Experimental Analysis of the Blocking Effect on Sight Word Acquisition in Children of Kindergarten Age

by

Terri L. Otto

A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

in partial fulfillment of the requirements of the degree of

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Department of Psychology

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Abstract

A series of 4 experiments, each one using an alternating treatment design, was conducted with kindergarten children to assess stimulus control over textual responding (sight word learning). All experiments used pictures or symbols in compound with words. In the first experiment, a systematic replication of Singh and Solman's (1990) research, sight word acquisition was fastest when the word was presented as a single stimulus versus as a compound stimulus (with a corresponding picture). The second experiment controlled for confounding variables (i.e., enhanced size, rehearsal, repeated exposure) present in the first experiment, and produced consistent, even more convincing, results. The third experiment assessed whether the superiority of the single word condition was due to the blocking effect (i.e., reduced conditioning) to a word when it is paired (compound stimulus) with a preconditioned stimulus; in the present case with a preconditioned Japanese symbol (Kanji) versus with a novel Kanji. The fourth experiment counterbalanced the components (word vs. Kanji) of the compound stimulus with the Kanji now to be sight read. Blocking was evident in both Experiments 3 and 4. However, the effect was larger and more consistent in Experiment 4, suggesting that overshadowing also may have played a role.

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When teaching beginning readers, extra-stimulus prompts in the form of pictures typically are presented along with the printed stimuli. Intuitively, displaying a corresponding picture (e.g., of a cat) of the word to be learned in conjunction with the printed stimulus (the word "cat") would seem an effective way of training initial reading skills. Indeed, no one appeared to have questioned the presumed positive effect of pictures as extra-stimulus prompts for beginning readers until Miller (1937), noting the increasing use of color and illustration in primary readers, raised awareness of the lack of knowledge concerning the value of pictures in primary readers. His concern was well founded. To date, the majority of studies indicate that when a novel word is presented in conjunction with the corresponding picture, sight word acquisition is poorer than when the word is presented alone (e.g., Didden, Prinsen, & Sigafoos, 2000; Harzem, Lee & Miles, 1976; Lang & Solman, 1979; Samuels, 1967, 1970; Saunders & Solman, 1984; Singh & Solman, 1990; Wu & Solman, 1993). (Of course, this finding does not invalidate the conception that acquisition of the meaning of a word may be facilitated by pairing it with a corresponding picture.)

Sight word learning can be defined as a "discrete observable [oral] response that is controlled by a printed stimulus" (Browder & D'Huyvetters, 1988). From an operant standpoint, the printed stimulus acquires discriminative stimulus (S^D) control over responding because of a history of reinforcement for the appropriate verbal (oral)

response in the presence of a particular printed stimulus (Miltenberger, 1997, p. 125). Skinner (1957, pp. 65-69) termed such a controlling relation "textual behavior".

To account for the detrimental effect of extra-stimulus pictorial prompts on sight word acquisition, explanations advanced (see Solman & Singh, 1992) have included the focal attention hypothesis (Samuels, 1967) and the limited processing capacity theory (Lang & Solman, 1979) (see Appendix A for a summary of these explanations). Also proposed, and relevant to my research, is the phenomenon of "blocking" (Singh & Solman, 1990). Blocking can be defined as the inhibitory effect that a preconditioned stimulus has on the establishment of control by a subsequently presented stimulus when the two are presented concurrently as a compound stimulus. The blocking effect has been identified in both animals and humans, although it has proved much more difficult to demonstrate in humans (Miller & Matute, 1998). It should be noted that "blocking" is best reserved as a term for the phenomenon described above. As a phenomenon, blocking is explained by stimulus control theory, particularly that involving competition amongst antecedent stimuli for control over behavior.

Blocking was first was proposed by Kamin (1968) following a series of conditioned suppression experiments using rats as subjects. Kamin's standard blocking design involved using an operant conditioning chamber to train rats to bar press using food pellets as reinforcers on a variable interval (VI) schedule. Once a stable rate of bar pressing had been achieved, two respondent conditioning phases and a test phase were implemented. A conditioned suppression procedure was employed as follows. During the first phase one group of rats (the experimental group) was exposed to either a tone or a

light (the conditioned stimulus [CS]) that was paired with an electric shock (the unconditioned stimulus [UCS]) over a number of trials. A second group of rats (the control group) was not exposed to the CS or to the UCS, but continued to bar press on the VI schedule for food pellets. In the second phase, both groups were exposed to a compound stimulus; the CS (either the tone or the light) from the first phase was presented with a neutral stimulus (the light or the tone, respectively) forming a compound stimulus. The compound stimulus then was paired with electric shock over several trials. During the third phase (test phase) both groups of rats were exposed to the second element of the compound stimulus (i.e., the stimulus not preconditioned during the first phase). Kamin found that the introduction of the second element of the compound stimulus alone during the test phase suppressed bar pressing for the control group, but had very little effect on the operant bar pressing of the experimental group. Despite the simultaneous pairings of the compound stimulus with the UCS in the experimental group, conditioning to the neutral stimulus was 'blocked' because of prior conditioning to the first element of the compound stimulus. Thus, Kamin (1968) demonstrated that when a respondent conditioning history is established to one stimulus, this conditioning history can result in interference (block) conditioning to a second redundant stimulus when the two stimuli subsequently are presented as a compound stimulus and paired with a UCS.

The blocking phenomenon also has been demonstrated within the operant paradigm using an S^D rather than a CS (e.g., Seraganian & Vom Saal, 1969; vom Saal & Jenkins, 1970; Williams, 1996). For example, Williams (1996) used a discriminated operant procedure to train rats to lever press in the presence of various types of

discriminative stimuli, using a blocking design. Williams randomly assigned subjects to one of two conditions, a Blocking group or a Control group. Phase 1 consisted of training with a noise stimulus in the Blocking group, and with a clicker stimulus in the Control group. Phase 2 consisted of training with noise plus houselight (compound stimulus) for both groups. During the test trials (extinction), the compound stimulus components were presented separately on alternating trials for both groups. Williams found a statistically significant difference between the two groups, with the mean number of responses to the houselight for rats in the Control group being reliably higher than that to the houselight for the rats in the Blocking group, demonstrating a blocking effect. Thus, the degree of stimulus control that was established by the houselight was reduced in the Blocking group, where one component of the compound stimulus (i.e., the noise stimulus) had been pretrained during Phase 1, as compared to the Control group, where no pretraining occurred. To further explore this effect, Williams added a third phase where he presented the houselight together with a tone stimulus that was novel to both groups of rats, followed by testing with the novel (tone) stimulus alone. Rats in the Blocking group responded similarly to both the houselight and the tone during the test trials, when the compound components were presented singly. This result was consistent with the Phase 2 results where conditioning to the houselight had not occurred (had been blocked) because of its compound presentation with a previous conditioned stimulus (i.e., the noise stimulus). In contrast, for the Control group rats (where conditioning to the houselight had occurred during Phase 2), the houselight continued to evoke responding, and

therefore conditioning to the tone did not occur, providing further support for the blocking effect.

The blocking phenomenon has been suggested as underlying a problem in sight word learning when a corresponding picture and word stimulus are presented together in training (e.g. Didden, Prinsen & Sigafoos, 2002; Singh & Solman, 1990). Singh and Solman (1990) conceptualized the picture-word problem as a compound conditioning event. The experimenters proposed that when presented together, the picture and word stimuli formed a compound stimulus where familiarity with, or prior conditioning to, one of the elements, that is, the picture stimulus (A), blocked acquisition of control by the other element of the compound, namely the word stimulus (B). This interference may be analogous to that demonstrated in the literature on operant blocking (e.g., Vom Saal & Jenkins, 1970) where one well-established S^D prevents the acquisition of control by another potential S^D with which it is simultaneously presented. In other words, where there has been preconditioning of a spoken response to a picture stimulus, this preconditioning may produce interference with the conditioning of a spoken response to the corresponding printed stimulus (a word) when the picture and printed stimulus are presented simultaneously.

