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Employing a Software-Administered Procedure in Both Office and Remote Online Settings to Assess the Visual Attention of Young Children and Adolescents with Developmental Disabilities

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Abstract

Establishing prior reinforcement histories for separate stimulus components was examined in this study, using a software-administered procedure, to determine if they controlled which features of compound visual cues young children of typical development and adolescents with intellectual disabilities attended to. In most instances, the response topographies and test performance of the young children indicated that they selectively attended to only symbols with an unchanged prior reinforcement history in the stimulus compounds when criterion accuracy was achieved. Symbols with a reversed prior reinforcement history in the compounds were usually ignored. The children differed, however, in how quickly they shifted their attention to the unchanged symbols. The adolescents with intellectual disabilities also eventually learned to selectively attend to unchanged symbols in the conflict compounds. In contrast to the young children of typical development, however, the adolescents required extended training before they attended to the unchanged symbols. Longer single-stimulus pretraining and additional exposure to the conflict compounds were required before the adolescents shifted their attention among stimulus elements in accordance with prior reinforcement histories. These findings suggest that the consistency with which students respond to compounds with conflicting prior reinforcement histories may prove to be an effective technique for identifying students with developmental disabilities and attentional deficits. In addition, administering the stimulus-control procedures online at remote sites where the author was not present also proved to be effective in assessing how participants attended to a stimulus compound with conflicting prior reinforcement histories. Despite individual differences, manipulating prior reinforcement histories of individual stimuli determined how the participants, who differed in age, attended to a stimulus compound when the procedures were provided online at remote sites. In contrast to the earlier phases of this study, this also occurred with laptop computers, where touch screens were not utilized, and where social and monetary reinforcement were not provided. Although prior reinforcement histories of individual stimuli failed to initially control how one participant, a young child, attended to a visual compound, when the procedures were repeated, he too selectively attended to the stimulus element whose prior reinforcement history was unchanged in the compound. Administering the stimulus-control procedures and automatically analyzing the results online

eliminated the need for sophisticated computer equipment or an expertise in discrimination learning in order to carry out the described procedures. Recording response topographies, in addition to response accuracy, in this series of investigations provided a more sensitive and fine-grain analysis of individual differences in how stimulus compounds were attended to.

Key Words: Visual Attention, Young Children, Adolescents with Developmental Disabilities, Overselective Attention, Computer Assessment, Online Assessment

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(Full text follows)

Discovering manipulations that affect how children attend to complex stimuli is important because of the presence of attentonal deficits that many children possess which can interfere with their learning and development. One attentional impairment that can interfere with a child's development is overselective attention. Overselective attention occurs when a child demonstrates restricted attention because the child attends to only a limited number of stimulus elements in compound stimuli. Overselective attention is common among individuals 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; Kelly, Leader, & Reed, 2015; 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),). It has also been reported in young children of typical development (Bickel, Stella, & Etzel, 1984; Eimas, 1969; Hale & Morgan, 1973; Huguenin, 2006, 2011, 2014; Smith 2005). If overselective attention is chronic it can affect many areas of a child's development involving the child's language, academic, and social skills (Burke, 1991; Dunlap, Koegel, & Burke, 1981; Ploog, 2010).

Past research has shown that one manipulation that affects which elements of stimulus compounds are attended to is the prior reinforcement histories of the individual stimuli (Huguenin, 2017). An early investigation (Huguenin & Touchette, 1980) demonstrated, by employing Ray's (1969) procedure, that the prior reinforcement histories of color and line-orientation stimuli controlled the attention of young adults with severe intellectual disabilities when these stimuli were combined. After 95% accuracy was achieved for both the color and line-orientation discriminations, they were combined to form "conflict-compound" stimuli where the prior reinforcement history was reversed for one element of the compound and remained unchanged for the other element. Following the achievement of criterion accuracy for the conflict-compound discrimination, the stimulus elements were presented separately to determine which stimulus elements were attended to when criterion accuracy was achieved.

The young adults with intellectual disabilities, with few exceptions, selectively attended to the unchanged element. Only the unchanged element exercised control in agreement with the reinforcement contingencies of the conflict compound. The reversed element, which had a conflicting prior history of reinforcement, was ignored. The prior reinforcement history of the individual stimuli determined which features of compound stimuli the individuals with intellectual disabilities attended to. Two subsequent investigations replicated and extended these results to stimulus compounds composed of haptic cues (Tomiser, Hollis, & Monaco, 1983) and to undergraduate students (Ryan, Hemmes, & Brown, 2011).

Other investigations have examined the effect of prior reinforcement histories on attention to stimulus compounds when multiple testing procedures were employed. In one investigation (Huguenin, 1987), we examined the effects of prior reinforcement histories on attention to compound displays in six

young children of typical development. After three separate visual discriminations composed of six symbols were first conditioned, the stimuli were combined to form conflict compounds. One conflict compound was created by keeping prior reinforcement contingencies unchanged for two symbols and reversing them for the remaining four symbols. In a second conflict compound, the prior reinforcement histories were unchanged for four symbols and reversed for the remaining two symbols. Both conflict-compound discriminations were presented until criterion accuracy was achieved.

Multiple stimulus-control tests administered by computer technology confirmed that prior reinforcement histories determined how the children attended to the conflict compounds. In one stimulus-control test, when unchanged and reversed symbols were presented individually following acquisition of the conflict compounds, only symbols with unchanged prior reinforcement histories controlled responding in agreement with the reinforcement contingencies of the compound stimuli. These test results also indicated the children attended to the unchanged symbols in the conflict compounds and ignored the reversed symbols. The other test measured the response topographies of the conflict compounds by automatically recording with a touch screen which stimulus the children touched in the conflict compounds when criterion accuracy was achieved. When response topographies were analyzed, the children touched, with one exception, only unchanged symbols and did not touch reversed symbols in the conflict compounds on most reinforced trials.

Both stimulus-control tests demonstrated that prior reinforcement histories controlled which stimulus features young children selectively attended to in the stimulus compounds. If only one stimulus-control test had been provided, in contrast, it would not have been possible to determine if test variables contaminated the test results. In addition, recording response topographies with a touch screen directly determined which symbols the children were attending to in the conflict compounds instead of inferring what they attended to from test trials administered following acquisition of the compound discriminations. In later investigations (Huguenin, 1997, 2000, 2004), we also recorded response topographies with a touch screen when criterion accuracy was achieved as an additional stimulus-control test to determine how stimulus compounds were attended to.

The current study examined the response topographies of young children of typical development and adolescents with developmental disabilities before and after criterion accuracy was achieved for compound discriminations with conflicting prior reinforcement histories. Previous studies examined how conflict compounds were attended to when criterion accuracy was achieved. The purpose of this study was, however, to assess how students attended to conflict compounds before and after they obtained criterion accuracy. This was done to examine if individual differences occurred in how quickly the young children and adolescents shifted their attention in accordance with prior reinforcement histories when conflict compounds were presented.

In addition, this study determined if continued exposure to conflict-compound discriminations resulted in the children and adolescents shifting their attention with fewer trials to symbols in the stimulus compounds with unchanged prior reinforcement histories. It was wondered if additional training would result in their becoming more sensitive to the effect of prior reinforcement histories on how they attended to stimulus compounds. As a result of comparing individual differences for both young children of typical development and adolescents with developmental disabilities, presenting compounds whose components have conflicting reinforcement histories might prove to be an effective technique for identifying children with attentional impairments.

Another purpose of this investigation was to administer the stimulus-control procedures online to determine if they would generalize to remote sites where personal computer technology was utilized and where the author was not present. Providing similar procedures online would be beneficial to students with developmental disabilities, especially for children with autism who have a higher incidence of overselective attention and, as a result, difficulties in shifting attention (Patten & Watson, 2011). Because of the rapid increase in children diagnosed with autism, 1 in 59 children according to the Centers for Disease Control and Prevention, it has become increasingly difficult to provide the adequate amount of behavioral interventions to address these issues. Online programs, which are fully automated, such as the procedures described in this study, could be provided in the home with parental supervision to increase the amount of weekly instruction provided. They could also be administered at a young age to both identify visual impairments and improve

their attention in their early years, which is critical in enhancing later development (Koegel, Koegel, Ashbaugh, & Bradshaw, 2014).

Experiment I

Method

Subjects

Three young children of typical development participated in the study. The chronological age and gender of the young children were 4.5 years (male), 5.0 years (female) and 5.5 years (male), respectively. Two of the subjects were children of acquaintances of the author, and the third child was enlisted through material describing the study.

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 child 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 child. 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.

General Procedure

Each session consisted of approximately 100 trials. A trial began when sets of symbols (Dreyfuss, 1972), which were centered on two 10- by 3-cm white illuminated backgrounds, appeared on the computer screen. The trial ended when the child touched a symbol in either illuminated area. A 3-s intertrial interval followed when the computer screen was dark, and then the next trial began. Correct choices during training sessions resulted in the delivery of pennies, a flashing computer screen, and verbal praise. Verbal praise was provided by the author who sat beside the child during the session. If an incorrect choice occurred, reinforcement was not provided. During test sessions, pennies were dispensed regardless of which symbol the child touched, and social praise was omitted. The children traded their accumulated pennies for snacks and recreational items at the end of each session.

Single Symbol Training

Each child in the first step learned three separate visual discriminations, composed of six different symbols (See Fig. 1). The S+ and S- symbols were presented simultaneously. Each individual symbol appeared an equal number of times on the left and right portions of the computer screen in a block of 20 trials. The S+ symbol never appeared more than twice in succession in the same location. Each pair of individual symbols during single symbol training was presented until criterion accuracy was achieved (90% accuracy in a 10-trial sequence). The first discrimination task consisted of providing a penny and praise to the children whenever they touched the rabbit symbol (S+) on the computer screen. Reinforcement was not provided if they touched the plum symbol (S-). When 90% accuracy was achieved, the scissors (S+) and cane (S-) symbols were presented. Touching scissors produced reinforcement but touching cane did not. After 90% accuracy occurred, the grasses (S+) and mule (S-) symbols appeared on the screen, and responses to grasses were now reinforced while responses to mule were not reinforced. This continued until criterion accuracy was achieved.

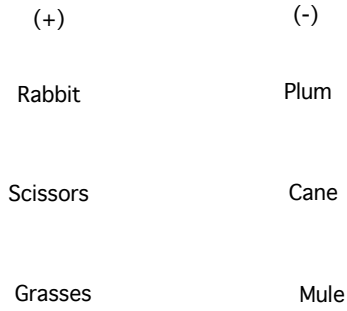

Fig.1. Diagram of the three separate visual discriminations established prior to formation of the compound stimuli. Plus (+) refers to symbols paired with reinforcement and minus (-) indicates symbols paired with extinction.

The three original symbol pairs were next presented in an unpredictable mixed sequence. Each symbol pair appeared twice in a block of six trials, and no more than two S+ symbols appeared twice in succession in the same location. Each individual symbol also occurred an equal number of times on the left and right portions of the computer screen in a block of 18 trials. The mixed symbol sequence was presented until 90% accuracy for each symbol pair occurred within a 30-trial sequence.

Conflict Compounds

The individual symbols were next combined to form a conflict compound following criterion accuracy for the mixed symbol pairs. Conflict compounds were formed by keeping prior reinforcement histories unchanged for one symbol pair in the compound. The prior reinforcement histories for the remaining two symbol pairs were reversed. One conflict- compound was created by keeping the prior reinforcement histories unchanged for only scissors and cane in the compound. The prior reinforcement histories were reversed for the remaining four symbols. Plum and mule were now paired with reinforcement in the compound and rabbit and grasses with extinction, which was the reverse of original single-symbol training (See Fig. 2, top row).

A second conflict-compound was formed by keeping the prior reinforcement histories unchanged for only rabbit and plum in the compound. The prior reinforcement histories for the other four symbols were again reversed. Cane and mule were paired with reinforcement in the second conflict-compound and scissors and grasses with extinction, which was the reverse of original training (See Fig. 2, middle row).

A third conflict-compound was created by keeping the prior reinforcement histories unchanged for only grasses and mule in the compound and reversing them for the remaining four symbols. Plum and cane were now paired with reinforcement and rabbit and scissors with extinction in the third conflict-compound, which was the reverse of original training (See Fig. 2, bottom row).

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The positions of individual symbols within the compounds did not change across trials. The positions of the unchanged symbols and reversed symbols did differ, however, in the three conflict-compounds. For instance, the two unchanged symbols in the three conflict compounds occupied the middle positions, left positions, and right positions, respectively. Finally, the order in which the three conflict-compounds were presented differed across the three children.

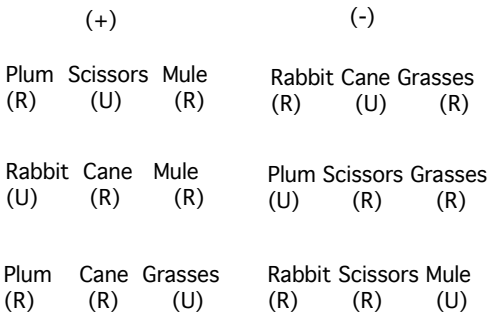

Fig.2. Diagram of the three conflict-compound discriminations. Plus (+) indicates stimulus compounds paired with reinforcement and minus (-) denotes stimulus compounds paired with extinction. The S+ and S- compounds were presented simultaneously and were each composed of three symbols. The positions of the unchanged symbols (U) and reversed symbols (R) within the compounds are shown in the diagram and remained constant across trials.

Test Conditions

Test trials were presented after 90% accuracy was achieved for the conflict compounds. Thirty-six test trials were administered in which the three symbol pairs were presented 12 times each in a mixed sequence. During the test trials, reinforcement was provided regardless of which symbol the child touched. The test was provided in order to determine which symbols the child was attending to when they achieved criterion accuracy for the compound discriminations. This was determined by calculating the percentage of responses during the unchanged-symbol and reversed-symbol test trials that were in agreement with the reinforcement contingencies of the conflict compounds. Symbols associated with high percent agreement scores (80% or greater) were shown to control responding in the conflict compound when criterion accuracy was attained.

The touch screen also recorded which symbols the children touched each time the conflict compounds appeared on the screen. This permitted a direct comparison of test session results with symbols that the children touched in the conflict compounds when compound criterion accuracy was achieved.

Table 1 lists the sequence of procedures provided to each of the three children.

Table 1

Sequence of Procedures

Single Symbol Training
Conflict Compound (1)
Test Trials
Single Symbol Training
Conflict Compound (2)
Test Trials
Single Symbol Training
Conflict Compound (3)
Test Trials

Results

For the young children, their response topographies and test performance indicated, with a few exceptions, that they selectively attended to only the unchanged symbols in the conflict compounds when criterion accuracy was achieved.

Child 1

For the first conflict-compound, Child 1 required 22 trials before he acquired criterion accuracy (18 out of 20 trials correct). Child 1 made only three errors (14% of total trials), and each of these errors occurred because Child 1 touched a reversed S- symbol in the conflict compound (See Fig. 3). In the remaining 19 trials (86% of total trials), however, Child 1 touched the unchanged S+ symbol in the conflict compound. When criterion accuracy was achieved, Child 1 touched the unchanged symbol in each of the 18 correct trials (100%). In the first conflict-compound, Child 1 shifted his attention to the unchanged symbol. His test performance, following criterion accuracy, also indicated that he selectively attended to the unchanged symbol in the first conflict-compound. This was because he obtained a high percent agreement score (80% or greater) during only the unchanged-symbol test trials (See Fig. 4). Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the first conflict-compound.

For the second conflict-compound, Child 1 required 20 trials to achieve criterion accuracy. He made only two errors (10% of total trials) when the second conflict-compound was initially presented, and both of these errors occurred because Child 1 touched a reversed S- symbol in the conflict compound (See Fig. 3). Beginning with the third trial, Child 1 switched to consistently touching the unchanged S+ symbol in the conflict compound for the remaining 18 trials (90% of total trials). When criterion accuracy was met, Child 1 touched the unchanged symbol in each of the 18 correct trials (100%). Child 1 also shifted his attention to the unchanged symbol in the second conflict-compound. His test performance, following criterion accuracy, further confirmed he selectively attended to the unchanged symbol in second conflict-compound. Only the unchanged-symbol pair exhibited stimulus control in agreement with the reinforcement contingencies of the second conflict-compound (See Fig. 4).

For the third conflict-compound, Child 1 again required 20 trials to achieve criterion accuracy. He made two errors when the conflict compound was initially presented. One of these errors (5% of total trials) occurred because Child 1 touched a reversed S- symbol in the conflict compound. The second error (5% of total trials) occurred because Child 1 touched the unchanged S- symbol in the conflict compound (See Fig. 3). On the third trial, Child 1 switched to consistently touching the unchanged S+ symbol in the conflict compound for the remaining 18 trials (90% of total trials). When criterion accuracy was obtained, Child 1 touched the unchanged symbol in each of the 18 correct trials (100%). In the third conflict- compound, Child 1 shifted his attention to the unchanged symbol. His test performance, following criterion accuracy, also indicated that he selectively attended to the unchanged symbol in the third conflict-compound. Only the unchanged-symbol pair exhibited stimulus control in agreement with the reinforcement contingencies of the third conflict-compound (See Fig. 4).

In summary, Child 1 learned the three conflict-compound discriminations quickly with only a few errors occurring for each of the conflict compounds. The response topographies of Child 1 revealed he shifted his attention to the unchanged symbols in all three conflict- compounds when criterion accuracy was obtained. His test performance also indicated that he selectively attended to the unchanged symbols in each of the conflict compounds. Child 1 learned to shift his attention to the unchanged symbols in all three conflict-compounds regardless of which position they occupied in the conflict compounds.

