Developmental Neuropsychology
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/hdvn20

The Stroop Color-Word task as a measure of selective attention: Efficiency in the elderly

Eli Vakil [a], Rachel Manovich [b], Esther Ramati [b] & Haya Blachstein [b]

[a] Psychology Department, Bar-Ilan University, Ramat-Gan, 52900, Israel

[b] Psychology Department, Bar-Ilan University, Ramat-Gan, Israel

Published online: 04 Nov 2009.

To cite this article: Eli Vakil, Rachel Manovich, Esther Ramati & Haya Blachstein (1996) The Stroop Color-Word task as a measure of selective attention: Efficiency in the elderly, Developmental Neuropsychology, 12:3, 313-325, DOI: 10.1080/87565649609540655

To link to this article: http://dx.doi.org/10.1080/87565649609540655

DEVELOPMENTAL NEUROPSYCHOLOGY, *12*(3), 313–325

The Stroop Color–Word Task as a Measure of Selective Attention: Efficiency in the Elderly

Eli Vakil, Rachel Manovich, Esther Ramati, and Haya Blachstein
Psychology Department
Bar-Ilan University
Ramat-Gan, Israel

Many studies have reported impaired selective attention in the elderly. Recent studies have isolated various underlying mechanisms of selective attention such as excitation, inhibition, and habituation. In the present study, 50 young adults and 50 elderly participants were compared on four conditions based on the Stroop Color–Word task (neutral, habituation, Stroop and negative priming). Cross comparison of the different tasks enables examination of the various components of selective attention. The neutral condition serves as a baseline for the groups, enabling between-groups comparison of proportional interference. The hypothesis that overall reading time of the younger group would be faster than that of the older group was confirmed. The hypothesis that the overall reading time pattern between task conditions would be neutral < habituation < Stroop < negative priming, was confirmed as well. Contrary to our prediction, negative priming caused more interference than the Stroop task for the elderly participants in the comparison between the Stroop and the negative priming conditions. This effect was found whether reading time or proportional interference was measured. Furthermore, in reading time, but not in the proportional measure, the effect was even stronger in the elderly than in the young participants. These results are discussed in terms of the unique characteristics of the Stroop Color–Word task.

Recent studies have attempted to isolate the underlying mechanisms of selective attention. A dual mechanism model for selective attention has been suggested

Requests for reprints should be sent to Eli Vakil, Psychology, Department, Bar-Ilan University, Ramat-Gan, 52900, Israel.

(Neill, 1977; Tipper, 1985). Two processes are involved: *excitatory,* where the selected object receives further analysis, and *inhibitory,* where the distractor that evokes competing responses is actively inhibited. Unlike early theories of selective attention that assumed passive decay of unattended information (Kahneman, 1973), Lorch and Horn (1986) proposed an additional mechanism, *habituation,* which takes place when stimuli are presented repeatedly. However, Tipper and Cranston (1985) argued that the inhibitory mechanism could account for habituation. Cowan (1988) considered habituation as reflecting inhibition of information as it becomes increasingly less novel.

Many studies have reported that selective attention is impaired among the aged (Layton, 1975; Madden, 1983; McDowd & Filion, 1992). Results suggest that the elderly's ability to inhibit attention to irrelevant stimuli is impaired (Hasher & Zacks, 1988). Using a reading task in which older and younger adults had to ignore distracting material, Connelly, Hasher and Zacks (1991) reached a similar conclusion, since the elderly had more difficulties in ignoring distracting information. Age-related inhibitory decline is evident from findings such as increased intrusion errors by elderly participants in a free recall task (Fuld, Katzman, Davis, & Taffy, 1982; Stine & Wingfield, 1987).

One paradigm frequently used to evaluate efficiency of the inhibitory mechanism is negative priming. Negative priming is the slowing down of response to a target stimulus that had been a distractor on the previous trial, since the response was inhibited. Thus, the process of selective attention involves an inhibitory mechanism that suppresses response to distractors. The more efficient this mechanism is, the stronger the negative priming effect, since the response to the new target (which was the distractor) must overcome stronger inhibition. Accordingly, lack of the negative priming effect is viewed as evidence of an impaired inhibitory mechanism (Neill, 1977; Tipper, 1985).

