Behavior Analysis & Technology

Monograph 140526

Assessing Overselective Attention to Words in Young Children: Effects of Single Letter Pretraining

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Abstract

Computer technology was used to administer multiple stimulus-control tests to identify the presence and intensity of overselective attention to words in young children. Identifying overselective attention to words is important since attending simultaneously to individual letters within words is critical for word recognition. In one test, word choice was determined when the S+ word appeared with three comparison words that differed by only one letter. A second test measured response topographies by using a touch screen that automatically recorded which letters the children touched when words were presented. This investigation also examined the effect of single-letter pretraining on how young children attended to words. Determining the amount of single-letter pretraining that is necessary before simultaneous attention to multiple letters occurs is another approach for assessing the intensity of overselective attention to words. While the children responded identically to individual letters during pretraining, they displayed a variety of attentional patterns when the same letters appeared in a word discrimination. Overselective attention was eliminated for two of the four children, however, and reduced for a third child following pretraining and repeated exposure to the word discrimination. The detection of overselective attention to words in young children depended on the type of response measurement. While two of the four children persisted in displaying overselective attention when word choice was assessed, all four children consistently exhibited selective attention to words when their response topographies were recorded. The intensity of their selective attention differed, as only two of the children exhibited letter preferences intense enough to prevent them from simultaneously attending to each letter of the S+ word. Utilizing multiple tests revealed differences in how young children attended to words that wouldn't have been demonstrated by a single test alone. Employing computer technology to administer similar procedures to identify overselective attention to words could result in more effective reading instruction.

Key Words: Overselective Visual Attention, Word Discriminations, Stimulus Overselectivity, Young Children

Behavior Analysis& Technology Monograph 140526, 1 – 21, 2014
Publication Date: 26 May 2014

BA&T Monographs is published by *BA&T, Inc.*, Groton, Massachusetts, USA,
N. H. Huguenin, Editor (contact: nhuguenin@ba-and-t.com)

Children with overselective attention demonstrate restricted attention, as they attend to only a limited number of stimulus elements in a stimulus compound. Overselective attention has often been reported in students with developmental disabilities (Bailey, 1981; Dickson, Deutsch, Wang, & Dube, 2006; Dickson, Wang, Lombard, & Dube, 2006; Dube & McIlvane, 1999; Fabio, Giannatiempo, Antonietti, & Budden, 2009; Huguenin, 1985, 1997, 2004; Koegel & Wilhelm, 1973; Lovaas & Schreibman, 1971; Lovaas, Schreibman, Koegel, & Rehm, 1971; Ploog & Kim, 2007; Reed, Broomfield, McHugh, McCausland, & Leader, 2009; Rincover & Ducharme, 1987; Schreibman & Lovaas, 1973; Schreibman, Koegel, & Craig, 1977; Schreibman, Kohlenberg, & Britten, 1986; Stromer, McIlvane, Dube, & Mackay, 1993; Ullman, 1974; Whiteley, Zaparniuk, & Asmundson, 1987; Wilhelm & Lovaas, 1976), but it can also occur in young children of typical development (Bickel, Stella, & Etzel, 1984; Eimas, 1969; Hale & Morgan, 1973: Huguenin, 2006, 2011; Smith 2005). When overselective attention is chronic, it can affect many areas of a child's development (Burke, 1991; Dunlap, Koegel, & Burke, 1981: Ploog, 2010).

Although previous studies have demonstrated overselective attention in children of typical development (e.g., Eimas, 1969; Hale & Morgan, 1973; Huguenin, 2006; Smith, 2005), none of these investigations determined if overselective attention occurred in children when words were presented. With a few exceptions, studies examining overselective attention in students with developmental disabilities have also not addressed word discriminations. One of the purposes of this investigation was to assess if overselective attention occurred in young children of typical development when word discriminations were presented. If a young child attends overselectively to words, this would affect word recognition and interfere, as a result, with his reading achievement. Attending simultaneously to the individual letters of words is critical for successful reading instruction (Birnie-Selwyn & Guerin, 1997; Saunders, Johnston, & Brady, 2000).

A fine-grained analysis of the control exhibited by the stimulus elements of compound stimuli is needed in order to accurately determine the presence of overselective attention. Multiple stimulus-control tests were automatically administered with computer touch-screen technology in this investigation to provide greater precision in identifying the presence and intensity of overselective attention to words in young children. In one stimulus-control test, which word the child chose was recorded when the S+ word appeared with three comparison words that differed from the S+ word by only one letter. If the child consistently selected the S+ word despite appearing with comparison words differing by only one letter, in each spatial position within the comparison word, attention to each letter of the S+ word was revealed. Previous investigations found similar testing procedures, which directly assessed the presence or absence of simultaneous attention to multiple cues, effective in determining the occurrence of overselective attention in young children of typical development (Huguenin, 2004, 2006, 2011) and students with intellectual disabilities (Huguenin, 1985, 2004; Doughty & Hopkins, 2011).

A second stimulus-control test measured the response topographies of the training and test words using a touch screen that automatically recorded which individual letters the children touched when words were presented. Other studies have employed touch screens for teaching visual discriminations (e.g., Bhatt & Wright, 1992; Cook, Geller, Zhang, & Gowda, 2004; Dube & McIlvane, 1999; Huguenin, 1987; Lynch & Green, 1991; Markham, Butt, & Dougher, 1996; Saunders, Johnston, & Brady, 2000; Stromer et al., 1993), but only a few studies have utilized touch screens for recording the spatial locations of responses to identify which stimulus elements are attended to in visual compounds (Huguenin, 1987, 1997, 2004). Recording response topographies revealed stimulus preferences for both young children of typical development and adolescents with developmental disabilities that their accuracy scores did not indicate (Huguenin, 1997, 2004). Recording response topographies when word discriminations are presented could discover letter preferences and provide, therefore, a more thorough analysis of how young children attend to words.

Multiple stimulus-control tests are needed to verify and confirm test performance. False conclusions can be made about which stimulus elements actually control responding in stimulus compounds if only one test condition is utilized. Misleading assumptions can be made, for example, when accuracy scores across probe trials are summarized since separate controlling stimulus-response relations can be hidden when accuracy scores are averaged together (Bickel, Richmond, Bell, & Brown, 1986;

Bickel, Stella, & Etzel, 1984; McIlvane & Dube, 2003; Sidman, 2008; Stromer et al., 1993). Other test variables can also contaminate test results. Test performance can be altered, for instance, by the reinforcement contingency in effect during the test trials (Huguenin, 2011; Huguenin & Touchette, 1980). This was demonstrated in an investigation where the effect of repeated testing on whether young children learned to attend to each letter of training words depended on the type of reinforcement contingency utilized during the test trials (Huguenin, 2011). If nondifferential reinforcement was employed during test trials, repeated stimulus-control testing for three young children did not produce attention to all three letters of the training words. In contrast, repeated testing with differential reinforcement employed during the test trials eliminated the overselective attention that the children displayed in the initial test sessions. Following extended testing with differential reinforcement, all of the children now attended to each individual letter of the training words.