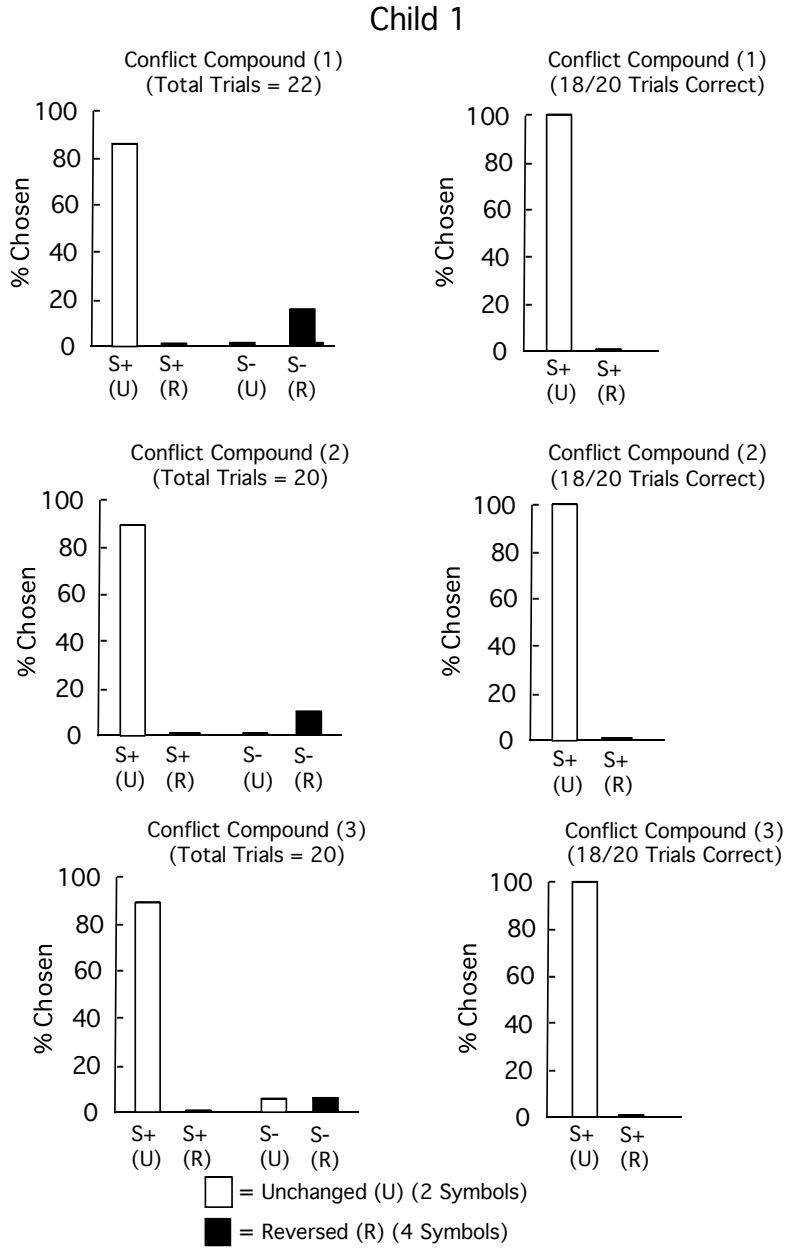

Fig. 3. For Child 1, (left graphs) percentage S+ and S- unchanged symbols (white bars) and S+ and S- reversed symbols (black bars) were chosen when each of the three conflict compounds were presented and (right graphs) percentage the unchanged S+ symbol (white bar) and the reversed S+ symbols (black bar) were chosen during reinforced trials when criterion accuracy was achieved for the three conflict compounds.

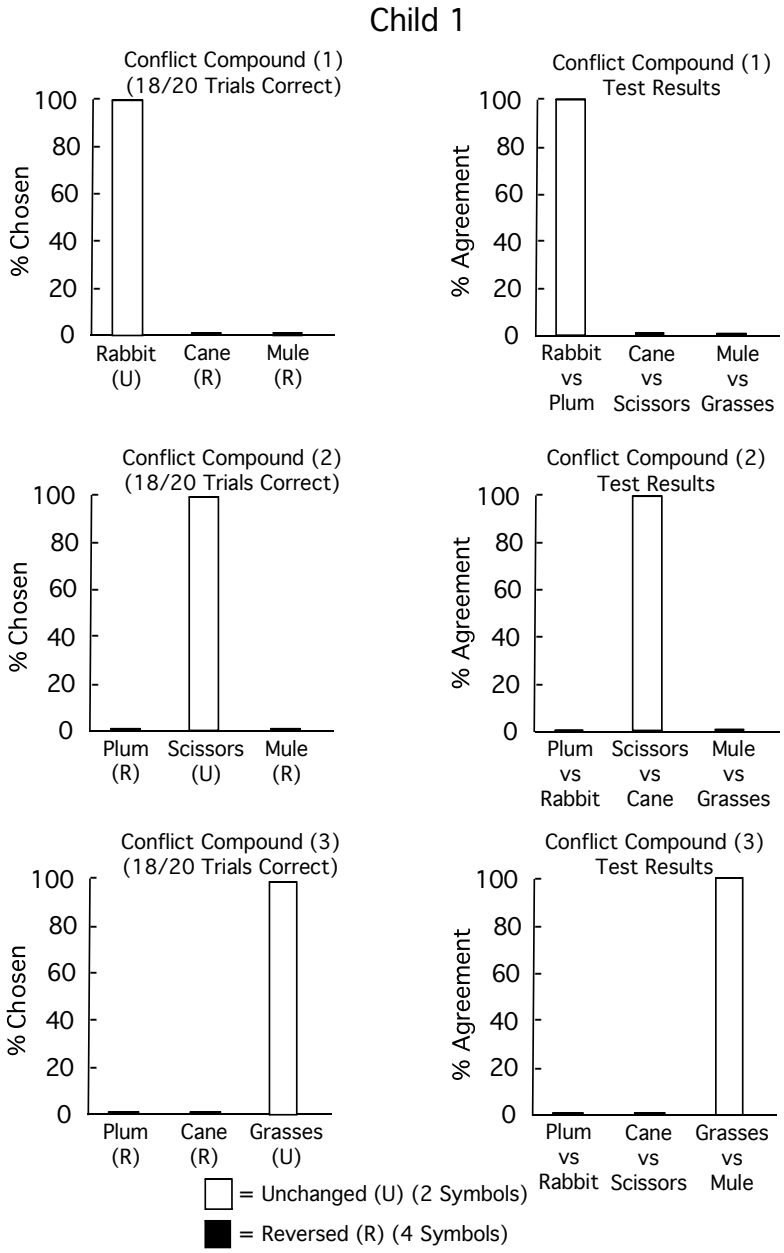

Fig. 4. For Child 1, (left graphs) percentage each of the three S+ symbols were chosen during reinforced trials when criterion accuracy was achieved for the three conflict compounds and (right graphs) percent agreement of responses during stimulus-element test trials with the reinforcement contingencies of the three conflict compounds. The top symbols shown for Child 1 were positive and the bottom symbols were negative in the three conflict-compound discriminations. White bars and black bars indicate unchanged and reversed symbols, respectively.

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Child 2

For the first conflict-compound, Child 2 required 111 trials before she acquired criterion accuracy. She made a total of 34 errors when criterion accuracy was finally achieved. Twenty-nine errors (26% of total trials) occurred because she touched a reversed S- symbol in the conflict compound and five errors (5% of total trials) occurred because she touched the unchanged S- symbol in the conflict compound (See Fig. 5). In the remaining 77 trials, she touched a reversed S+ symbol in the conflict compound in 41 of the trials (37% of total trials) and the unchanged S+ symbol in the conflict compound in 36 of the trials (32% of total trials). When criterion accuracy was obtained, Child 2 touched the unchanged symbol in 7 of the 18 correct trials (39%) and reversed symbols in 11 of the 18 correct trials (61%). In the first conflict-compound, Child 2 did not shift her attention to the unchanged symbol when criterion accuracy was achieved. She responded, instead, to both unchanged and reversed symbols in the conflict compound. Her test performance, following criterion accuracy, also demonstrated that she did not selectively attend to the unchanged symbol in the first conflict-compound. Both the unchanged-symbol pair and the reversed-symbol pairs exhibited stimulus control in agreement with the reinforcement contingencies of the first conflict-compound (See Fig. 6).

In the second conflict-compound, Child 2 required 39 trials before she acquired criterion accuracy. She made a total of four errors when criterion accuracy was achieved. Two of the errors (5% of total trials) occurred because Child 2 touched a reversed S- symbol in the conflict compound, and two of the errors (5% of total trials) occurred because she touched the unchanged S- symbol in the conflict compound (See Fig. 5). In the remaining 35 trials, she touched a reversed S+ symbol in the conflict compound in seven of the trials (18% of total trials) and the unchanged S+ symbol in the conflict compound in 28 of the trials (72% of total trials). When criterion accuracy was obtained, Child 2 touched the unchanged symbol in 16 of the 18 correct trials (89%) and a reversed symbol in 2 of the 18 correct trials (11%). In the second conflict-compound, Child 2 shifted her attention to the unchanged symbol. Her test performance, following criterion accuracy, also indicated that she selectively attended to the unchanged symbol in the second conflict- compound. Only the unchanged-symbol pair exhibited stimulus control in agreement with the reinforcement contingencies of the second conflict-compound (See Fig. 6).

In the third conflict-compound, Child 2 required only 20 trials before she acquired criterion accuracy. She made a total of two errors (10% of total errors), and both errors occurred because she touched a reversed S- symbol in the conflict compound (See Fig. 5). Child 2 touched the unchanged S+ symbol in the conflict compound in the remaining 18 trials (90% of total trials). When criterion accuracy was achieved, Child 2 touched the unchanged symbol in each of the 18 correct trials (100%). In the third conflict-compound, Child 2 shifted her attention to the unchanged symbol. Her test performance, following criterion accuracy, also confirmed that she selectively attended to the unchanged symbol in the third conflict-compound. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the third conflict-compound (See Fig. 6).

In summary, the response topographies of Child 2 indicated that she did not shift her attention to the unchanged symbol in the first conflict- compound when criterion accuracy was achieved. She did, however, shift her attention to the unchanged symbols in the second and third conflict- compounds when criterion accuracy was obtained. Her test performance confirmed that she did not selectively attend to the unchanged symbol in the first conflict-compound but did selectively attended to the unchanged symbols in the second and third conflict-compounds. Although Child 2 did not selectively attend to the unchanged symbol in the first conflict-compound, she did learn to selectively attend to unchanged symbols when additional conflict compounds were presented.

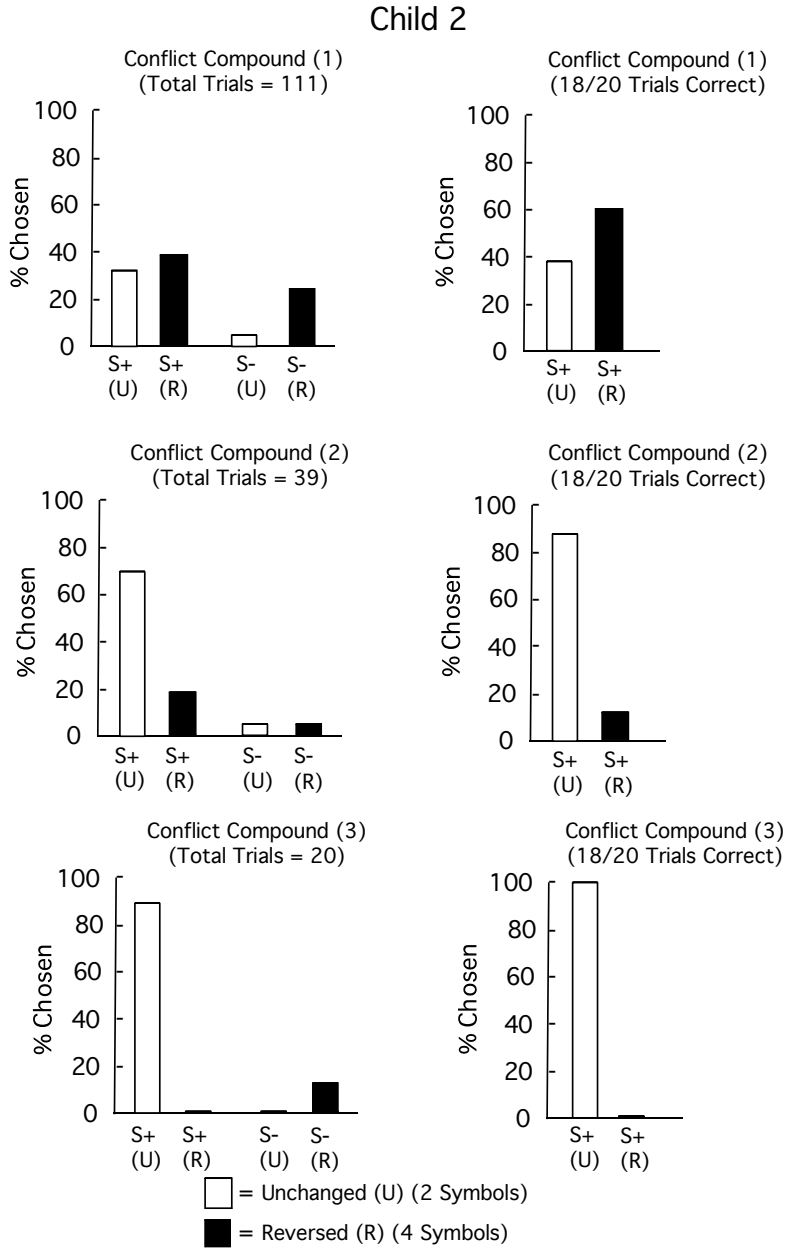

Fig. 5. For Child 2, (left graphs) percentage S+ and S- unchanged symbols (white bars) and S+ and S- reversed symbols (black bars) were chosen when each of the three conflict compounds were presented and (right graphs) percentage the unchanged S+ symbol (white bar) and the reversed S+ symbols (black bar) were chosen during reinforced trials when criterion accuracy was achieved for the three conflict compounds.

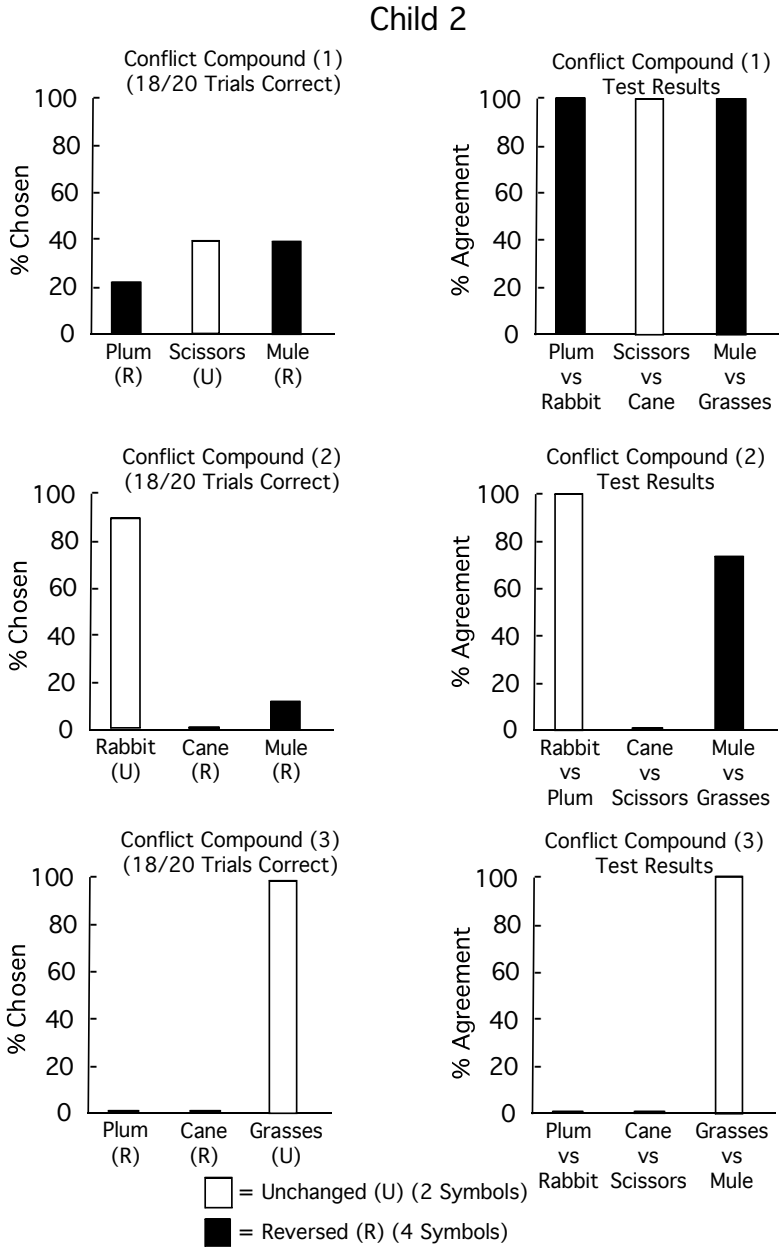

Fig. 6. For Child 2, (left graphs) percentage each of the three S+ symbols were chosen during reinforced trials when criterion accuracy was achieved for the three conflict compounds and (right graphs) percent agreement of responses during stimulus-element test trials with the reinforcement contingencies of the three conflict compounds. The top symbols shown for Child 2 were positive and the bottom symbols were negative in the three conflict-compound discriminations. White bars and black bars indicate unchanged and reversed symbols, respectively.