In an empirical test of the blocking phenomenon in sight word learning, Singh and Solman (1990) employed eight students as participants. The students were between the ages of 7 and 9 years and previously had been diagnosed with mental disabilities. The researchers used an alternating conditions design to compare the effects of four experimental conditions for each participant. Participants were pre-tested for their ability

to textually respond to word and picture stimuli. A list of 16 words that participants were unable to name, with corresponding pictures that participants could name, was developed. The words were assigned randomly, four per condition, and no two children had the same words in each condition. In addition, word presentation order was randomized for each training session. During each session, participants were exposed to all four experimental conditions, as well as to a post-test. The conditions were comprised of a blocking condition (Condition A - Blocking of the word by the picture), a control condition (Condition B - Control for Condition A), a reduced blocking condition (Condition C - Reduction of the "blocking effect" of the picture), and a second control condition (Condition D- Control for Condition C). In the blocking condition, Condition A, two slides were presented, one after the other. The first slide was presented for 15 s and consisted of a picture located in the centre of the slide. The experimenter said, "This is a picture of _____." Following the first slide by 2 s, a second slide was displayed, also for 15 s. The same picture that appeared on the first slide plus the corresponding printed word appeared on the second slide. In this compound presentation, the picture stimulus was enhanced in size relative to the word stimulus, appearing on the top two-thirds of the slide with the word stimulus appearing on the bottom one-third of the slide. The word stimulus was 2.5 cm high (criterion size). Precise dimensions for the picture stimulus were not specified. The second condition, Condition B, was a word-alone control condition for Condition A. In this condition the word was presented without the picture stimulus, in the same size and position on the slide as in Condition A (i.e., criterion size, bottom one-third). The slide was presented for 15 s and the student was asked, "What is

that word?" Two slides also were presented for Condition C. The first slide presented the word stimulus alone for 15 s. The word was printed in criterion size letters and appeared in the centre of the slide. The student was told, "This word is _____." A second slide followed the presentation of the first and consisted of the same word printed in 5 cm letters (enhanced size) in the upper two-thirds of the slide with the corresponding picture in the lower one-third. In this compound presentation the salience of the word stimulus was enhanced in terms of size relative to the picture stimulus. The student was asked, "What is that word?" This slide also was presented for 15 s. The final condition, Condition D, served as a word-alone control for Condition C. In this condition the word stimulus was presented for 15 s without the picture stimulus and the participant was asked, "What is that word?" The two control conditions, Condition B and Condition D both consisted of slides presenting the word alone; however the words presented in Condition D were printed in enhanced size letters, twice the size of the words in Condition B. Following the four conditions, each student was given a post-test. During the post-test the students were shown slides of the 16 words (criterion size), in random order, one at a time, and were asked, "What is that word?"

Singh and Solman (1990) found that all students had the slowest rate of learning during Condition A, where blocking had been maximized. Where the word had been presented alone, either at the standard size (Condition B) or at an enhanced size (Condition D), 6 out of 8 students had the fastest rate of learning. Two of the children had the fastest rate of learning during Condition C, where the "blocking effect" had been

minimized by presenting the word alone first, and then enhancing the size of the word relative to the picture during the compound presentation.

From their results, the experimenters concluded that the prior conditioning of the verbal (spoken) response to the picture stimulus blocked conditioning of the verbal response to the printed stimulus when the printed stimulus and picture were presented as a compound stimulus. When the picture and the word were presented simultaneously (Condition A), performance was the poorest for all eight students. Given the importance of investigating the blocking phenomenon as it relates to the necessary and sufficient conditions for learning in general (Lyzak & Tighe, 1975; Rehfeldt et al., 1998), and for sight word acquisition in particular, Singh and Solman's (1990) study is an important one. However, a number of methodological problems exist with the research that prevent drawing firm conclusions about the role that extra-stimulus prompts play in sight word learning.

A major methodological concern with Singh and Solman's (1990) research involves the deviation from the standard experimental paradigm for demonstrating blocking. An experimental demonstration of blocking typically involves establishing a conditioning history with one stimulus (stimulus A), followed by a second phase where a redundant stimulus (stimulus B) is added to form a compound stimulus (AB). The third phase, or test phase, involves the presentation of stimulus B alone. In the case of sight word learning, blocking is evidenced when the printed word (stimulus B) fails to evoke the appropriate spoken response, notwithstanding extensive training with the picture paired with the word (AB compound) in the context of reinforced responding. As a result

of being presented in conjunction with a previously conditioned stimulus, the ability of the new stimulus to evoke a response is hindered (Wu & Solman, 1993). The discriminative control established by conditioning of an oral response to the picture stimulus leads to blocking of conditioning of the oral response to the word stimulus, when the two are presented simultaneously. In the Singh and Solman (1990) study, conditioning of the oral naming response to the picture stimuli presumably had been established prior to the commencement of their experiment; all picture stimuli were tested for their ability to evoke the appropriate spoken response as a criterion for inclusion in the experiment. Consequently, conditioning of the spoken response to stimulus A was not necessary, and therefore was not part of the experimental procedure, as it is typically in a blocking design. Without the establishment of the preconditioning history within the experiment itself, experimental control potentially is weakened by uncontrolled variables relating to variability in the participants' conditioning history.

A second major methodological problem is the absence of an appropriate control condition. In the place of an appropriate control condition (i.e., unfamiliar words paired with unfamiliar pictures), the experimenters employed word-alone stimuli. Effectively, single stimulus training (word alone) is compared to compound control stimulus training (picture plus word). Without the inclusion of an appropriate control condition where unconditioned stimuli are paired with target stimuli in a test of the blocking hypothesis, conclusions regarding blocking cannot safely be made (Arcediano, Escobar, & Matute, 2001).

A third methodological concern is the inclusion of an initial stimulus, with

concurrent verbal prompting, prior to the presentation of the compound stimulus in Conditions A and C. In these conditions, each compound stimulus was preceded by the presentation of an initial stimulus (either a picture alone [Condition A] or a word alone [Condition C]) that was verbally labeled by the experimenter (e.g., "This is a picture of _____/This word is _____". Presenting, and then verbally labeling stimuli that precede the compound stimuli introduce additional, confounding variables (i.e., increasing exposure and providing correct answers), which are not included in the control conditions.

A fourth methodological problem concerns the error correction technique employed. Following a correct response to the question "What is that word?" participants were given verbal praise and feedback in the form of "Yes, you are right! The word is _____. That's great!" These remarks were consistently applied in all conditions. However, when the response was incorrect, a rehearsal teaching strategy for error correction was employed where the student was told, "No, that word is _____. Now, say the word correctly five times." Due to the design of the experimental conditions, error correction likely was disproportionately applied in 2 of the 4 conditions, namely Conditions B and D. In these conditions the word stimulus would appear alone on a card, without the assistance of the picture stimulus or explicit naming of the word. Presumably students would have a higher error rate during these conditions, as compared to Conditions A and C where the picture stimulus appeared together with the word thereby prompting a correct spoken response. Consequently, the higher learning rate in the conditions where the word was presented alone (Conditions B and D) may be confounded

by the disproportionately applied behavioral rehearsal (i.e., repetition of the word five times).

A fifth and final methodological concern involves Singh and Solman's (1990) inclusion of a salience manipulation within the compound stimulus presentation. In Condition A, the size of the picture stimulus was enhanced relative to the size of the word stimulus. In contrast, in Condition C the size of the word stimulus was enhanced relative to that of the picture stimulus. Given the difference in salience between the stimuli, overshadowing may better conceptualize part of Singh and Solman's experimental results. Overshadowing is distinguished from blocking in that one component of the compound stimulus acquires stimulus control over responding because of its relative physical characteristics (e.g., its intensity). In contrast, in an investigation of the blocking phenomenon, prior conditioning to one component of the stimulus compound interferes with conditioning to the second stimulus in a compound presentation. Therefore, manipulating salience within the confines of the Singh and Solman experiment represents a confounding variable.

In order to provide an empirical test of blocking as it relates to sight word learning, four experiments were conducted using kindergarten children without developmental delays. Participants from this population were selected for practical reasons; this population could be readily accessed, and the implications for sight word learning were directly relevant to them, since they represent the majority of children that are taught to read.