Even though numerous studies have demonstrated the advantage of multiple test conditions for accurately assessing how stimulus compounds are attended to (Born & Peterson, 1969; Danforth, Chase, Dolan, & Joyce, 1990; Dickson, Wang, Lombard, & Dube, 2006; Fields, 1985; Huguenin, 1987, 1997, 2004; Huguenin & Touchette, 1980; Merrill & Peacock, 1994; Newman & Benefield, 1968; Ploog & Kim, 2007; Sloutsky & Napolitano, 2003; Smeets, Hoogeveen, Striefel, & Lancioni, 1985; Van Laarhoven, Johnson, Repp, Karsh, & Lenz, 2003; Wilkie & Masson, 1976), equipment limitations have prevented multiple testing procedures from being used. Computer touch-screen technology, in contrast, permits different response parameters to be simultaneously recorded when compound stimuli are presented. Utilizing computer technology to administer multiple test conditions could more accurately identify overselective attention to words in children and contribute to the development of procedures for eliminating this attentional deficit.

Assessing how young children visually attend to words under a variety of test conditions, in addition, provides greater precision not only in identifying overselective attention but also its intensity. In a previous investigation (Huguenin, 2011), young children differed in both the number of test conditions and test sessions in which they displayed overselective attention. By employing more than one type of stimulus-control test, not only the reliability of occurrence but also the robustness of overselective attention can be determined. Multiple testing procedures can also discover individual differences in how children attend to words, which a single testing procedure might not reveal. Previous research has shown even children of similar age can vary in how they attend to words (Huguenin, 2008). Presenting multiple test conditions with computer technology in order to identify the presence and intensity of overselective attention to words in young children could result in more effective reading programs.

The present investigation also examined the effect of repeated single-letter pretraining and exposure to a word-discrimination task on how young children attended to words. Single-element pretraining was effective in past research in teaching simultaneous attention to two visual cues for young adults with severe intellectual disabilities (Huguenin, 1985) and young children of typical development (Huguenin, 2006). The amount of single-stimulus pretraining that was required, however, before students simultaneously attended to multiple elements in a visual compound differed across students (Huguenin, 2004, 2006). Determining the amount of single-letter pretraining and exposure to a word discrimination that is needed before a child simultaneously attends to multiple letters could be another parameter for assessing the intensity of a child's overselective attention to words. This type of assessment could assist in identifying if a child has the prerequisite behaviors for reading since attending simultaneously to multiple letters is a requirement for learning to read.

Developing procedures for identifying and eliminating overselective attention to words would be especially beneficial for children with autism and intellectual disabilities due to their high prevalence of overselective attention. Utilizing computer technology to monitor how children with developmental disabilities respond to words would assist in creating more individualized reading instruction since factors contributing to the emergence of reading difficulties for each child could be determined. Demonstrating the effectiveness of behavioral procedures for students of typical development before extending them to students with developmental disabilities is also recommended as critical instructional time for students with developmental disabilities could be lost while attempting to find effective instructional techniques (Broomfield, McHugh, & Reed, 2008a, 2008b).

Method

Subjects

Four young children of typical development participated in the study. Their ages ranged from approximately six to seven years of age, and they had no known sensory, motor, or cognitive impairments. They were enlisted by placing an ad in a local newspaper.

Apparatus

An Apple Macintosh desktop computer with a MicroTouch 14-in monitor was used. Macintosh-standard graphical user interface dialog boxes initialized the sessions. The procedure, data acquisition, and output file generation were fully automated and event-driven.

The computer presented stimuli and recorded responses. When stimuli appeared on the display screen, the computer decoded the correct position for each trial. The computer also kept a running account of trials, stimuli presented, the location on the display screen where the student touched during each trial, as well as response choice. A report was provided following each session that supplied this information. A BCI, Inc. token/coin dispenser was located to the left of each student. This device was operated after each correct response, and pennies dropped into a 9.6- by 14- by 9.6-cm receptacle at the base of the dispenser.

Experimental Design

A within-subject reversal design was employed to evaluate the effect of different stimulus-control testing procedures in revealing how young children attended to words. A within-subject reversal design was also employed to assess the effect of single-letter pretraining on word-discrimination test performance and to determine if original training effects generalized to words containing novel letters.

General Procedure

Each child sat in a chair facing a computer display screen with the author sitting beside the student. Sessions consisted of approximately 80 trials in length. A trial began when words, centered on two white illuminated backgrounds, appeared on the computer screen, and the trial ended when the student touched either illuminated area. If the child touched the correct word, he was reinforced with the delivery of a penny, a flashing computer screen, and verbal praise. If the child touched the incorrect word, however, reinforcement was not provided. At the end of the session, each child exchanged their accumulated pennies for recreational items of their choosing. Word pairs were presented in an unpredictable sequence with the restriction that each word never appeared more than twice in succession in the same location. The words also occurred an equal number of times on the left and right portions of the computer screen. An individual session consisted of approximately 30 pretraining trials, 20 word-discrimination training trials, and 30 word test trials.

Word Discrimination

Each child was presented a word discrimination in which the S+ word and the S- word were presented simultaneously. The children were required to select the S+ word (BAG) to obtain reinforcement. If the S- word (RED) was selected, reinforcement was not provided (see Fig. 1). The word discrimination was presented until criterion accuracy (18/20 trials correct) was achieved to determine baseline performance, and the word discrimination continued to be presented after differing amounts of single-letter pretraining were provided.

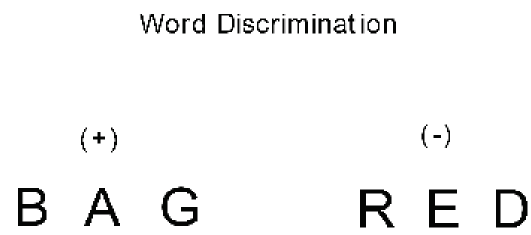

Figure 1. Diagram of the word-discrimination task, which was composed of two consonant-vowel-consonant words. Plus (+) indicates the word (BAG) paired with reinforcement and minus (-) denotes the word (RED) paired with nonreinforcement. The word-discrimination task was presented until the child achieved 90% accuracy in a block of 20 trials.

Single-Letter Pretraining

Single-letter pretraining was accomplished by teaching the children to attend to each letter of the S+ word (BAG). Stimulus control by the letter (B) in the S+ word was obtained by making the letters (A and G) common to both the S+ word (BAG) and the S- word (RAG) and consistently pairing the letter (B) with reinforcement. The letter (R) was always paired with extinction (see Fig. 2). A prompt was provided during the first trial when the experimenter, who sat beside the children during the sessions, pointed to the letter (B) for a few seconds and indicated it was the correct choice. If two errors occurred in ten trials, another prompt was provided.

Following criterion accuracy (9/10 trials correct) for the initial discrimination, stimulus control by the letter (A) in the S+ word (BAG) was next established by making the letters (B and G) common to both the S+ word (BAG) and the S- word (BEG). The letter (A) was now consistently paired with reinforcement and the letter (E) with extinction (see Fig. 2). The experimenter again provided a prompt during the first trial by pointing to the letter (A).