The Stroop Color–Word task (Stroop, 1935) is frequently used as a measure of selective attention as well as of negative priming (Lowe, 1985; Tipper, Bourque, Anderson, & Brehaut, 1989). In the standard administration of the Stroop Color–Word task, participants are presented with a list of words that are color names (e.g., *green, red*). Each word is printed in different colored ink. The order of words and colors is random, and participants are asked to name the color while ignoring the conflicting word. Several studies in the literature have reported that the Stroop Color–Word task is affected significantly by age. Elderly participants performed more slowly than younger individuals on color naming and interference tasks (Cohen, Dustman, & Bradford, 1984; Comalli, Krus, & Wapner, 1965; Comalli, Wapner, & Werner, 1962). In order to elicit the negative priming effect with the Stroop Color–Word task, the distractor in the previous display (i.e., the same word) is used again as the subsequent target color. Thus, in order to respond correctly, one must first inhibit an overlearned response to a meaningful word that automatically activates the word's meaning. In the next item participants are required to respond to the same color that was previously inhibited (Neill, 1977; Tipper, 1985). Using the Stroop Color–Word task (Lowe, 1985; Tipper, et al., 1989) and Stroop-like task (Tipper, 1985), this negative priming effect was found in young participants. Using the Stroop Color–Word task, Tipper et al. (1989) reported findings of impaired inhibitory mechanism in young children, based on the lack of negative priming. Hasher, Stoltzfus, Zacks, and Rypma (1991), and McDowd and Oseas-Kreger (1991) used a Stroop-like task to test younger and older adults. In this task single letters were used as experimental stimuli. Two letters appeared on the screen: a target in one color (e.g., green) and a distractor in a different color (e.g., red). In the standard control task, participants were asked to name the target letter as determined by the color. Negative priming was elicited by presenting the letters in an order such that the current target letter had been the previous pair's distractor. Both studies (Hasher et al., 1991; McDowd & Oseas-Kreger, 1991) reported a lack of negative priming for the elderly, which was interpreted as an indication of an impaired inhibitory mechanism.

The two studies on the elderly discussed previously focused only on the inhibitory mechanism by using negative priming and an interference task as a control condition. In the present experiment different components of selective attention were tested. In addition to the negative priming and interference conditions, this paradigm includes habituation and neutral conditions. The paradigm used by Tipper et al. (1989) with the original Stroop Color–Word task (not a Stroop-like task) were applied. Most of the studies that used the Stroop Color–Word task or a Stroop-like task analyzed reading time as the dependent measure. It is well documented that slowing in response time is associated with age (Botwinick, 1973). The neutral condition enabled us to generate an additional measure that took into account the basic difference in reading time, thus expressing interference scores (i.e., habituation, Stroop, and negative priming) as proportional scores based on the different reading-time baseline. It is important to note that previous studies included these conditions (e.g., McDowd & Oseas-Kreger, 1991; Tipper et al., 1989), but did not use them to generate proportional scores as suggested here.

The habituation condition was tested because of its theoretical implication when compared with the negative priming condition. Tipper et al. (1989) reported a dissociation in young children between habituation and inhibition mechanisms, since habituation (but not inhibition) functions just as it does in adults. This finding was interpreted to support Lorch and Horn's (1986) claim that habituation is an attentional mechanism distinct from inhibition. In light of this finding, in the present study we addressed the same question in the elderly: Will the same dissociation be evident in the elderly? Or does the breakdown of selective attention in the elderly occur simultaneously in all components?

We tested the neutral condition without any interfering stimuli, to serve as a baseline for the younger and older adults. This condition enables a between-groups comparison of proportional interference by the different interfering conditions.

Such a comparison is important because it takes into account the basic difference in reading speed, which is ignored when only absolute differences are compared. Furthermore, performance on this task can be compared to performance on the Stroop Color–Word task in order to measure the interference effect in the case of conflicting inputs, one of which should be ignored.

The paradigm used by Tipper et al. (1989) was found to be suitable for the purposes of the present study as presented previously. This paradigm consists of four tasks: (a) neutral, (b) Stroop, (c) habituation ("repeated ignored" in Tipper's terminology), and (d) negative priming ("ignored repetition" in Tipper's terminology). These tasks will be described further in the next section.