Because the participants in the series of experiments differed from those in the Singh and Solman (1990) research, a demonstration of the generality of the "blocking" effect across populations was undertaken by systematically replicating (Kazdin, 1982, p. 284; Sidman, 1960, p. 111) Singh and Solman's research in the first experiment. Replication was necessary given that the subsequent experiments, predicated on the Singh and Solman study, also involved children without developmental delays.

The second experiment altered Singh and Solman's (1990) research design by controlling potentially confounding variables described earlier. Specifically, the second experiment omitted (a) the presentation and labeling of any stimuli prior to the presentation of the picture-word compound stimulus, to avoid any confounding effect of verbal prompting; (b) the error correction technique to avoid any confounding effect due to practice; and (c) the conditions that enhanced either component of the picture-word pairings, which may have resulted in overshadowing on the basis of the size of a stimulus.

The third experiment adhered to the scientific requirements of experimental control using the standard blocking paradigm (see Arcediano, Escobar, and Matute, 2001). Specifically, this experiment included: (a) a phase in which the A component of the AB compound was preconditioned within the confines of the experiment itself, and (b) a control condition in which a compound stimulus was composed of two novel stimuli (e.g., picture plus word). In order to achieve these outcomes Japanese symbols, known as Kanji, were employed as pictorial stimuli that could be matched to the corresponding English word. Kanji were selected because the majority of Canadian children at the

elementary school level do not have a conditioning history to these pictorial representations, and therefore a conditioning history could be established within the experiment. Implementing such alterations in the experimental design allowed for greater experimental control and consequently, a less confused demonstration of the blocking effect (Arcediano, Escobar, and Matute, 2001).

Finally, the fourth experiment involved a systematic replication (Kazdin, 1982, p. 284; Sidman, 1960, p. 111) of the third experiment described above. In the fourth experiment the stimulus materials that comprised the components of the AB compound were counterbalanced; the pictorial stimuli (the Kanji) were utilized as the B component, and conversely, the word stimuli were utilized as the A component. All other features of the third experiment remained the same. The alteration provided a test of the generality of the blocking effect across stimulus materials.

Experiment 1

The first experiment was a systematic replication (Kazdin, 1982, p. 284; Sidman, 1960, p. 111) of Singh and Solman's (1990) research. The purpose was to demonstrate generality of the experimental effects across populations, that is, from children with, to children without, developmental delays.

Method

Participants and Setting

Four children were recruited from a kindergarten class of an elementary school located in a middle-class neighbourhood of Winnipeg, Manitoba. Participants ranged in age from 5-0 years to 5-4 years, with a mean age of 5-2 years. Participants were selected

based on recommendations from the classroom teacher of children with no known learning disabilities or behavioural or emotional problems, and who spoke English as a first language.

Each experimental session was conducted individually in a private office in the school. The office measured approximately 5 m X 3 m and contained two office desks, a student desk and three bookshelves containing books and supplies, situated on adjacent walls at the back of the office. The participants sat on one side of the student desk and the experimenter sat on the other side. Cards were placed on the desk, one at time, in front of the student. Participants were tested (Baseline Phase) for their ability to name the word and picture stimuli. Only those individuals who were able to name all of the pictures, and who could not read any of the words, were included in the study. The Baseline Phase also functioned to establish rapport with the children.

Materials

The 16 five-lettered common, concrete nouns used were knife, lemon, money, radio, fence, nurse, bread, stamp, chalk, queen, giant, piano, eagle, jelly, train and horse. These words were the same as those used by Singh and Solman (1990), with the exception of the word "horse" which was substituted for the word "zebra" because of frequent correct reading of the latter word during an initial screening phase. Stimulus materials were presented on 28 cm X 21 cm white cards. Word stimuli were presented in either criterion size (2.5 cm) or enhanced size (5 cm). Singh and Solman did not delineate the dimensions of picture stimuli. However, a description was provided in their design section indicating that "the picture was on the top two thirds of the slide and the word on

the bottom third", and that "the salience of the picture was enhanced (in terms of size) in the compound stimulus". Given their description, the picture size was determined based on its overall dimensions and appearance when placed on the "top two thirds" of the card. Therefore, criterion-size words and pictures were 2.5 cm high and 7 cm high, respectively. Enhanced-size words and pictures were 5 cm high and 14 cm high, respectively. Each word was typed in lower case letters using black ink, and the corresponding pictures were drawn in black-and-white. Four words were randomly assigned to each condition. Words in each condition were counterbalanced across participants.

Interobserver Agreement

Interobserver agreement data on response recording (correct or incorrect) were collected during 25% of the sessions by a research assistant. To calculate the percentage of agreement between the experimenter and the assistant, the number of agreements was divided by the total number of agreements plus disagreements, and multiplied by 100 (Kazdin, 1982, p. 54). Interobserver agreement was 100%.

Procedural Reliability

To assess the accuracy with which the experimental procedure was implemented (see Billingsley, White & Munson, 1980), a research assistant recorded the experimenter's adherence to procedure during 25% of the sessions. Procedural reliability per session was calculated by dividing the total number of specified behaviors to be emitted by the experimenter by the number of specified behaviors actually emitted by the

experimenter, and multiplying by 100. Treatment integrity ranged from 94% to 100% with a mean of 98%.

Design

An alternating conditions design (Kazdin, 1982, p. 178; Miltenberger, 1997, p. 53) was used to compare the effects of four experimental conditions (see Table 1). Following the pretest (baseline) phase, participants were exposed to the training phase, consisting of repeated presentations of each of the following conditions as in Singh and Solman's (1990) research. For the purposes of my research, the condition labels have been altered to provide mnemonic labels.

Picture (enhanced size) + Word Condition. Two cards were presented in this condition, one after the other. The first card displayed a criterion-size picture situated in the center of the card; the second displayed the same picture in enhanced-size situated on the top two thirds of the card with the corresponding criterion-size word situated below the picture on the bottom one-third of the card (compound stimulus). The size of the picture was exaggerated relative to the size of the word in order to enhance the salience of the picture stimulus.

Word Alone (criterion size) Condition. One card was displayed in this condition. A criterion-size word was typed on the bottom one-third of the card and it was presented alone.

Word (enhanced size) + Picture Condition. Two cards were presented in this condition, one after the other. A criterion-size stimulus word was typed in the center of the first card. The same word typed in enhanced-size with the corresponding criterion-

size picture was displayed on the second card. On this card, the word was enhanced in size relative to the picture stimulus. The word was printed on the top two-thirds of the card and the picture on the bottom one-third of the card.

Word Alone (enhanced size) Condition. One card was displayed in this condition. An enhanced-size word was situated in the top two thirds of the card.

Table 1

Design for Experiment 1

	Training	Test
Picture + Word	Card 1: Picture (criterion)	Word (criterion)
	Card 2: Picture (enhanced) + Word (criterion)	
Word Alone	Card 1: Word (criterion)	Word (criterion)
Word + Picture	Card 1: Word (criterion)	Word (criterion)
	Card 2: Word (enhanced) + Picture (criterion)	
Word Alone	Card 1: Word (enhanced)	Word (criterion)

Procedure

Baseline Phase. To ensure that the stimulus words could not be named prior to the intervention phase, all participants were tested over the course of three baseline sessions for their ability to name word stimuli. Each word was typed in lowercase criterion-size

letters in the center of a card. The experimenter said, "I am going to show you a number of cards that have words printed on them. Try to read each word. I know it is very hard. I don't expect you to know any of them because you haven't learned them yet. So, tell me the word if you know it. If you don't know it, just say, "I don't know". Okay? Try to read each word". Cards were presented individually for 15 s. Participants were asked, "What is this word?" Throughout the experiment, a response was recorded as correct, if it matched the stimulus word. If the participant self-corrected before the experimenter indicated the inaccuracy of the response, a correct response also was recorded. A response was recorded as incorrect, if the participant did not respond or gave a response that did not match the stimulus word. During the Baseline Phase, the experimenter provided information regarding the inaccuracy of the response and reinforcement for the attempt (e.g., "No, but that was a good try"). Once a response was made, the participant was shown the next word. If the participant did not respond within 15 s, the experimenter displayed the next word and said, "Let's try this one. Do you know what this word is?" The experimenter did not verbally label the word during this phase.