Child 3

For the first conflict-compound, Child 3 required 20 trials before he acquired criterion accuracy. He made two errors (10% of total trials) when the conflict compound was initially presented, and both errors occurred because Child 3 touched a reversed S- symbol in the conflict compound (See Fig. 7). Child 3 consistently touched the unchanged S+ symbol in the conflict compound in the remaining 18 trials (90% of total trials). When criterion accuracy was achieved, Child 3 touched the unchanged symbol in each of the 18 correct trials (100%). In the first conflict-compound, Child 3 shifted his attention to the unchanged symbol. His test performance, following criterion accuracy, also demonstrated that he selectively attended to the unchanged symbol in the first conflict-compound. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the first conflict-compound (See Fig. 8).

For the second conflict-compound, Child 3 required 68 trials before he achieved criterion accuracy. He made a total of 16 errors before criterion accuracy was finally obtained. Fourteen of the errors (21% of total trials) occurred because Child 3 touched a reversed S- symbol in the conflict compound, and two errors (3% of total errors) occurred when he touched the unchanged S- symbol in the conflict compound (See Fig. 7). In the remaining 52 trials, he touched a reversed S+ symbol in the conflict compound in 15 of the trials (22% of total trials) and the unchanged S+ symbol in the conflict compound in 37 of the trials (54% of total trials). When criterion accuracy was achieved, however, Child 3 consistently touched the unchanged symbol in the conflict compound in each of the 18 correct trials (100%). In the second conflict-compound, Child 3 shifted his attention to the unchanged symbol. His test performance, following criterion accuracy, further demonstrated that he selectively attended to the unchanged symbol in the second conflict- compound. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the second conflict-compound (See Fig. 8).

For the third conflict-compound, Child 3 required 28 trials to achieve criterion accuracy. He made a total of four errors, and three of these errors (10% of total trials) occurred because Child 3 touched a reversed S- symbol in the conflict compound. The fourth error (4% of total trials) occurred because Child 3 touched the unchanged S- symbol in the conflict compound (See Fig. 7). In the remaining 24 trials, Child 3 touched a reversed S+ symbol in the conflict compound in one of the trials (4% of total trials) and the unchanged S+ symbol in the conflict compound in 23 of the trials (82% of total trials). When criterion accuracy was met, Child 3 touched the unchanged S+ symbol in the conflict compound in 17 of the 18 correct trials (94%) and touched a reversed S+ symbol in the conflict compound in one of the 18 correct trials (6%). The response topographies of Child 3 indicated he shifted his attention to the unchanged symbol in the third conflict-compound. His test performance, however, failed to reveal that selective attention to the unchanged symbol occurred. None of the three symbol-pairs exercised stimulus control in agreement with the reinforcement contingencies of the third conflict-compound (See Fig. 8).

In summary, the response topographies of Child 3 revealed he did learn to shift his attention to the unchanged symbols in all three conflict- compounds regardless of which positions they occupied in the conflict compounds when criterion accuracy was obtained. His test performance also confirmed that he selectively attended to the unchanged symbols in the first and second conflict-compounds.

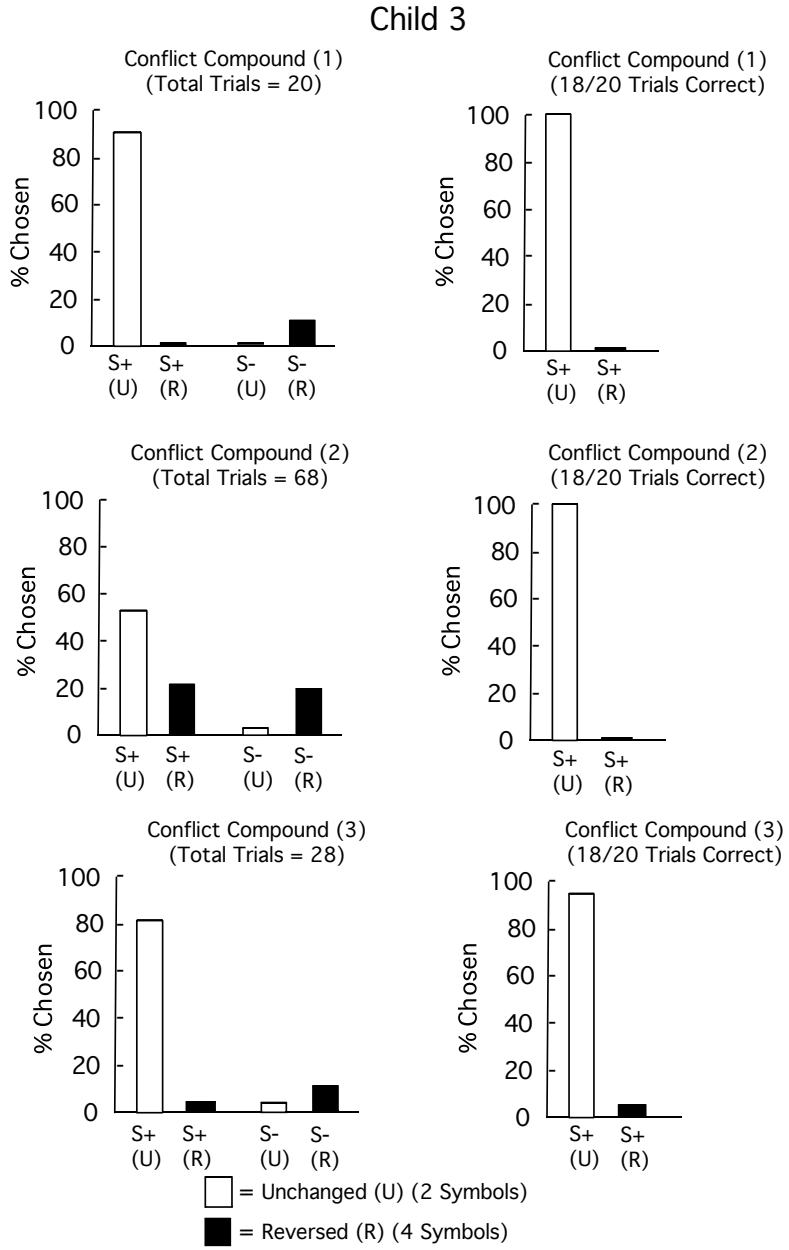

Fig. 7. For Child 3, (left graphs) percentage S+ and S- unchanged symbols (white bars) and S+ and S- reversed symbols (black bars) were chosen when each of the three conflict compounds were presented and (right graphs) percentage the unchanged S+ symbol (white bar) and the reversed S+ symbols (black bar) were chosen during reinforced trials when criterion accuracy was achieved for the three conflict compounds.

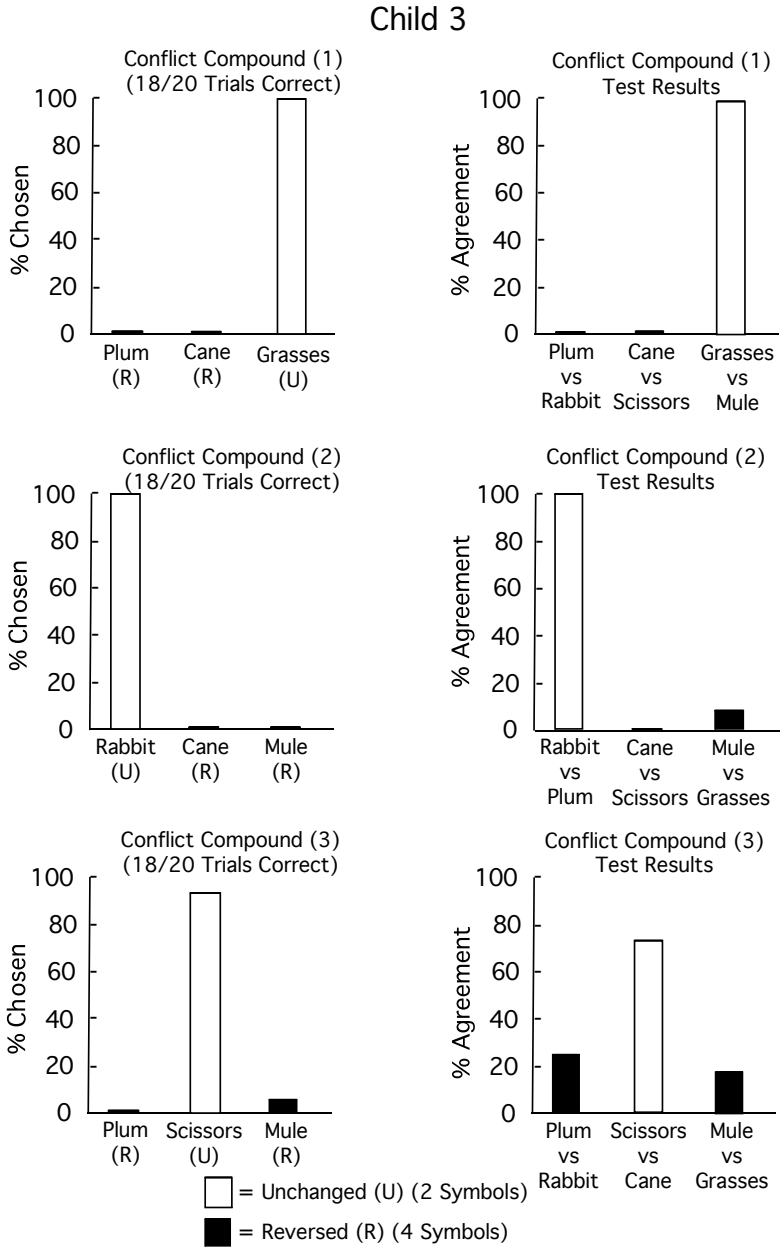

Fig. 8. For Child 3, (left graphs) percentage each of the three S+ symbols were chosen during reinforced trials when criterion accuracy was achieved for the three conflict compounds and (right graphs) percent agreement of responses during stimulus-element test trials with the reinforcement contingencies of the three conflict compounds. The top symbols shown for Child 3 were positive and the bottom symbols were negative in the three conflict-compound discriminations. White bars and black bars indicate unchanged and reversed symbols, respectively.

Experiment II

Method

Subjects

Three female adolescents with intellectual disabilities participated in the research study. Their chronological ages were 14 years, 15 years, and 17 years, respectively. They were enlisted through material describing the study, and all three adolescents attended the same special-education program. Their mental ages were approximately 4-6 years of age, and they were diagnosed within the severe range of intellectual disabilities.

Apparatus

The apparatus was the same as in Experiment 1.

Experimental Design

A within-subject reversal design was also employed to determine whether prior reinforcement histories associated with individual stimuli controlled the elements of compound stimuli that adolescents with intellectual disabilities attended to before or after extended training was provided.

General Procedure

The general procedure was the same as in Experiment 1.

Single Symbol Training

In the first step, each adolescent learned the same three separate visual discriminations, composed of six different symbols, which had been presented to the young children (See Fig. 1). During single symbol training, each pair of individual symbols was presented on the computer screen until criterion accuracy was achieved as had occurred for the young children. The three original pairs also appeared in a mixed symbol sequence in which each symbol pair appeared twice in a block of six trials in an unpredictable mixed sequence. This continued until 90% accuracy for each symbol pair was maintained within a 30-trial sequence.

Conflict Compounds

The individual symbols were next combined to form the three conflict-compounds, which had been presented to the young children. Conflict compounds were again created by keeping prior reinforcement histories unchanged for one symbol pair in the compound and reversing them for the remaining two symbol pairs (See Fig. 2). One conflict- compound was again created by keeping the prior reinforcement histories unchanged for scissors and cane in the compound and reversing them for the remaining four symbols. A second conflict-compound was created by keeping the prior reinforcement histories unchanged for rabbit and plum in the compound while reversing the prior reinforcement histories for the remaining four symbols. The third conflict-compound was created by now keeping the prior reinforcement histories unchanged for grasses and mule in the compound and reversing them for the remaining four symbols. The order in which the three conflict-compounds were presented differed across the three adolescents.

Test Conditions

Test trials were presented after 90% accuracy was achieved for the conflict compounds. The same test trials were administered to the adolescents that had been provided to the young children in order to determine which symbols each adolescent was attending to when they achieved criterion accuracy for the compound discriminations. A total of 36 test trials were again provided in which the three symbol pairs were presented 12 times each in a mixed sequence. During the test trials, reinforcement was provided regardless of which symbol the adolescent touched.

The touch screen also recorded which symbols the adolescents touched each time the conflict compounds appeared on the screen. This provided a direct comparison of test session results with symbols touched in the conflict compounds when compound criterion accuracy was met.

Extended Training

Each adolescent was also given additional exposure to the initial stimulus control procedures. The initial procedures were repeated to determine the effect of prior reinforcement histories on which symbols of the compound stimuli the adolescents attended to when additional training was provided. In the first step, the three visual discriminations, composed of six different symbols, were presented for a second time until criterion accuracy was achieved. Mixed symbol training was also presented a second time until 90% accuracy for each symbol pair was again maintained within a 30-trial sequence. The individual symbols were next combined for a second time to form the three original conflict-compounds. Conflict compounds were again created by keeping prior reinforcement histories unchanged for one symbol pair in the compound and reversing them for the remaining two symbol pairs. After 90% accuracy was met once more for the conflict compounds, 36 test trials were again provided, insuring the three symbol pairs were present 12 times each in a mixed sequence.

A touch screen also recorded as before which symbols the adolescents touched each time the conflict compounds appeared on the screen. This again provided a direct comparison of test session results with symbols selected in the conflict compounds when compound criterion accuracy was achieved.

Results

In contrast to the young children, the response topographies and test performance of the adolescents with intellectual disabilities did not demonstrate they selectively attended to the unchanged symbols in the conflict compounds in most cases when criterion accuracy was originally achieved. After extended training was provided, however, both their response topographies and test performance demonstrated they selectively attended, with one exception, to the each of the unchanged symbols in the three conflict compounds.

Adolescent 1

In the first conflict compound, Adolescent 1 required only 18 trials to achieve criterion accuracy. Adolescent 1 made no errors, and she consistently touched the unchanged S+ symbol in the conflict compound in the 18 trials (100% of total trials). (See Fig. 9). When criterion accuracy was met, Adolescent 1 touched the unchanged symbol in each of the 18 correct trials (100%). In the first conflict-compound, Adolescent 1 selectively attended to the unchanged symbol. The test performance of Adolescent 1, following criterion accuracy, also confirmed that she selectively attended to the unchanged symbol in the first conflict-compound. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the first conflict-compound (See Fig. 10).

In the second conflict-compound, Adolescent 1 required 22 trials to achieve criterion accuracy. She made four errors (18% of total trials), and all four errors occurred because she touched a reversed S- symbol in the conflict compound (See Fig. 9). In the remaining 18 trials (82% of total trials), she touched a reversed S+ symbol in the conflict compound. When criterion accuracy was met, Adolescent 1 touched a reversed symbol in each of the 18 correct trials (100%). Although Adolescent 1 learned the second conflict-compound with few errors, she did not shift her attention to the unchanged symbol in the second conflict-compound. She selectively responded, instead, to a reversed symbol in the conflict compound when criterion accuracy was achieved. The test performance of Adolescent 1, following criterion accuracy, also confirmed that she did not selectively attend to the unchanged symbol in the second conflict-compound. None of the three symbol-pairs exercised stimulus control in agreement with the reinforcement contingencies of the second conflict-compound (See Fig. 10).

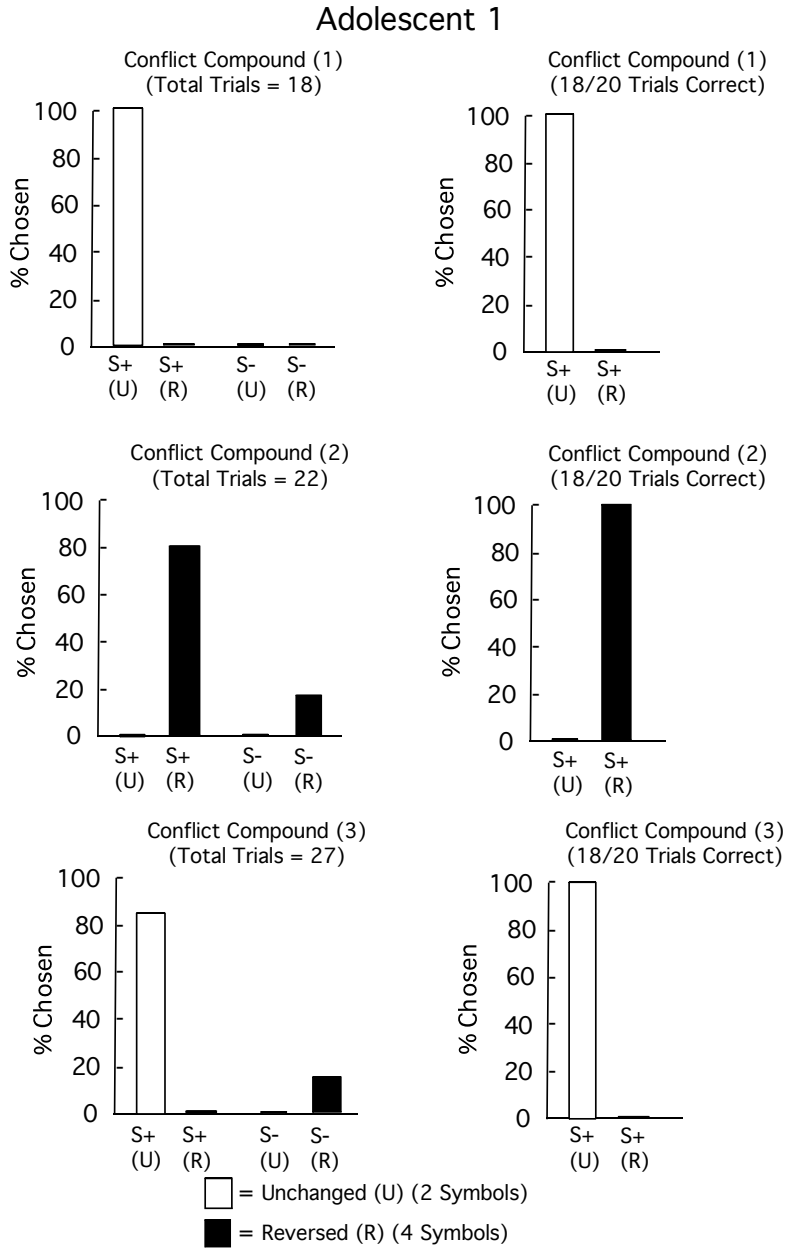

Fig. 9. For Adolescent 1, (left graphs) percentage S+ and S- unchanged symbols (white bars) and S+ and S- reversed symbols (black bars) were chosen when each of the three conflict compounds were presented and (right graphs) percentage the unchanged S+ symbol (white bar) and the reversed S+ symbols (black bar) were chosen during reinforced trials when criterion accuracy was achieved for the three conflict compounds.

