Two experiments investigated the effects of preceding sentence context on the naming times of sentence completion words in third-grade children and college students. In the first study, subjects were shown incomplete sentences with four types of target words: best completions; semantically and syntactically appropriate, but less likely completions; related associates of the best completion words; and anomalous words. In the second experiment, the target words consisted of those that were both semantically acceptable in the sentence and semantically related to the best completion words; words which were semantically acceptable in the sentence but not strongly related to the best completion words; and semantically unacceptable completion words that were not strongly related to the best completion word. After the incomplete sentence was flashed on a screen, the target word appeared. Students were told to read the target word aloud as rapidly as possible. Results showed that contextual facilitation effects were observed both for highly predictable and for semantically appropriate (but less likely) completions. In both cases, the facilitation effect was much greater for children than for adults. Children also exhibited contextual interference for anomalous word completions, whereas no such effects were observed in adults. (Materials used in the study are appended.)
Age Differences In Context Effects

Automatic, Attentional, And Interactive Processes:
Age Differences In The Nature Of Words Affected By Sentence Context

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Abstract

The effects of preceding sentence context on the naming times of sentence completion words were investigated in third-grade children and college-grade students. Contextual facilitation effects were observed for both highly predictable and for semantically appropriate (but less likely) completions. In both cases, the facilitation effect was much greater for children relative to adults. Children also exhibited contextual interference for anomalous word completions, whereas no such effects were observed in adults. Developmental differences in context effects were negligible for associatively related words which were semantically inappropriate in the sentence. The results were interpreted in terms of a two-factor automatic expectancy/semantic integration model. Both factors are assumed to operate across a wide range of reading experience. Facilitation effects were attributed to both factors. Interference effects were attributed to a semantic integration process operating in children on a word by word basis.
Many recent studies have explored the effects of preceding sentence context on children's visual word identification latency (Perfetti & Roth, 1981; Schwantes, 1981, 1982; Stanovich, West, & Feeman, 1981). In such studies, the student typically reads an incomplete sentence (e.g., The little boy fell down and started to) followed by a sentence completion target word which is to be identified (e.g., cry). Using this procedure three basic findings have been obtained with children.

(a) Target words which are semantically congruous with the preceding sentence show shorter identification latencies than the same words presented without prior context. This facilitation effect is also present in adults, although the magnitude of such facilitation is greater for children as compared to adults (Schwantes, 1981; Schwantes, Boesl, & Ritz, 1980). (b) Target words which are semantically incongruous with the preceding sentence show longer latencies relative to a no-context condition. This interference effect is quite marked in children but it is relatively negligible in adults (Schwantes et al., 1980; West & Stanovich, 1978). (c) The degree of context effect in children varies as a function of the probability that the particular target word is elicited by the context (Perfetti, Goldman, & Hogaboam, 1979; Schwantes et al., 1980).

The theoretical framework typically used to explain these findings combines an interactive compensatory assumption (Stanovich, 1980) with a two-process time-locked model of expectancy (Posner & Snyder, 1975; Stanovich & West, 1981). The interactive compensatory assumption
postulates that word identification is based on simultaneous accumulation of information from several knowledge sources. A deficiency in one source may be compensated for by greater use of information from other sources.

The two-process time-locked expectancy model postulates that two expectancy processes are activated by preceding context. The first process is characterized as a fast-acting, automatic spreading activation operation which produces contextual facilitation without corresponding interference. The second expectancy process is characterized as a slower-acting directed attention operation which produces both facilitation beyond that from the automatic expectancy process, as well as interference.

Word identification ability is assumed to function so rapidly in adults that only the fast-acting, automatic expectancy process has time to operate, producing contextual facilitation. In young children, word identification ability is assumed to function more slowly (Schwantes, 1981) so that the slower-acting directed attention expectancy process has time to operate, producing both relatively greater contextual facilitation for correct expectancies and interference for incorrect expectancies. Thus, a number of researchers have suggested that the effect of context on word identification is influenced primarily by a directed attention process in children and by an automatic spreading activation process in adults. In addition to accounting for the differential magnitudes of contextual facilitation and interference between children and adults, this type of explanation also has implications for the degree of specificity of the context effect observed in children as compared to adults.

The purpose of the present study is to investigate whether the size and nature of the set of words potentially influenced by sentence context
is greater in adults than in children. The basic argument presented here is that the automatic expectancy process has a general facilitation effect which covers a relatively wider range of words; while the attentional expectancy process has a more specific facilitation effect which covers a much narrower set of words. If this is the case, then sentence context may potentially influence and facilitate the identification of a much broader range of words in adults than in children. Consequently, although the magnitude of contextual facilitation is greater in children as compared to adults, this facilitation effect is hypothesized to cover a much smaller set of words in children than in adults.

The automatic spreading activation process as described by Collins and Loftus (1975) assumes that each concept in memory is represented as a node in a semantic network. Each concept node is linked to other nodes which are associated with or which describe properties of that concept. When the semantic and syntactic constraints of a sentence context activate a concept, the signal spreads outward from that concept activating other nodes in the network. The degree of activation of an associated node is influenced by a number of factors, including the time elapsed since activation, the distance and number of paths between these nodes, and the strength of the association between the particular nodes in the network pathway. The result of activation of a node is to make that node easier to access, such that less sensory information is required to identify the word which names the node concept. Contextual facilitation is assumed to occur whenever the concept named by the target word is activated by the sentence information. Within this framework, sentence context should activate the nodes which represent those words that best fit or best
complete the sentence. There are however at least two additional classes of words which may be potentially activated: other semantically and syntactically appropriate, but less likely completion words in the sentence; and words which are associated with or related to the best completion word. Thus maximum facilitation should occur for the words which best fit the sentence information, but some automatic facilitation should also occur for words which form acceptable, but less likely completions to the sentence, as well as for words that are highly related to the best completion word. In addition, the automatic spreading activation process does not affect the retrieval of information from nodes which are not activated by the sentence context. Thus, the automatic activation expectancy process is predicted to produce a general contextual facilitation effect for a broad range of words, but should not produce an interference effect for words which are incongruous with preceding context. Some adult data consistent with this notion have been reported by Kleiman (1980).