After criterion accuracy was achieved, stimulus control by the letter (G) in the S+ word (BAG) was obtained by making the letters (B and A) common to both the S+ word (BAG) and the S- word (BAD). The letter (G) was consistently paired with reinforcement in this step and the letter (D) with extinction until criterion accuracy was met (see Fig. 2). On the initial trial, the experimenter provided a prompt by pointing to the letter (G).

Following pretraining, the word discrimination (BAG + vs. RED -) was presented again. Pretraining trials and the word discrimination were repeated in additional sessions until the word discrimination was presented a total of six times to each child.

(+) (-)

B A G R A G

(Letter B Pretraining)

(+) (-)

B A G B E G

(Letter A Pretraining)

(+) (-)

B A G B A D

(Letter G Pretraining)

Figure 2. Diagram of three separate word discriminations established to provide single-letter pretraining for each letter of the S+ word (BAG) by providing S- words with two letters in common with the S+ word. The S+ and S- words were presented simultaneously. Plus (+) refers to the word paired with reinforcement and minus (-) refers to the word paired with nonreinforcement.

Word-Discrimination Test

Each time criterion accuracy was achieved for the word discrimination, a stimulus-control test was administered. In the word-discrimination test, the S+ word (BAG) appeared with three comparison words (RAG, BEG, and BAD) that differed by only one letter (see Fig. 3). During the 30-trial test, the three word pairs were presented ten trials each in an unpredictable mixed sequence, and a nondifferential-reinforcement contingency was employed during the word test trials. This consisted of providing reinforcement whichever illuminated area the child touched regardless of the word presented.

The purpose of the word-discrimination test was to determine how many letters of the S+ word each child was attending to when they achieved criterion accuracy for the word discrimination. This was accomplished by recording the percentage of trials in which the child chose the S+ word (BAG) when presented with comparison words that differed by only one letter, in each spatial position within the comparison word. Individual letters of the S+ word (BAG) were said to control responding when the child chose the S+ word at levels of 80% or higher when each letter of the S+ word (BAG) differentiated it from comparison words (RAG, BEG, and BAD) having two letters in common.

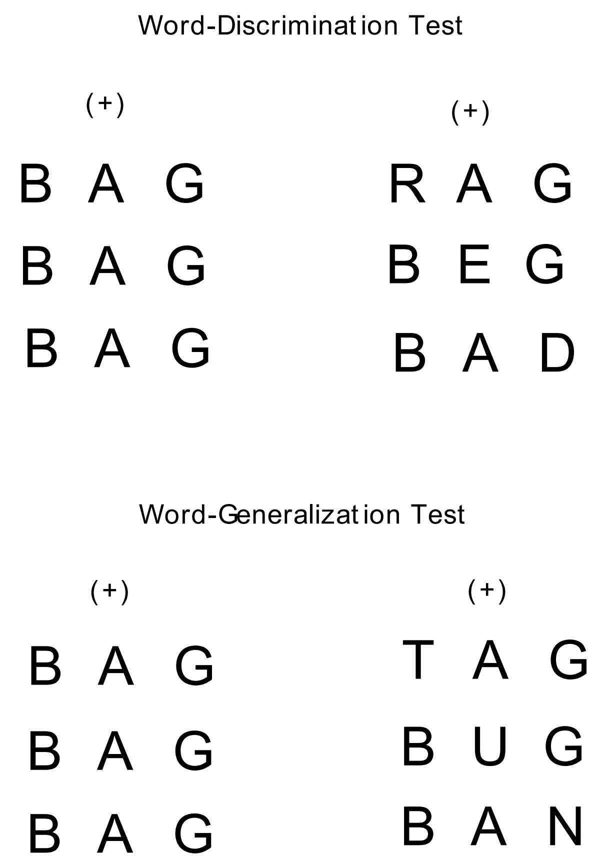

Figure 3. Diagram of stimulus-control tests administered following criterion accuracy to assess how the children attended to the S+ word (BAG). The word-discrimination test consisted of recording response choice when the S+ word (BAG) appeared with three different words (RAG, BEG, BAD) that differed from the S+ word by only one letter. The word-generalization test consisted of recording response choice when the S+ word (BAG) appeared with three different words (TAG, BUG, BAN) that differed from the S+ word by one novel letter. During the test trials, a nondifferential-reinforcement contingency was employed.

Word-Generalization Test

A word-generalization test was also provided to each of the children. During the 30-trial test, the S+ word (BAG) appeared with three comparison words (TAG, BUG, and BAN) that had two letters in common with the S+ word but differed by one novel letter (see Fig. 3). The purpose of the word-generalization test was to assess how many letters of the S+ word the children attended to when novel comparison words were introduced during the test.

Data Collection

Data collection during the word tests consisted of recording response choice when pairs of words were presented on the computer screen. Because a touch screen was employed, which of the individual letters the children touched each time word pairs appeared on the computer screen was also automatically recorded. This permitted a direct comparison of test-session results with letters touched in the word discrimination when criterion accuracy for the word discrimination was achieved.

Table 1 lists the sequence of stimuli and procedures provided to each of the four children.

Table 1

Sequence of Stimuli and Procedures

Word-Discrimination BAG (+) RED (-)
Word-Discrimination Test Trials
Letter Pretraining (B)
Letter Pretraining (A)
Letter Pretraining (G)
Word-Discrimination BAG (+) RED (-)
Word-Discrimination Test Trials
Letter Pretraining (B)
Letter Pretraining (A)
Letter Pretraining (G)
Word-Discrimination BAG (+) RED (-)
Word-Discrimination Test Trials
Letter Pretraining (B)
Letter Pretraining (A)
Letter Pretraining (G
Word-Discrimination BAG (+) RED (-)
Word-Discrimination Test Trials
Letter Pretraining (B)
Letter Pretraining (A)
Letter Pretraining (G)
Word-Discrimination BAG (+) RED (-)
Word-Generalization Test Trials
Letter Pretraining (B)
Letter Pretraining (A)
Letter Pretraining (G)
Word-Discrimination BAG (+) RED (-)
Word-Generalization Test Trials

Results

In this investigation, young children showed individual differences in how they attended to words even when single-letter pretraining was provided. All four children achieved high levels of accuracy (80% or higher) during single-letter pretraining and consistently touched each letter in the S+ word when it predicted reinforcement in pretraining, with one exception. While the children responded identically to individual letters during pretraining, they displayed a variety of attentional patterns when the same letters appeared in a word-discrimination task.

Child 1

Word-discrimination test. Child 1 exhibited high levels of stimulus control for each letter of the S+ word (BAG) during the word test before and after single-letter pretraining was provided (See Fig. 4). This was shown as Child 1 consistently selected the S+ word at 100% levels in the baseline test session when each letter of the S+ word (BAG) differentiated it from comparison words (RAG, BEG, and BAD), having two letters in common. After single-letter pretraining was provided in the subsequent sessions, Child 1 continued to demonstrate high levels of stimulus control for each letter of the S+ word (BAG) during the word test trials (See Fig. 4). Simultaneous attention to all three letters of the S+ word was evident in all four test sessions despite the occurrence of nondifferential reinforcement during the word test trials.