Based on the preceding selective review of the literature, it was hypothesized that the elderly would be more distracted overall by irrelevant information than would young adults. Thus, the reading-time pattern of the tasks for the young adults group was predicted to be as follows:

1. When groups are compared on the neutral and Stroop conditions, the elderly were expected to have not only slower reading time overall, but it is further expected that they would be slowed down more by the Stroop task than would the young adults. This prediction was based on previous studies showing age-related performance on the Stroop task (Cohen, et al., 1984; Comalli, et al., 1962; Comalli, et al., 1965). A similar pattern of results was expected even when the distractor was constant; the reading time of older adults was expected to be slower than that of young adults (McDowd & Filion, 1992; McDowd & Oseas-Kreger, 1991).

2. Results from previous studies suggest that the elderly's ability to inhibit attention to repeated irrelevant stimuli is impaired. Thus, it was predicted (2a) that when groups are compared on neutral and habituation conditions or (2b) on the Stroop and habituation conditions, the elderly group would derive less advantage from the consistency of the distractors than would the younger group.

3. Finally, when both groups were compared on the Stroop and negative priming tasks, an interaction was expected. Due to the inhibition effect, the younger group was expected to show a slower reading time on the negative priming task as compared to the Stroop Color–Word task. However, due to their impaired inhibitory mechanism, the elderly group was not expected to show such a difference. Previous studies have reported such findings when Stroop-like tasks were used (Hasher, et al., 1991; McDowd & Oseas-Kreger, 1991).

METHODS

Participants

Two groups of participants took part in the present study: a group of young adults and an elderly group. The group of young adults consisted of 50 volunteers (17 men and 33 women) whose ages ranged from 17 to 35 years (M = 22.8) and whose educational level ranged from 10 to 12 years of schooling (M = 11). The elderly group consisted of 50 (20 men and 30 women) participants from two senior citizen community centers, whose ages ranged from 60 to 84 years (mean age = 71.4), and whose educational level ranged from 10 to 12 years of schooling (mean = 11.6). All the elderly, when tested, were alert and oriented to time and place. They were retired middle-income people. All participants were reported to be in good health and had no uncorrected vision or hearing problems. None of the participants had a history of alcohol, drug abuse, or psychiatric illness. Their intellectual and verbal functioning was at a level enabling adequate responsiveness to the task requirements.

Apparatus and Materials

The paradigm used in this experiment was an exact replication of that used by Tipper et al. (1989), with the single exception that in our study we used Hebrew instead of English words. The experiment included four conditions: (a) neutral, (b) habituation, (c) Stroop, and (d) negative priming. Each condition consisted of 90 stimuli; words printed in different colored ink, and in varying order according to the condition.

1. Neutral: The stimuli consisted of three to five *X*s (eg., *XXXX*) printed in different colors.
2. Stroop: The stimuli were names of colors printed in conflicting colored inks, but there was no relationship between successive items on the list.
3. Habituation: The stimulus was the word *green* printed several times in different colors.
4. Negative priming: The color of the print was the same as the printed color name in the previous trial.

The stimuli were printed on white 23 × 16.5 cm cards. They consisted of the words *black, blue, green, red, yellow,* and *brown* (in Hebrew), as well as the row of *X*s. Stimuli measured 1 cm in height, the width varied from 2 to 3.5 cm, and the space between them was 1 cm. Each condition consisted of three cards with 30 stimuli on each card, arranged in three columns of 10 items each. No color appeared successively throughout a list except when required by the condition. In addition to these cards, we composed a color verification card as a test for color blindness. This card consisted of rows of *X*s in the six colors used in the test. An additional card consisting of one example from each of the four conditions served as a practice card.

