

# The Effects of Antecedent Color on Reading for Students with Learning Disabilities and Co-Occurring Attention-Deficit/Hyperactivity Disorder

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## Abstract

The effects of color on the reading recognition and comprehension of 3 students with learning disabilities and attention-deficit/hyperactivity disorder were assessed in a single-subject design. Color did not enhance sight-word learning; for longer reading comprehension tasks, color had an immediate effect across and within sessions.

Improved academic attention has been documented for students with attention-deficit/hyperactivity disorder (ADHD) on simple vigilance or writing/copying tasks that add color during initial training trials (e.g., Swanson, Barlow, & Kinsbourne, 1979; Zentall, 1985) and on more complex tasks that add color during later training trials after practice (e.g., Zentall, Zentall, & Booth, 1978). Furthermore, color added late to enhance some component of the relevant instructional stimulus (i.e., added information) improved the more complex performance of students with ADHD (on spelling; Zentall, 1989). It is not known, however, whether color *must* be added late with information or whether nonspecific color is sufficient. Also, previous research has not addressed (a) the generalization of performance gains to other types of complex selective-attention tasks (e.g., reading); (b) the effects of repeated exposure to novel colored stimuli; or (c) the responses of individual students. An understanding of the generalization of group effects to individual students is important for teachers and researchers.

The purpose of this study was to examine the effects of nonspecific antecedent color added late on the word acquisition and reading comprehension of elementary-school students with learning disabilities (LD) and ADHD. We hoped to demonstrate that simple, nonspecific color stimuli embedded late into a task sequence would improve academic performance.

## Study 1: Method

### Participants and Setting

Three students (ages 10 to 11) were identified by their physicians as having ADHD. Their hyperactivity status was confirmed by teacher ratings (a score of 11 or more; Loney & Milich, 1982) on the inattention factor of the IOWA Conners Teacher Rating Scale (Pelham, Milich, Murphy, & Murphy, 1989) and confirmed by a score of 8 out of 14 behavioral items rated "considerably more than other children of the same mental age" on the SNAPz (Zentall, 1990). Age; grade; use of medication; and scores for IQ, hyper-

activity, and reading levels are reported in Table 1.

All students were receiving part-time services in a resource room for students with learning disabilities and were reading at least two grade levels below their grade placement. The criteria for determining eligibility for services for a learning disability followed federal guidelines and Indiana State Rule Article 7. Criteria included a severe discrepancy between the students' achievement and normal potential—Characterized by severe, specific deficits in perceptual, integrative, or expressive processes that severely impaired learning efficiency. Additionally, 1 student, Tim, was classified as emotionally handicapped.

Session settings for all participants alternated between the school counselor's office and the art room. Both settings were similar in that they displayed brightly colored posters and examples of students' art work. The rooms were different in that the art room had windows and was larger (approximately 6 m by 9 m) than the counselor's office (approximately 3 m by 3.7 m).

**TABLE 1**  
Participant Demographics

Students	Age (month/yr)	Grade	Med	SNAPz		Inattention		Aggression		Health Reading Inventory			SRA grade placement	
				no meds	on meds	no meds	on meds	no meds	on meds	WR <sup>a</sup>	OR <sup>a</sup>	C <sup>a</sup>		
Tim	10-4	4	No	7/14	—	14/15	—	7/15	—	94 (Stanford-Binet)	primer	1.0	1.0	2.5
Darrell	11-0	5	20 mg Ritalin daily	14/14	3/14	15/15	10/15	8/15	1/15	119 (WISC-R)	1.0	2.2	2.2	5.0
Jason	11-9	5	20 mg Ritalin daily	14/14	13/14	15/15	10/15	15/15	11/15	92 (WISC-R)	primer	1.0	1.0	1.6

Note. WR = Word Recognition; OR = Oral Reading; C = Comprehension; meds = medications.

<sup>a</sup>Reported in grade equivalents.

## *Experimental Design and Measures*

The effects of color added late on reading was measured, using a single-subject, alternating-treatments design with order of conditions counterbalanced, and replicated across 3 students. The dependent measures were the cumulative frequency of sight words mastered during daily assessment (defined as any target word spoken correctly on two consecutive probes) and, during follow-up, the percentage of mastered sight words spoken correctly when embedded in short sentences.