Training Phase. All participants were exposed to each of the four experimental conditions during each training session, followed by a test trial. The 16 words were randomly presented during the training session. The Training Phase continued until the participant correctly identified all four words in any one condition during three consecutive test trials ("learning criterion"). As in the Baseline Phase, a response was recorded as correct, if it matched the stimulus word. If the participant self-corrected before the experimenter indicated the inaccuracy of the response, a correct response also

was recorded. Following a correct response, the experimenter provided descriptive praise in the form of, "Yes, you are right! That word is _____. That's great!" A rehearsal strategy was used for incorrect responses. Following an incorrect response, participants were told, "No, that word is _____. Now say that word five times." A 2 min break was provided at the end of the Training Phase.

Picture (enhanced size) + Word Condition. A card displaying a stimulus picture was presented for 15 s. The participant was told, "This is a picture of _____". A second card followed the removal of the first. The second card displayed the same picture as on the first card, together with the corresponding word. This card also was presented for 15 s. The participants were asked, "What is this word?"

Word Alone (criterion size) Condition. A card displaying a stimulus word alone was presented for 15 s. The participant was asked, "What is this word?"

Word (enhanced size) + Picture Condition. A card displaying a stimulus word alone was presented for 15 s. The participant was told, "This word is _____". The card was then removed and a second card displaying the same stimulus word together with the corresponding picture was presented for 15 s. The participant was asked, "What is this word?"

Word Alone (enhanced size) Condition. Only one card was presented for this condition. A word alone appeared on the card, which was displayed for 15 s. The participant was asked, "What is this word?"

Test. A test trial was conducted following each training session. The participant was told, "I am going to show you the same words that you have just seen. Try to read

each word". The participant was shown each criterion-size word centered on a card, in random order, one at a time for 15 s and asked, "What is this word?" As in the Baseline Phase, the experimenter provided praise only for accurate naming. The experimenter did not verbally label the word during this phase. If the participant did not respond within 15 s, the next word was shown. An edible treat was given at the end of each test trial.

Remediation Phase. The Remediation Phase was included to increase the applied benefit. This phase was initiated once the participant correctly identified all four words in any one condition during three consecutive test trials. The condition that produced the fastest learning was used to teach the remainder of the words to the participant. Remediation continued until the participant correctly identified all 16 words during 3 consecutive remediation test trials.

Results and Discussion

The dependent measure was number of words identified correctly per session for each participant. As in Singh and Solman (1990), data for all conditions have been graphed and are presented in Appendix B. For the purpose of consistency in the presentation of the data for the series of experiments in my research, Figure 1 displays data for the two primary conditions used by Singh and Solman: their "blocking condition" where the compound stimulus condition was comprised of an enhanced picture with a criterion sized word, and their "control for blocking condition", which was comprised of a word alone, in criterion size.

Figure 1 displays data for all 4 participants. Comparison of the two primary conditions (Picture (enhanced size) + Word Condition and Word Alone (criterion size) Condition) described above, reveals that 3 out of 4 of the participants showed a substantially faster rate of learning when the word was presented alone. For the fourth participant, Jordan, the rate of learning was somewhat faster in the Word Alone (criterion size) Condition than in the Picture (enhanced) + Word Condition. For three of the first four sessions his performance was superior for the Word Alone (criterion size) Condition. Similarly, his performance was superior in the Word Alone (criterion size) Condition during the last three sessions before optimal performance was reached. Overall, where there was a difference between the two conditions, in 6 of the 7 sessions it was in favour of the Word Alone (criterion size) Condition. Further support for this conclusion can be obtained by examining Jordan's data from the other two conditions (i.e., Word (enhanced size) + Picture Condition and Word Alone (enhanced-size) Condition) shown in Appendix 3. The last four data points in these two conditions reveal that performance for the "reduced blocking" compound stimulus condition (i.e., Word (enhanced size) + Picture Condition) is inferior to its corresponding "control condition" (i.e., Word Alone (enhanced size) Condition). Thus, consistent with Singh and Solman's (1990) results, all 4 participants learned the words at a faster rate when the words were presented alone versus when they were paired with the corresponding picture. Overall, the results from my first experiment confirmed the main finding of Singh and Solman (1990), that is, the rate of learning in the word alone condition was much faster than that in the picture-word condition. Therefore, generality of the results from children diagnosed with

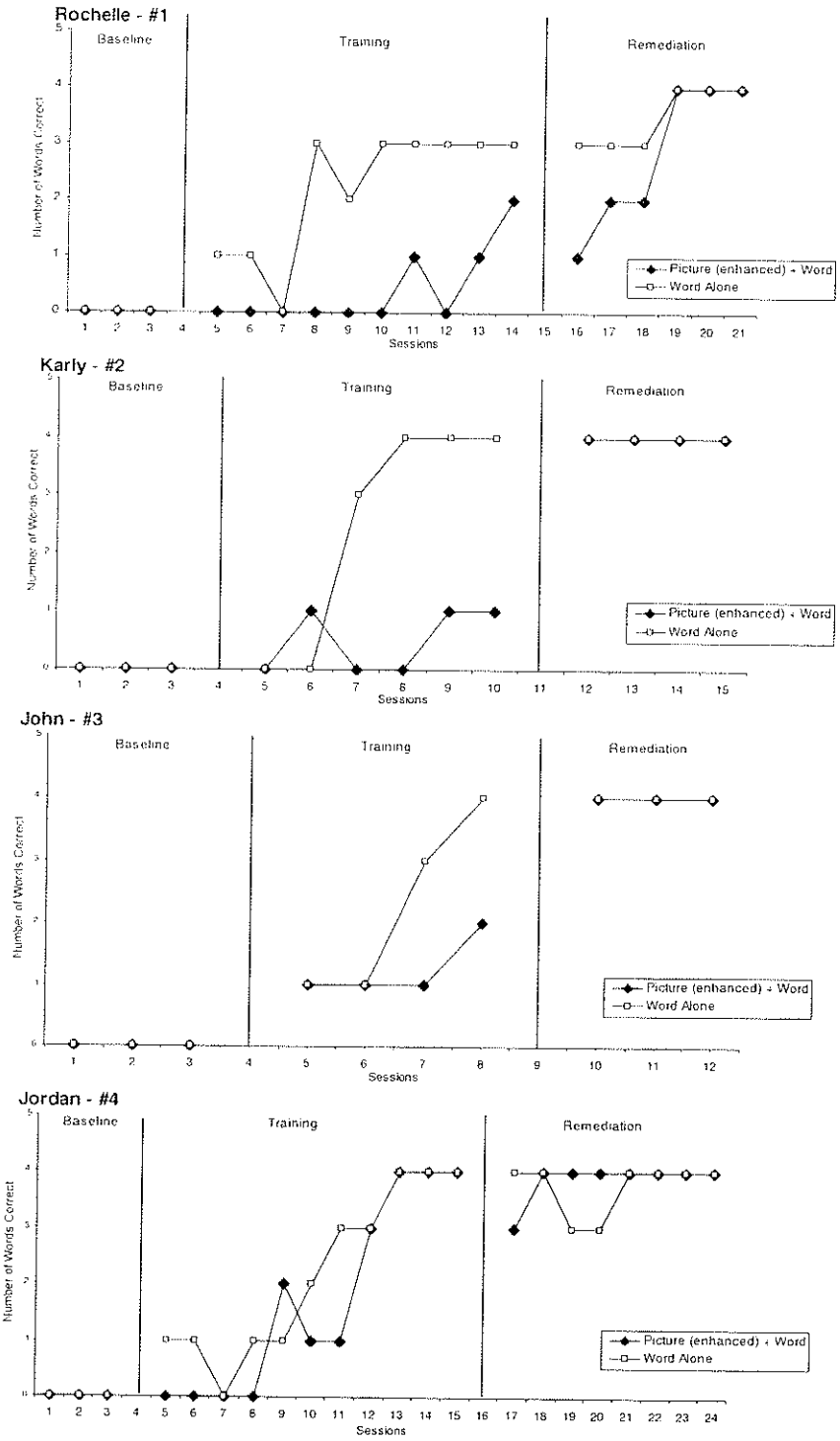


Figure 1. The number of words identified correctly during the Baseline, Training, and Remediation Phases in the two primary conditions (i.e., a compound stimulus condition and its control condition) for all four participants.

developmental delays to children without such delays was achieved. However, a variety of confounding variables existed in the experimental method which led to undertaking Experiment 2.