In contrast, the directed attention expectancy process as described by Posner and Snyder (1975), LaBerge and Samuels (1974), and Stanovich and West (1981) has been characterized as a means of responding to a preceding cue or context by directing a limited-capacity processor to the memory location of the expected stimulus. In comparison to the automatic spreading activation process, the number of concept nodes that can be activated by attentional expectancy is sharply reduced. If the expected stimulus word is presented, the processing of that stimulus should be facilitated. If instead a different stimulus occurs, the reader must shift attention away from the expected word to a new memory
location so that information can be accessed. In this sense the operation of the directed attention mechanism serves to inhibit the retrieval of information from an unexpected location until the limited-capacity processor is shifted to that location. Within this framework, the effect of sentence context will be one of facilitation for those words that best fit or best complete the sentence. Given the focus of attention on a dominant predictable item, the identification of other appropriate but less likely word completions and of related word completions may not be facilitated.

**Experiment 1**

In the present study developmental differences in the size and nature of the set of words primed by sentence context were investigated by varying the degree of relationship of the presented target word to the word which best completed the preceding sentence context. Four types of target words were presented following an incomplete sentence: best completions; semantically and syntactically appropriate, but less likely completions; related associates of the best completion words; and anomalous words. Best completion words and appropriate less likely words were determined from a sentence completion task. Related associates of best completion words were determined from a word-association task. Anomalous completions were produced by randomly interchanging best completion target words across original contexts. If children's word identification is affected primarily by the directed attention process, then contextual facilitation might be observed only for the best completion targets. As suggested by the data of Schwantes et al. (1980), context use in young readers may be of specific benefit only
when the stimulus item is accurately predicted. Adults' word identification, however, is assumed to be affected primarily by the automatic spreading activation process. For adults, greatest contextual facilitation should be observed for best completion targets, but some facilitation should also be observed for appropriate less likely completions and for related associates of best completions.

Method

Subjects. The subjects were 18 third-grade children (with a mean age of 8-6 and a range of 7-10 to 9-0) and 18 college students (with a mean age of 19-5 and a range of 18-0 to 21-4). The children were volunteer participants recruited from an elementary school serving both a small urban and a rural community. The college students were volunteer participants recruited from an introductory psychology class at a four-year university.

Stimuli. The test stimuli consisted of 108 nine-word sentences (see Appendix A). Each sentence was presented to the subject in two parts: the sentence context containing the first eight words of the sentence, and the target word which completed the sentence. Each target word formed one of four different sentence completion conditions: best completion, less likely completion, related completion, or anomalous completion. The 108 test stimuli were derived from an initial pool of 180 nine-word sentences. This larger pool of stimuli was presented in a sentence completion task. This task was administered to 25 students from each of the third and college grade levels. None of these students participated in any other portion of the study. In this task the first eight words of each sentence were read to the students, after
which they wrote down the word they believed best completed that sentence.

A different set of thirty incomplete sentences was read to the same groups of students on each of six successive school days. One hundred forty-four best completion words were obtained from this task.

A best completion word was defined as that word which was provided as the completion word to the sentence by both at least 80% of the third graders and by at least 80% of the college students. For example, the context "Out in the rain he got cold and" was completed with the target word "wet" by 96% of the third graders and by 96% of the college students. All of the test sentences used in the study had best completion words, but these words were only presented as target words in the best completion condition.

Fifty-four of these best completion words and their contexts were randomly chosen to serve in the best completion target word condition. Averaging across these sentences, the mean percentage of students from each grade who responded with the same best completion target words was 95.9 for third graders and 95.4 for college students.

A less likely completion word was defined as a semantically and syntactically appropriate word to the sentence that was provided as the completion word in the sentence completion task by both between 4% and 20% of the third graders and by between 4% and 20% of the college students. For example, the context "He jumped in his car and away he" was completed with the word "drove" by 4% of the third graders and also by 4% of the college students. Eighteen less likely word completions and their corresponding sentence contexts were selected from the above pool of 90 remaining stimuli and were used in the less likely completion target word condition. Averaging across these sentences, the mean
percentage of students from each grade who responded with the same less likely but appropriate completion words was 5.6 for third graders and 6.9 for college students.

Related completion words were obtained by using the remaining 72 best completion words from the sentence completion task. These words were employed as stimuli in a word association task. This task was administered to 25 students from each of the third and college grade levels. Again, none of these students participated in any other portion of the study. In this task each stimulus word was read to the students, immediately after which they wrote down the word they thought of after listening to the stimulus word. A different set of twenty-four stimulus words was read to the same groups of students on each of three successive school days. A related word was defined as that word which was provided by both the third graders and by the college students as the most frequent associative response to the stimulus word. For example, the word "under" was given as the most frequent response to the stimulus "over" by third graders (60% responded with "under") and by college students (56% responded with "under"). This word was then presented as a related completion target with the context "They went to bed after the movie was". Eighteen such related words and their corresponding sentence contexts were selected for use in the related completion target word condition. Averaging across these target words, the mean percentage of students from each grade who responded with the most frequent word associate was 56.4 for third graders and 55.1 for college students.

