplete and ambiguous. Morton used a task requiring sorting cards according to the number of symbols on the card while the name of the symbols conflicted. His model uses black boxes and flow diagrams and tries to locate the source of interference. In his model there are six "black boxes," which are in order of their information flow: (1) visual and auditory stimulus information, (2) either stimulus analysis or counting, (3) a logogen system, (4) a response buffer, (5) mediation, and (6) sorting. His model posits that interference occurs as verbal responses become available. The third component or the logogen is where all information pertaining to a response converges. If the nameable symbol enters the logogen and the name becomes available before the count, then that would interfere with the wording since the response buffer only accepts one name at a time. He suggests also that many connections exist between the logogens that have response similarities. Once past the logogen and response buffer, either the incorrect response (the digit response instead of the count) or the correct response would trigger the mediation required for sorting the cards.

Morton's model also explains the phenomenon known as priming (Storms, 1958). This is a response becoming more likely when the response has previously been emitted. The logogens of the correct sorting response would be primed in this case. In Morton's studies the cards are sorted from one to six, so the digits 3, 4, and 5 would be primed but 7, 8, and 9 would not. He found that the effects of digits 7, 8, and 9 are similar to those found using letters; thus, priming increases the interference for this task. Dalrymple-Alford (1968) had data on priming that support Morton's point of view rather than the semantic gradient view. He used an interlingual version of the Stroop Test in which the words are in one language and the S names the colors in another. With some color-words the colors were incongruent (the traditional Stroop condition) and with others the colors and color-words matched. He found that when the interfering words were equivalents of the correct response in the other language, interference was less than in the incongruent condition even though the semantic gradient hypothesis would have predicted otherwise. Similarity should have caused maximum interference according to that theory. He eliminated the possibility of greater speed due to translating the word instead by timing translating. He suggested that perceiving a word automatically primes all its associates (or attributes) and these responses become more available. So priming facilitates the response in the congruent condition. Priming would also explain why Langer and Rosenberg (1966) found that nonsense syllables which evoke certain colors facilitate color naming if they are written in those colors.

Dalrymple-Alford (1972) further investigated the effect of congruence using unrelated words, color-related words (sky, grass, snow, blood), color names (blue, green, white, red), and control Xs. In accord with Klein (1964) and Fox, Shor, and Sternman (1971) he found that color-related words when printed in incongruent colors inhibited performance but not to the extent of the color-words. More important was the finding that the response time of the unrelated words was significantly greater than both congruent conditions. Thus, congruence is more than a matter of no color interference; it is actual facilitation.

The theories and models discussed so far have dealt with the actual performance on the Stroop Test or on variations. How do the different conditions of the tests effect recall? Grand and Segal (1966) used priming by a word association task to study recall. Seemingly paradoxically, they found that priming was inversely related to recall. They used 45 different words unrelated to color which were printed in colored inks. These words were known to elicit certain associates at a specific frequency. Two tasks were used; one group of Ss crossed out vowels on a list of the associates, and the other group named the colors they were written in. Vowel crossing was used because it was a low arousal, low conflict task while the color naming task was conflict-producing and caused high arousal (Johnson, 1963). Grand and Segal tried to find out whether conflict over saying the color-words' colors would lead to their activation. Activation was measured by the increase in associative frequency of these words when given cue words known to elicit them. They found that for color-naming priming was much greater than for vowel-crossing, but recall was superior for the vowel-crossing-task words. Kleinsmith and Kaplan (1964) also found poor recall of items which were learned during high arousal. Grand and Segal suggested in their paper (1966) that because of the task, the words were not in full awareness and learning could only be measured by indirect associative techniques and not by immediate recall.

In summary, it can be seen that encoding, mediation, and recall are some of the possibilities of study using the original or modified Stroop Test. It has been seen that subjects cannot totally ignore information from the verbal material even if this information conflicts with the output required of the subjects. This paper will explore the encoding and recall processes using a modified Stroop Test. Previously, researchers have not dealt with recall of color-related words or with the subject's awareness of the color congruence or incongruence of these words. Also, although some researchers have developed a theory or model that tries to explain the interference phenomenon, none have tried to incorporate recall into this model. Thus, the experiments to be reported will deal with the interaction of noncolor-related words, congruently printed color-related words, and incongruently printed color-related words with recall, the perception of the congruence or incongruence, and localization of the source of interference in terms of Morton's model.