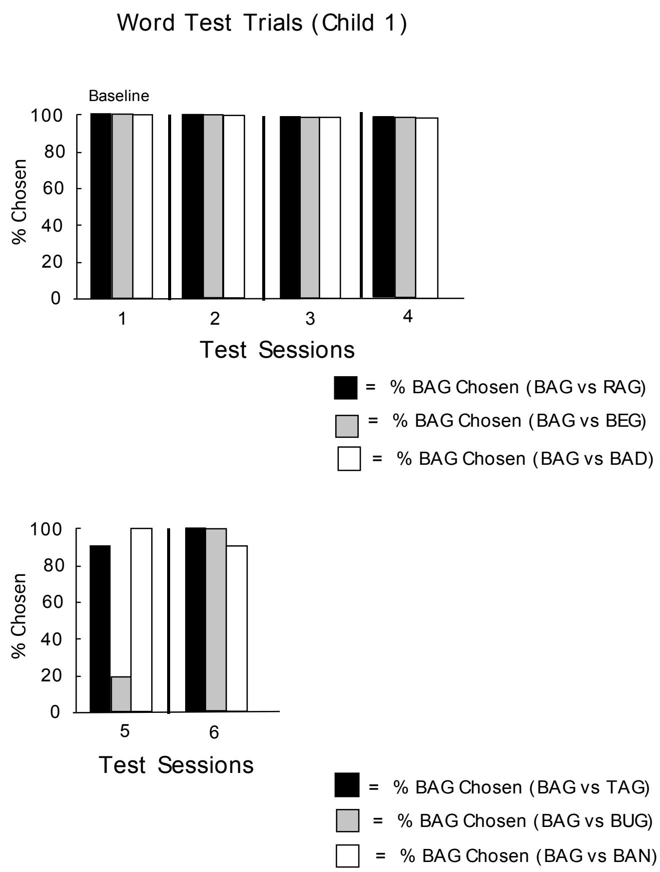

Figure 4. For Child 1, percent response choice during the word test trials when the S+ word (BAG) appeared with three different words (RAG, BEG, BAD) that differed from the S+ word by only one letter (top graph) and when the S+ word (BAG) appeared with three different words (TAG, BUG, BAN) that differed from the S+ word by one novel letter (bottom graph).

Word-generalization test. Child 1 demonstrated overselective attention, however, when comparison words containing novel letters were introduced in the word-generalization test. In the initial generalization test session, Child 1 exhibited stimulus control for only two letters of the S+ word (BAG) (See Fig. 4). When the first (B) and third letters (G) of the S+ word (BAG) differentiated it from novel comparison words (TAG and BAN), having two letters in common, Child 1 chose the S+ word (BAG) at levels of 90% and 100%, respectively. Child 1 failed to attend, in contrast, to the middle letter (A) of the S+ word during the generalization test. He selected the S+ word (BAG) on only 20% of the trials when the middle letter (A) of the S+ word differentiated it from a novel comparison word (BUG). Following repeated single-letter pretraining, his overselective attention was eliminated. Simultaneous attention to each letter of the S+ word was now evident, as all three letters of the S+ word exhibited high levels of stimulus control in the second generalization test (See Fig 4).

Response topographies. Letter preferences, however, were observed in all six sessions when the response topographies of Child 1 were examined See Fig. 5). A letter preference was demonstrated whenever Child 1 selectively touched the same letter in the S+ word (BAG) in 80% or more of the trials when criterion accuracy for the word discrimination was achieved. During the first three sessions, Child 1 revealed a letter preference for the initial letter of the S+ word (BAG), as he selectively touched the letter (B) on 100% of the trials when criterion accuracy for the word discrimination (BAG + vs. RED-) was obtained (See Fig. 5). In the fourth session following single-letter pretraining, he selectively touched the letter (G) in the S+ word (BAG) and persisted in selectively touching the letter (G) in the following two sessions (See Fig. 5). The word test demonstrated Child 1 attended simultaneously to all three letters of the S+ word, with one exception, but his response topographies showed letter preferences and changes in selective attention, which were not revealed by the word test. Although the response topographies of Child 1 consistently revealed letter preferences, his letter preferences were not intense enough, with one exception, to prevent him from attending simultaneously to all three letters of the S+ word (BAG) in the word test.

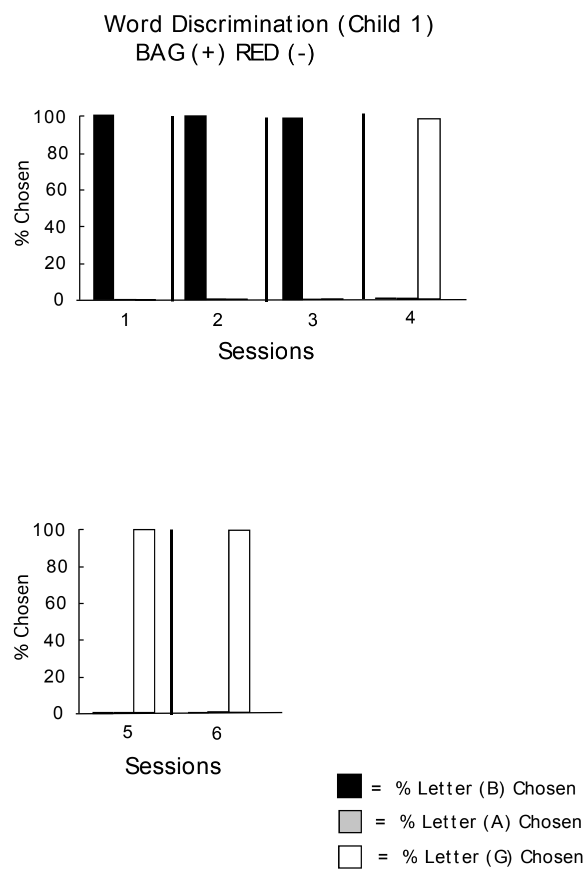

Figure 5. For Child 1, percentage individual letters of S+ word (BAG) were chosen when criterion accuracy for the word discrimination (BAG + vs. RED -) was achieved in each of the six sessions.

Child 2

Word-discrimination test. In opposition to Child 1, Child 2 displayed overselective attention prior to single-letter pretraining. Only two letters (B and G) of the S+ word (BAG) exhibited stimulus control in her initial word test (See Fig. 6). When the middle letter (A) of the S+ word (BAG) differentiated it from a comparison word (BEG), in contrast, she only chose the S+ word on 10% of the test trials. After single-letter pretraining was administered, however, the word test indicated Child 2 attended simultaneously to all three letters of the S+ word, as each of the individual letters of the training word now exhibited high levels of stimulus control (See Fig. 6). Child 2 continued to attend simultaneously to each letter of the S+ word when pretraining, the word discrimination, and the word-discrimination test were repeated in the following two sessions. In both of these test sessions, Child 2 selected the S+ word at 100% levels when each letter of the S+ word differentiated it from comparison words having two letters in common (See Fig. 6).