Eighteen of the remaining best completion words and their sentence contexts were randomly chosen for use in the anomalous completion target
word condition. Stimuli in this condition were constructed by randomly re-pairing completion words with contexts. For example, the context "All the children got up to go to" was paired with the target completion "street".

All subjects saw the same 108 target words, although presentation of each target word in the context versus a no-context condition was counterbalanced across subjects. Seventy-two target words were preceded by an eight-word context and 36 target words were presented without preceding context (the no-context condition). The 72 targets in the context condition were comprised of 36 best completions, 12 less likely completions, 12 related completions, and 12 anomalous completions. Ordering of the 108 test trials comprising the no-context and the four context target completion conditions was random.

Three different lists of the 108 test trials were constructed. In each list two-thirds of the words of every target completion condition were presented in the context condition and the remaining one-third of these words was presented in the no-context condition. Across lists every target word appeared equally often in the context condition and every target word appeared equally often in the no-context condition. Two different random orderings of the trials were used for each list. No subject saw the same target word or sentence more than once during the course of the experiment.

Apparatus. Separate negative slide photographs were constructed for each eight-word context and for each target word. Blank negatives were constructed for the no-context condition. These slides were back-projected onto a translucent screen by two Kodak Carousel slide
projectors. One projector contained the context and blank slides; the other projector contained the target word slides. The images of the two projectors were aligned so that the target word appeared directly below the context. The subject sat approximately 55 cm from the screen. A five-letter word subtended a horizontal visual angle of approximately 2.0 degrees.

Target onset was controlled by a Lafayette electronic shutter attachment that was placed over the lens of the projector that contained the target slides. When the experimenter pushed a control button the shutter opened immediately and the projected image of the target word appeared on the screen. A Hunter Kolckounter, accurate to the millisecond, was started by the same push of the control button. When the subject responded verbally to the target, a voice-activated relay stopped the clock and closed the shutter. The microphone that led to the voice-activated relay was situated on the table directly in front of the subject.

Procedure. Subjects were tested individually in a session that lasted approximately 20 minutes. They were told to read aloud the sentence context that appeared on the screen in front of them. Immediately after the subject pronounced the last word of the context (or when a blank no-context slide was presented, immediately after they said "ready"), the target word appeared on the screen. Subjects were told to read the target word aloud as rapidly as possible. The subjects were told that only the response to the target word was timed, so they were free to read the context at a comfortable pace. The session began with the presentation of eight practice
trials. This was followed by presentation of the 108 test trials. A brief rest period was provided following the completion of each quarter of the test trials.

Results and Discussion

Trials on which the target word was incorrectly named and trials on which the response time was greater than 2000 msec were scored as subject errors and were dropped from the reaction-time analysis. The mean reaction time and the mean percentage of errors in each condition are displayed in Table 1. As may be observed in that table, response accuracy was quite high in each condition and the overall percentage correct was 93.0 for third graders and 98.6 for college students.

The mean reaction times for correct responses for each subject in each condition were used in a 2 (grade) x 2 (context presence vs. absence) x 4 (target condition) analysis of variance. The major outcome of this analysis was a significant triple interaction of grade x context x target condition, $F(3, 102) = 6.51, p < .01$. As indicated in Table 1, the context effect (difference between the no context and context condition) is greater for children than for adults, although the magnitude of this developmental difference varies as a function of target condition. Follow-up analyses were conducted for each target condition. In the best completion target condition, follow-up analyses indicated that a significant contextual facilitation effect was present both for third grade students, $F(1, 17) = 64.75, p < .01$, and for
college students, $F(1, 17) = 67.99, p < .01$. A significant grade x context interaction in this condition reflected the observation that the magnitude of facilitation was significantly greater for the third graders, $F(1, 34) = 10.78, p < .01$.

A parallel set of findings was obtained in the less likely completion target condition. A significant contextual facilitation effect was present both for third grade students, $F(1, 17) = 11.34, p < .01$ and for college students, $F(1, 17) = 8.52, p < .01$. The magnitude of this facilitation effect was again significantly greater for third graders, grade x context interaction, $F(1, 34) = 4.58, p < .05$. As may be seen in Table 1, the degree of contextual facilitation in the less likely target condition for each grade level was much smaller than that obtained in the best completion target condition.

In the related target condition the magnitude of contextual facilitation was also smaller than that obtained in the best completion target condition, although the main effect of context was still significant, $F(1, 34) = 6.48, p < .05$. The relatively larger context effect observed for the third graders did not significantly differ from that of the college students; the grade x context interaction was not significant.

In the anomalous target condition, it may be seen that contextual interference was present for third grade students, $F(1, 17) = 9.42, p < .01$, but not for college students, $F < 1$. The grade x context interaction was reliable, $F(1, 34) = 7.59, p < .01$.

The developmental findings in the best completion and anomalous target conditions replicate those from other studies (e.g., Schwantes,
1981; West & Stanovich, 1978) in that relatively greater contextual facilitation as well as contextual interference effects were found for children, but only contextual facilitation was found for adults. Such findings have been interpreted in terms of directed attention processes operating in children and spreading activation processes operating in adults. On the basis of such an interpretation, it was hypothesized that adults, but not children, would also show facilitation in the less likely and related target conditions. Only the adult data were consistent with this hypothesis. Significant contextual facilitation was present for adults in the less likely and related target conditions. These findings are compatible with the operation of an automatic spreading activation process in adults. For children, contextual facilitation was also present in the less likely target condition and this facilitation was significantly greater than that observed for adults. This finding suggests that the directed attention process operating in children may be described as one which enhances the identification of several words which would be semantically acceptable within the sentence context frame. The contextual facilitation effect in children may be strongly related to the general semantic acceptability of the word within the sentence.