Experiment 2

Experiment 2 was designed to replicate the experimental effect described above under conditions similar to those used by Singh and Solman (1990), while controlling for potentially confounding variables. Specifically, the introduction and verbal labeling of an initial stimulus prior to the presentation of the compound stimulus, the error correction technique, and the stimulus enhancement variables were eliminated in order to improve experimental control.

Method

Participants and Setting

Four students were recruited from the same population using the same criteria for inclusion as in Experiment 1. Participants ranged in age from 5-0 years to 5-6 years, with a mean age of 5-1 years. Testing proceeded in the same manner and in the same setting as in Experiment 1.

Materials

The 16 stimulus words were the same as those of Experiment 1. Because this experiment consisted of two conditions versus four conditions as in the previous experiment, eight words were randomly allocated to each of the conditions and the word sets were counterbalanced across participants. The stimulus words were 2.5 cm high and the corresponding pictures were 7 cm high. In the compound stimulus condition the

picture appeared on the upper half of the card and the corresponding word was typed below, on the lower half of the card (to eliminate the enhancement of either stimulus by its predominant placement on the card). In the word alone condition the word appeared on the bottom half of the card; the top half of the card remained blank

Interobserver Agreement

Interobserver agreement data on response recording (correct or incorrect) was collected during 25% of the sessions by a research assistant. Interobserver agreement ranged from 94% to 100% with a mean of 99%.

Procedural Reliability

A research assistant recorded the experimenter's adherence to procedure during 25% of the sessions. Procedural reliability ranged from 94% to100% with a mean of 99%.

Design

Using an alternating conditions design, the effects of the following two conditions were compared:

Compound Stimulus Condition. A card displaying the stimulus picture together with the corresponding word was presented to the participant.

Word Alone Condition. A card displaying the stimulus word alone was presented to the participant.

Table 2

Design for Experiment 2

	Training	Test
Compound Stimulus	Picture + Word	Word
Word Alone	Word	Word

Procedure

Baseline Phase. The Baseline Phase was identical to that described for Experiment 1.

Training Phase. Both experimental conditions were presented during each session. The manner of presentation of the stimulus materials was similar to that used in Experiment 1 (exceptions involved changes in conditions and associated variables).

Test. As in Experiment 1, a test trial was conducted following each training session. The procedure for the test trial was identical to that for Experiment 1.

Remediation. The Remediation Phase began once the participant correctly identified all eight words in any one condition during three consecutive test trials. The procedure for this phase was identical to that described for Experiment 1.

Results and Discussion

The dependent measure was the number of words read correctly in each condition per session for each participant. Figure 2 presents data from the Baseline, Training, and Remediation Phases for all four participants. As shown in Figure 2 all participants had

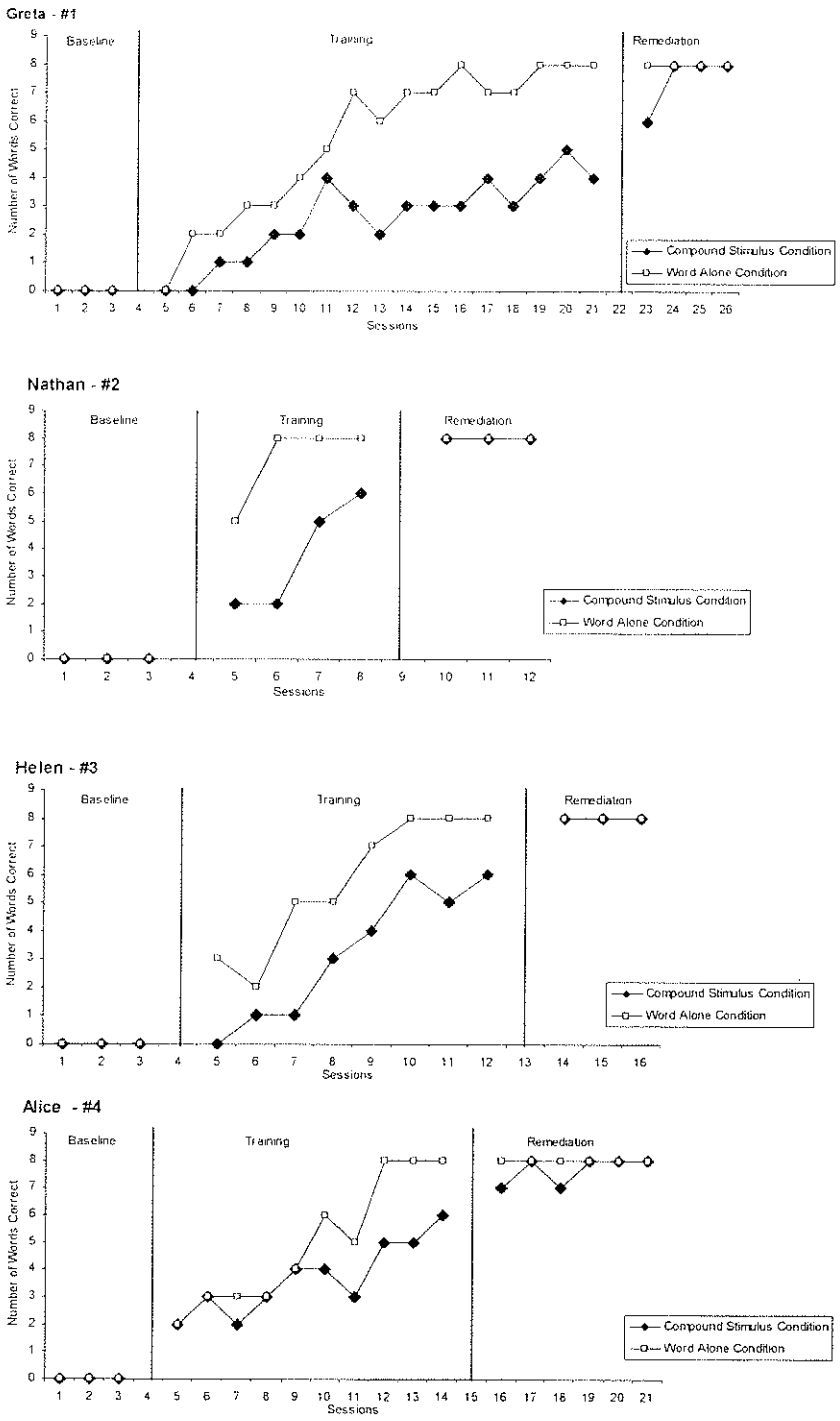


Figure 2. The number of words identified correctly during the Baseline, Training, and Remediation Phases for all four participants.

a slower rate of learning in the compound stimulus condition. As well, participants learned all words to criterion (i.e., accurately naming the words during three consecutive test trials) during the Training Phase, when the words were presented alone without pictorial prompts. In contrast, none of the participants was able to learn all eight words in the Blocking Condition by the end of the Training Phase, even under circumstances where there were several sessions of exposure to the words in this condition. When the pictorial prompts were removed during the Remediation Phase, 3 out of 4 participants rapidly (within 3-4 sessions) met the learning criterion for the balance of the target words. The fourth participant (Alice) took somewhat longer, needing 6 sessions to meet the learning criterion for the target words.

The increasing experimental control present in Experiment 2 provides clearer and more consistent support for the efficacy of sight word learning using a word alone presentation versus a word plus picture presentation than provided by Experiment 1. Data from the Remediation Phase further confirms the superiority of learning under conditions where the word is presented alone.