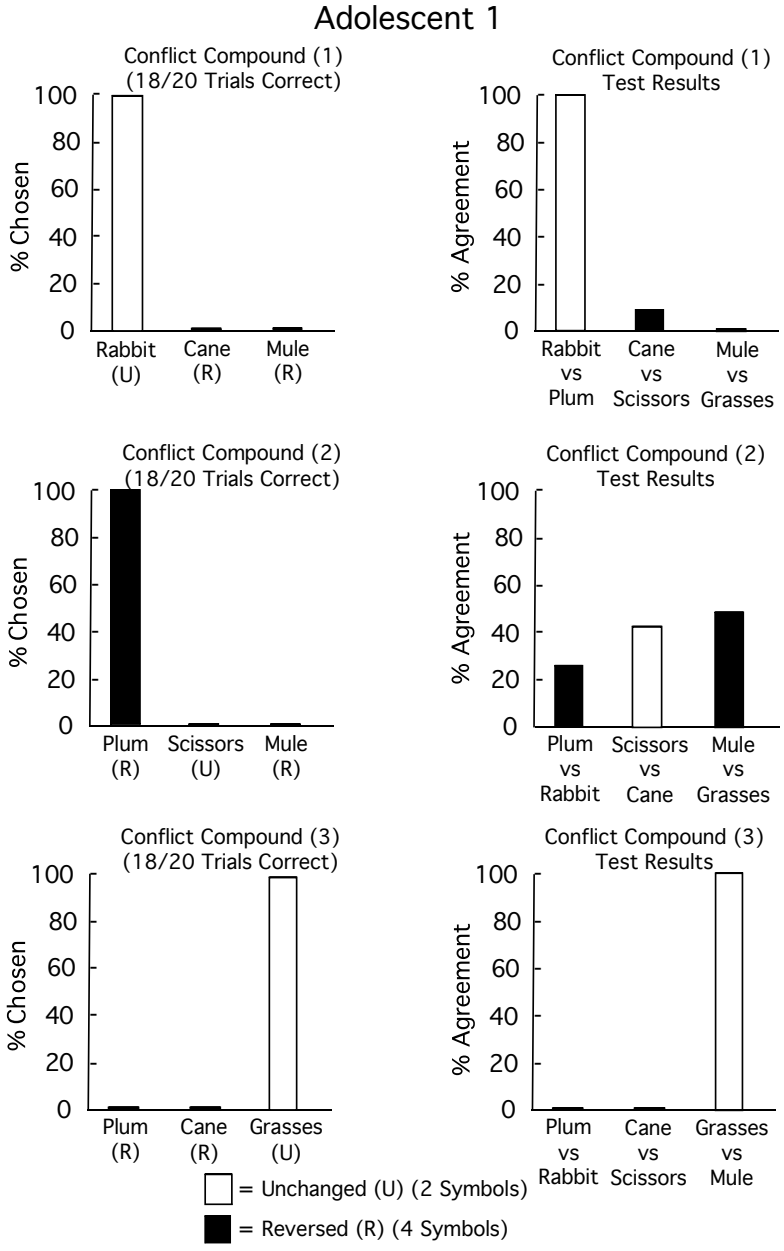

Fig. 10. For Adolescent 1, (left graphs) percentage each of the three S+ symbols were chosen during reinforced trials when criterion accuracy was achieved for the three conflict compounds and (right graphs) percent agreement of responses during stimulus-element test trials with the reinforcement contingencies of the three conflict compounds. The top symbols shown for Adolescent 1 were positive and the bottom symbols were negative in the three conflict-compound discriminations. White bars and black bars indicate unchanged and reversed symbols, respectively.

In the third conflict-compound, Adolescent 1 required 27 trials to achieve criterion accuracy. Adolescent 1 made four errors (15% of total trials), and all four errors occurred because she touched a reversed S- symbol in the conflict compound (See Fig. 9). In the remaining 23 trials (85% of total trials), Adolescent 1 touched the unchanged S+ symbol in the conflict compound. When criterion accuracy was obtained, Adolescent 1 touched the unchanged symbol in each of the 18 correct trials (100%). In the third conflict-compound, Adolescent 1 shifted her attention to the unchanged symbol. Her test performance, following criterion accuracy, also demonstrated that she selectively attended to the unchanged symbol in the third conflict-compound. Only the unchanged-symbol pair exhibited stimulus control in agreement with the reinforcement contingencies of the third conflict-compound (See Fig. 10).

In summary, the response topographies of Adolescent 1 revealed that she attended to the unchanged symbols in the first and third conflict- compounds when criterion accuracy was achieved. She did not, however, shift her attention to the unchanged symbol in the second conflict- compound when criterion accuracy was met. Her test performance also confirmed that she selectively attended to the unchanged symbols in the first and third conflict-compounds but did not selectively attend to the unchanged symbol in the second conflict-compound. Adolescent 1 did attend to unchanged symbols, however, when they occupied two different positions in the conflict compounds as demonstrated by her response topographies and test performance.

Adolescent 1(Extended Training)

When extended training was provided, Adolescent 1 required 20 trials to reach criterion accuracy for the first conflict-compound. She made only two errors, and one of these errors (5% of total trials) occurred because Adolescent 1 touched a reversed S- symbol in the conflict compound. The second error (5% of total trials) occurred because Adolescent 1 touched the unchanged S- symbol in the conflict compound (See Fig. 11). In the remaining 18 trials, she touched a reversed S+ symbol in the conflict compound in one of the trials (5% of total trials) and the unchanged S+ symbol in the conflict compound in 17 of the trials (85% of total trials). When criterion accuracy was met, Adolescent 1 touched the unchanged symbol in 17 of the 18 correct trials (94%) and a reversed symbol in 1 of the 18 correct trials (6%). In the first conflict-compound, after extended training was provided, Adolescent 1 shifted her attention to the unchanged symbol. Following criterion accuracy, her test performance also revealed that she selectively attended to the unchanged symbol in the first conflict-compound when extended training was provided. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the first conflict-compound following extended training (See Fig. 12).

When extended training was provided for the second conflict- compound, Adolescent 1 again required only 20 trials to reach criterion accuracy. She made only two errors (10% of total trials), and both errors occurred because Adolescent 1 touched a reversed S- symbol in the conflict compound (See Fig. 11). In the remaining 18 trials, she touched a reversed S+ symbol in the conflict compound in one of the trials (5% of total trials) and the unchanged S+ symbol in the conflict compound in 17 of the trials (85% of total trials). When criterion accuracy was obtained, Adolescent 1 touched the unchanged symbol in 17 of the 18 correct trials (94%) and a reversed symbol in one of the 18 correct trials (6%). In the second conflict-compound, following extended training, Adolescent 1 shifted her attention to the unchanged symbol. Her test performance, following criterion accuracy, further confirmed that she selectively attended to the unchanged symbol in the second conflict- compound when extended training was provided. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the second conflict-compound following extended training (See Fig. 12).

When extended training was provided for the third conflict- compound, Adolescent 1 required 28 trials to reach criterion accuracy. She made five errors (18% of total trials), and each of the five errors occurred because Adolescent 1 touched a reversed S- symbol in the conflict compound (See Fig. 11). In the remaining 23 trials (82% of total trials), she touched the unchanged S+ symbol in the conflict compound. When criterion accuracy was achieved, Adolescent 1 touched the unchanged symbol in each of the 18 correct trials (100%). In the third conflict-compound, following extended training, Adolescent 1 switched her attention to the unchanged symbol. The test performance of Adolescent 1, following criterion accuracy, also demonstrated that she selectively attended to the unchanged symbol in the third conflict- compound when

extended training was provided. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the third conflict-compound following extended training (See Fig. 12).

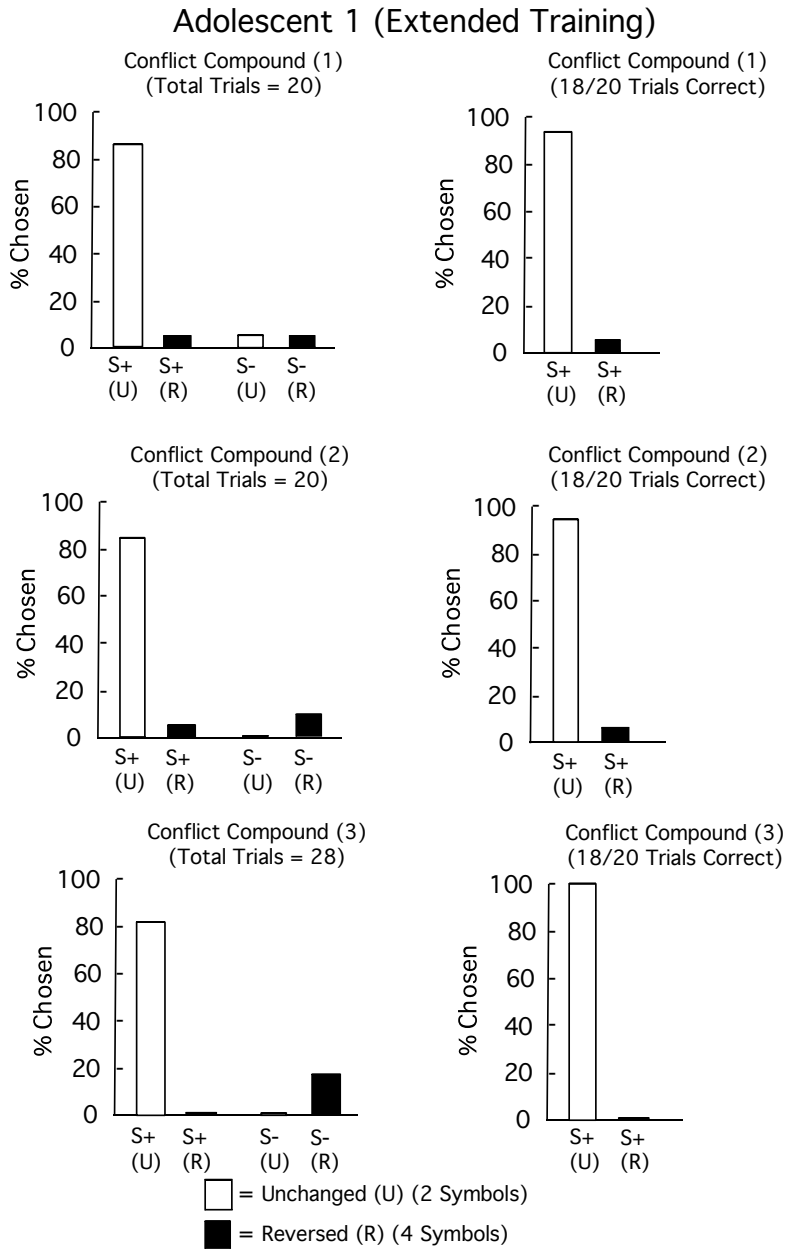

Fig. 11. For Adolescent 1, (left graphs) percentage S+ and S- unchanged symbols (white bars) and S+ and S- reversed symbols (black bars) were chosen when each of the three conflict compounds were presented a second time following extended training and (right graphs) percentage the unchanged S+ symbol (white bar) and the reversed S+ symbols (black bar) were chosen during reinforced trials when criterion accuracy was again achieved for the three conflict compounds following extended training.

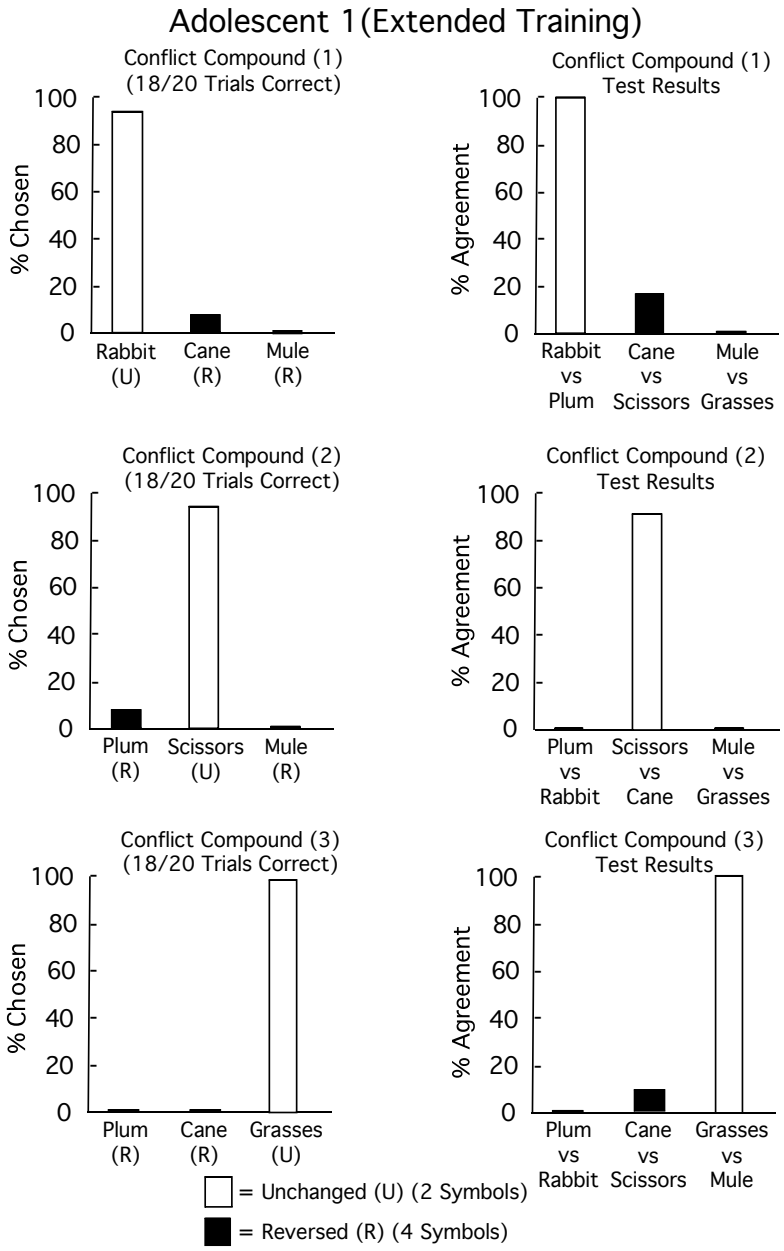

Fig. 12. For Adolescent 1, (left graphs) percentage each of the three S+ symbols were chosen during reinforced trials when criterion accuracy was again achieved for the three conflict compounds following extended training and (right graphs) percent agreement of responses during stimulus-element test trials with the reinforcement contingencies of the three conflict compounds when extended training was provided. The top symbols shown for Adolescent 1 were positive and the bottom symbols were negative in the three conflict-compound discriminations. White bars and black bars indicate unchanged and reversed symbols, respectively.

In summary, the response topographies of Adolescent 1 revealed, after extended training was provided, that Adolescent 1 learned to shift her attention to the unchanged symbols in all three conflict-compounds when criterion accuracy was achieved. Her test performance, following extended training, also confirmed that Adolescent 1 selectively attended to the unchanged symbols in all three conflict-compounds. After extended training was administered, Adolescent 1 learned to shift her attention to the unchanged symbols in all three conflict-compounds regardless of which positions they occupied in the conflict compounds and with relatively few errors occurring.

Adolescent 2

In the first conflict-compound, Adolescent 2 required 103 trials before she acquired criterion accuracy. She made a total of 70 errors, and 67 of these errors (65% of total trials) occurred because she touched a reversed S- symbol in the conflict compound. Three errors (3% of total trials) occurred because she touched the unchanged S- symbol in the conflict compound (See Fig. 13). In the remaining 33 trials, Adolescent 2 touched a reversed S+ symbol in the conflict compound in 30 of the trials (29% of total trials) and the unchanged S+ symbol in the conflict compound in 3 of the trials (3% of total trials). When criterion accuracy was achieved, Adolescent 2 touched a reversed symbol in each of the 18 correct trials (100%). In the first conflict- compound, Adolescent 2 did not shift her attention to the unchanged symbol. She selectively responded, instead, to a reversed symbol in the conflict compound when criterion accuracy was met. Her test performance, following criterion accuracy, also demonstrated that she did not selectively attend to the unchanged symbol in the first conflict- compound. Only a reversed-symbol pair exhibited stimulus control in agreement with the reinforcement contingencies of the first conflict-compound (See Fig. 14).
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In the second conflict-compound, Adolescent 2 required only 18 trials to achieve criterion accuracy. Adolescent 2 did not make any errors, and she consistently touched the unchanged S+ symbol in the conflict compound in the 18 trials (100% of total trials) (See Fig. 13). When criterion accuracy was achieved, Adolescent 2 touched the unchanged symbol in each of the 18 correct trials (100%). In the second conflict-compound, Adolescent 2 selectively attended to the unchanged symbol. Her test performance, following criterion accuracy, also confirmed that she selectively attended to the unchanged symbol in the second conflict- compound. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the second conflict-compound (See Fig. 14).