It must be pointed out, however, that performance in the related target condition shows a similar developmental trend, albeit nonsignificant, to that obtained in the less likely target condition. Marked contextual facilitation was again present for children. Pertinent to this finding are the observations from a post-hoc examination of the stimuli employed in this related target condition.
This examination revealed that several of the target words used in this condition were not only related to the best completion word, but were also semantically acceptable within the sentence context (e.g., the context "When I get sick my mother calls the" was paired with the target word "nurse"). Other related target words were not semantically acceptable within the sentence context (e.g., "The fire will burn for a very long" was paired with the target word "clock").

The mean response times for these two types of related target words (semantically acceptable and semantically unacceptable) were calculated for each age group. For the related target words which were semantically acceptable, it was observed that the degree of contextual facilitation was much greater for children relative to adults. This developmental difference was similar in magnitude to that obtained for the less likely target words. However, for the related target words which were semantically unacceptable, it was observed that the degree of contextual facilitation, and, in particular, the developmental differences in contextual facilitation were relatively attenuated.

Because the number of trials presented to each subject was so few for each of these two types of related targets, no statistical analyses were performed on these data. Nevertheless, this post-hoc breakdown of the data yields information which is consistent with the notion that the process underlying the relatively greater context effects on children's word recognition speed is not so much linked to a single specific expectancy operation, but may be more closely linked to the semantic acceptability vs. unacceptability of the words within the sentence frame. This notion was investigated more directly in the second
There were two findings of particular interest from Experiment 1 which provided the impetus for the second experiment. First, contextual facilitation was significantly greater in children as compared to adults for those target words which were less likely completions to the sentence, although still semantically acceptable in the sentence. Second, although sentence context facilitated recognition of those target words which were related to the best completion word, a post-hoc inspection of these data indicated that such facilitation was markedly greater for children relative to adults only when the related completion words were also semantically acceptable in the sentence.

One aspect of this second experiment includes an attempt to replicate the finding of developmental differences in degree of contextual facilitation for less-likely completion target words. However, the major focus of this second experiment is to examine the hypothesis that developmental differences in contextual facilitation would be obtained for semantically acceptable words, regardless of their degree of semantic relatedness to the best completion word. Four types of target words were presented following an incomplete sentence: words which were both semantically acceptable in the sentence and semantically related to the best completion word; words which were semantically acceptable in the sentence but not strongly related to the best completion word; semantically unacceptable completion words which were related to the best completion word; and semantically unacceptable completion words which were not strongly related to the
best completion word.

Method

Subjects. The subjects were 20 third-grade children (mean age 9-1, range 8-6 to 9-8) and 20 college students (mean age 18-7, range 17-6 to 20-11). Subjects were recruited in the same fashion as described in Experiment 1.

Stimuli. The test stimuli consisted of 112 nine-word sentences (see Appendix B). As in the first experiment, stimulus presentation consisted of the preceding sentence context followed by the sentence completion target word. Each target word formed one of four different sentence completion conditions: acceptable-related, acceptable-unrelated, unacceptable-related, or unacceptable-unrelated. The 112 test stimuli were taken from the pool of 144 best completion words obtained in Experiment 1. As in Experiment 1, all test sentences had best completion word endings; however, in the present experiment none of these best completion words was paired as a target with its corresponding sentence.

Target words used in the two related completion conditions were obtained as in Experiment 1. In the acceptable-related completion target condition, 28 words were used which were acceptable in their sentence contexts and which were also related to the best completion words for these sentences. For example, the word "snow" was given as the most frequent response associate to the stimulus "rain" by third graders (40% responded with "snow") and by college students (48%). This word was presented as an acceptable-related target with the context "The sky turned dark and it started to". Averaging across these target words, the mean percentage of students who responded with the most
frequent word associate was 45.6 for third graders and 46.9 for college students.

In the unacceptable-related completion target condition, 28 words were used which were semantically unacceptable in their sentence contexts, but which were related to the best completion words for these sentences. For example, the word "dog" was given as the most frequent response associate to the stimulus "tail" by third graders (40%) and by college students (48%). This word was presented as the unacceptable-related target with the context "Every fox has a white tip on its". Averaging across these target words, the mean percentage of students who responded with the most frequent word associate was 40.6 for third graders and 46.1 for college students.

In the acceptable-unrelated completion target condition, 28 words were used which were defined as were the less likely target words in Experiment 1, with the additional restriction that none of these words was given as the most frequent response associate to the best completion word. For example, the context "The children got on the horse for a" was completed with the word "picture" by 4% of the third graders and also by 4% of the college students. Averaging across the stimuli in this condition, the mean percentage of students from each grade who responded with the same less likely but semantically appropriate completion words was 5.1 for third graders and 4.9 for college students. This condition is most analogous to the less likely target condition of Experiment 1.

In the unacceptable-unrelated completion target condition, 28 words and their contexts were re-paired such that the targets were
both semantically unacceptable in their sentence contexts and unrelated to the best completion words for these sentences. For example the context "Johnny grew up to be a fine young" was paired with the target completion "shoe". This condition is most analogous to the anomalous target condition of Experiment 1.