Experiment 3

The results from the first two experiments provide dual support for the efficacy of sight word learning under conditions where the word is presented without an extra-stimulus pictorial prompt. However, a conclusion regarding the role of "blocking" in diminished sight word acquisition when a pictorial prompt is paired with the word to be learned cannot be drawn without implementing the procedural requirements of the standard blocking paradigm. Therefore, in order to assess the blocking effect on sight

word learning, a third study was undertaken in which a conditioning history to novel pictorial stimuli was established prior to compound stimulus conditioning. Specifically, in Experiment 3 a conditioning history of appropriate verbal responding to novel Japanese symbols ("Kanji") was established prior to compound stimulus conditioning. The Kanji were employed as the A component of the AB compound stimulus. The B component of the compound stimulus was represented by novel English words that corresponded to the Kanji.

The first phase of Experiment 3 consisted of conditioning of the appropriate oral response to novel Kanji. The second phase involved testing the blocking phenomenon by pairing preconditioned Kanji with the corresponding novel printed English word, in one condition, and by pairing novel Kanji with the corresponding novel printed English word, in a second (control) condition.

Method

Participants and Setting

Six students were recruited, in order to counterbalance materials across students, using the same criteria for inclusion as in the first two experiments. Participants ranged in age from 5-1 years to 5-6 years, with a mean age of 5-3 years. Each experimental session was conducted individually in a private room in the students' school. The room measured approximately 3 m X 4.5 m and contained one desk, three chairs, and a movable blackboard along one side of the room. A participant sat on one side of the desk and the experimenter sat on the other side. Testing proceeded in the same manner as in the first

two experiments. A baseline session confirmed that the word and pictorial (Kanji) stimuli were novel to the participants.

Materials

Fifteen words were required for this experiment in order to maintain a total word count that was similar to that used by Singh and Solman (1990), while allowing for counterbalancing of the words across three word sets (i.e., five words per set). The15 words (with corresponding Kanji) to be learned in this experiment were block, jewel, river, plant, child, field, earth, water, light, shell, mouth, house, table, ocean and giant. Five words were randomly allocated to each of three word sets (Set 1, Set 2, or Set 3). It was necessary to develop a unique set of words for this experiment because of the requirement that each word have a simple Kanji that corresponded to it. In addition, it was necessary that the stimulus words be common, concrete nouns that each start with a different consonant, and that each consist of five letters, as in the Singh and Solman (1990) study. To ensure that words were equally associated with each condition the words sets were counterbalanced across children. The Kanji were employed as the A component and the corresponding printed English words were employed as the B component of the AB compound stimulus. All stimuli appeared on 26 cm X 21 cm white cards. Kanji were 7 cm high and the words were 2.5 cm high. The difference in height between these two stimuli was based on the word-picture ratio used in the first two experiments. When the stimuli were presented as a compound stimulus, the Kanji appeared on the upper half of the card and the corresponding word was typed below, on the lower half of the card.

When presented during the baseline and test trials, word stimuli appeared alone in the center of the cards.

Interobserver Agreement

Interobserver agreement data were collected during 30% of the sessions by a research assistant. Interobserver agreement ranged from 98.75% to 100%, with a mean of 99.6%.

Procedural Reliability

Procedural reliability data were collected during 30% of the sessions. Values ranged from 90% to100% with a mean of 97%.

Design

The effects of two experimental conditions were compared using an alternating conditions design. Following a baseline phase, participants were exposed to a preconditioning phase until the individual Kanji reliably evoked the corresponding oral response. The Training Phase began following the Preconditioning Phase, and was comprised of two conditions:

Blocking Condition. In this condition, five compound stimulus cards were presented, one at a time. The A component of the compound was a preconditioned Kanji and the B component was the corresponding printed English word.

Control Condition. In this condition, as in the Blocking Condition, five compound stimulus cards were presented, one at a time. However, both the Kanji and the corresponding printed English words were novel to participants.

Table 3

Design for Experiment 3

	Preconditioning	Training	Test
Blocking	Kanji Set 1	Kanji Set 1 + Word	Word
Control	Kanji Set 2	Kanji Set 3 + Word	Word

Procedure

Baseline Phase. The Baseline Phase differed slightly from the first two experiments. Instead of establishing a baseline for three consecutive sessions, a baseline measure was obtained during a single session. The decision to alter the baseline procedure was prompted by participants' comments during the first two experiments; several children expressed confusion and disappointment regarding repetitive exposure to materials to which they could not respond, and for which they were not provided corrective feedback. Given the absence of change in responding by participants over the course of three baseline sessions in the first two experiments, a single baseline session was deemed to be suitable for the purposes of measuring pre-experimental responding.

The baseline measure was established for all words and Kanji. The Baseline Phase was similar to that in the first two experiments, except that both words and Kanji were presented to the participants. Participants were informed that, in addition to unfamiliar words, they would be shown Japanese symbols.

Preconditioning Phase. During this phase each participant was exposed to 10

Kanji (e.g., five from Set 1 and five from Set 2). The Kanji were centered on the card, and the cards were presented one at a time for 15 s each. Five additional Kanji (e.g. from Set 3) remained unconditioned (i.e., novel), to be used in the Control Condition of the Training Phase. At the outset of the first preconditioning session, the experimenter said, "I am going to show you a number of cards that have Japanese symbols on them. Try to tell me what the symbols mean. I know it is very hard. I don't expect you to know any of them because you haven't learned them yet. So, tell me what the symbol means if you know it. If you don't know it, just say, "I don't know". Okay?" Following the presentation of each symbol, participants were asked, "What does this symbol mean?" As in the Baseline Phase, a response was recorded as correct, if it matched the symbol stimulus. If the participant self-corrected before the experimenter indicated the inaccuracy of the response, a correct response also was recorded. Following a correct response, the experimenter provided descriptive praise in the form of, "Yes, you are right! This symbol means _____. That's great!" Following an incorrect response, participants were told, "No, this symbol means _____." A response was recorded as incorrect, if the participant did not respond or gave a response that did not match the symbol stimulus. Once a response was made, the participant was shown the next symbol. If the participant did not respond within 15 s, the experimenter said "This symbol means _____. Let's try another one. Do you know what this symbol means?" The next symbol card was displayed, until all cards had been shown.

Test. A test trial was conducted at the end of each preconditioning session, in the same manner as in the earlier experiments. The Preconditioning Phase was terminated

once all stimuli evoked the correct naming response during three consecutive sessions.

Compound Stimulus Training Phase. All participants were exposed to two experimental conditions followed by a test trial at the end of each session. As in the preceding experiments, the order of the cards was randomized prior to each session. At the beginning of the first session of this phase participants were instructed in a manner similar to that in the preceding experiment.

Blocking Condition. The materials in this condition consisted of five compound stimulus cards, each comprised of a Kanji and the corresponding printed English word. The Kanji had been preconditioned in the Preconditioning Phase.

Control Condition. The materials in this condition consisted of five compound stimulus cards, each comprised of a Kanji and the corresponding printed English word. The Kanji, as well as the words, were novel to participants, not having been preconditioned.

Test. A test trial was conducted at the end of each training session. During the test trial the experimenter presented the experimental words alone (i.e., words from the two experimental conditions). The test procedure was the same as that in the preceding experiments. The Compound Stimulus Training Phase was terminated once the participant correctly identified all five words from either condition during three consecutive test trials.

Remediation Phase. The Remediation Phase began once the learning criterion had been met in training for either condition, and included only the number of sessions required to achieve a total of three consecutive sessions of optimal performance in both

conditions. During Experiment 2, evidence was provided that learning occurred fastest when words were presented alone, rather than as compound stimuli. Based on the results of Experiment 2, participants were given the words alone during this phase, independent of the Compound Stimulus Training Phase results. Remediation proceeded as in the same manner as in the preceding experiments.