In the third conflict-compound, Adolescent 2 required 46 trials before she acquired criterion accuracy. She made a total or 14 errors (30% of total trials), and all 14 errors occurred because Adolescent 2 touched a reversed S- symbol in the conflict compound (See Fig. 13). In the remaining 32 trials (70% of total trials), Adolescent 2 touched a reversed S+ symbol in the conflict compound. When criterion accuracy was achieved, Adolescent 2 touched a reversed symbol in each of the 18 correct trials (100%). In the third conflict- compound, Adolescent 2 did not shift her attention to the unchanged symbol. She selectively responded, instead, to a reversed symbol in the conflict compound when criterion accuracy was met. Her test performance, following criterion accuracy, also confirmed that she did not selectively attend to the unchanged symbol in the third conflict-compound. Both the unchanged-symbol pair and a reversed-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the third conflict-compound (See Fig. 14).

In summary, the response topographies of Adolescent 2 revealed that she attended to the unchanged symbol in the second conflict- compound when criterion accuracy was met. She did not, however, shift her attention to the unchanged symbols in the first and third conflict- compounds when criterion accuracy was achieved. Her test performance, following criterion accuracy, also confirmed that she selectively attended to the unchanged symbol in the second conflict-compound but did not selectively attend to the unchanged symbols in the first and third conflict- compounds. She selectively responded, instead, as revealed by her response topographies, to the same symbol pair in all three conflict- compounds when criterion accuracy was achieved regardless of whether its prior reinforcement contingencies were unchanged or reversed in the compounds.

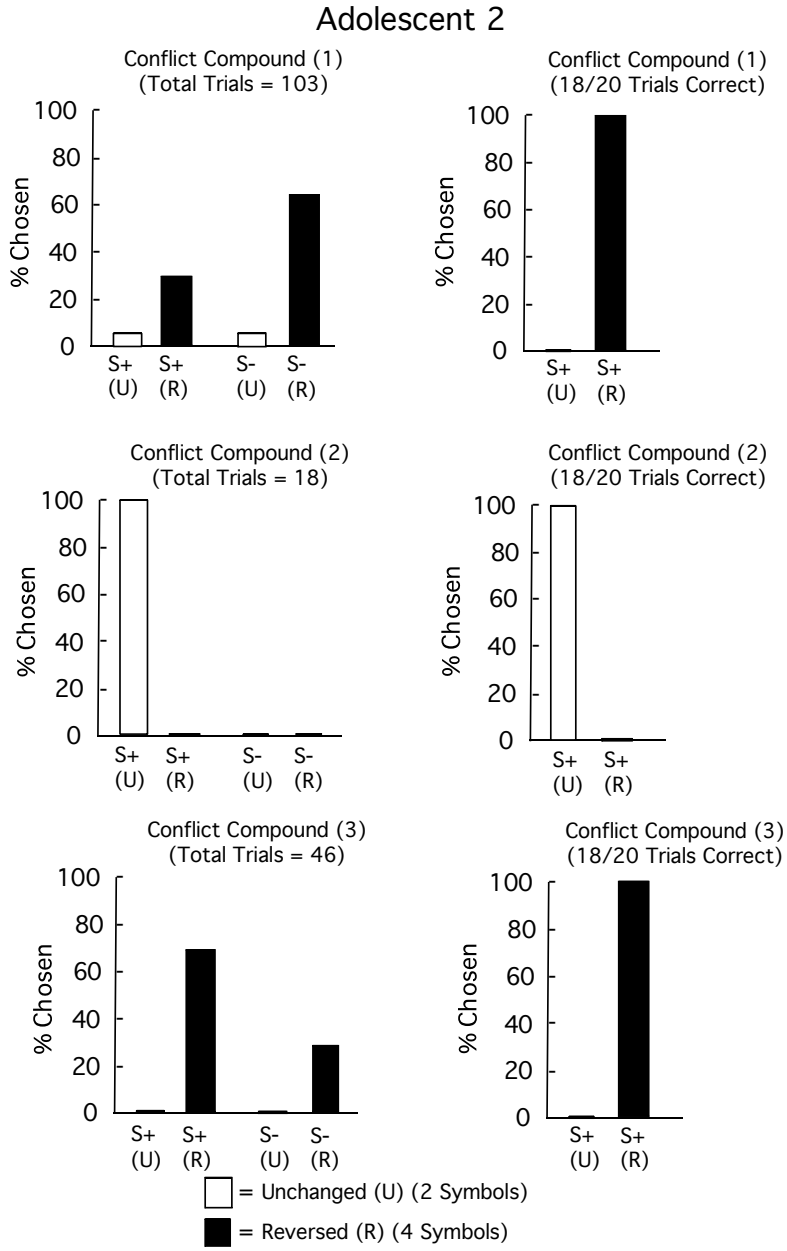

Fig. 13. For Adolescent 2, (left graphs) percentage S+ and S- unchanged symbols (white bars) and S+ and S- reversed symbols (black bars) were chosen when each of the three conflict compounds were presented and (right graphs) percentage the unchanged S+ symbol (white bar) and the reversed S+ symbols (black bar) were chosen during reinforced trials when criterion accuracy was achieved for the three conflict compounds.

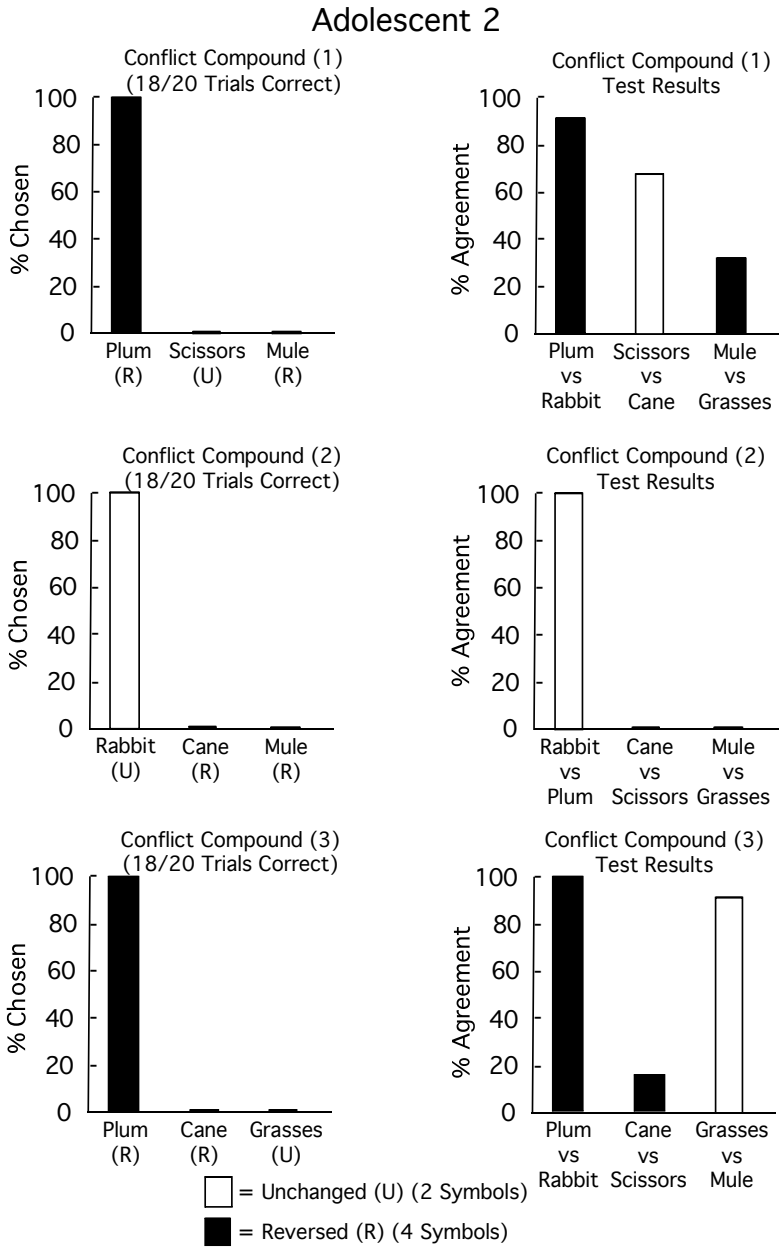

Fig. 14. For Adolescent 2, (left graphs) percentage each of the three S+ symbols were chosen during reinforced trials when criterion accuracy was achieved for the three conflict compounds and (right graphs) percent agreement of responses during stimulus-element test trials with the reinforcement contingencies of the three conflict compounds. The top symbols shown for Adolescent 2 were positive and the bottom symbols were negative in the three conflict-compound discriminations. White bars and black bars indicate unchanged and reversed symbols, respectively.

Adolescent 2 (Extended Training)

When extended training was provided, Adolescent 2 required 47 trials to reach criterion accuracy for the first conflict-compound. She made 14 errors, and 13 of these errors (28% of total trials) occurred because Adolescent 2 touched a reversed S- symbol in the conflict compound. One of the errors (2% of total trials) occurred because Adolescent 2 touched the unchanged S- symbol in the conflict compound (See Fig. 15). In the remaining 33 trials, she touched a reversed S+ symbol in the conflict compound in 32 of the trials (68% of total trials) and the unchanged S+ symbol in the conflict compound in one of the trials (2% of total trials). When criterion accuracy was achieved, Adolescent 2 touched the unchanged symbol in 1 of the 18 correct trials (6%) and a reversed symbol in 17 of the 18 correct trials (94%). In the first conflict-compound, following extended training, Adolescent 2 did not shift her attention to the unchanged symbol. She selectively responded, instead, to a reversed symbol in the conflict compound when criterion accuracy was achieved. Her test performance did indicate, however, following extended training that she selectively attended to the unchanged symbol in the first conflict-compound when criterion accuracy was met. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the first conflict- compound following extended training (See Fig. 16).

When extended training was provided for the second conflict- compound, Adolescent 2 required 30 trials to reach criterion accuracy. Adolescent 2 made five errors, and four of these errors (14% of total trials) occurred because Adolescent 2 touched a reversed S- symbol in the conflict compound. One of the errors (3% of total trials) occurred because she touched the unchanged S- symbol in the conflict compound (See Fig. 15). In the remaining 25 trials, she touched a reversed S+ symbol in the conflict compound in one of the trials (3% of total trials) and the unchanged S+ symbol in the conflict compound in 24 of the trials (80% of total trials). When criterion accuracy was achieved, Adolescent 2 touched the unchanged symbol in 17 of the 18 correct trials (94%) and a reversed symbol in 1 of the 18 correct trials (6%). In the second conflict-compound, after extended training was provided, Adolescent 2 shifted her attention to the unchanged symbol. Her test performance, following extended training, also revealed that she selectively attended to the unchanged symbol in the second conflict-compound when criterion accuracy was met. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the second conflict-compound following extended training (See Fig. 16).

When extended training was provided for the third conflict- compound, Adolescent 2 required 69 trials to reach criterion accuracy. She made 16 errors, and eight of these errors (12% of total trials) occurred because Adolescent 2 touched a reversed S- symbol in the conflict compound. The other eight errors (12% of total trials) occurred because she touched the unchanged S- symbol in the conflict compound (See Fig. 15). In the remaining 53 trials (76% of total trials), Adolescent 2 touched the unchanged S+ symbol in the conflict compound. When criterion accuracy was achieved, Adolescent 2 touched the unchanged symbol in each of the 18 correct trials (100%). After extended training was provided for the third conflict-compound, Adolescent 2 shifted her attention to the unchanged symbol. Her test performance, following extended training, also indicated that she selectively attended to the unchanged symbol in the third conflict-compound when criterion accuracy was achieved. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the third conflict-compound following extended training (See Fig. 16).

In summary, the response topographies of Adolescent 2 revealed, after extended training was provided, that she shifted her attention to the unchanged symbols in the second and third conflict-compounds when criterion accuracy was obtained. She did not, however, shift her attention to the unchanged symbol in the first conflict-compound when criterion accuracy was achieved. Her test performance, on the other hand, indicated that she selectively attended to the unchanged symbols in all three conflict- compounds when extended training was provided.

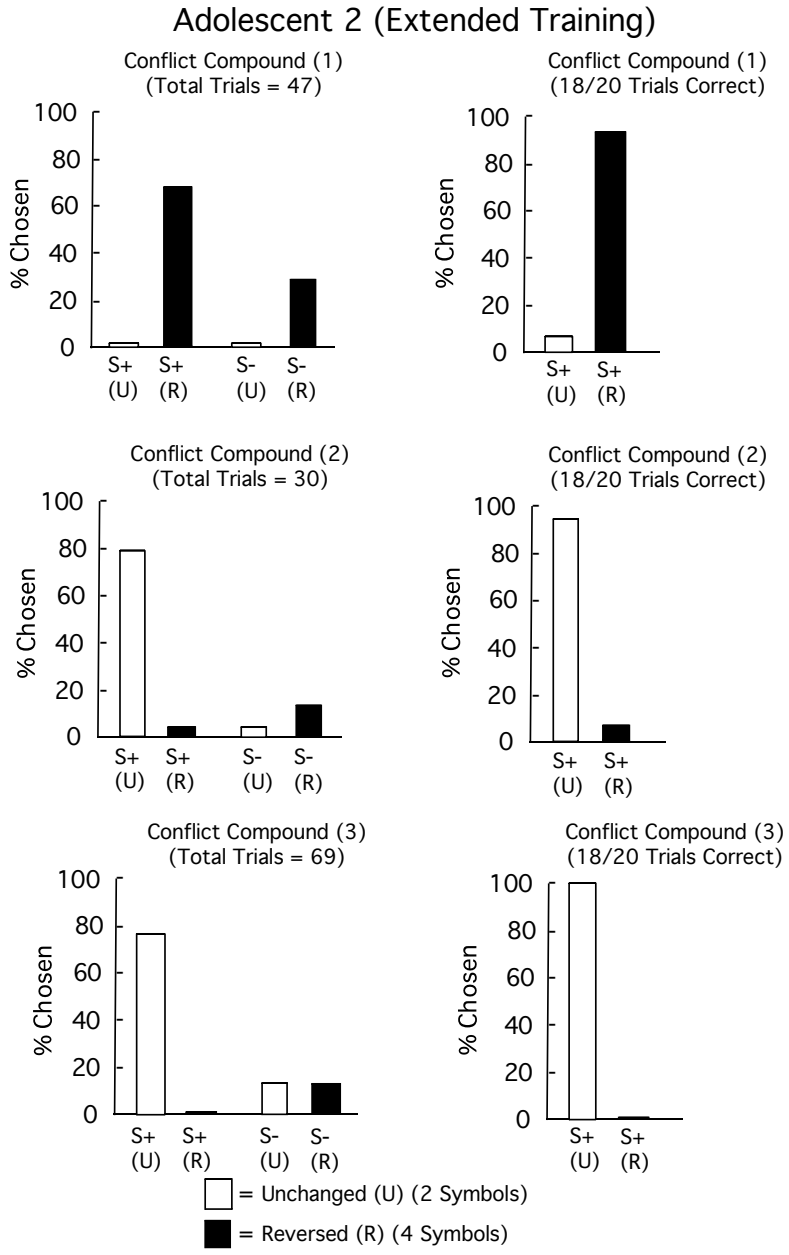

Fig. 15. For Adolescent 2, (left graphs) percentage S+ and S- unchanged symbols (white bars) and S+ and S- reversed symbols (black bars) were chosen when each of the three conflict compounds were presented a second time following extended training and (right graphs) percentage the unchanged S+ symbol (white bar) and the reversed S+ symbols (black bar) were chosen during reinforced trials when criterion accuracy was again achieved for the three conflict compounds following extended training.