### *Procedure*

**Baseline Phase.** To create a master list of unknown words, the third-grade Heath text and grade-level science and social studies texts were used. Each word was produced on a laser printer using 14-point black Geneva font, pasted on individual 10.16 cm by 15.24 cm white note cards, and placed in vinyl three-ring binders. Any word the student identified correctly in preliminary assessments was deleted, until each student had a pool of 80 unknown words. To decrease frustration during future assessments, 10 known words were added to each 80-word pool.

The pool of 90 sight words (80 unknown, 10 known) was assessed for 3 days, averaging 6 min per session. For each baseline assessment a word was presented, the student had 3 s to respond, and then the next card was presented. No teacher feedback was provided, and words were scored as correct or incorrect. At the end of each session, the word cards were shuffled, to control for word order effects, and the teacher delivered general verbal praise for participating.

**Intervention Phase.** For the intervention phase, two sets of cards were created, one each for the traditional (black on white) and color conditions. The five cards in the traditional set appeared similar to the baseline cards

(black printed words on a white background). Each of the five words assigned to the color condition appeared on three separate cards, making a 15-card set with three levels of visual stimulation per word. The words in the first level, shown in Trial 1, looked the same as the words in the traditional condition. Trial 2 showed the same training words (printed on a jet ink color printer) in a novel font, color, and style (e.g., outline, bold, shadow). Trial 3 showed the training words in either black or white letters appearing in the center of a 7.5 cm by 2 cm colored box, surrounded by a 10 cm by 3.5 cm white box with a thin colored frame.

Prior to the first intervention session, 10 words were randomly selected from the unknown word pool and placed into two groups of 5. At the start of each intervention session, all 90 words were assessed in a method identical to that in baseline assessment.

Following the assessment probe, training began. Prior to training, cards in the five-word card sets were shuffled. Words in the black-on-white condition were presented, one at a time, then were reshuffled and presented in this sequence twice more, resulting in three opportunities to respond to each training word in this set. In the color-added-late condition, the five words in the black-and-white format were presented first, followed by presentation of the two color versions, also resulting in three opportunities to respond to each training word in the set.

For both conditions, a card was presented and the researcher said, "What is this word?" If the student responded correctly, the researcher said, "Yes, the word is \_\_\_\_." If the student did not respond within 3 s or responded incorrectly, the researcher said, "This word is \_\_\_\_\_. You say it." After the student repeated the word correctly, the researcher said, "Good, the word is \_\_\_\_\_. Thus, the student had an opportunity to say and hear the word correctly each trial. On the average, training duration was 1 min for each

condition. Mastered words were removed from the training set and replaced by new words selected randomly from the pool of unknown words. Mastered words continued to be assessed during daily intervention assessment.

**Follow-up.** One month after the formal training sessions ended, all mastered words were assessed for generalization. Simple sentences, containing an average of 6.85 words each (5 to 9 words), were constructed for each training word. One- or two-syllable nontrained words that added context clues for the trained words were used (e.g., for the trained word "corduroy": "I have a pair of corduroy pants"). The sentences were printed in black 12-point type and pasted onto white index cards. Sentences were presented to the students one at a time. If a student did not know a nontrained word, the word was verbally prompted. Three seconds were allowed for identifying the trained word. After 3 s, a new sentence card was presented.

### *Results and Discussion*

Interobserver agreement on cumulative frequency of mastered sight words across sessions and students was scored from videotapes for 16% of all sessions. Agreement was 100%. Procedural integrity was assessed at 100% by an independent observer to ensure consistency in the application of assessment and intervention.

The main findings showed that all 3 students learned sight words equally well in both the black-on-white and the color-added-late condition (see Figure 1). Discrete tasks of short duration did not seem to be affected by nonspecific color stimuli added late. These findings led us to hypothesize that color added late may affect longer tasks that require extended responding. This hypothesis was consistent with research findings indicating that performance differences have been observed more frequently during later trials for groups of students with

ADHD relative to comparisons (e.g., Zentall, 1985, 1986).