EXPERIMENT I

Method

Subjects.

The Ss were Ohio State University students enrolled in the Introductory Psychology course. A total of 120 Ss were tested.

Apparatus.

The Ss were tested in a cubicle. Three Stimuli charts constructed on $8\frac{1}{2}$ x 10 in. white paper were mounted inside a manila folder. On the outside of each folder was a sample stimuli list consisting of the numbers 1 through 7 printed in six different colors. Each chart had ninety stimuli arranged in fifteen rows of six stimuli each. All letters and numerals were printed with a 3/16 in. "Easy Print" lettering guide, and all letters were noncapitalized. Each ink color appeared the same number of times on each list and appeared randomly with the restriction that colors never appear twice in succession either horizontally or vertically. The stimuli were printed in red, green, blue, black, yellow, or brown ink. On Chart 1 the stimuli consisted of colored circles only. On Charts 2 and 3 the stimuli were twelve nouns randomly ordered. There were two color-associated words for each color: red--ruby, blood; yellow--canary, banana; blue--sky, ocean; green--emerald, spinach; black--coal, tar; brown--chocolate, walnut. The words were chosen after many color-related words were rated independently. Initially, a dictionary was read by the E and used to list all color associated words. After ten to twelve words for each color were found, the E asked fifteen graduate students to rank each group according to which word was best associated with that color. The two words for each group that ranked the highest were used. The two words in each color group appeared fifteen times on each chart. On Chart 2 the words were printed in congruent colors. On Chart 3 each word was printed in each of the five incongruent colors. A stopwatch accurate to the nearest 1/5 sec. was used in timing Ss' performances.

Procedure.

Each S was seated in a comfortable chair and given only one of the folders. Since each subject was to name the colors both horizontally and vertically, the instructions for the direction was counterbalanced. All Ss were given the following instructions:

> Please sit back in the chair and hold the folder in front of you. On the cover you can see a sample of the test I am giving. You are to name the colors as quickly as you can by going across/down the list in rows/columns.

The Ss read the sample. If any errors were made, the S was corrected and then read the next instructions.

> In the next list you should also name the colors in rows (columns). Go as quickly as you can without making any errors. If you do make a mistake, correct it before you go on to the next color. When I say "Ready-Go," you are to turn the page and begin reading immediately. When you finish naming the colors, close the folder. Ready-go.

The stopwatch was started when the S named the first color and stopped at the last color. Both time and errors were recorded. Then the S was asked to read the list again but in the alternate direction. After each S had completed both tasks on Chart 2 or 3, he was asked if he recognized any pattern between the words and the colors. If the S said "yes," then the E asked what it was and determined if the S recognized the congruence or incongruence. For the last nine Ss in the congruent and incongruent group, they were also asked to recall all the words on the list.

Results

Table 1 gives the means of total reading times in the three conditions. The reading time of color-naming was significantly faster than both other conditions.

TABLE 1

Reading Time: Experiment I

Group	Mean Total Reading Time in Seconds
Control	111.0
Congruent	132.0
Incongruent	143.0

An analysis of variance showed that group differences were significant at the .01 level, $F(2/120) = 6.85$, but differences between direction of reading was not, $F < 1$. Tests on means using the Newman-Keuls test (Winer, 1962) showed significant differences between every other group ($p < .01$). A *t* test on the number of words remembered showed that the congruent group remembered significantly more words ($p < .005$). Table 2 shows the means of words recalled.

TABLE 2

Words Recalled

Experiment	Group	Mean Number of Recalled Words
I N = 9	Congruent	7.9
	Incongruent	5.0
II N = 20	Congruent	7.95
	Incongruent	4.65
	Unrelated	4.50
III N = 40	Congruent	8.12
	Incongruent	5.21
	Unrelated	4.25

On the pattern question, 25 out of 40 of the congruent group recognized the congruence whereas only 7 of the 40 in the incongruent group recognized the incongruence. A X^2 showed significance at $p < .01$.