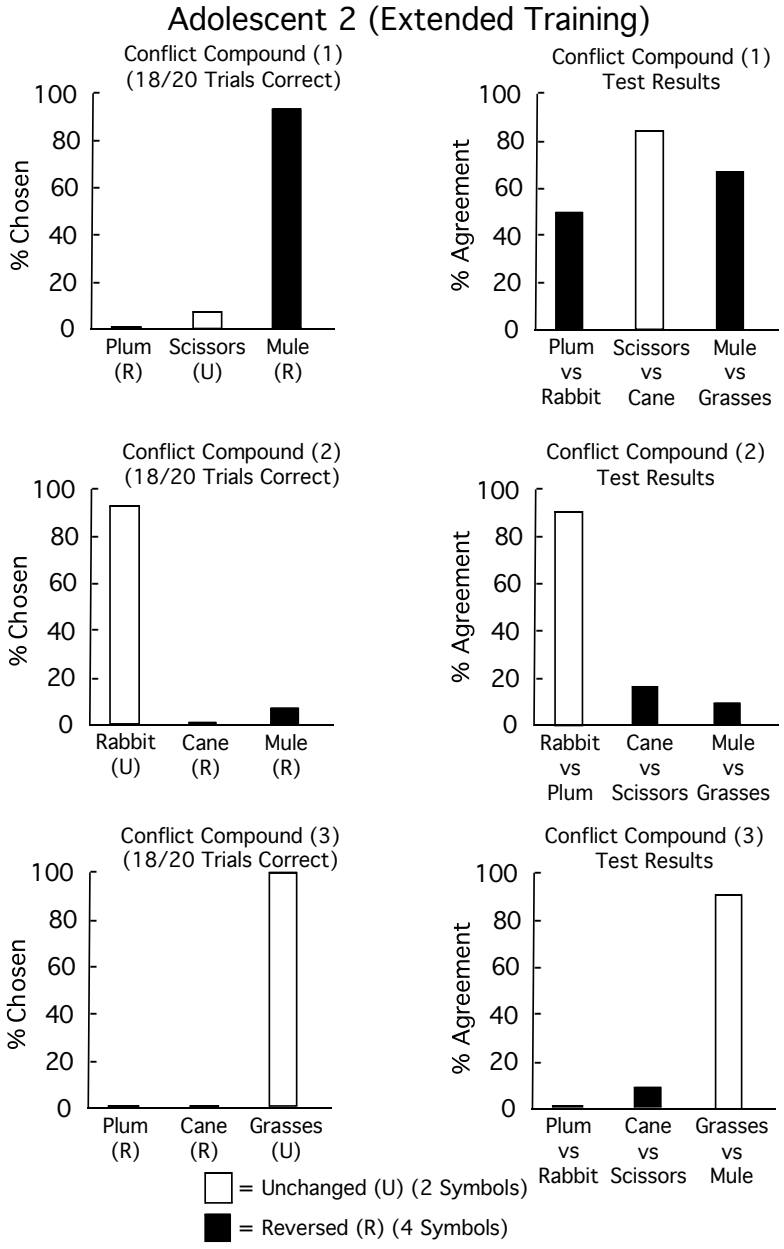

Fig. 16. For Adolescent 2, (left graphs) percentage each of the three S+ symbols were chosen during reinforced trials when criterion accuracy was again achieved for the three conflict compounds following extended training and (right graphs) percent agreement of responses during stimulus-element test trials with the reinforcement contingencies of the three conflict compounds when extended training was provided. The top symbols shown for Adolescent 2 were positive and the bottom symbols were negative in the three conflict-compound discriminations. White bars and black bars indicate unchanged and reversed symbols, respectively.

Adolescent 3

In the first conflict-compound, Adolescent 3 required 35 trials to acquire criterion accuracy. She made six errors, and two of these errors (6% of total trials) occurred because she touched a reversed S- symbol in the conflict compound. The other four errors (11% of total trials) occurred because she touched the unchanged S- symbol in the conflict compound (See Fig. 17). In the remaining 29 trials, she touched a reversed S+ symbol in the conflict compound in one of the trials (3% of total trials) and the unchanged S+ symbol in the conflict compound in 28 of the trials (80% of total trials). When criterion accuracy was achieved, Adolescent 3 touched the unchanged symbol in each of the 18 correct trials (100%). In the first conflict-compound, Adolescent 3 shifted her attention to the unchanged symbol. Her test performance, following criterion accuracy, also confirmed that she selectively attended to the unchanged symbol in the first conflict-compound. Only the unchanged- symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the first conflict-compound (See Fig. 18).

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In the second conflict-compound, Adolescent 3 required 53 trials to reach criterion accuracy. She made 13 errors, and 12 of these errors (23% of total trials) occurred because she touched a reversed S- symbol in the conflict compound. One error (2% of total trials) occurred because she touched the unchanged S- symbol in the conflict compound (See Fig. 17). In the remaining 40 trials, Adolescent 3 touched a reversed S+ symbol in the conflict compound in 39 of the trials (73% of total trials) and the unchanged S+ symbol in one of the trials (2% of total trials). When criterion accuracy was achieved, Adolescent 3 touched a reversed symbol in each of the 18 correct trials (100%). In the second conflict-compound, Adolescent 2 did not shift her attention to the unchanged symbol when criterion accuracy was obtained. She, instead, selectively responded to a reversed symbol in the conflict compound. Her test performance did not confirm, however, that she selectively attended to a reversed symbol in the second conflict-compound when criterion accuracy was met. None of the three symbol-pairs exercised stimulus control in agreement with the reinforcement contingencies of the second conflict-compound (See Fig. 18).

In the third conflict-compound, Adolescent 3 required 50 trials to reach criterion accuracy. She made 15 errors, and eight of these errors (16% of total trials) occurred because she touched a reversed S- symbol in the conflict compound. The other seven errors (14% of total trials) occurred because she touched the unchanged S- symbol in the conflict compound (See Fig. 17). In the remaining 35 trials, Adolescent 3 touched a reversed S+ symbol in the conflict compound in 26 of the trials (52% of total trials) and the unchanged S+ symbol in 9 of the trials (18% of total trials). When criterion accuracy was achieved, Adolescent 3 touched a reversed symbol in the conflict compound in each of the 18 correct trials (100%). In the third conflict-compound, Adolescent 3 did not shift her attention to the unchanged symbol. She, instead, selectively responded to a reversed symbol in the conflict compound when criterion accuracy was met. Her test performance also demonstrated that she selectively attended to a reversed symbol in the third conflict-compound when criterion accuracy was obtained. Only a reversed-symbol pair exhibited stimulus control in agreement with the reinforcement contingencies of the third conflict- compound (See Fig. 18).

In summary, the response topographies of Adolescent 3 indicated that she shifted her attention to the unchanged symbol in the first conflict- compound when criterion accuracy was achieved. She did not, in contrast, shift her attention to the unchanged symbols in the second and third conflict-compounds when criterion accuracy was met. Her test performance, following criterion accuracy, also confirmed that she selectively attended to the unchanged symbol in the first conflict- compound but did not selectively attend to the unchanged symbols in the second and third conflict-compounds. She selectively responded, instead, as revealed by her response topographies, to the same symbol pair in all three conflict-compounds when criterion accuracy was met regardless of whether its prior reinforcement contingencies were reversed or unchanged in the compounds.

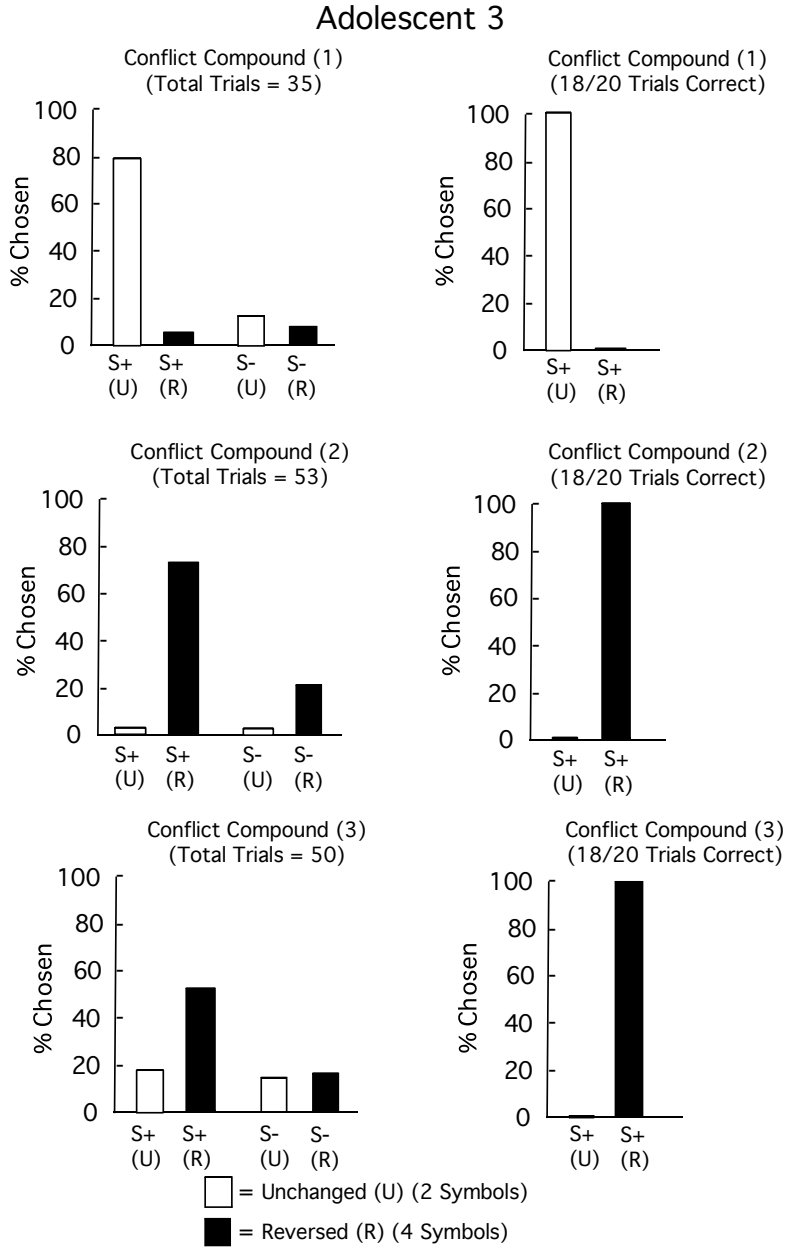

Fig. 17. For Adolescent 3, (left graphs) percentage S+ and S- unchanged symbols (white bars) and S+ and S- reversed symbols (black bars) were chosen when each of the three conflict compounds were presented and (right graphs) percentage the unchanged S+ symbol (white bar) and the reversed S+ symbols (black bar) were chosen during reinforced trials when criterion accuracy was achieved for the three conflict compounds.

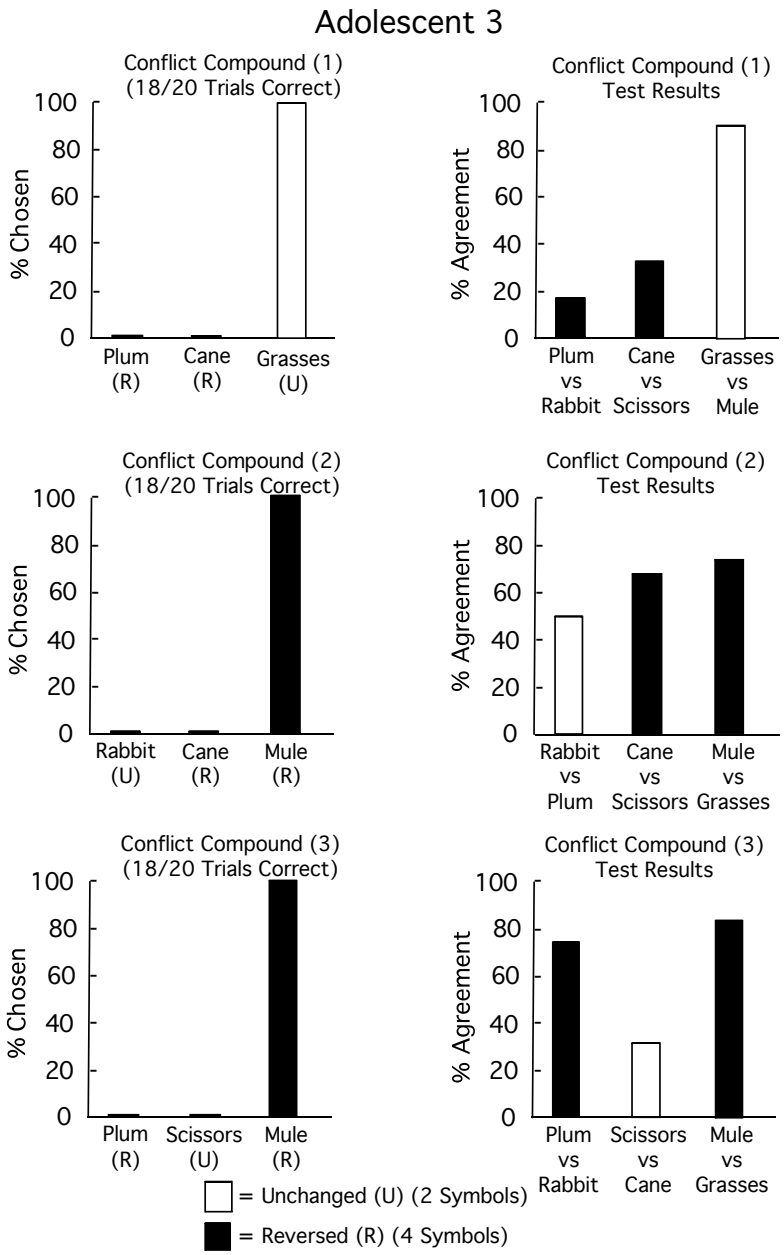

Fig. 18. For Adolescent 3, (left graphs) percentage each of the three S+ symbols were chosen during reinforced trials when criterion accuracy was achieved for the three conflict compounds and (right graphs) percent agreement of responses during stimulus-element test trials with the reinforcement contingencies of the three conflict compounds. The top symbols shown for Adolescent 3 were positive and the bottom symbols were negative in the three conflict-compound discriminations. White bars and black bars indicate unchanged and reversed symbols, respectively.

Adolescent 3 (Extended Training)

When extended training was provided for the first conflict- compound, Adolescent 3 required 27 trials to reach criterion accuracy. She made six errors (22% of total trials), and all six errors occurred because she touched a reversed S- symbol in the conflict compound (See Fig. 19). In the remaining 21 trials (78% of total trials), Adolescent 3 touched the unchanged S+ symbol in the conflict compound. When criterion accuracy was met, Adolescent 3 touched the unchanged symbol in each of the 18 correct trials (100%). In the first conflict-compound, following extended training, Adolescent 3 shifted her attention to the unchanged symbol. Her test performance also confirmed, after extended training was provided, that she selectively attended to the unchanged symbol in the first conflict-compound when criterion accuracy was obtained. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the first conflict-compound following extended training (See Fig. 20).

When extended training was provided for the second conflict- compound, Adolescent 3 required 26 trials to reach criterion accuracy. She made five errors (19% of total trials), and all five errors occurred because she touched a reversed S- symbol in the conflict compound (See Fig. 19). In the remaining 21 trials, Adolescent 3 touched a reversed S+ symbol in the conflict compound in one of the trials (4% of total trials) and the unchanged S+ symbol in the conflict compound in 20 of the trials (77% of total trials). When criterion accuracy was achieved, Adolescent 3 touched the unchanged symbol in each of the 18 correct trials (100%). In the second conflict-compound, after extended training was provided, Adolescent 3 shifted her attention to the unchanged symbol. Her test performance also indicated, following extended training, that she selectively attended to the unchanged symbol in the second conflict-compound when criterion accuracy was obtained. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the second conflict-compound following extended training (See Fig. 20).

When extended training was provided for the third conflict- compound, Adolescent 3 required 25 trials to reach criterion accuracy. She made three errors, and two of these errors (8% of total trials) occurred because she touched a reversed S- symbol in the conflict compound. The third error (4% of total trials) occurred because she touched the unchanged S- symbol in the conflict compound (See Fig. 19). In the remaining 22 trials (88% of total trials), Adolescent 3 touched the unchanged S+ symbol in the conflict compound. When criterion accuracy was obtained, Adolescent 3 touched the unchanged symbol in each of the 18 correct trials (100%). In the third conflict-compound, following extended training, Adolescent 3 shifted her attention to the unchanged symbol. Her test performance also confirmed, when extended training was provided, that she selectively attended to the unchanged symbol in the third conflict-compound when criterion accuracy was met. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the third conflict-compound following extended training (See Fig. 20).

In summary, the response topographies of Adolescent 3 demonstrated, following extended training, that she shifted her attention to the unchanged symbols in all three conflict-compounds when criterion accuracy was achieved. Her test performance, after extended training was provided, also confirmed that she selectively attended to the unchanged symbols in all three conflict-compounds. After extended training was provided, Adolescent 3 learned to shift her attention to the unchanged symbols in all three conflict-compounds regardless of which positions they occupied in the conflict compounds.