## Study 2: Method

### Participants and Setting

Participants and setting were identical to those described in Study 1.

### Experimental Design and Measures

An alternating-treatments design was used to compare two conditions, counterbalanced within sessions. The dependent measure was the percentage correct on comprehension tests of story facts and concepts. Each test consisted of 10 written questions per story (see Note). Three short-answer questions were constructed for each third of the text, and a tenth question was developed for the overall meaning of the reading passage. Answers were text dependent and not available from inference, wording of another question, or prior experience or knowledge.

### Procedure

**Baseline Phase.** Stories from the SRA Developmental 1 (Parker & Scannell, 1984) and Developmental 2 (Parker, 1987) Reading Laboratories were adapted. Students were assigned to a reading level at which they answered 40% to 50% of the 10 questions correctly for two consecutive stories. (See Table 1 for student reading placement.) SRA stories were retyped in black 12-point, double-spaced type with no pictures or drawings into a single 11.43-cm-wide paragraph on white pages with 4.45 cm justified margins.

**Intervention Phase.** Stories used for baseline assessment and in the black-on-white condition appeared as described above. Stories assigned to the color condition also appeared as described, except they were then

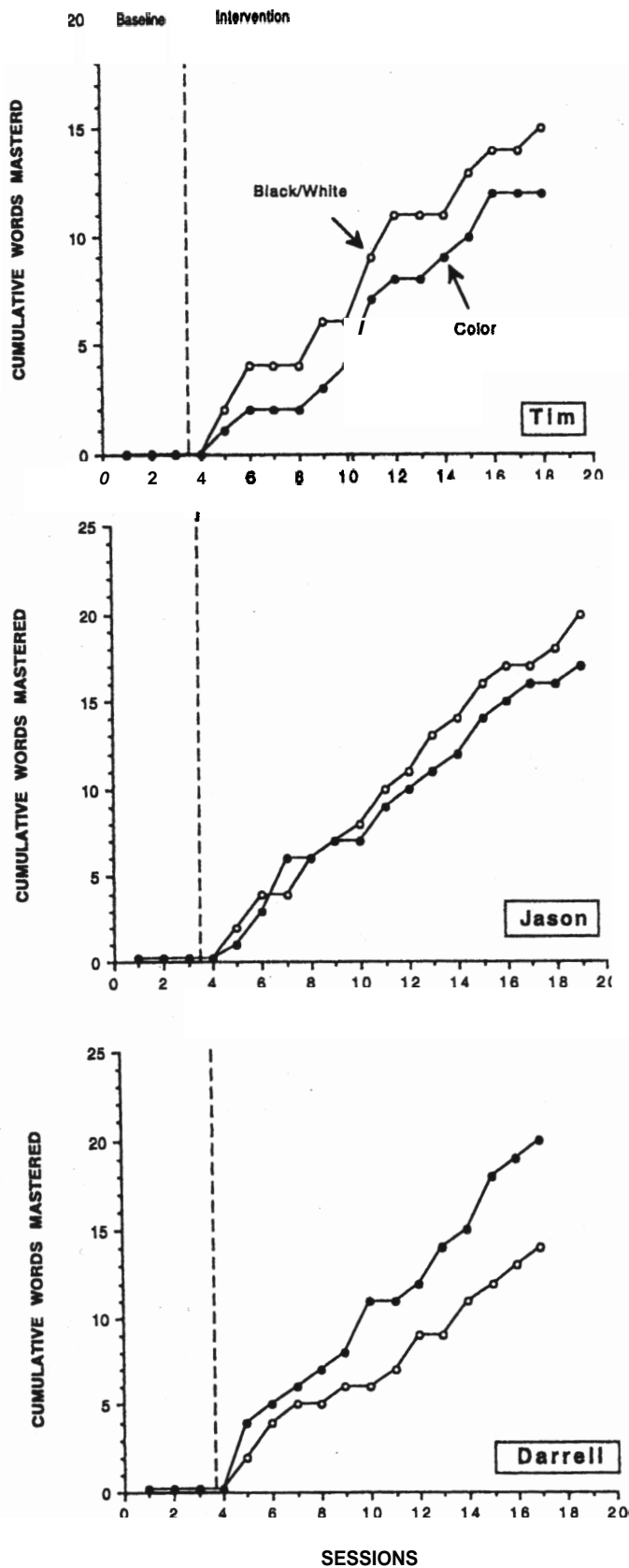


FIGURE 1. Results of Study 1: Cumulative sight-word acquisition.