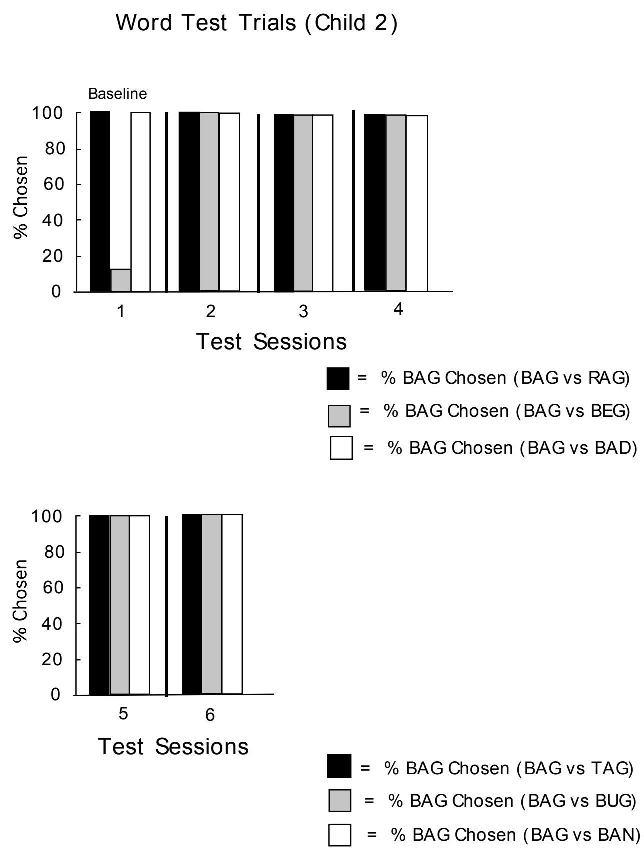

Figure 6. For Child 2, percent response choice during the word test trials when the S+ word (BAG) appeared with three different words (RAG, BEG, BAD) that differed from the S+ word by only one letter (top graph) and when the S+ word (BAG) appeared with three different words (TAG, BUG, BAN) that differed from the S+ word by one novel letter (bottom graph).

Word-generalization test. Child 2 persisted in attending simultaneously to all three letters of the S+ word (BAG) in the generalization test condition when comparison words containing novel letters were presented. In the initial generalization test session, Child 2 selected the S+ word (BAG) on 100% of the test trials even though it was presented with three novel comparison words (TAG, BUG, and BAN), which had two letters in common but differed by one novel letter (See Fig. 6). The word-generalization test was repeated, and Child 2 continued to exhibit high levels of stimulus control for each letter of the S+ word (BAG) when it was presented again with the novel comparison words (See Fig. 6).

Response topographies. Although Child 2 attended simultaneously to each letter of the S+ word (BAG) in all of the test sessions when single-letter pretraining was provided, her response topographies demonstrated letter preferences, which were not shown in the word tests. She too selectively touched the same letter in the S+ word in 80% or more of the trials when she achieved criterion accuracy for the word discrimination, and this occurred in all six sessions as had also occurred for Child 1. In the first three sessions, Child 2 selectively touched the first letter (B) of the S+ word (BAG) and then switched her letter preference in the fourth session when she selectively touched the middle letter (A) in the S+ word (BAG) (See Fig. 7). In the final two sessions, Child 2 selectively touched again the first letter (B) of the S+ word (BAG) as she had done in the initial three sessions. The response topographies of Child 2 revealed letter preferences and changes in selective attention not shown by her test performance, which had also been observed for Child 1. Although the response topographies of Child 2 demonstrated letter preferences in each of the six sessions, her letter preferences, with only one exception, were not intense enough to prevent her from simultaneously attending to all three letters of the S+ word in the word test.

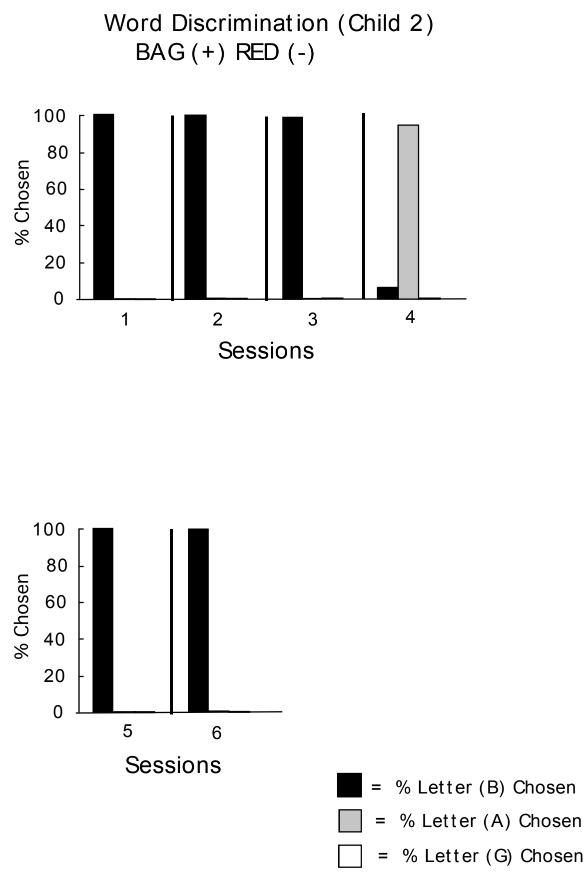

Figure 7. For Child 2, percentage individual letters of S+ word (BAG) were chosen when criterion accuracy for the word discrimination (BAG + vs. RED -) was achieved in each of the six sessions.

Child 3

Word-discrimination test. Although single-letter pretraining eliminated the overselective attention of both Child 1 and Child 2, Child 3 persisted in demonstrating overselective attention after single-letter pretraining was provided (See Fig. 8). Even though single-letter pretraining did not eliminate the overselective attention of Child 3, it did increase, however, the number of letters in the S+ word that Child 3 attended to. Prior to single-letter pretraining, Child 3 failed to exhibit stimulus control for any of the individual letters of the S+ word (BAG) during the word test. After single-letter pretraining was initially provided, the word test indicated that Child 3 attended to the middle letter (A) of the S+ word (BAG) when criterion accuracy was obtained (See Fig. 8). Although Child 3 failed to demonstrate stimulus control for any of the individual letters of the S+ word in the third test session, he did exhibit stimulus control for two of the three letters of the S+ word in the fourth test session. After single-letter pretraining was again repeated, Child 3 now attended simultaneously to both the letter (B) and letter (A) of the S+ word (BAG) (See Fig. 8). Single-letter pretraining did not eliminate the overselective attention of Child 3 but it did reduce his overselective attention.