Results and Discussion

The dependent measure was the number of words named correctly during each condition per session for each participant. The results for each participant were graphed and evaluated in the same manner as in the earlier experiments. The data from each participant's performance during the Baseline Phase and the Preconditioning Phase can be found in Appendix C. Figure 3 presents the data from the Compound Stimulus Training Phase and the Remediation Phase for all six participants. Graphs are presented in descending order of experimental effect. Data for Jake and Logan reveal that both participants learned the words that were paired with unfamiliar Kanji (i.e., Control Condition) quickly; Jake achieved optimal performance, accurately naming all 5 words by the fifth session, Logan by the second session. In contrast, when the words were paired with known Kanji (conditioning history previously established), neither participant was able to name all five words prior to the end of the Compound Stimulus Training Phase. However, once the pictorial prompts were removed during remediation, both participants learned the balance of the words quickly.

Angela's performance during the first seven sessions reveals a higher rate of learning in the Control Condition than in the Blocking Condition. A higher rate in the

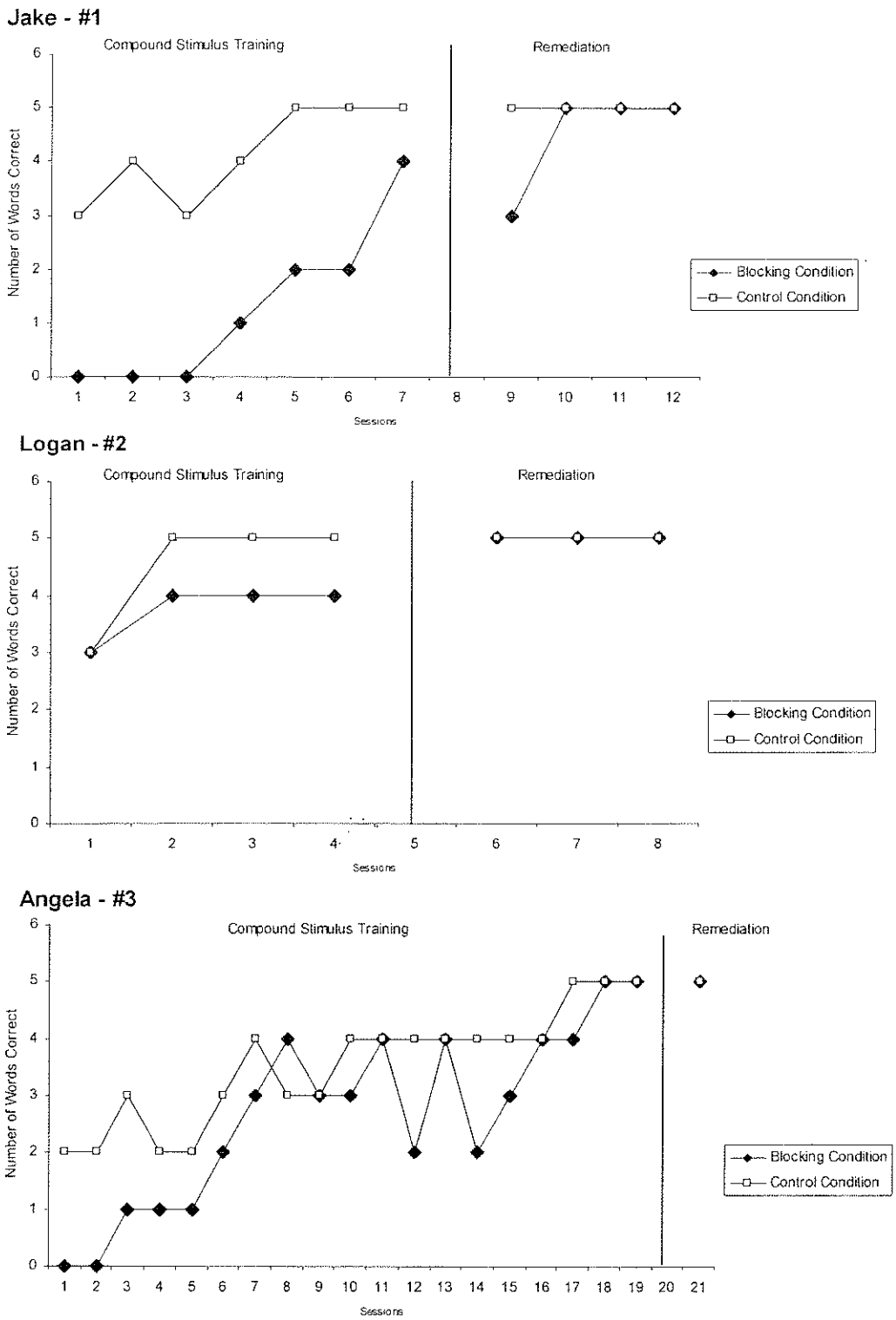
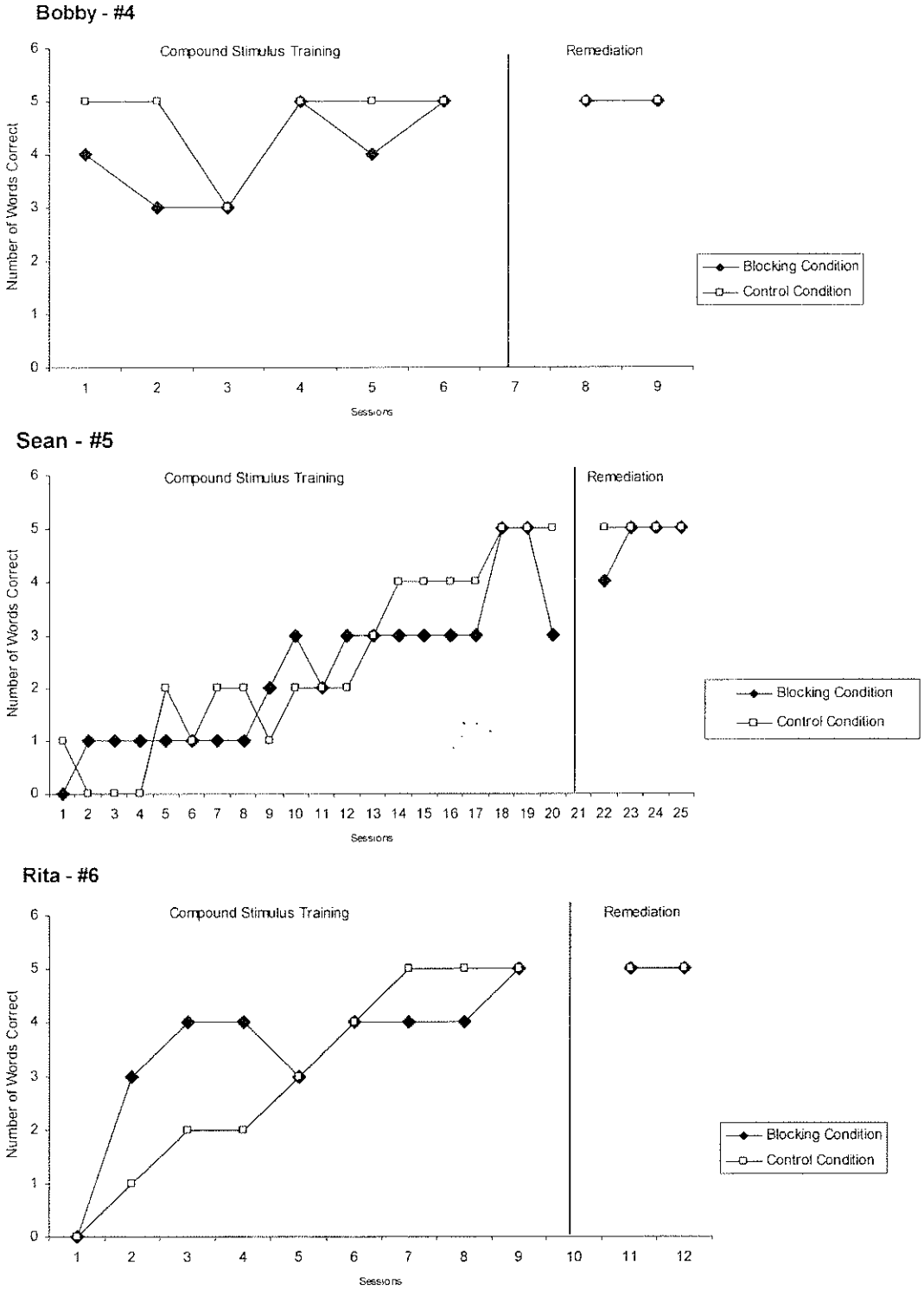


Figure 3. The number of words identified correctly during the Compound Stimulus Training Phase and the Remediation Phase for all six participants.