divided into three passages of equivalent line length and highlighted (.64 cm mark over the entire line of type) with colored markers. The first third of the story was left in the traditional black-on-white format. The second third was highlighted with one of seven subtle, pastel-colored Crayola washable markers (e.g., sky blue, gray, apricot, orchid, pink, spring green). The last third was highlighted with one of seven bright, bold, or fluorescent-colored Crayola markers (e.g., fiery orange, bittersweet, shocking pink, goldenrod, electric blue).

Students were asked to read two stories per session silently at their own pace, one in black on white and one in color added late. When they had finished the first story, they were given the 10 questions, and the process was repeated with the second story and questions. Because students displayed poor handwriting, their written responses were verified before scoring. No feedback on accuracy was given.

## Results and Discussion

Interobserver agreement was collected for a random sample of 25% of the comprehension tests for each student. Agreement was 98% (range = 90% to 100%).

Data were analyzed across and within sessions. Percentage correct across sessions showed that all students increased comprehension accuracy under the color condition, when compared to the black-on-white condition (see Figure 2). Specifically, we compared the first and last assessment sessions during the intervention phase and observed an initial increase in comprehension accuracy during the antecedent color condition for all 3 students. For 2 of the students, this effect did not maintain over sessions.

Second, to assess the effects of antecedent color within a session over the length of a single story, the data were analyzed by question placement order (Questions 1-3 vs. Questions 4-9; see Figure 3). Jason and Darrell showed increased accuracy in reading compre-

hension questions 1 through 3 (pertaining to the first third of the reading passage) in the color condition when compared to comprehension questions 4 through 9 (the last two thirds) in the color condition; and their performance on comprehension questions 1 through 3 in the color condition was better than their performance on comprehension questions 1 through 3 and 4 through 9 in the black-on-white condition.

This initial performance gain can possibly be attributed to anticipating or viewing color in the periphery in the color condition. When color was visible at the bottom two thirds of the text, students initially read more thoroughly. These within-session results from Jason and Darrell are consistent with the across-session effect of color for all 3 students, that is, antecedent color added late had an initial performance effect above that of the black-on-white condition. The within-session results from Jason and Darrell were also consistent with the across-sessions results from Tim and Darrell, that is, initial effects under the color condition "wash out" over time.

Tim's data for within-session question order did not show an initial benefit of color. Thus, for Tim, the anticipation effect of color was not evident. This could be attributed to the fact that he consistently covered the color portion of his stories with his folded arms until he had finished reading the black-and-white section. By "saving" the color until the last two thirds, he may have eliminated the effect of viewing color at the periphery of the page. Thus, color mainly improved the last two thirds of his performance, where color overlapped text.

## Discussion

It has been previously documented that students with ADHD and students with LD (two thirds of whom have attention deficits; Zentall, 1990) fail to maintain attention to lengthy tasks and show a decline in performance

over time due to loss in task novelty. It has also been documented that color added late to some component of a relevant stimulus in a complex (selective-attention) task produces better performance. We do not know, however, whether the gains occurred because color highlighted relevant aspects of the task, or if the presence of nonspecific color could produce similar outcomes for complex tasks of short and longer duration.

In Study 1, we found that all students learned sight words equally well in both conditions, which was attributed to the fact that single-word recognition required only a brief response. In Study 2, using a reading comprehension task of longer duration, we found initial improvements in reading comprehension, within and across sessions, for all 3 students under the color condition. (Tim did not perform as well as the other 2 students initially only in the within-session comparison. Tim covered the lower portion of the page, where the color was overlaid, until the top portion was completed, negating or saving the potential early effects of the additional color.)