Discussion

Consistent with Dyer (1970) and Sichel and Chandler (1969) the color naming is quicker for congruent items. A question raised was whether or not they were faster than neutral words. The priming of their attributes could reduce the response time since the color attribute and the response was the same. The next two experiments explored this possibility and also explored recall further. Recall was best for the congruent group which in view of the priming effect in recall (Grand and Segal, 1966) was not expected. Another question to be answered was whether or not pattern recognition aided recall.

EXPERIMENT II AND III

Method

These two experiments were identical in method and procedure except that for Experiment II only 20 Ss per group were used but for Experiment III 40 Ss per group were used. A total of 240 Ss were used.

Subjects.

All subjects were Ohio State University students enrolled in the Introductory Psychology Class and had normal color vision.

Apparatus.

Everything was identical to Experiment I except an additional chart was used which was identical to the other three in arrangement of words and color ordering but had stimuli items which were nouns not related to color. They were "zoo, bits, grimace, icicle, opportunity, outlaws, golf, angles, van, duct, fiasco, and hole." Each was matched on frequency and number of syllables to one other word on the other lists.

Procedure.

The procedure was the same for both experiments. Each S was given only one chart, and he named the colors horizontally. They were given the following instructions:

> You are looking at a sample of the test I am giving. You are to name the colors as quickly as you can. Name all the colors and you may begin. now. [They read the sample and errors were corrected.] In the next list you should name all the colors in rows. Go as quickly as you can without making any errors. If you do make a mistake, correct it before you go on to the color. When I say "Ready go," you are to turn the page and begin reading immediately.

Their times were recorded, and immediately after their folder was retrieved, they were asked to name all the words on the list. After the S had indicated that no more words could be recalled, the E asked if a pattern between the words and colors was noticed. The S was asked to state the nature of the pattern.

Results

Experiment II.

Table 3 gives the means and standard deviations of reading time for Experiments II and III.

For Experiment II an analysis of variance showed that group differences were significant at the .01 level, $F(3,80) = 12.49$. When differences between groups were tested for significance by the method of Scheffe, the control differed significantly from the other three groups ($p < .01$), but all other comparisons were not significant.

TABLE 3

Reading Time: Experiments II and III

Experiment	Group	Mean Reading Time	S.D.
II	Control	52.62	9.2
	Congruent	66.64	7.5
	Unrelated	67.77	10.3
	Incongruent	69.93	12.2
III	Control	54.78	7.6
	Congruent	64.83	8.0
	Unrelated	65.63	6.8
	Incongruent	72.05	10.9

A difference of 9.1 secs. was needed. An analysis of variance on the number of words recalled indicated that between group differences were significant, $p < .01$, $F(2/60) = 14.52$. Analysis using the Scheffe test indicated that the congruent group remembered more words than both the non-color group and the incongruent group ($p < .01$). Also, the non-color group was not significantly different from the incongruent group. Table 2 shows the means of the words recalled for all three studies. Table 4 shows the pattern-recognizing percentages. A X^2 indicated significance for pattern differences at $p < .01$ for all three

TABLE 4

Congruence and Incongruence
Pattern Recognition

Experiment	Group	Percentage of Ss Recognizing the Pattern
I	Congruent	62.5%
	Incongruent	17.5%
II	Congruent	85.0%
	Incongruent	20.0%
III	Congruent	75.0%
	Incongruent	17.5%

experiments. Table 5 shows how recall is related to pattern recognition.

Experiment III.

An analysis of variance indicated that group differences were significant at $p < .001$, $F(3, 160) = 30.3$. Analysis using the Scheffe method showed that only the congruent and non-color group did not differ significantly from each other. All other comparisons were significant at $p < .01$. Analysis on words recalled showed the same ordering and level of significance as Experiment II for $F(3, 120) = 8.12$, $p < .01$. Both Experiments II and III showed a tendency for the unrelated words to have poorest recall.