Procedure

The participants were tested individually, seated in front of the researcher, who measured response time. At the beginning of the session, participants were presented with the color verification card and asked to name the color of each row of *X*s. All participants passed this test. Participants were then told that they would have to name the color in which each word was printed, going from the rightmost to the leftmost column and from top to bottom in each column, which is the reading direction in Hebrew. They were asked to do this as quickly and as accurately as possible. Furthermore, they were told to continue if they made a mistake and not to stop. Participants were then presented with the practice list to test their comprehension of the instructions. The neutral testing condition was always given first. The order of the remaining three testing conditions was counterbalanced. Note that the counterbalancing was not complete insofar as there are six possible combinations of presentation order for the three tests, which cannot be divided fully to the 50 individuals participating in each group. For each condition, the researcher said "start," and when the first color was named, the stopwatch was activated. When the subject named the last color on the list, the watch was stopped. Reading time was recorded by the experimenter at the end of each trial. Errors were not recorded, since in most studies errors were very few and did not contribute beyond the information obtained from the analysis of the reading time measure (e.g. McDowd & Oseas-Kreger, 1991; Tipper et al., 1989).

RESULTS

Mean reading times (in sec) on the neutral, habituation, Stroop, and negative priming conditions for the young and elderly groups are presented in Figure 1. A mixed design analysis of variance (ANOVA) was conducted to analyze the effect of Group (Young and Elderly) × Testing Conditions (Neutral, Habituation, Stroop, & Negative Priming), the former being a between-participants factor and the latter a within-participants factor. Both main effects were found to be significant. Since the interaction between them was significant as well, the main effects should be interpreted cautiously. The significant group main effect, $F(1, 98) = 116.64$, $p < .001$, suggests that overall, the younger group is reading faster than the older group. As can be seen in Figure 1, the significant main effect of testing condition, $F(3, 294) = 156.53$, $p < .001$, demonstrates that the predicted pattern of reading time results was obtained (neutral < habituation < Stroop < negative priming). The significant Group × Testing Conditions interaction $F(3, 294) = 6.64$, $p < .001$, suggests that the increase in reading time from one condition to the other was not identical for both groups.

Follow-up analyses were conducted in order to interpret the results more specifically and to test each of the a priori predictions discussed previously. The first analysis was conducted in order to examine the effect of distractors on age. Wilcoxon *T* tests, contrasting reading time scores of two of the testing conditions (neutral and Stroop), demonstrated significant interference effects in both young and elderly groups ($p < .001$). The increase in reading time from the neutral to the

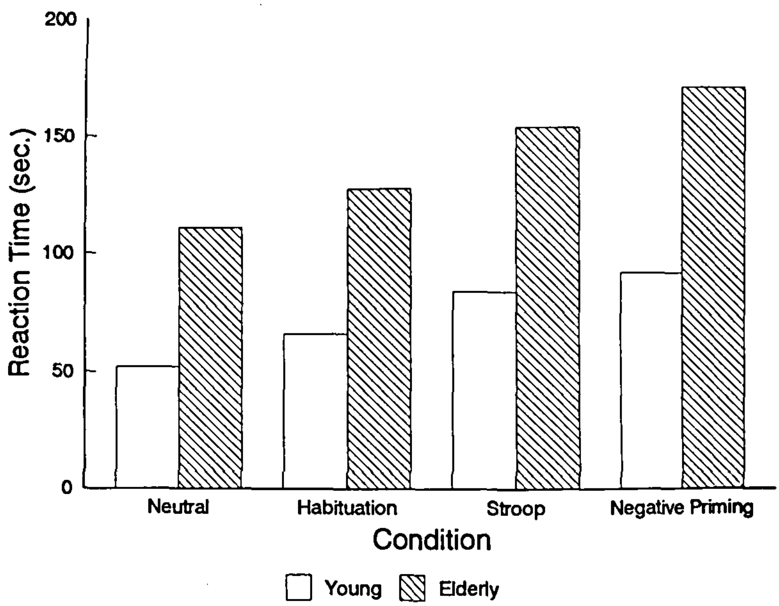

FIGURE 1 Mean reading times on the neutral, habituation, Stroop, and negative priming conditions for the young and elderly groups.

Stroop condition was from 51.94 to 83.32 and from 110.66 to 153.12 for the young and elderly groups, respectively. The increase was significantly greater in the elderly group than in the younger adults group (Mann–Whitney *U* test, $p < .01$).