All subjects saw the same 112 target words although presentation of each target word in the context versus the no context condition was counterbalanced across subjects. Half of the target words were preceded by an eight-word context while the remaining half were presented without preceding context (the no context condition). The 56 targets presented in the context condition were comprised of 14 targets from each target completion condition. Ordering of the 112 trials was random.

Two different lists of the 112 test trials were constructed such that those words presented in the context and no context conditions in list one were presented in the no context and context conditions, respectively, in list two. Across lists every target word appeared equally often in the context and no context conditions. Two different random orderings of the trials were used for each list. No subject saw the same target word or sentence more than once during the course of the experiment.

Apparatus and Procedure. The apparatus and procedure were the same as those described in Experiment 1.

Results and Discussion

Trials on which the target word was incorrectly named and trials on which the response time was greater than 2000 msec were again
scored as subject errors and were dropped from the reaction time analysis. The mean reaction time and the mean percentage of errors in each condition are displayed in Table 2. As may be observed in that table, response accuracy was very high in each condition and the overall percentage correct was 95.5 for third graders and 96.5 for college students.

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The mean reaction times for correct responses for each subject in each condition were used in a 2(grade) x 2(context presence vs. absence) x 4(target condition) analysis of variance. The major outcome of this analysis was a significant triple interaction of grade x context x target condition, $F(3, 114) = 13.07, p < .01$. As indicated in Table 2, the context effect is greater for children than for adults, although the magnitude of this developmental difference varies as a function of target condition. Of particular interest is the observation that the developmental difference in size of the context effect is very similar in the acceptable-related and acceptable-unrelated target conditions; and that this developmental difference in context effect magnitude is markedly reduced in the unacceptable-related target condition. The attenuation of developmental differences in context effect size in this latter condition is due primarily to a relatively smaller context effect for third graders.

Follow-up analyses were conducted for each target condition. In the acceptable-related condition, significant contextual facilitation
was present for both third graders, \( F(1, 19) = 13.48, p < .01 \), and for college students, \( F(1, 19) = 5.96, p < .05 \). A significant grade x context interaction in this condition reflected the observation that the magnitude of facilitation was significantly greater for the third graders, \( F(1, 38) = 4.23, p < .05 \).

An identical pattern of findings was obtained in the acceptable-unrelated condition. A significant contextual facilitation effect was present both for third grade students, \( F(1, 19) = 14.12, p < .01 \), and for college students, \( F(1, 19) = 5.59, p < .05 \). The magnitude of this facilitation effect was again significantly greater for third graders, grade x context interaction, \( F(1, 38) = 4.97, p < .05 \).

In the unacceptable-related condition, the magnitude of the context effect was similar across grade levels, and the grade x context interaction was not significant. The main effect of context was significant in this condition, \( F(1, 38) = 5.64, p < .05 \).

In the unacceptable-unrelated condition, it may be seen that contextual interference was present for third grade students, \( F(1, 19) = 40.87, p < .01 \), but not for college students, \( F < 1 \). The grade x context interaction was reliable in this condition, \( F(1, 38) = 27.00, p < .01 \).

For adults, significant contextual facilitation was obtained for target words which were semantically acceptable in the sentence context, both when these targets were presented in the related and in the unrelated condition. In addition, significant contextual facilitation was obtained for adults when the target word did not complete the sentence in a meaningful way, but was still related.
to the best completion word. The degree of contextual facilitation obtained for adults was quite similar across these three conditions, and very comparable to those obtained for adults in the less likely condition and in the related condition of Experiment 1. Across both experiments, greatest facilitation was obtained for adults in the best completion condition of Experiment 1. Although of lesser magnitude, significant facilitation effects were also obtained for target words which were semantically acceptable but far less predictable in the context than the best completion words; and significant facilitation effects were obtained for target words which were related associates to the expected words. Thus, for adults a general contextual facilitation effect was obtained across a broad range of semantically acceptable words and words related to semantically acceptable words.

Of greater interest is the observation that for the third graders, contextual facilitation was also present in the two conditions when the target word was semantically acceptable in the sentence context, even though this word was not the dominant expected completion item. Furthermore, the magnitude of the facilitation effect in these semantically acceptable conditions was significantly greater for third graders as compared to adults, regardless of the degree of relatedness of the target to the best completion word. These developmental findings replicate those obtained in the less likely target condition of Experiment 1. In the unacceptable-related target condition the degree of contextual facilitation for third graders was sharply reduced, as was the developmental difference in contextual facilitation.
Across both experiments, the largest developmental difference in facilitation was present in the best completion condition of Experiment 1. Pronounced developmental differences in facilitation effects were also present for semantically acceptable target words which were much less predictable in the sentence context than the best completion items. However, developmental differences in contextual facilitation were negligible for target words which were related to the best completion word, but which were not also semantically acceptable in the sentence context. Thus, the semantic acceptability of the word in the sentence context has a much greater influence on children's as compared to adults' word identification times, both when the word is highly predictable, as well as when it is much less predictable in the sentence context.

**General Discussion**

The present study was designed to investigate developmental differences in the size and nature of sentence context effects on word identification latency. Three major findings were obtained. Each of these findings is pertinent to one of the three predictions derived from the processing-time, interactive-compensatory model of reading (Stanovich, 1980). First, it was predicted that for highly predictable best completion words, greater facilitation from preceding context would be obtained for third graders relative to adults. The results from the best completion target condition of Experiment 1 are consistent with this prediction. Second, it was predicted that children, but not adults, would display interference effects for contextually anomalous words. The results from the anomalous
target condition of Experiment 1 and from the unacceptable-unrelated target condition of Experiment 2 are consistent with this prediction. Third, it was predicted that adults, but not children, would display contextual facilitation effects for less predictable words and for words related to the best completion words. In the less likely condition of Experiment 1 both the adults (as predicted) and the children (contrary to prediction) displayed marked contextual facilitation effects. These findings were replicated for both age groups for the low probability targets in the acceptable-related and in the acceptable-unrelated conditions of Experiment 2.