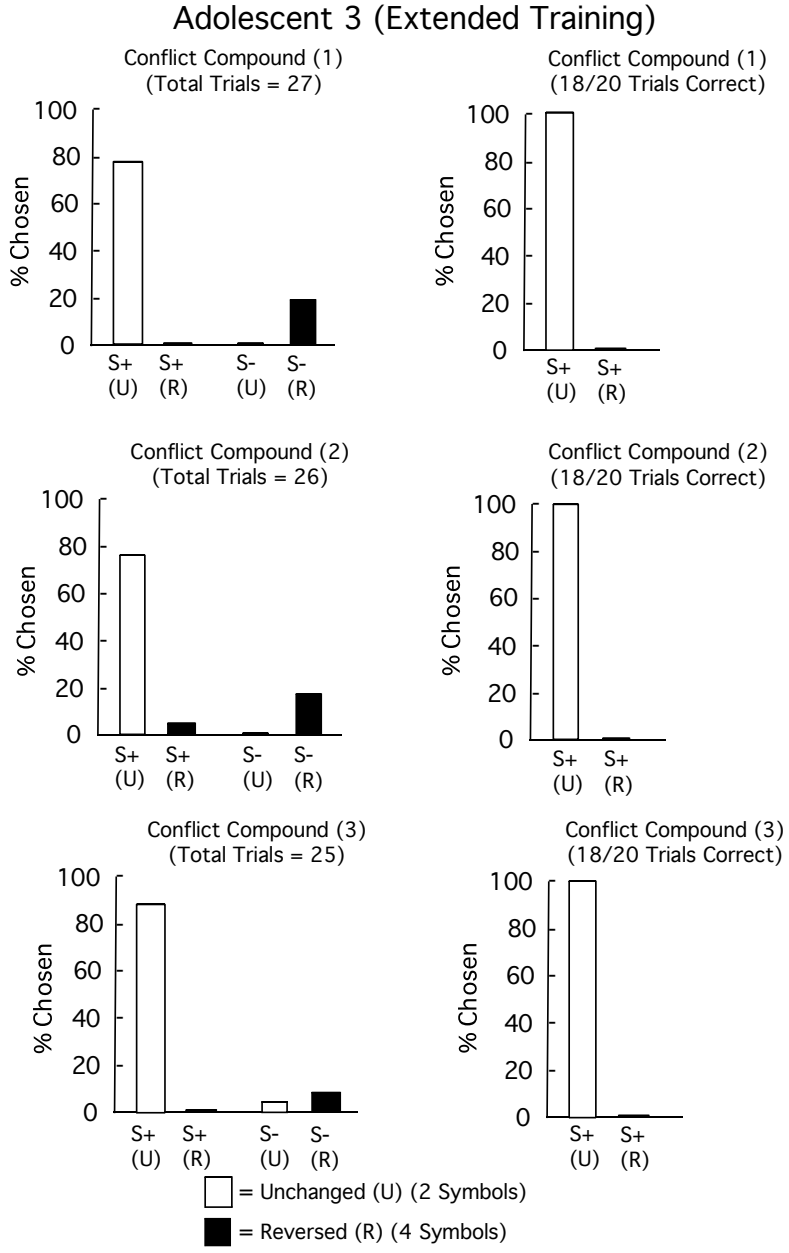

Fig. 19. For Adolescent 3, (left graphs) percentage S+ and S- unchanged symbols (white bars) and S+ and S- reversed symbols (black bars) were chosen when each of the three conflict compounds were presented a second time following extended training and (right graphs) percentage the unchanged S+ symbol (white bar) and the reversed S+ symbols (black bar) were chosen during reinforced trials when criterion accuracy was again achieved for the three conflict compounds following extended training.

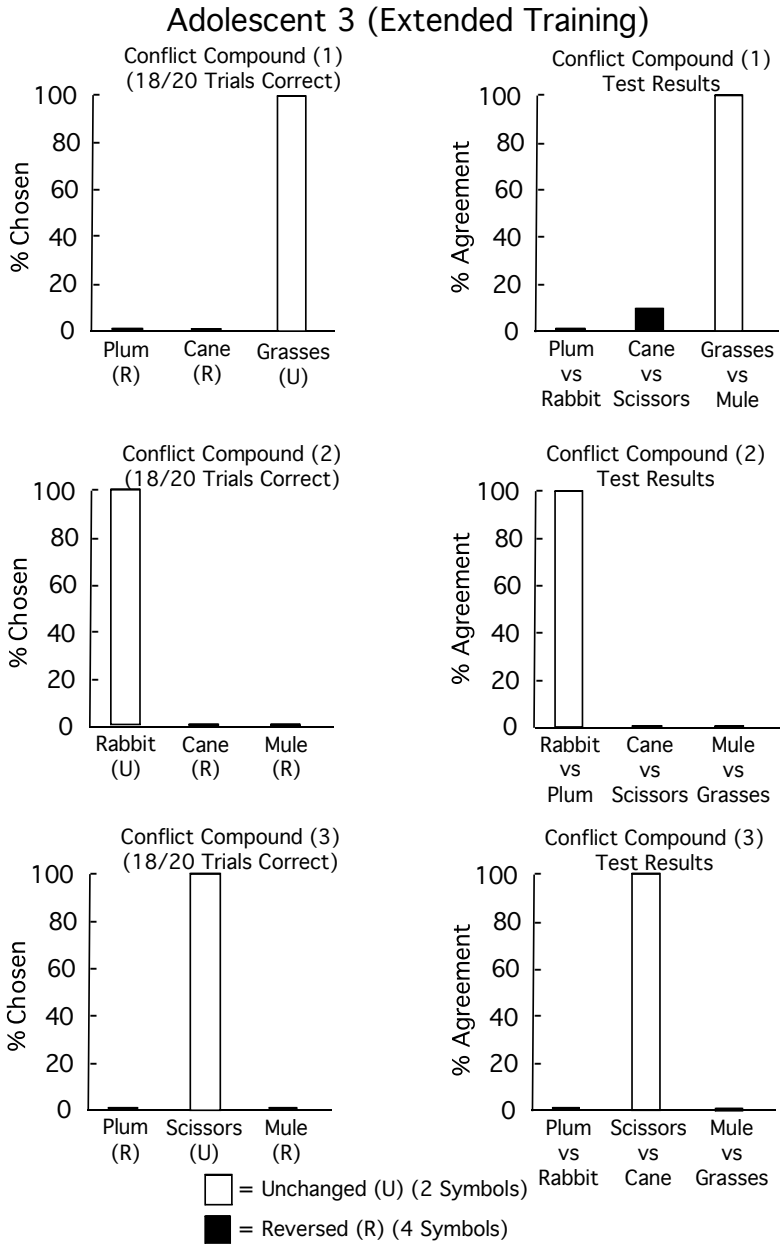

Fig. 20. For Adolescent 3, (left graphs) percentage each of the three S+ symbols were chosen during reinforced trials when criterion accuracy was again achieved for the three conflict compounds following extended training and (right graphs) percent agreement of responses during stimulus-element test trials with the reinforcement contingencies of the three conflict compounds when extended training was provided. The top symbols shown for Adolescent 3 were positive and the bottom symbols were negative in the three conflict-compound discriminations. White bars and black bars indicate unchanged and reversed symbols, respectively.

Experiment III

Method

Participants

Two adults, an adolescent, and a young child participated in this study. Two of the participants were acquaintances of the author, and two of the participants were not known by the author.

Apparatus

The stimulus-control procedures were provided online, which were accessible from the author's website (www.ba-and-t.com). They were administered automatically at remote sites were the author was not present.

General Procedure

Each session consisted of approximately 100 trials. A trial began when sets of symbols, which were centered on two white illuminated backgrounds, appeared on the computer screen. The trial ended when the participant selected with a cursor a symbol in either illuminated area. A 3-s intertrial interval followed when the computer screen was dark, and then the next trial began. Correct choices during training sessions resulted in a flashing computer screen. In addition, a point was earned for each correct response, and the total number of points accumulated was displayed as a score in the upper right corner of the computer screen. If an incorrect choice occurred, reinforcement was not provided. During test sessions, reinforcement was provided regardless of which symbol the participant selected.

After each session, the results were automatically analyzed, and a printable report was generated, which was displayed on the participant's computer screen. The report not only documented and analyzed the findings, but also indicated whether repeating the procedures would be beneficial to improve attentional skills. Included in the report was an assessment of learning efficiency, which determined how quickly the participant attended to the relevant features of the visual materials. Also included was an assessment of attention durability, which identified the extent to which attentional skills were disrupted. A third element was an assessment of attention focus, which identified whether attention could be directed to relevant features in the visual display.

Single Symbol Training

In the first step, each participant learned the same three separate visual discriminations, composed of six different symbols, which had been presented to the young children and adolescents (See Fig. 1). Each pair of individual symbols was presented on the computer screen during single-symbol training until criterion accuracy was achieved as had also occurred for the young children and adolescents. The three symbol pairs next appeared in an unpredictable mixed sequence where each symbol pair appeared twice in a block of six trials. This continued until 90% accuracy was maintained for each symbol pair within a 30-trial sequence.

Conflict Compound

The individual symbols were next combined to form a conflict compound. The conflict compound was created by keeping the prior reinforcement unchanged for scissors and cane in the compound and reversing them for the remaining four symbols. Plum and mule were paired with reinforcement in the compound and rabbit and grasses with extinction, which was the reverse of original single symbol training (See Fig. 2).

Test Conditions

Test trials were presented after 90% accuracy was achieved for the conflict compound. The same test trials were administered to the participants that had been provided to the young children and adolescents in order to determine which symbols each participant was attending to when they achieved criterion accuracy for the conflict compound. Thirty-six test trials were administered in which the three symbol pairs were presented 12 times each in a mixed sequence. During the test trials, reinforcement was provided regardless of which symbol the participant selected.

Software also recorded which symbols the participants selected each time the conflict compound appeared on the screen in order to provide a direct comparison of test session results with symbols selected in the conflict compound when compound criterion accuracy was met.

Extended Training

The young child, who participated in this study, was given additional exposure to the initial stimulus-control procedures. The initial procedures were repeated to determine the effect of prior reinforcement histories on which symbols of the compound stimuli the child attended to when additional training was provided. In the first step, the three visual discriminations, composed of six different symbols, were presented for a second time until criterion accuracy was achieved. Mixed symbol training was also presented again until 90% accuracy for each symbol pair was maintained within a 30-trial sequence. The individual symbols were next combined a second time to form the conflict compound, which was created by keeping the prior reinforcement unchanged for scissors and cane in the compound and reversing them for the remaining four symbols. After 90% accuracy was met for the conflict compound, 36 test trials were again provided, in which the three symbol pairs were present 12 times each in a mixed sequence. Software also recorded as before which symbols the child selected each time the conflict compound appeared on the screen.

Results

The response topographies and test performance of two of the three older participants revealed selective attention to the unchanged symbol in the conflict compound when criterion accuracy was achieved. Although the third older participant did not selectively respond to the unchanged symbol when criterion accuracy was obtained, her test performance did indicate selective attention to the unchanged symbol in the conflict compound. In contrast, neither the response topographies nor the test performance of the young participant revealed that he selectively attended to the unchanged symbol when criterion accuracy was originally achieved. After extended training was provided, however, now both his response topographies and his test performance indicated selective attention to the unchanged symbol in the conflict compound when criterion accuracy was met.

Participant 1 (Adolescent)

For the conflict compound, Participant 1 required 21 trials to reach criterion accuracy. Participant 1 made only three errors (14% of total trials), and each of the errors occurred because Participant 1 selected a reversed S- symbol in the conflict compound (See Fig. 21). In the remaining 18 trials (86% of total trials), Participant 1 selected the unchanged S+ symbol in the conflict compound. When criterion accuracy was achieved, Participant 1 selected the unchanged symbol in each of the 18 correct trials (100%). In the conflict compound, Participant 1 shifted his attention to the unchanged symbol. The test performance of Participant 1 also confirmed that he selectively attended to the unchanged symbol in the conflict compound when criterion accuracy was met. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the conflict compound (See Fig. 22). In summary, both the response topographies and the test performance of Participant 1 revealed that he shifted his attention to the unchanged symbol in the conflict compound with only a few errors occurring.

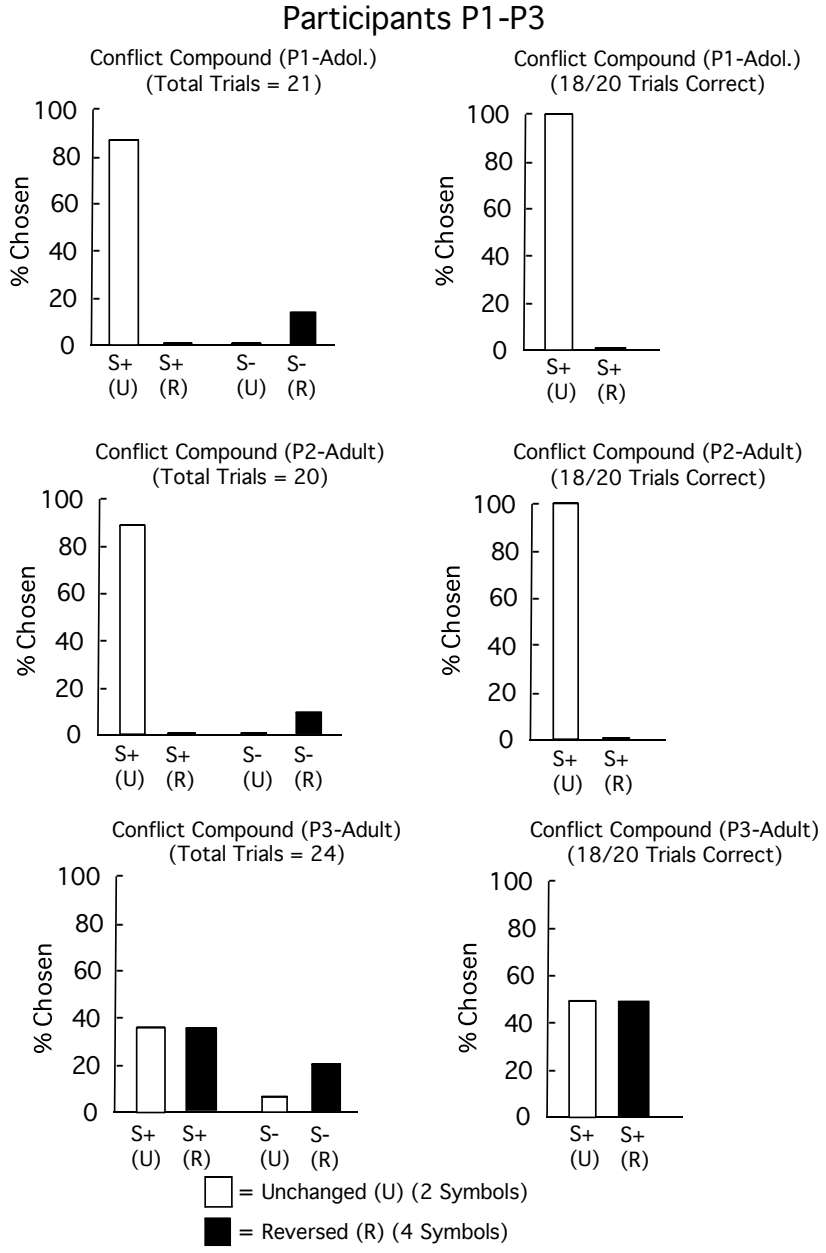

Fig. 21. For Participants 1-3, (left graphs) percentage S+ and S- unchanged symbols (white bars) and S+ and S- reversed symbols (black bars) were chosen when the conflict compound was presented and (right graphs) percentage the unchanged S+ symbol (white bar) and the reversed S+ symbols (black bar) were chosen during reinforced trials when criterion accuracy was achieved for the conflict compound.

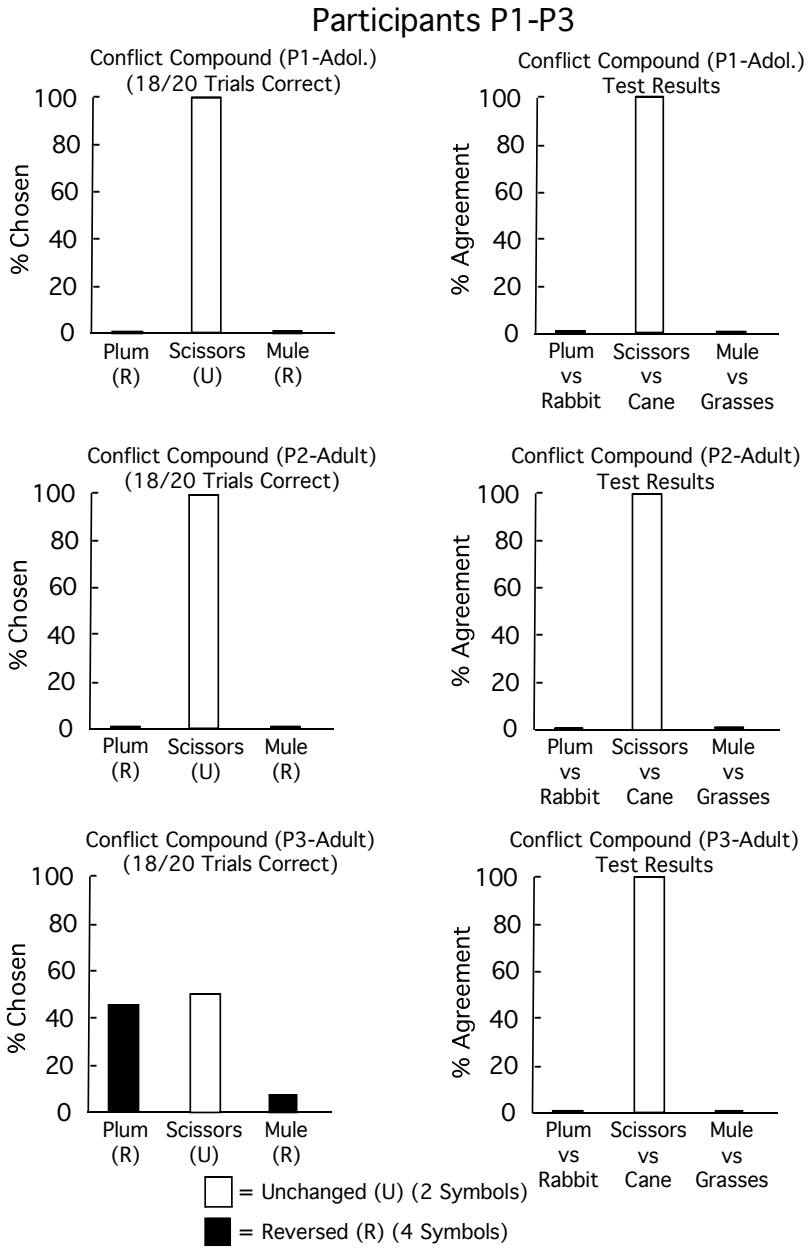

Fig. 22. For Participants 1-3, (left graphs) percentage each of the three S+ symbols were chosen during reinforced trials when criterion accuracy was achieved for the conflict compound and (right graphs) percent agreement of responses during stimulus-element test trials with the reinforcement contingencies of the conflict compound. The top symbols shown for Participants 1-3 were positive and the bottom symbols were negative in the conflict-compound discrimination. White bars and black bars indicate unchanged and reversed symbols, respectively.