The next three follow-up analyses were conducted in order to examine both groups' ability to inhibit attention to a repeated irrelevant stimulus: habituation. In the first analysis, groups were compared on the habituation and neutral testing conditions. Wilcoxon *T* tests, contrasting reading time scores of two of the testing conditions (neutral and habituation), demonstrated significant interference effects in both young and elderly groups ($p < .001$). The increase in reading time from the neutral to the habituation condition was from 51.94 to 65.70 and from 110.66 to 126.88 for the young and elderly groups, respectively. The increase in reading time was not significantly greater in the elderly group than in the younger adults group (Mann–Whitney *U* test, $p > .05$). In the second analysis, groups were compared on the habituation and Stroop testing conditions. Wilcoxon *T* tests, contrasting reading time scores of two of the testing conditions (habituation and Stroop), demonstrated significant interference effects in both young and elderly groups ($p < .001$). The increase in reading time from the habituation to the Stroop condition was from 65.70 to 83.32 and from 126.88 to 153.12 for the young and elderly groups, respectively. The increase in reading time was significantly greater in the elderly group than in the younger adults group (Mann–Whitney *U* test, $p < .03$). In the third analysis, groups were compared on the habituation and negative priming testing conditions. Wilcoxon *T* tests, contrasting reading time scores of two of the testing conditions (habituation and negative priming), demonstrated significant interference effects in both young and elderly groups ($p < .001$). The increase in reading time from the habituation to the negative priming condition was from 65.70 to 91.88 and from 126.88 to 170.88 for the young and elderly groups, respectively. The increase was significantly greater in the elderly group than in the younger adults group (Mann–Whitney *U* test, $p < .001$).

Finally, groups were compared on the Stroop and negative priming conditions in order to test the third prediction. Wilcoxon *T* tests, contrasting reading time scores of two of the testing conditions (Stroop and negative priming), demonstrated significant interference effects in both young and elderly groups ($p < .001$). The increase in reading time from the Stroop to the negative priming condition was from 83.32 to 91.88 and from 153.12 to 170.88 for the young and elderly groups, respectively. The increase was significantly greater in the elderly group than in the younger adults group (Mann–Whitney *U* test, $p < .02$).

Since both groups differ on initial reading time in the neutral condition, $t(98) = 10.38$, $p < .001$, a percent interference score was derived in order to reflect the proportional interference of each condition in relation to the different basic neutral condition. This percent interference score was calculated as follows: [(interference condition - neutral condition)/neutral condition] × 100. Thus, three such scores were produced for each interference condition: habituation, Stroop, and negative priming. Figure 2 presents the habituation, Stroop, and negative priming percent interference scores for both young and elderly groups.

The same statistical procedures as discussed previously were conducted using the percent interference scores. A mixed design ANOVA was conducted to analyze the effect of Group (Young and Elderly) × Interference Testing Conditions (Habituation, Stroop, & Negative Priming), the former being a between-participants factor and the latter a within-participants factor. Both main effects were found to be significant, but not the interaction between them. The significant main effect of group $F(1, 98) = 9.20$, $p < .001$, suggests that the younger group, overall, shows more proportional interference than the older group. As can be seen in Figure 2, the significant main effect of testing condition, $F(3, 196) = 156.36$, $p < .001$, suggests that the interference was the least under the habituation and the most under the negative priming condition.

Follow-up analyses were conducted in order to interpret the results more specifically and to test each of the a priori predictions discussed previously. In the first analysis, groups were compared on the habituation and Stroop conditions. Wilcoxon *T* tests, contrasting interference scores of two of the testing conditions (habituation and Stroop), demonstrated significant interference effects in both