That reading comprehension but not reading recognition was sensitive to the color condition is not unexpected. That is, reading comprehension has been documented to produce poorer performance for students with ADHD than for comparisons (Forness, Youpa, Hanna, Cantwell, & Swanson, 1992; Nussbaum, Grant, Roman, Poole, & Bigler, 1990). Reading recognition does not produce group differences, perhaps because reading recognition is not associated with sustained attention.

Overall, these findings show that nonspecific color added to the later part of a lengthy task, but observable throughout the task, may help students with LD and ADHD sustain their attention through (a) early training sessions and (b) initial phases of tasks of long duration. Nevertheless, the results presented here should be viewed as preliminary and provide the basis for future investigations into the area of stimulus novelty and academic per-

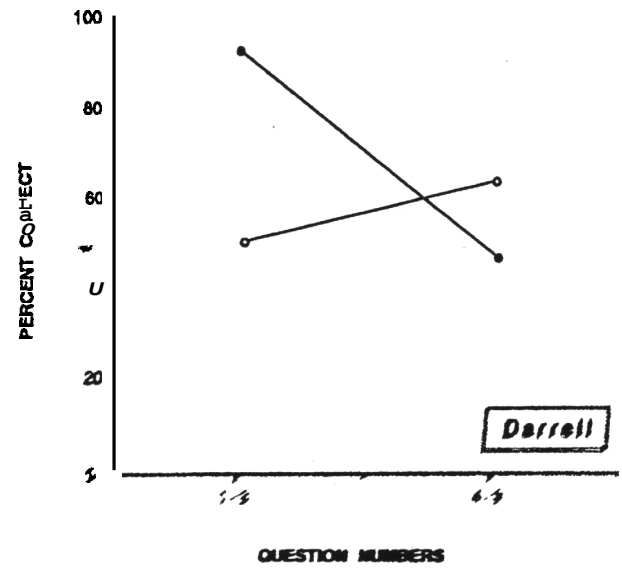
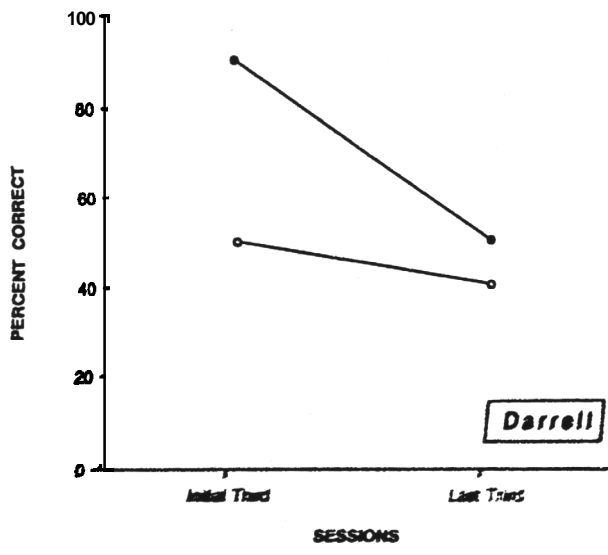
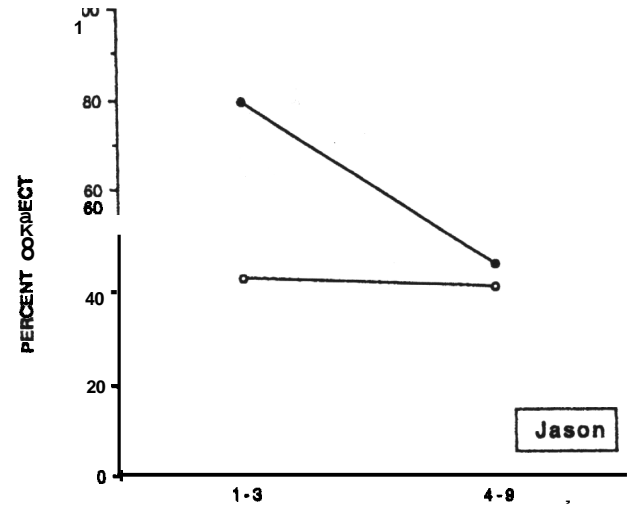
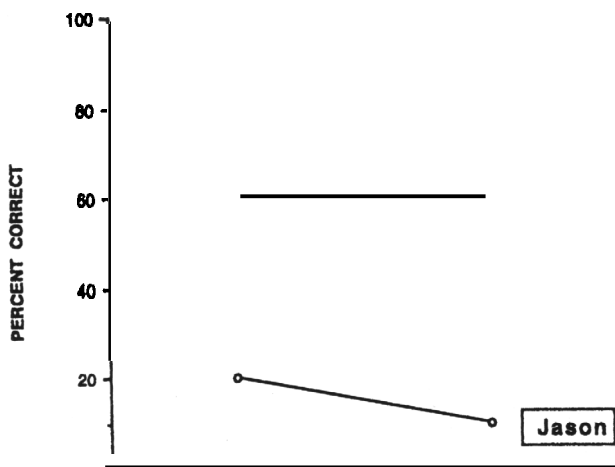
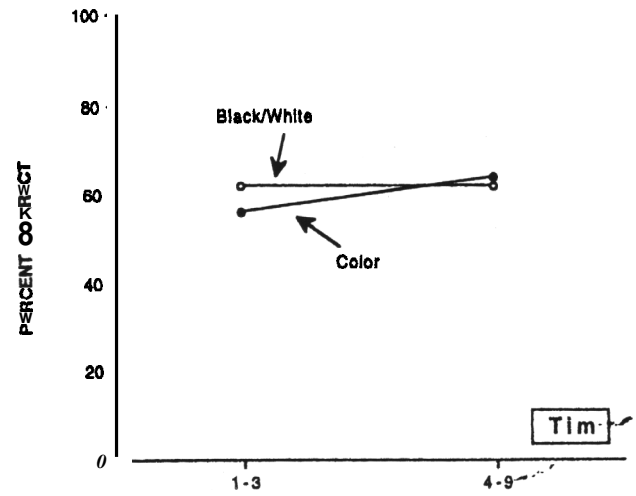
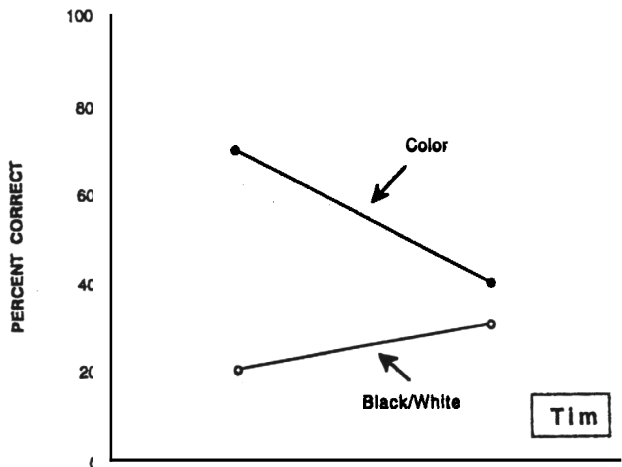