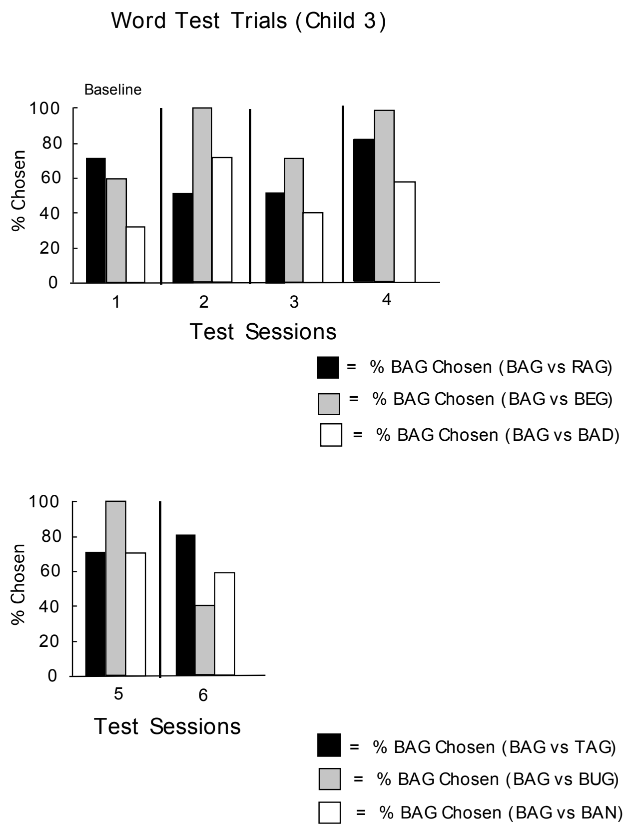

Figure 8. For Child 3, percent response choice during the word test trials when the S+ word (BAG) appeared with three different words (RAG, BEG, BAD) that differed from the S+ word by only one letter (top graph) and when the S+ word (BAG) appeared with three different words (TAG, BUG, BAN) that differed from the S+ word by one novel letter (bottom graph).

Word-generalization test. When novel comparison words were introduced in the word-generalization test, Child 3 persisted in displaying overselective attention. He only chose the S+ word in the initial generalization test at levels of 80% or higher when the middle letter (A) of the S+ word (BAG) differentiated it from a novel comparison word (BUG) (See Fig. 8). When the first (B) and third letters (G) of the S+ word (BAG) differentiated it from novel comparison words (TAG and BAN), in contrast, Child 3 chose the S+ word at levels below 80%. In the second generalization test, Child 3 continued to display overselective attention when he only chose the S+ word at levels of 80% or higher when the first letter (B) of the S+ word (BAG) differentiated it from a novel comparison word (TAG) having two letters in common. When the middle letter (A) and the third letter (G) of the S+ word (BAG) differentiated it from novel comparison words (BUG and BAN), Child 3 failed to demonstrate stimulus control for either letter (See Fig. 8).

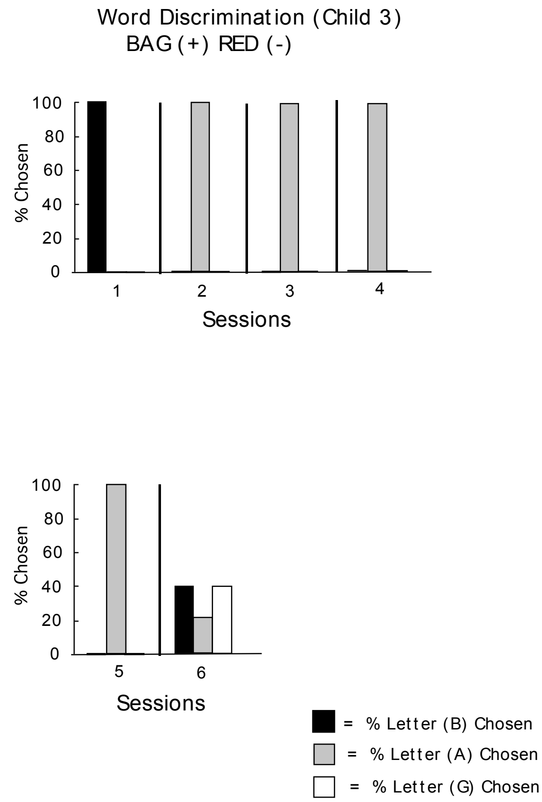

Figure 9. For Child 3, percentage individual letters of S+ word (BAG) were chosen when criterion accuracy for the word discrimination (BAG + vs. RED -) was achieved in each of the six sessions.

Response topographies. The response topographies of Child 3 demonstrated letter preferences in five of the six sessions where he selectively touched the same letter in the S+ word in 80% or more of the trials when he achieved criterion accuracy (See Fig. 9). In the first session, his response topography revealed a preference for the first letter of the S+ word (BAG) when he selectively touched the letter (B) (See Fig. 9). This contrasted with the word test, which indicated in the first session that none of the individual letters of the S+ word were attended to when criterion accuracy was achieved (See Fig. 8). After single-letter pretraining was provided in the next session, Child 3 now selectively touched the middle letter (A) of the S+ word (BAG) (See Fig. 9). Child 3 persisted in selectively touching the middle letter (A) in the S+ word in the subsequent sessions, with one exception. In two of these sessions, the word test revealed an identical preference for the middle letter (A) of the S+ word following single-letter pretraining (See Fig. 8). In the third word test session, however, none of the letters of the S+ word exhibited stimulus control, and two letters (B and A) of the S+ word (BAG) displayed stimulus control in the fourth word test session. Although the response topographies of Child 3 revealed letter preferences, as had occurred for Child 1 and Child 2, the selective attention of Child 3 was more intense. When Child 3 displayed letter preferences, his letter preferences prevented him from simultaneously attending to each individual letter of the S+ word as demonstrated in his word tests. This contrasted with Child 1 and Child 2 who also displayed letter preferences, but their letter preferences did not prevent them from simultaneously attending to all of the letters of the S+ word.

Child 4

Word-discrimination test. Prior to single-letter pretraining, Child 4 exhibited stimulus control for only the middle letter (A) of the S+ word (BAG) in the word test after criterion accuracy was achieved. Child 4 only chose the S+ word (BAG) at levels of 80% or higher when the letter (A) differentiated it from a comparison word (BEG) having two letters in common (See Fig. 10). When single-letter pretraining was provided in the following session, the middle letter (A) of the S+ word remained the only letter, which exhibited stimulus control. In the third test session, the test results demonstrated Child 4 now selectively attended to the third letter (G) of the S+ word (BAG) following pretraining (See Fig. 10). Child 4 only chose the S+ word in the third test session at levels of 80% or higher when the letter (G) of the S+ word (BAG) differentiated it from a comparison word (BAD) having two letters in common. None of the individual letters of the S+ word exhibited stimulus control in the fourth test session, however, as Child 4 chose the S+ word (BAG) at levels below 80% throughout the word test (See Fig. 10). Although Child 4 learned to attend successively to each letter of the S+ word in pretraining, he did not maintain simultaneous attention to each letter of the S+ word in any of the word tests. Child 4 either exhibited overselective attention following single-letter pretraining or did not attend to any of the individual letters of the S+ word during the test trials, as also occurred for Child 3.