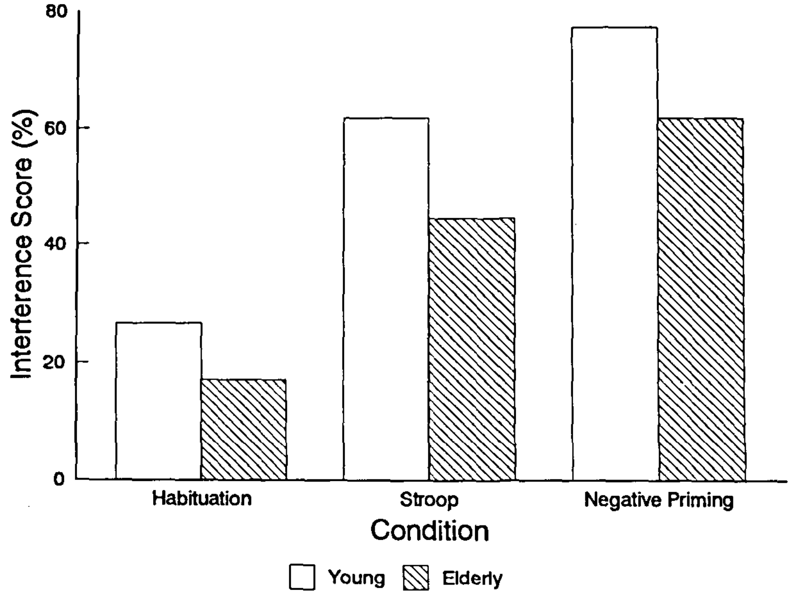

FIGURE 2 Habituation, Stroop, and negative priming percent interference scores, for both young and elderly groups.

young and elderly groups ($p < .001$). The increase in the proportional size of interference from the habituation to the Stroop condition was from 26.61 to 61.54 and from 17.06 to 44.32 for the young and elderly groups, respectively. The insignificant interaction reported previously suggest that this increase was similar in both groups.

Second, groups were compared on the habituation and negative priming conditions. Wilcoxon *T* tests, contrasting interference scores of two of the testing conditions (habituation and negative priming), demonstrated significant interference effects in both young and elderly groups ($p < .001$). The increase in the proportional size of interference from the habituation to the negative priming condition was from 26.61 to 76.84 and from 17.06 to 61.40 for the young and elderly groups, respectively. The aforementioned insignificant interaction suggests that this increase was similar in both groups.

Third, groups were compared on the Stroop and negative priming interference scores. Wilcoxon *T* tests, contrasting interference scores of two of the testing conditions (Stroop and negative priming), demonstrated significant interference effects in both young and elderly groups ($p < .001$). The increase in the proportional interference from the Stroop to the negative priming condition was from 61.54 to

76.84 and from 44.32 to 61.40 for the young and elderly groups, respectively. The aforementioned insignificant interaction suggest that this increase was similar in both groups.

Another possibility is to calculate a proportional change score, using the Stroop score as the baseline to assess proportional slowing in the negative priming condition, that is: [(negative priming - Stroop)/Stroop] × 100. This approach might be more appropriate to control for baseline performance differences. This proportion score yielded 10.49% disruption for the younger adults and 12.48% disruption for the older adults. These two scores did not significantly differ from each other, $t(98) = .62, p > .05$.

DISCUSSION

Results of the raw score analyses showed the expected overall advantage of the younger group over the older group. The younger group's reading time was faster under all conditions. Also confirmed was the hypothesis that the overall reading time pattern between task conditions would be in this order: neutral < habituation < Stroop < negative priming. The significant interactions in this analysis indicates (based on the follow-up analyses) that the increase in reading time from one condition to the other was greater for the elderly than for the younger group (with one exception, when the neutral and habituation conditions are compared). Analyses of the percent interference scores reflect a different aspect of the results. The *younger* group experienced proportionally *more* interference on all tasks. In other words, when basic reading time is taken into account (i.e., neutral condition), the percentage increase in reading time relative to other conditions with interference was higher in the younger group than in the older group. The proportional interference pattern between task conditions was parallel to the above reading time pattern; that is, habituation < Stroop < negative priming (the neutral condition served as the baseline). The lack of significant interaction in this analysis indicates that this group difference is consistent across conditions. Thus, the major findings of our study were the overall slowing in the elderly group's reading time, on the one hand, and more proportional interference in the younger group, on the other hand. While the former was expected, the latter finding was not. However, it is important to note that the greater interference in the younger group is revealed only after the correction for the initial difference in reading speed; in the raw score analysis, the older group did show greater interference as compared to the younger group.