The first and second findings replicate the prior results obtained by Schwantes (1981), Schwantes et al. (1980), and West and Stanovich (1978). This pattern of findings has been interpreted previously in terms of the influence of an automatic spreading activation process on adult performance and the influence of a slower-acting directed attention expectancy process on children's performance. The adult data from the third finding are also consistent with this interpretation, but the child data from the third finding are not consistent with this interpretation.

The overall college grade data in the present study are quite compatible with the notion that an automatic spreading activation process is the primary influence on the contextual effects observed in adults. Adults' word recognition times displayed contextual facilitation not only for highly predictable words, but also for semantically acceptable—less predictable words, as well as for semantically unacceptable words which were associatively related.
to the best completion word. In these latter two conditions, the
target words were less likely to benefit from conscious predictions,
but were likely to benefit from the activation which spreads from
words primed by the sentence context. The findings in these conditions
are consistent with the operation of a general automatic semantic
priming effect. This effect may result not only from individual words
in the sentence, but also from inter-word combinations which prime the
semantic network (Schwantes, in press; West & Stanovich, 1982).

The overall child data and the pattern of developmental findings
in the present study are not consistent with the operation of a
directed attention expectancy process as the major influence on
the children's performance. The attentional expectancy process
has been characterized as producing contextual facilitation for
a relatively narrow range of items. The finding that children's
word identification time was contextually facilitated across a wide
range of semantically acceptable words in the sentence context
(for low-predictable words, as well as for dominant completion ites)
is difficult to account for in terms of the directed attentional
expectancy process. In fact, the completion probability of the
semantically plausible, low predictable words in Experiments 1
(less likely condition) and 2 (acceptable-related and acceptable-
unrelated) was so low that if conscious expectan es were being
generated, interference for these words would be expected; a result
that was not obtained in any of the low probability semantically
acceptable target conditions of the present study. It should be
noted that the low probability words in these conditions were neither
less familiar nor more difficult to read.

While the children's data are not consistent with the operation of an attentional expectancy process, neither is their performance entirely consistent with an interpretation based solely on an automatic spreading expectancy operation. Two sets of developmental findings must be taken into account in attempting to provide a general conceptual framework for understanding the children's data. First, children showed relatively greater degrees of contextual facilitation than adults when the target word was semantically congruent with the sentence. This finding was obtained whether the word was the best completion item or a less likely completion item (Experiment 1). This developmental difference for low probability items was replicated in the two semantically acceptable target conditions of Experiment 2. Second, children displayed contextual interference in both experiments, whereas no such interference was present for adults.

A potentially useful framework for conceptualizing the obtained pattern of developmental findings may be provided by an expectancy/integration model of context effects. This model includes the interactive-compensatory assumption and distinguishes between contextually based effects from an automatic expectancy process and contextually based effects from an attentional-integrative process. Both of these processes are assumed to operate across a wide range of reading experience. The automatic expectancy process, as described earlier, is assumed to operate via spreading activation which primes a relatively large set of words in accordance with their degree of relationship in the associative semantic network. These activated
words require less perceptual information for recognition, and thus contextual facilitation (but not interference) is produced by this process. In addition it is assumed that this automatic process is not under subject control and that it does not deplete cognitive capacity (cf. Stanovich & West, 1983). The major developmental changes associated with this process relate to basic changes in the accessibility and organization of the semantic network.

The attentional-integrative process is not viewed as an expectancy process operating prior to information pick up. Rather it is assumed to focus on and to integrate information incoming from different processing levels (visual, lexical, syntactic, semantic) and to make decisions based upon this combined information. Contextual information may either facilitate or interfere with this integration process. The operation of this process is conceptualized as being similar to the general decision making problem solver in McClelland's (1979) cascade model and in Forster's (1979) language processing model. The attentional-integrative process, like the automatic expectancy operation, is assumed to operate in the same general fashion in both children and adults, i.e., information from different sources is combined and a decision concerning this information is obtained; but unlike the automatic expectancy operation, this process is assumed to require cognitive capacity. The major developmental changes associated with this process relate to the size of the linguistic frame which is being focused on and integrated. Young readers may focus their attention on integrating that information which is directly pertinent to individual word identification and meaning. Since word identification is one of the primary aspects of early reading development, the young reader's attention
may be captured by and focused upon this process. More experienced readers may focus their attention on extracting meaning from larger units (e.g., phrases, clauses) and on integrating this with the overall message meaning. Thus, the underlying processes of automatic expectancy and attentional integration are operative in and serve similar functions in both children and adults; the key difference is the size of the linguistic frame being attended to during the attentional integrative process.