FIGURE 2. Results of Study 2: Percentage-correct reading comprehension on the first and last assessment sessions.

FIGURE 2. Results of Study 2: Percentage-correct reading comprehension for Questions 1, 2, 3 and Questions 4 & 5.

formance. With performance data from only 3 students, additional replications across students are required. Performance observed initially returned to performance similar to that in the black-on-white condition after repeated exposure to the color condition (i.e., after habituation to the color novelty). Because color will always cease to be novel after repeated exposure, researchers and practitioners need to plan for the effects of habituation to novelty interventions. It was observed that students had clear preferences for specific stories, which contributed to performance variability. Story interest may have been more novel than color, because color was repeated whereas story plot changed across and within each session.

From the initial effects demonstrated in this study, we conclude that color has the potential for improving the performance of students with LD and ADHD on a task that does not require repeated sessions (e.g., on a standardized reading test). Nonspecific (non-informational) color added could provide a fair and unbiased assessment of their abilities, in that students with ADHD score lower than their classmates by as much as 10 to 15 points on standardized tests (Barkley, 1990). Other educational implications could be derived from an examination of methods for students to generate their own color novelty (e.g., by selecting and using color overlays or by using color highlighters).

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#### AUTHORS' NOTES

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#### NOTE

Examples of stories with color added and comprehension questions can be obtained from the last author.

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