One possible explanation for these findings is that the absence of an age decrement in the interference conditions reflected age difference in task strategies (i.e., a tradeoff of speed vs. accuracy). Elderly participants may be slower and more conservative than younger participants, which in turn serves as an advantage in the interference condition. In light of this, error data should have been recorded. In most reports, error scores yielded exactly the same results as the reading time measure (e.g., McDowd & Oseas-Kreger, 1991; Tipper et al., 1989); however, had error data been recorded in this experiment, they may have given us an indication of this possible tradeoff. Another possible interpretation of these results is that the elderly's significantly slower reading time in the neutral condition reflects the well documented finding of slowing in response time (Botwinick, 1973) or reduced processing speed, particularly when measured by perceptual speed tests, which are reported to be associated with age (Salthouse, 1993). When interference is presented that requires more processing from both groups, the older group is *proportionally* less affected than the younger group. Since the basic reading time is slower, it concomitantly enables the additional processing required by interference. Thus, the final result is that, by comparison with the neutral condition, the younger group has to allocate proportionally more attentional resources. These results emphasize the importance of analyzing data using raw, as well as relative scores, since each scoring system reflects a different aspect of the results. It is important to note that the use of a row of Xs in different colors as the neutral condition, as in Tipper et al. (1989), might not be the best control for simple reading time. It is possible that participants may quickly learn to react to the neutral stimuli as a whole visual image rather than processing the stimuli sequentially, as in reading. Color names printed all in black might be a better baseline for reading time.

At this stage we would like to more specifically address the results obtained in the comparison of the Stroop Color–Word task with the negative priming task. The results suggest that the Stroop condition causes less interference than the negative priming condition. As may be seen in Figure 1, the raw score analysis indicates that although the younger group's reading time is faster, the elderly were more impeded than young adults in transition from the Stroop to the negative priming condition. However, as may be seen in Figure 2, when proportional scores are analyzed by using either the neutral condition or the Stroop condition as the baseline, results suggest that both groups are equally interfered with by the negative priming condition as compared to the Stroop condition.

These results are contrary to our prediction and to previous reports in the literature that expected the younger group to be more interfered by the negative priming condition as compared to the Stroop condition (Hasher et al., 1991; McDowd & Oseas-Kreger, 1991). A possible explanation for our findings is that the slower reading time observed in the elderly group represents a more general reduction of processing speed as suggested previously, based on Salthouse (1993). Thus following, inhibition also may be processed slower. If this is indeed so, such sequential trial examinations might provide an advantageous setting to find the effects of such "delayed" inhibition. Another possible interpretation for this discrepancy in the findings may lie in the different paradigms used: a Stroop Color–Word task in the present study and a *Stroop-like* task in the other studies that tested the elderly (Hasher et al., 1991; McDowd & Oseas-Kreger, 1991). Many researchers have discussed the unique aspects of the Stroop Color–Word task (e.g., Tipper & Cranston, 1985). We would like to emphasize three of these differences that, in our opinion, are crucial with regard to involvement of the inhibitory mechanism. First, in the Stroop test format, the target and the distractor stimuli are presented in the *same perceptual* object, whereas in the Stroop-like task the two stimuli are presented separately, next to each other (Tipper & Cranston, 1985). Second, in the Stroop Color–Word task, in order to respond correctly, one must first inhibit an *overlearned* response to a meaningful word that automatically activates the word's meaning (e.g., the word *red*), while the Stroop-like paradigm lacks such an overlearned association between the colors and the letters. Third, the distractor stimulus is in *conflict* with the target stimulus (i.e., the word *red* is printed in green ink), while in the Stroop-like task the distractors are different but not conflicting. These characteristics are absent in the Stroop-like task; therefore, the distractor stimuli in the Stroop Color–Word task are much more difficult to ignore, and cause much more interference. This may have possibly activated the inhibitory mechanism in the elderly, while the Stroop-like task did not. Hasher and her colleagues (1991) acknowledge the fact that older adults show some kind of inhibition, but suggest that selective attention is possible without suppressing the distractor. This suggestion seems reasonable in the Stroop-like task because of the aforementioned differences, provided the distractor is weak and causes little interference. However, as shown in our study and in previous studies (Burke & Light, 1981), the elderly do eventually respond to selected targets such as the Stroop Color–Word task. Further research is required to understand the underlying processes of the different tasks that may account for the different results.

This finding also has theoretical implications regarding the question of whether habituation is a separate attentional mechanism (Lorch & Horn, 1986), or a product of the inhibitory mechanism (Tipper & Cranston, 1985). Our results based on both the raw and proportional data analysis support the latter, since there is no dissociation between habituation and inhibition. It would be interesting to see similar analyses of the Tipper et al. (1989) data since children and young adults also have a very different baseline reading time.