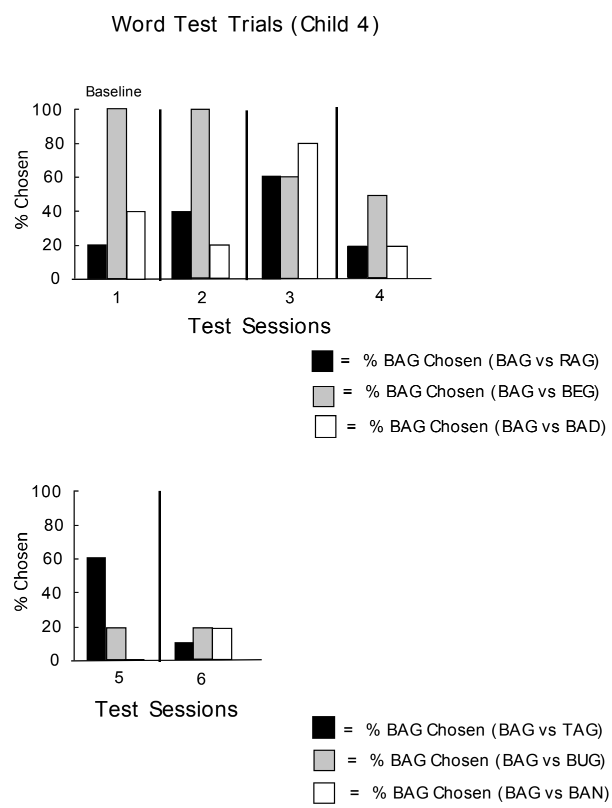

Figure 10. For Child 4, percent response choice during the word test trials when the S+ word (BAG) appeared with three different words (RAG, BEG, BAD) that differed from the S+ word by only one letter (top graph) and when the S+ word (BAG) appeared with three different words (TAG, BUG, BAN) that differed from the S+ word by one novel letter (bottom graph).

Word-generalization test. During the generalization test, Child 4 did not display stimulus control for any of the letters of the S+ word when novel comparison words were introduced (See Fig. 10). He chose the S+ word (BAG) at levels below 80% throughout the generalization test when each letter of the S+ word (BAG) differentiated it from novel comparison words (TAG, BUG, and BAN) having two letters in common. When single-letter pretraining was repeated in the final session prior to the word discrimination, Child 4 continued to choose the S+ word at levels below 80% in the generalization test when the novel comparison words were presented a second time (See Fig. 10). Each of the individual letters of the S+ word (BAG) again failed to exhibit stimulus control when the generalization test was repeated.

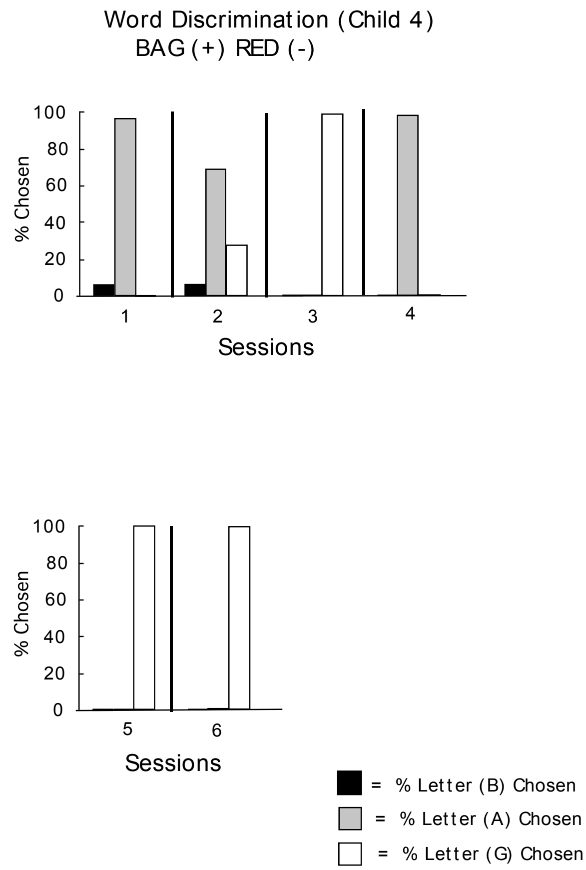

Figure 11. For Child 4, percentage individual letters of S+ word (BAG) were chosen when criterion accuracy for the word discrimination (BAG + vs. RED -) was achieved in each of the six sessions.

Response topographies. When the response topographies of Child 4 were examined, he too demonstrated letter preferences in five of the six sessions where he selectively touched the same letter in the S+ word when he achieved criterion accuracy (See Fig. 11). In the initial session, Child 4 selectively touched the middle letter (A) in the S+ word (BAG) (See Fig. 11). Although his response topography did not indicate a letter preference after single-letter pretraining was provided in the second session, Child 4 selectively touched the third letter (G) in the S+ word in the third session. When Child 4 achieved criterion accuracy in the fourth session, his response topography had changed, and he revealed again a preference for the middle letter (A) of the S+ word (See Fig. 11). In the final two sessions, the response topographies of Child 4 demonstrated a preference for the third letter (G) of the S+ word. Child 4 persisted in selectively touching the letter G in both sessions when he obtained criterion accuracy (See Fig. 11). The word test confirmed the same letter preferences in the first and third sessions as those shown by his response topographies (See Fig 10). In three sessions, however, the word test failed to indicate a letter preference, which the response topography of Child 4 revealed. In these word tests, none of the letters of the S+ word exhibited stimulus control (See Fig. 10). The intensity of the letter preferences of Child 4 also prevented him from simultaneously attending to each letter of the S+ word, which had also been the case for Child 3.

Discussion

Young children differed in how they attended to a word-discrimination task. Individual differences continued to occur in how they attended to the training word even after they were pretrained to attend to each letter of the S+ word before the word discrimination was presented. Single-letter pretraining eliminated, however, overselective attention for two of the four children. Although each of these two children exhibited overselective attention in one of the test sessions, they attended simultaneously to each letter of the training word after single-letter pretraining was provided. The remaining two children displayed persistent overselective attention or a loss of stimulus control for all three letters of the training word in the test sessions in spite of repeated single-letter pretraining. Although single-letter pretraining did not eliminate their overselective attention, it did increase the number of letters in the S+ word that one of these children attended to. These findings contrast with a previous investigation where overselective attention was not eliminated or reduced for young children when a word discrimination was repeated without pretraining if nondifferential reinforcement was employed during the test trials (Huguenin, 2011). In the current investigation, however, the potentially disrupting effects of nondifferential reinforcement in the test trials did not prevent the elimination or reduction of overselective attention to words for three of the four children when single-letter pretraining was employed.