Within this expectancy/integration model, contextual facilitation for word identification may stem from automatic spreading activation as well as from the attentional-integration process. In relatively young readers contextual expectancy effects are automatic (West & Stanovich, 1978), but word recognition may not yet be automatic (cf. LaBerge & Samuels, 1974) and the focus of attention is on integrating that information which is directly pertinent to word identification. As in adults, the automatic expectancy process serves to delimit and prime a potential pool of relevant words. Recognition of any of these primed words will be facilitated as a result of this process. However, encoding of visual information is still relatively slower in younger readers (Maisto & Baumeister, 1975; Schwantes, 1981, 1982) and in poorer readers (Maisto & Sipe, 1980; Perfetti & Roth, 1981; Simpson, Lorsbach, & Whitehouse, 1983) and this allows additional time for information from the message processor (Forster, 1979) to have an effect on the information accumulating from word identification. Information from the message processor may affect word recognition directly by facilitating the ongoing processing of visual and lexical information or it may function indirectly by increasing
the accessibility of the processed visual and lexical data to the general problem solver. In either case, recognition of those words which are semantically plausible with the meaning of the sentence would be facilitated. In adults, word recognition is typically automatic (an exception would occur when the stimulus word is visually degraded, see Schitzes, 1981; Stanovich & West, 1979). When word identification is automatic, the attentional integrative process is still operative, but it is assumed to be directed toward higher levels of semantic extraction, formation of inferences, etc. Under normal comprehension demands this process does not influence automatic word recognition.

Contextual interference with children's word identification is not assumed to stem from incongruities with conscious expectancies or predictions. Rather, within the present model, interference with word identification results from the focus of the attention-integration process at the level of word recognition and extraction of individual word meaning. When integration is occurring word by word and an anomalous word is presented, the decision maker may detect an incompatibility between the meaning of the recognized word and the information from the message processor concerning the meaning of the prior sentence context. Under such conditions, additional analyses may be performed (e.g., conducting a second look at the visual information, checking for additional meanings of the recognized word, attempting to revise the context meaning, etc.). These additional analyses require time and may slow down decision and response processes, resulting in a contextual interference effect (for a similar suggestion see Mitchell & Green, 1978). Thus, when the attentional-integrative process is operating in
a word by word fashion, as may be the case with young readers, contextual interference for anomalous words will be obtained. When this process is focused on extracting and integrating the meanings of larger units (e.g., phrases), as may be the case with adults, then contextual interference with recognition of an individual word may not be obtained.

The failure to obtain interference for the third graders in the unacceptable-related condition may initially appear to be inconsistent with the proposed source of interference in the present model. However, this apparent inconsistency does not render the distinction between the expectancy effect and the integrative effect less useful. Rather this finding suggests that additional empirical work is required to sharpen the definition of semantic incompatibility and to delineate the conditions under which such an incompatibility may be detected. For example, the finding for children in the unacceptable-related condition of Experiment 2 might be explained if it is assumed that semantic compatibility for children at the word level consists of merely the detection of either an associative relatedness and/or of a semantic relatedness with prior contextual material.

In summary, an expectancy/integration model has been proposed to account for developmental differences in the effects of context on word recognition. This model shares some general similarities to that recently described by Stanovich and West (1983). The model assumes that sentence context activates a single expectancy process that affects word recognition. This process is assumed to be automatic and it is assumed to operate in both young children and adults. Contextual effects at the level of word recognition may also derive from an attentional-integration
process which operates during, but not prior to, the analysis of incoming information. If word recognition in young readers is not automatic, their attention may be focused on integrating different sources of information at the word level. In this case, contextual effects on word recognition beyond that from automatic expectancy may be observed. In adults, word recognition is assumed to be automatic. Consequently, their attention may be focused elsewhere, e.g., on integrating higher levels of information, forming inferences, etc. In this case, contextual effects on word recognition may derive only from automatic expectancies. An interesting speculation is that a transition phase occurs during the middle to later elementary school years. During this transition phase, word recognition may become automatic, but integration of the semantic message may still occur on a word by word basis. The integration process may consist of a post-recognition comprehension check of each word with the sentence meaning. This would result in a similar degree of facilitation as that found in adults (and smaller than that obtained with younger readers), but a greater degree of interference as compared to adults. The empirical results from the sixth grade data of West and Stanovich (1978), Schwantes et al. (1980), and Schwantes (1982) are consistent with such speculation.
References


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<th>&amp; TARGET</th>
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<td>House</td>
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</table>

(table continues)
I heard my stomach growl because I was hungry. My balloon got away and I couldn't catch it. The door was locked so I used my key to open it. I fell off my bike and skinned my knee. The children stopped to take a good look. I liked him from the first time we met. To buy a present I need some more money. I've eaten so much I can't eat any more. It is hard to get up in the morning.

Everyone went home so I was all by myself. She remembered my face but she forgot my name. She don't have a pencil useful a pen. Both fall out put them under your pillow. The lady in the library said to be quiet. The sky turned dark and it started to rain. My father always uses too much pepper and salt. The farmer told us that wool comes from sheep. I had to ask her to tie my shoe. The cat curled up and soon went to sleep. He looked at the sun and the blue sky.

<table>
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## Context

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<td>sister</td>
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<td>94</td>
<td>brother</td>
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</table>

The cat chased and tried to catch the bird.
Johnny has five big brothers and one little sister.
The baseball hit the house and broke the window. The lake, which covered "beautiful dark blue water," was a favorite spot. The children went to slice in one big hole. The elevator broke so we walked up the stairs. The children got there before it was dark. I went to bed because I was so tired. The elevator broke, so we walked up the stairs. They all went to ice cream in one big hole. The wine was empty. No one drove it. The tree was empty. No one drove it. They didn't want to tell now and then. She didn't want to tell now and then.
Age Differences in Context Effects

Table:

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Anomalous Condition

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</table>

Johnny grew up to be a very fine young man.
The caboose is the last car in the train. My mother and the teacher had a long talk. Sometimes I forget because I have a bad memory. Do drive to work in his big new car before you eat make sure your hands are clean.

The new baby is a be not a mother and dad all away on a long trip. We waited a long time for something to happen. The children watched the cars go down the street. I couldn’t see because the sun was too bright. All the children got up to go to school. Dad works up the top floor of the building.