Finally, although very few studies take into account the effect of person-related variables such as anxiety and self-awareness, undoubtedly they have some effect on performance, particularly when tested under pressure, as in the present task. An effect on performance in such conditions would especially be observed in elderly participants. Thus, future studies should at least make an attempt to either control for, or measure, such parameters.

REFERENCES

Burke, D. M., & Light, L. L. (1981). Memory and aging: The role of retrieval processes. *Psychological Bulletin, 90,* 513–546.

Botwinick, J. (1973). *Aging and behavior: A comprehensive integration of research findings.* New York: Springer.

Cohen, N. B., Dustman, R. E., & Bradford, D. C. (1984). Age-related decrements in Stroop color test performance. *Journal of Clinical Psychology, 40,* 1244–1250.

Comalli, P. E., Jr., Krus, D. N., & Wapner, S. (1965). Cognitive functioning in two groups of aged: One institutionalized, the other living in the community. *Journal of Gerontology, 20,* 9–13.

Comalli, P. E., Jr., Wapner, S., & Werner, H. (1962). Interference effects of Stroop Color–Word test in childhood, adulthood and aging. *Journal of Genetic Psychology, 100,* 47–53.

Connelly, S. L., Hasher, L., & Zacks, R. T. (1991). Age and reading: The impact of distraction. *Psychology and Aging, 6,* 533–541.

Cowan, N. (1988). Evolving conceptualizations of memory storage, selective attention, and their mutual constraints within the human information-processing system. *Psychological Bulletin, 104,* 163–191.

Fuld, P. A., Katzman, R., Davis, P., & Taffy, R. D. (1982). Intrusions as a sign of Alzheimer dementia: Chemical and pathological verifications. *Annuals of Neurology, 11,* 155–159.

Hasher, L., Stoltzfus, E. R., Zacks, R. T., & Rypma, B. (1991). Age and inhibition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 17,* 163–169.

Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. In G. H. Bower (Ed.), *The psychology of learning and motivation,* (Vol. 22, pp. 193–225). San Diego, CA: Academic Press.

Kahneman, D. (1973). *Attention and Effort.* Englewood Cliffs, NJ: Prentice-Hall.

Layton, B. (1975). Perceptual noise and aging. *Psychological Bulletin, 82,* 875–883.

Lorch, E. P., & Horn, D. G. (1986). Habituation of attention to irrelevant stimuli in elementary school children. *Journal of Experimental Child Psychology, 41,* 184–197.

Lowe, D. G. (1985). Further investigations of inhibitory mechanisms in attention. *Memory and Cognition, 13,* 74–80.

Madden, D. J. (1983). Aging and distraction by highly familiar stimuli during visual search. *Developmental Psychology, 19,* 499–507.

McDowd, J. M., & Filion, D. L. (1992). Aging, selective attention, and inhibitory processes: A psychophysiological approach. *Psychology and Aging, 7,* 65–71.

McDowd, J. M., & Oseas-Kreger, D. M. (1991). Aging, inhibitory processes, and negative priming. *Journal of Gerontology, 46,* 340–345.

Neill, W. T. (1977). Inhibition and facilitation processes in selective attention. *Journal of Experimental Psychology: Human Perception and Performance, 3,* 444–450.

Salthouse, T. A. (1993). Speed mediation of adult age differences in cognition. *Developmental Psychology, 29,* 722–738.

Stine, E. L., & Wingfield, A. (1987). Process and strategy in memory for speech among younger and older adults. *Psychology and Aging, 2,* 99–110.

Stroop, J. R. (1935). The basic Ligon's theory. *American Journal of Psychology, 47,* 499–504.

Tipper, S. P. (1985). The negative priming effect: Inhibitory priming by ignored objects. *The Quarterly Journal of Experimental Psychology, 37A,* 571–590.

Tipper, S. P., Bourque, T. A., Anderson, S. H., & Brehaut, J. C. (1989). Mechanisms of attention: A developmental study. *Journal of Experimental Child Psychology, 48,* 353–378.

Tipper, S. P., & Cranston, M. (1985). Selective attention and priming: Inhibitory and facilitatory effects of ignored primes. *The Quarterly Journal of Experimental Psychology, 37A,* 591–611.