Single-letter pretraining also assisted in determining the intensity of overselective attention to words by assessing how quickly simultaneous attention to each letter of the training word was established. Although one child did not require single-letter pretraining before he simultaneously attended to all three letters of the training word, he did display overselective attention when novel letters were introduced in the generalization test condition. Following repeated single-letter pretraining, however, he now simultaneously attended to each letter of the S+ word during the second generalization test. Another child demonstrated overselective attention in the baseline test session before single-letter pretraining was provided. After single-letter pretraining was administered, she simultaneously attended to each letter of the S+ word and continued to attend to all the letters of the S+ word in the subsequent test sessions. Despite the occurrence of overselective attention, single-letter pretraining quickly established simultaneous attention to each letter of the S+ word for both children. Extended single-letter pretraining and repeated exposure to a word-discrimination task was not effective, however, for two children in establishing simultaneous attention to the individual letters of the training word. Although extended pretraining increased the number of letters of the training word that one of the children attended to, his attention to only a single letter of the training word returned in the generalization test condition. In summary, establishing high levels of stimulus control for each letter of the S+ word in pretraining quickly eliminated overselective attention to words for two children. The attention of two other children to the individual letters of the training word was disrupted, however, for some or all of the letters when test conditions were presented despite extended single-letter pretraining.

Recording response topographies revealed all four children displayed letter preferences when they acquired the word discrimination both before and after pretraining was administered. Letter preferences were exhibited by the response topographies of two of the children even when their test performance did not demonstrate overselective attention. Although the test results of both children indicated they attended simultaneously to each letter of the training word, with only one exception, their response topographies consistently revealed letter preferences, which were not eliminated by single-letter pretraining. Recording the response topographies of both children also demonstrated changes in letter preferences after pretraining was provided even though their test performance continued to reveal high levels of stimulus control for each letter of the training word. In contrast, both the response topographies of the remaining two children as well as their test performance revealed letter preferences. Although the response topographies of all four children consistently indicated letter preferences with few exceptions, the letter preferences of these two children were intense enough to prevent simultaneous attention to each letter of the training word from occurring as demonstrated by their test performance.

Recording word choice in the test trials was found in this investigation to provide a limited picture of how young children attended to words. If only the words the children chose during the test trials were analyzed, incomplete conclusions would have been made about how the individual letters of the training words were attended to. Individual letters were discovered to exhibit stronger or weaker levels of stimulus control, which were not reflected in most cases in the children's choice of words. Although the word choice of two children during the test trials indicated equal levels of stimulus control for the individual letters of the S+ word, their response topographies consistently revealed selective attention. The response topographies of the other two children also demonstrated selective attention in each of the sessions, with one exception, in contrast to their test performance, which demonstrated selective attention to a single letter in only half of the test sessions. While recording the words the children chose in the test trials indicated whether or not they simultaneously attended to each letter of the training word, it did not frequently disclose the relative differences in stimulus control that their response topographies revealed. Recording individual letters selected in the training word with a touch screen provided a more direct analysis of letter preferences since exactly where the child was attending was determined whenever words appeared on the computer screen. Recording word choice in the test trials, on the other hand, assessed stimulus control of the individual letters following criterion accuracy for the word discrimination.

In conclusion, the detection of overselective attention to words in young children depended on the type of response measurement. While two of the four children persisted in displaying overselective attention when word choice was assessed, all four children consistently exhibited selective attention to words when their response topographies were recorded. Although the response topographies of each child revealed letter preferences, the intensity of their selective attention differed. Only two of the children exhibited letter preferences intense enough to prevent them from simultaneously attending to each letter of the S+ word, which was demonstrated in their word tests.

The results of this investigation support the findings of previous investigations, which found employing multiple tests to record stimulus choice and response topographies provided a more detailed picture of how stimulus compounds were attended to (Huguenin, 1987, 1997, 2004). When both word choice and response topographies were utilized to measure stimulus control in this study, they also provided a more complete assessment of how young children attended to words. By recording the number of letter preferences and the degree of restricted attention in the two test conditions, both the presence as well as the intensity of overselective attention to words were determined. It may be all children display selective attention when words are presented but it is the intensity of their selective attention that is the critical factor. By administering multiple stimulus-control tests, individual differences in how young children attended to words were discovered.

Finally, the results of this study indicate that pretraining the individual letters of a training word does not guarantee all the individual letters of the word will be simultaneously attended to. Overselective attention and letter preferences still occurred in multiple test conditions for some of the young children despite single-letter pretraining. The effect of pretraining on the prevalence of simultaneous attention to each letter of a training word in the current investigation may have been reduced, however, by the nondifferential reinforcement employed during the test trials. Nondifferential reinforcement may have disrupted some or all of the pretrained letter discriminations since whichever word the child chose in the test was reinforced regardless of whether or not it was previously correct. The degree to which the pretrained letter discriminations were disrupted when nondifferential reinforcement was in effect during the test trials was, as a result, another means of evaluating the relative levels of stimulus control of the pretrained letters. Letters exhibiting stronger levels of stimulus control would be more durable and less disrupted by the nondifferential reinforcement, whereas letters exhibiting weaker stimulus control would be disrupted sooner and to a greater extent. Although all four children achieved criterion accuracy during single-letter pretraining with few errors occurring, the stability of the individually pretrained letter discriminations differed across the four children. Two of the children maintained all three pretrained letter discriminations with no disruption in the test sessions when nondifferential reinforcement was employed. Disruption occurred, in contrast, for some or all of the pretrained letter discriminations for the remaining two children when nondifferential reinforcement was utilized. Relative levels of stimulus control of the individual elements of compound stimuli may be determined in test trials by not only response choice but also by how easily stimulus control is disrupted when original training conditions are altered.

In summary, young children differed in how they attended to words both before and after single-letter pretraining was provided. While the children responded identically to individual letters during pretraining, they displayed diverse attentional patterns when the same pretrained letters appeared in a word-discrimination task. In addition, the type of response measurement affected the detection of their overselective attention to words. Two of the four children displayed persistent overselective attention when word choice was assessed. When response topographies were recorded, however, all four children consistently revealed selective attention to words with few exceptions. Utilizing multiple tests provided a fine-grain analysis of how children attended to words and identified individual differences that wouldn't have been discovered if only a single test had been utilized. Although young children differed in how they attended to words, overselective attention was eliminated for two children and reduced for a third child following single-letter pretraining. Employing computer technology to administer similar procedures to identify and eliminate overselective attention to words could result in more individualized and effective reading programs. Past research found that inattentiveness in young children predicted later difficulties in reading achievement (Dally, 2006; Rabiner, Coie, & The Conduct Problems Prevention Research Group, 2000). Providing behavioral treatment and individualized instruction to children with learning and developmental disabilities in their early years that improves their visual attention is fundamental to their later development and academic progress (Ploog, 2010).

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Footnotes

The results of this study were presented at the 85th Annual Meeting of the Eastern Psychological Association, Boston, 2014. The author wishes to thank the children who participated in this study and to acknowledge the technical assistance of Robert Huguenin. Requests for reprints may be addressed to Nancy H. Huguenin, Ph.D., Behavior Analysis & Technology, Inc., P.O. Box 327, Groton, MA 01450-0327. Email: rnhuguenin@net1plus.com Website: www.ba-and-t.com