Chickens and fish are two foods I really like.

Means
They went to school in a big yellow WIC.

To buy a present I need some more money.

He hit the ball right between the man's legs.

Susie knew the answer so she raised her hand.

What time today is the race going to start?

My room was so dark that I got scared.

The baseball hit the house and broke the window.

Mary went over to stay at her friend's house on the top floor of the building.

I didn't go to school because I was sick.

I fell off my bike and skinned my knee.

I couldn't see because the sun was too bright.

She turned on the light so she could see.

Last Saturday turned out to be a beautiful day when I got sick my mother calls the doctor.

<table>
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<tr>
<th>Context</th>
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<td>To buy a present I need some more money.</td>
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<td>He hit the ball right between the man's legs.</td>
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<tr>
<td>Susie knew the answer so she raised her hand.</td>
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<tr>
<td>What time today is the race going to start?</td>
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<td>My room was so dark that I got scared.</td>
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<td>The baseball hit the house and broke the window.</td>
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<td>Mary went over to stay at her friend's house on the top floor of the building.</td>
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<tr>
<td>I didn't go to school because I was sick.</td>
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<td>I couldn't see because the sun was too bright.</td>
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<td>She turned on the light so she could see.</td>
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</tr>
<tr>
<td>Last Saturday turned out to be a beautiful day when I got sick my mother calls the doctor.</td>
<td></td>
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</table>
I never want to do anything like that again.

The children watched the car go down the street. They were excited. I went to bed because I was so tired.

This week the farmer told us that wool comes from sheep. The little girl fell and started to cry.

Instead of watching TV let's listen to some music. We can dance.

All the children got up to go to school.

The little girl fell and started to cry.
My father likes to have some peace and
I stopped at the store on my way.
I promised my husband I would always love
I always wished that I could fly like a
He looked at the sun and the blue
I can't go today but I can go
The caboose is the last car in the
I'm not going to worry about it very
My aunt wanted me to write her a
They went to bed after the movie was
The pen was empty so I threw it.
The children got on the horse for a
Johnny has five big brothers and one little
On the playground we run around and have
He was staying with his aunt and his
He put all his money in the downtown
They all went to sleep in one big
Bananas and oranges are my favorite kinds of
He took something to drink because he was
He spoke so softly that I could not
Means

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Unacceptable Related Condition

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<th>Context</th>
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<th>%</th>
<th>Target</th>
<th>%</th>
<th>%</th>
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<td>apple</td>
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<td>cheese</td>
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<td>It is dark in the middle of the night</td>
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<td>80</td>
<td>day</td>
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<td>90</td>
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<td>before you eat make sure your hands are clean</td>
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<td>40</td>
<td>dirty</td>
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<td>Every fox has a white tip on its tail</td>
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<td>80</td>
<td>dog</td>
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<td>Out in the rain he got cold and wet</td>
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<td>96</td>
<td>dry</td>
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<td>eyes</td>
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<td>Mother and Dad are away on a long trip</td>
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<td>He jumped in his car and away he went</td>
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<td>80</td>
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<tr>
<td>I've eaten so much I can't eat anymore</td>
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<td>100</td>
<td>less</td>
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<td>It was the very best time I ever</td>
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<td>Everyone wore home so I was all by myself</td>
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<td>96</td>
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</table>

(table continues)
### Table 1

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<td>93.1</td>
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<td>50.1</td>
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</table>

### Unacceptable Uncorrelated Condition

The tire will burn for a very long time.

I heard my stomach growl because I was hungry.

Before eating dinner I had to set the table.

I got an invitation to go to the party.

His hair was so long he got it cut.

The little girl was stung by a big bee.

She asked me the secret but I wouldn't tell.

Green, blue, and red are my very favorite colors.

I went to the library to get a book.

Sometimes I forget because I have a bad memory.

I forgot my kitten so my hands were cold.

(Continued)
I go to the pool so I can

I couldn't see because the room was too

do and what he thought was the right

He looked in the kitchen for something so

Then I climbed in and unlocked the front

The door was unlocked so I used my

First he looked over here and then over

If you don't have a pencil use a

Hopscotch and jacks are two fun games to

He failed because he could not subtract or

The new baby is a he not a

I will cut up some wood for the

My father always uses too much pepper and

Johnny grew up to be a fine young

She didn't want to tell how old she

He reached down for the keys in his

My balloon got away and I couldn't catch

Means

<table>
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<tr>
<th>Best</th>
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Note: The values represent the percent of third grade students and college students who responded with the corresponding word in a sentence completion or word association task. The abbreviation "Best Cope" stands for best completion word, and the column labeled "Target Stimulus" is the word actually presented in the experiment.
Footnote

1. Portions of this paper were presented at the meeting of the Society for Research in Child Development, Detroit, 1983. Thanks are extended to the children and staff of Tilton Elementary School, Rochelle, Illinois for their cooperation and to Dayle Ashley and Emily Richardson for their assistance in data collection. Requests for reprints should be addressed to Frederick M. Schwantes, Department of Psychology, Northern Illinois University, DeKalb, IL 60115.
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<td>No Context</td>
<td>Context Effect</td>
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<td>596 (0.02)</td>
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Table 1
Mean Response Times in Msec (and mean error proportions) for Each Grade as a Function of Target Completion Condition in Experiment One.


Table 2

Mean Response Times in Msec (and mean error proportions) for Each Grade as a Function of Target Completion Condition in Experiment Two

<table>
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Error proportions in parentheses.