TABLE 5

Mean Number of Words Recalled Divided Into Conditions of Pattern Recognition Vs. Nonrecognition

Experiment	Group	Mean Number of Recalled Words	
		Recognition	Nonrecognition
I	Congruent	8.1	7.7
	Incongruent	5.0	4.8
II	Congruent	7.9	5.3
	Incongruent	7.0	4.0
III	Congruent	8.0	8.2
	Incongruent	5.4	4.3

Discussion

As was expected in two studies the incongruent group exhibited the most interference in line with Klein (1964), Fox, Shor, and Sternman (1971), and others. However, in Experiment II, the incongruence did not seem to cause increased response time. Nevertheless, the response times were in the expected direction and relationship to one another. The reduced response time for the incongruent group could be due to the large variability exhibited in the incongruent group. Shor (1970) also found that individual differences increased directly proportional to the difficulty of task. So the gradient of difficulty varies with the S. Stern (1966) suggested that a large proportion of the variation could be due to personality variables relating to personality adjustment deviation. Since the sample size was relatively small in Experiment II for the incongruent group, personality factors could have been significant. Also, previous to the present studies, interference has been eliminated or reduced by special manipulations (Pritchatt, 1968; Derks and Calder, 1969). In the color counting task used by Derks and Calder (1969), there was practically no interference in the incongruent color-word condition. Egeth and Blecker (1969) suggested that it was a task that did not engage the cognitive system as much as the color-naming task. Their research included a pair comparison task in which the Ss had to say whether the colors of a word-pair were the same or different. For instance, if two words are printed in the same color yet are different color-words, the S could perceive the meaning difference and say "different." In this case, however, there were two dimensions operating--color meaning and the meaning of same vs. different. When the word pairs were SAME and DIFF and not color-words, interference for the incongruent condition reoccurred. This suggests that the interference is between components of one dimension. According to Morton's model you would expect less interference from color-words than from SAME and DIFF because the former logogens would not be primed by the response set SAME and DIFF. When both the stimuli and responses are SAME and DIFF, less stimulus information would be needed to elicit the wrong name.

One of the most important effects has to do with the lessening of interference in the congruent condition. Langer and Rosenberg (1966) found that congruent color-associated nonsense syllables produced less interference than incongruent nonsense syllables. Practically every study also shows that congruence, no matter whether spatial, numeric, or color-related, decreases interference. Table 6 is a summary table of the relationship of congruence to some of the other conditions already examined by various experimenters. There are several conflicting reports. Dalrymple-Alford (1972) found less interference with congruence than with color-unrelated words; however, Pritchatt (1968) found no difference between the color-word congruent condition and the unrelated condition. The data from this study confirmed Pritchatt's findings but with using a congruent condition with color-<u>related</u> words. This study showed the congruent condition to exhibit greater reading time than the control in all three cases, and Sichel and Chandler (1969) found the same result using paired and unpaired stimuli. In contrast, Dalrymple-Alford (1972) and Dyer and Severance (in press) did not

TABLE 6

Mean Reading Time Relationships
Between Conditions

Experimenter	Relationship
Langer & Rosenberg 1966	color-word congruent < color-word incongruent
Dalrymple-Alford 1972	control = related & color-word congruent < unrelated < related incongruent < color-word incongruent
Pritchatt 1968	color-word congruent = unrelated < color-word incongruent
Dyer & Severence in press	black word+ control = bl. word+ color-word congruent < black word+ color-word incongruent
Dalrymple-Alford 1968	word naming = color-word congruent < color-word incongruent
Sichel & Chandler 1969	control < color-word congruent < color-word incongruent (paired and unpaired)
Dyer 1971 at 455 msec.	black word+ color-word congruent < black word + control < black word+ color-word incongruent

find their congruent conditions to differ greatly from their control condition.

Although the evidence is conflicting, a theory of congruence has been emerging which seems to relate encoding, priming, and recall. Dyer (1971) came to the conclusion that congruence is not simply the converse of the incongruent condition. Dyer's conclusion was based on his data of preexposing the color-word in black prior to the same word in congruent or incongruent colors. The preexposing varied from 0 to 500 msec. He found that while the interference decreased from 0 to 500 msec. for the incongruent combination, the congruent condition showed its greatest facilitation relative to the control condition at 200 msec. He states this facilitation implies that parallel processing or encoding of the word and its color can occur concurrently. Viewing congruence in terms of Morton's model and supposing that both the word and the color are processed automatically both outputs from the logogen system would be the same; thus, there would be no interference between two different responses for a one response-available channel. This would also support Morton's notion that interference occurs as responses emerge from the logogen system (Morton, 1969).