Participant 2 (Adult)

For the conflict compound, Participant 2 required 20 trials to reach criterion accuracy. Participant 2 made only two errors (10% of total trials) and both errors occurred because Participant 2 selected a reversed S- symbol in the conflict compound (See Fig. 21). In the remaining 18 trials (90% of total trials), Participant 2 selected the unchanged S+ symbol in the conflict compound. When criterion accuracy was achieved, Participant 2 selected the unchanged symbol in each of the 18 correct trials (100%). In the conflict compound, Participant 2 shifted his attention to the unchanged symbol. The test performance of Participant 2 also confirmed that he selectively attended to the unchanged symbol in the conflict compound when criterion accuracy was achieved. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the conflict compound (See Fig. 22). In summary, both the response topographies and the test performance of Participant 2 revealed that he shifted his attention to the unchanged symbol in the conflict compound with only a few errors occurring.

Participant 3 (Adult)

For the conflict compound, Participant 3 required 24 trials to reach criterion accuracy. Participant 3 made six errors, and five of these errors (21% of total trials) occurred because she selected a reversed S- symbol in the conflict compound. The remaining error (5% of total trials) occurred because she selected the unchanged S- symbol in the conflict compound (See Fig. 21). In the remaining 18 trials, Participant 3 selected a reversed S+ symbol in the conflict compound in nine of the trials (37% of total trials) and the unchanged S+ symbol in the conflict compound in nine of the trials (37% of total trials). When criterion accuracy was achieved, Participant 3 selected the unchanged symbol in nine of the 18 correct trials (50%) and a reversed symbol in nine of the 18 correct trials (50%). In the conflict compound, Participant 3 did not shift her attention to the unchanged symbol. She responded, instead, to both the unchanged symbol and reversed symbols in the conflict compound when criterion accuracy was obtained. Her test performance, following criterion accuracy, indicated, however, that she selectively attended to the unchanged symbol in the conflict compound. Only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the conflict compound (See Fig. 22). In summary, the test performance of Participant 3 indicated that she selectively attended to the unchanged symbol in the conflict compound although it was not confirmed by her response topographies.

Participant 4 (Child)

For the conflict compound, Participant 4 required 20 trials to reach criterion accuracy. Participant 4 made only two errors (10% of total trials), and both errors occurred because he selected a reversed S- symbol in the conflict compound (See Fig. 23). In the remaining 18 trials, Participant 4 selected reversed S+ symbols in the conflict compound in 16 of the trials (80% of total trials) and the unchanged S+ symbol in two of the trials (10% of total trials). When criterion accuracy was achieved, Participant 4 selected the unchanged symbol in two of the 18 correct trials (11%) and reversed symbols in 16 of the 18 correct trials (89%). In the conflict compound, Participant 4 did not shift his attention to the unchanged symbol. He responded, instead, to primarily reversed symbols in the conflict compound when criterion accuracy was met. His test performance, following criterion accuracy, also indicated he did not selectively attend to the unchanged symbol in the conflict compound. None of the three symbol-pairs exercised stimulus control in agreement with the reinforcement contingencies of the conflict compound (See Fig. 24). In summary, both the response topographies and the test performance of Participant 4 indicated that he did not selectively attend to the unchanged symbol in the conflict compound.

Participant 4 (Child) (Extended Training)

When extended training was provided for the conflict compound, Participant 4 required 22 trials to reach criterion accuracy. Participant 4 made three errors, and two of these errors (9% of total trials) occurred because he selected a reversed S- symbol in the conflict compound. The remaining error (5% of total trials) occurred because he selected the unchanged S- symbol in the conflict compound (Fig. 23). In the remaining 19 trials (86% of total trials), he selected the unchanged S+ symbol in the conflict compound. When criterion accuracy was achieved, Participant 4 selected the unchanged symbol in each of the 18 correct trials (100%).

In the conflict compound, following extended training, Participant 4 shifted his attention to the unchanged symbol. His test performance, which was based on less than 36 trials due to equipment malfunction, also confirmed, after extended training was provided, that he selectively attended to the unchanged symbol when criterion accuracy was achieved. Only the unchanged symbol exercised stimulus control in agreement with the reinforcement contingencies of the conflict compound following extended training (See Fig. 24). In summary, after extended training was provided, both the response topographies and the test performance of Participant 4 revealed that he shifted his attention to the unchanged symbol in the conflict compound with only a few errors occurring.

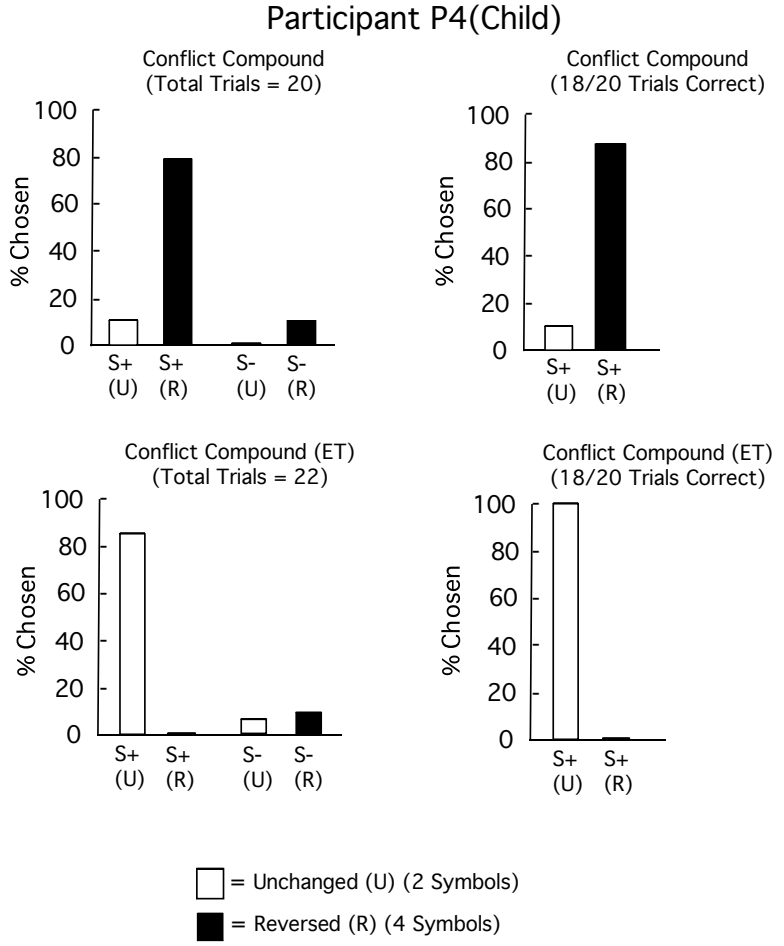

Fig. 23. For Participant 4, (top graphs) percentage S+ and S- unchanged symbols (white bars) and S+ and S- reversed symbols (black bars) were chosen when the conflict compound was originally presented (left graph) and percentage the unchanged S+ symbol (white bar) and the reversed S+ symbols (black bar) were chosen during reinforced trials when criterion accuracy was originally achieved for the conflict compound (right graph). For Participant 4,(bottom graphs) percentage S+ and S- unchanged symbols (white bars) and S+ and S- reversed symbols (black bars) were chosen when the conflict compound was presented a second time following extended training (ET) (left graph) and percentage the unchanged S+ symbol (white bar) and the reversed S+ symbols (black bar) were chosen during reinforced trials when criterion accuracy was again achieved for the conflict compound following extended training (ET) (right graph).

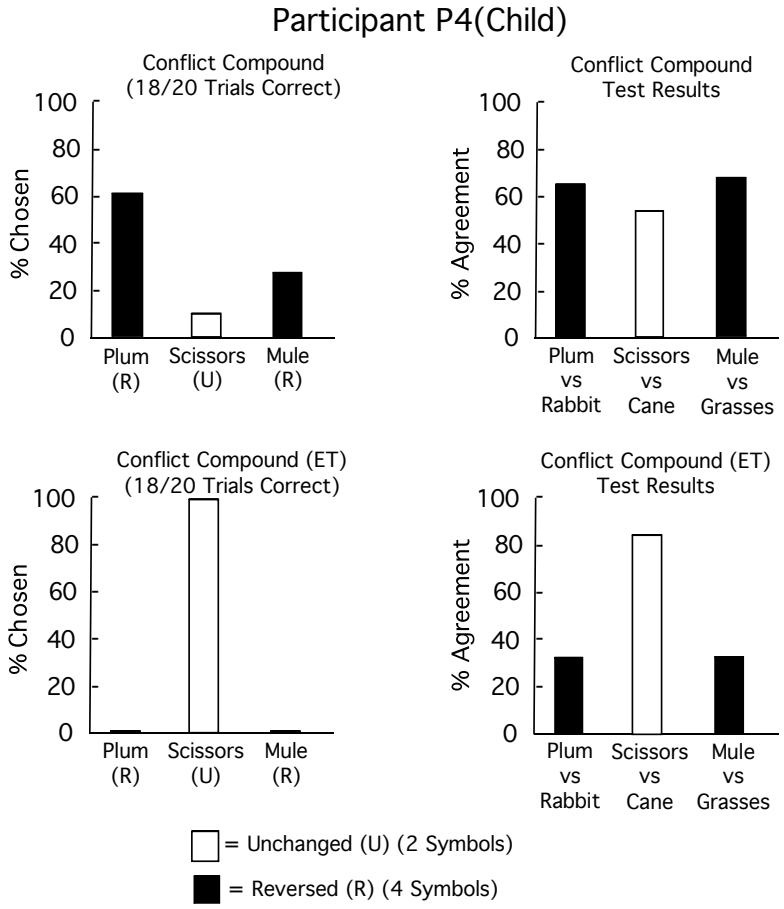

Fig. 24. For Participants 4, (top graphs) percentage each of the three S+ symbols were chosen during reinforced trials when criterion accuracy was originally achieved for the conflict compound (left graph) and percent agreement of responses during stimulus-element test trials with the reinforcement contingencies of the conflict compound (right graph). For Participant 4, (bottom graphs), percentage each of the three S+ symbols were chosen during reinforced trials when criterion accuracy was again achieved for the conflict compound following extended training (ET) (left graph) and percent agreement of responses during stimulus-element test trials with the reinforcement contingencies of the conflict compound when extended training (ET) was provided (right graph). The top symbols shown for Participant 4 were positive and the bottom symbols were negative in the conflict-compound discrimination. White bars and black bars indicate unchanged and reversed symbols, respectively.

Discussion

Establishing prior reinforcement histories for separate stimulus components determined which features of compound visual cues young children of typical development attended to. In most instances, the response topographies and test performance of the young children indicated that they selectively attended to only the unchanged symbols in the conflict compounds when criterion accuracy was achieved. Symbols with a reversed prior reinforcement history were usually ignored. This was shown as on most reinforced trials when criterion accuracy was met, the young children touched only unchanged symbols in the conflict compounds. In addition, in the majority of test sessions, only the unchanged-symbol pair exercised stimulus control in agreement with the reinforcement contingencies of the conflict compounds.

Although the three young children attended to only the unchanged symbols in the conflict compounds, with one exception, the children differed in how quickly they shifted their attention to unchanged symbols. One of the children shifted his attention, with only a few errors occurring, to the unchanged symbols in all three conflict-compounds. Another child shifted his attention to the unchanged symbols in the first and third conflict-compounds after only a few errors. He made considerably more errors, however, before he shifted his attention to the unchanged symbol in the second conflict-compound.

The remaining child, in contrast, did not shift her attention to the unchanged symbol in the first conflict-compound. Her response topographies and test performance indicated, instead, that she attended to both the unchanged symbol and reversed symbols in the first conflict-compound when criterion accuracy was achieved. With exposure to the second and third conflict-compounds, however, her response topographies and test performance now revealed she selectively attended to the unchanged symbols when she achieved criterion accuracy for both conflict-compounds. Although the remaining child did not selectively attend to the unchanged symbol in the first conflict-compound, she learned to selectively attend to unchanged symbols when additional conflict compounds were presented.

The three adolescents, in contrast to the young children, did not selectively attend in most cases to the unchanged symbols when criterion accuracy for the conflict compounds was initially achieved. They required extended training before they selectively attended to each of the unchanged symbols. The response topographies and test performance of one adolescent revealed that she selectively attended to the unchanged symbols in the first and third conflict-compounds, when criterion accuracy was initially achieved. She did not, however, shift her attention to the unchanged symbol in the second conflict-compound. After extended training was administered, the adolescent now shifted her attention to the unchanged symbols in all three conflict-compounds and with relatively few errors occurring.

The response topographies and test performance of another adolescent revealed that although she selectively attended to the unchanged symbol in the first conflict-compound, she did not shift her attention to the unchanged symbols in the second and third conflict- compounds. She selectively responded, instead, to the same symbol pair in all three conflict-compounds when criterion accuracy was initially achieved regardless of whether its prior reinforcement contingencies were reversed or unchanged in the compounds. After extended training was provided, the adolescent shifted her attention with relatively few errors to the unchanged symbols in all three conflict-compounds.

The response topographies and test performance of the remaining adolescent indicated that she selectively attended to the unchanged symbol in the second conflict-compound but did not shift her attention to the unchanged symbols in the first and third conflict-compounds. This occurred because she responded to the same symbol pair in all three conflict-compounds when criterion accuracy was initially achieved. After extended training was provided, she shifted her attention to the unchanged symbols in the second and third conflict-compounds when criterion accuracy was obtained. Although her response topography did not demonstrate that she selectively attended to the unchanged symbol in the first conflict-compound, her test performance indicated that she attended to the unchanged symbols in all three conflict- compounds after extended training was provided.

A difference was found in this study between young children of typical development and adolescents with severe intellectual disabilities of comparable mental age in how quickly they shifted their attention among elements of complex stimuli in accordance with prior conditioning histories. Longer single stimulus pretraining and additional exposure to the conflict compounds were required before the adolescents shifted their attention among stimulus elements depending on prior reinforcement histories. These findings suggest that a critical distinction between children with developmental disabilities and children of typical development may lie in the efficiency with which prior reinforcement histories determine how they attend to elements of complex visual stimuli. Indeed, the consistency with which students respond to compounds with conflicting prior reinforcement histories may prove to be an effective technique for identifying students with developmental disabilities and attentional deficits.

Two of the three adolescents with intellectual disabilities failed to originally shift their attention among stimulus elements in accordance with prior reinforcement histories because of overselective attention.

The two adolescents displayed overselective attention because both adolescents responded to the same symbol pair in all three conflict-compounds regardless of whether the prior reinforcement histories of the symbol pair were unchanged or reversed in the compound. After additional training was provided, however, their overselective attention was eliminated. The two adolescents now selectively attended to the unchanged symbols regardless of which positions they occupied in the three conflict compounds following extended training. Stimulus overselectivity in this investigation was not an unmodifiable perceptual characteristic.

In addition, administering the stimulus-control procedures online at remotes sites where the author was not present also proved to be effective in assessing how the participants attended to a stimulus compound with conflicting prior reinforcement histories. By employing multiple testing procedures, which were automatically administered by the software, individual differences were also revealed in how the four participants attended to the conflict compound. The response topographies and test performance of two of the three older participants revealed they selectively attended to the unchanged symbol in the conflict compound when criterion accuracy was achieved. Both older participants shifted their attention to the unchanged symbol with only a few errors occurring.

The third older participant, however, had opposing response topographies and test results. Although she responded to both the unchanged symbol and reversed symbols in the conflict compound when criterion accuracy was achieved, her test performance indicated that she selectively attended to the unchanged symbol. Finally, neither the response topographies nor the test performance of the young participant demonstrated that he selectively attended to the unchanged symbol when he originally achieved criterion accuracy. After extended training was provided, however, now both his response topographies and test performance revealed that he shifted his attention to the unchanged symbol in the conflict compound and with only a few errors occurring.

Despite individual differences, manipulating prior reinforcement histories of individual stimuli was effective in controlling how the participants, who differed in age, attended to a stimulus compound even when the procedures were provided online at remote sites. This also occurred with laptop computers, where touch screens were not utilized, and where social and monetary reinforcement were not provided. Although prior reinforcement histories of individual stimuli failed to initially control how one participant, a young child, attended to a visual compound, when the procedures were repeated, he too selectively attended to the stimulus element whose prior reinforcement history was unchanged in the compound. Administering the stimulus-control procedures and automatically analyzing the results online eliminated the need for sophisticated computer equipment or an expertise in discrimination learning in order to carry out the described procedures. By automatically generating a report following the session, the participants also received immediate feedback concerning their performance.

In conclusion, recording response topographies, in addition to response accuracy, in this series of investigations provided a more sensitive and fine-grain analysis of individual differences in how stimulus compounds were attended to. This supported the results of past studies where response topographies revealed the presence of stimulus preferences when compound discriminations were acquired, which were not evident by accuracy scores (Huguenin, 2008, 2014). By recording response topographies in the current investigations, it was also possible to determine how quickly the subjects shifted their attention, when stimulus compounds were presented, in accordance with prior reinforcement histories. This was accomplished by analyzing response topographies both before and after criterion accuracy for the compound discriminations was achieved. As a result of this analysis, individual differences were revealed in how quickly the subjects shifted their attention to stimulus elements with unchanged prior reinforcement histories. Individuals with developmental disabilities were found to have greater difficulty in shifting their attention because of overselective attention than children of typical development. We also developed an online version of the stimulus-control procedures, which was successful in assessing the visual attention of four participants differing in age. This demonstrated, as a result, the feasibility of providing visual attention assessments online for both identifying and eliminating visual attention impairments in both children and individuals with developmental disabilities.

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Footnotes

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