The Stroop Test shows consistently that word naming is faster than color naming (or direction reading than naming directions from arrows on a spatial test) on separate tasks (Klein, 1964; Shor, 1970). This indicates faster processing of the word name; so, if they are perceived simultaneously it is possible that the word would flow through Morton's model's channels faster than would its color name. If so, then the word would prime its color attribute before the color would prime its name and attribute. If the response buffer only accepts one symbol as it does in Morton's model, then the word's attribute would be dominent. In the case of congruence, the word's attribute would be correct and time would be saved. However, obviously, for the incongruent condition, time would be wasted since after mediation the word-attribute response would be rejected.

For recall, the model has interesting implications. In the congruent situation, the identical attribute of both word and the color would arrive at the logogen system. Morton's experiments support his contention that learning takes place before output from the logogen network. The same code or learning process would be activated twice in the case of congruence which should increase the efficiency of learning. For the incongruent and unrelated condition, there would be no additive effect. So recall is better in the congruent condition because the same response is primed twice. The data from the present study shows much better recall for the congruent group than for both the unrelated and incongruent group which supports that idea. Dyer (1971) when he flashed the black word at intervals before the congruent-color condition, got so much facilitation that the congruent group was faster than the no-word control condition. The same response perhaps was primed three times in succession.

Grand and Segal (1966) found poor recall with the increase of priming, but they did not use a congruent condition. Also, they did not use words related to color and measured priming by the frequency that cue words elicited those words perceived and primed while naming the color of the ink. He suggested that the "high" arousal condition of color-naming kept the circuits refiring and thus inhibited the response. However, since his words were not color related, he actually only infers his task caused arousal. In fact, control, congruent, and unrelated words cause much less arousal than do incongruent words. He did find that priming occurred for the color-unrelated associates, however.

In the present study, the data showed that the mean recall for color-unrelated words and words from the incongruent conditions were almost equal. The recall of unrelated words was always slightly worse. However, the difference of mean reading time for the incongruent and unrelated condition were significantly different which indicated that the interference and arousal were probably not at the same level for both groups. Also, the incongruent and congruent color words both prime color, and according to Grand and Segal (1966) the congruent condition should also have poor recall. This study found, however, that recall in the congruent condition was consistently superior. The congruent condition has a combination of less interference and more priming than the incongruent group. The interaction of these could be the important difference that facilitates recall. Since the incongruent group also primes the colors for recall, this could be why recall for the unrelated words was inferior.

Houston (1967) found that for an interference task that demands inhibition of a prominent response like the naming of colors of color-words certain kinds of blanket inhibition-distractors facilitate performance. As a distraction, they used noises that consisted of a variety of sounds (trains, dripping water, electronic music, gibberish). The subjects were instructed to completely ignore the sounds. When exposed to these noises and these instructions, they did better on the interference test. It was as if the "set" to ignore was strengthened. It could also be that the crucial difference with congruence is that there is no strong set to ignore. It was found that simply recognizing the pattern did not help recall. Only in Experiment II did pattern recognition seem to overcome the set to ignore. Using the reverberating circuit idea combined with the idea of an inhibition set, it could be that the circuits of the congruent word codes are not inhibited to refire as are those for the incongruent and unrelated words. Grand and Segal's (1966) explaination is that during recall the conflict situation causes a period where items are unavailable for refiring and causes poor immediate recall but because of the continued reverberation would be better consolidated and would exhibit a reminescense effect. This idea could be explored by further experimentation. It could be that the reverberating circuit hypothesis is unnecessary and that the inhibition set is simply not operating in the congruent condition. Also, the inhibition set would explain why the perception of the pattern of congruence occurs over 60% of the time whereas incongruence is never recognized over 20% of the time. Thus, if Morton's model could be expanded to include a "black box" for inhibition set, it would be very economical for illustrating the wide range of data on Stroop and Stroop-like Tests.

To summarize, this paper explored the encoding of attributes and recall of color-related nouns on the serial Stroop Test. Presenting the items tahistoscopically would be another method to use in investigating the encoding process. Also, a PI release paradigm switching from congruent to incongruence and the reverse might also give data on encoding. Words could be printed in congruent colors and then switched to incongruent colors to see if recall is increased or reduced. Although in this study incongruence causes poorer recall, the use of the PI release paradigm might show otherwise. With further experimentation, Morton's rather simple association model could be greatly elaborated to explain more clearly priming and recall.

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