Figure 3 cont'd.



Control Condition occurs again in sessions 10 to 17, at which time optimal learning is achieved in the Control Condition. These data contrast to her performance in the Blocking Condition, which tends to be more variable during sessions 8 to 17. Optimal learning was achieved slightly later in the Blocking Condition, not occurring until session 18. For Bobby, a similar effect occurred at the outset of the Compound Stimulus Training Phase, where he had a higher rate of learning in the Control Condition than in the Blocking Condition (for the first two sessions in Bobby's case). However, he reached learning criterion quickly in the Control Condition (by the end of the 6^{th} session), slightly earlier than he did in the Blocking Condition, similar to Angela's performance.

Relatively weaker support for the blocking effect occurs in the data for Sean and Rita, compared to the previous participants. For both Sean and Rita, responding in the Blocking Condition was superior to responding in the Control Condition at the outset of the Compound Stimulus Training Phase. However, towards the end of the Compound Stimulus Training Phase for both participants (session 13 for Sean and session 7 for Rita), more words were accurately named when they had not been paired with preconditioned Kanji. The learning criterion was met in the Control Condition only for both participants, suggesting some interference with learning when the Kanji had been preconditioned (Blocking Condition).

Overall, the data for all six participants provided evidence of blocking when English words were paired with picture stimuli to which a conditioning history had been previously established. For 2 of the 6 participants, this effect was pronounced; for the

balance of the participants the effect, although present, was not as strong, particularly for the last pair of participants. However, in general, the data suggest that the rate of sight word acquisition was better when the word was paired with an unconditioned stimulus, providing support for the blocking effect.

Given the consistent finding of stimulus competition when preconditioned extra-stimulus pictorial prompts are paired with target words to be learned, the degree of variability in participants' performances raised concerns that overshadowing continued to be a confounding variable within this experiment. Because the use of Japanese symbols (instead of standard pictures) was unique to Experiment 3, the role of these symbols required further evaluation. Most Canadian children have limited exposure or conditioning histories to these types of pictorial representations. In contrast, these same children often have extensive conditioning histories to printed word stimuli through every day occurrences (e.g., advertising, picture books) even before they are developmentally ready or able to begin to read. Prior to beginning a formal education, most children are exposed to numerous printed words (e.g., "STOP", "MacDonald's", "Fisher-Price") in their natural environment. Consequently, the unique and unfamiliar presence of the Japanese pictorial stimuli may have resulted in less stimulus competition when paired with the printed words, which were more familiar/salient stimuli to the participants.

Experiment 4

Experiment 4 was designed to demonstrate the blocking effect under conditions that implemented the standard blocking paradigm while providing a demonstration of the generality of the blocking effect across languages. This experiment also provided an

opportunity to assess, to some degree, the role of overshadowing as a potential confounding variable present in Experiment 3. Specifically, if the word stimuli were more salient to the participants in Experiment 3 thereby working against the effect of the extra-stimulus pictorial prompts (the less familiar Kanji), utilizing the word stimuli as the A component (the preconditioned stimuli) and the Kanji as the B component (the target stimuli to be learned) adds overshadowing to the blocking effect.

Method

Participants and Setting

Six students were recruited from the same population using the same criteria for inclusion as in Experiment 3. Participants ranged in age from 5.0 to 5.8 years, with a mean age of 5.3 years. Testing proceeded in the same manner as in Experiment 3, and in the same setting.

Materials

The stimulus materials (words and Kanji) and the manner of presentation were the same as in Experiment 3. However, in Experiment 4, English words were employed as the A component and the corresponding Kanji were employed as the B component of the AB compound stimulus. Five words were randomly allocated to each of three word sets (Set 1, Set 2, or Set 3). To ensure that words were equally associated with each condition the words sets were counterbalanced across children.

Interobserver Agreement

Interobserver agreement on response recording was collected during 30% of the sessions by a research assistant. Agreement ranged from 98.75% to 100%, with a mean of 99.8%.

Procedural Reliability

Procedural reliability data were collected during 30% of the sessions. Values ranged from 80% (for one participant during one session where descriptive praise was inadvertently omitted, i.e., the experimenter failed to name the word following feedback), to 100%, with a mean of 95%.

Design

As in Experiment 3, the effects of two experimental conditions were compared using an alternating conditions design. Following the Baseline Phase, participants were exposed to a Preconditioning Phase until the individual printed English words reliably evoked the corresponding oral response. The Compound Stimulus Training Phase began following the Preconditioning Phase, and was comprised of two conditions:

Blocking Condition. In this condition, five compound stimulus cards were presented, one at a time. The A component of the compound stimulus was a preconditioned word and the B component was the corresponding Kanji. The Kanji was novel to the participant.

Control Condition. In this condition, as in the Blocking Condition, five compound stimulus cards were presented, one at a time. In contrast to the Blocking Condition, in this condition the A component of the compound stimulus was a novel

word that was paired with the B component, the corresponding novel Kanji (to be learned during the Compound Stimulus Training Phase).

Table 4

Design for Experiment 4

	Preconditioning	Training	Test
Blocking	Word Set 1	Word Set 1 + Kanji	Kanji
Control	Word Set 2	Word Set 3 + Kanji	Kanji

Procedure

Baseline Phase. The Baseline Phase was identical to that described for Experiment 3.

Preconditioning Phase. The procedure for this phase was the same as in Experiment 3, except that stimulus materials were counterbalanced. Specifically, each participant was exposed to 10 words (e.g., five from Set 1 and five from Set 2). In addition, five words from the third word set (e.g., Set 3) remained novel (i.e., a naming response was not conditioned) and they were used in the Control Condition of the Compound Stimulus Training Phase. Instructions by the experimenter were similar to those provided in Experiment 3; however they were adjusted in accordance with changes in the stimulus materials.

Test. A test trial was conducted at the end of each preconditioning session in the same manner as in Experiment 3.

Compound Stimulus Training Phase. The procedure used in the Compound Stimulus Training Phase was the same as that in Experiment 3. Instructions provided by the experimenter were altered in accordance with the altered roles of Kanji and word stimuli.

Blocking Condition. The materials in this condition consisted of five compound stimulus cards, each comprised of a printed English word with the corresponding novel Kanji. The English words had been preconditioned in the Preconditioning Phase.

Control Condition. The materials in this condition consisted of five compound stimulus cards, each comprised of a printed English word with the corresponding Kanji. Both the words and the corresponding Kanji were novel to participants.

Test. A test trial was conducted at the end of each training session in the same manner as in Experiment 3.

Remediation Phase. The Remediation Phase began once the participant correctly identified all five Kanji in either condition during three consecutive test trials. Participants were exposed to the Kanji symbols alone during this phase, and remediation proceeded in the same manner as in the preceding experiments.

Results and Discussion

The dependent measure was the number of Kanji correctly named per session for each participant. The results for each participant were graphed and evaluated in the same manner as in the earlier experiments. The data from each participant's performance during the Baseline Phase and the Preconditioning Phase can be found in Appendix D. Figure 4 presents the data from the Compound Stimulus Training Phase and the

Remediation Phase for all six participants. As in Experiment 3, graphs are presented in descending order of experimental effect. Data for Alex and Brayden reveal that during the Compound Stimulus Training Phase, both participants reached optimal learning in the Control Condition (i.e., where the Kanji had been paired with unfamiliar words). In contrast, when the Kanji were paired with corresponding preconditioned words (i.e., the Blocking Condition), they were unable to reach optimal learning prior to the end of the Compound Stimulus Training Phase. For Alex, this was the case, despite exposure to the Blocking Condition Kanji for 10 training sessions. However, once the Remediation Phase was initiated and he was exposed to the Kanji alone, he rapidly reached the learning criterion.

Ella and Susan also learned the Kanji faster in the Control Condition, where the Kanji were paired with words that were novel. The experimental effect was replicated across participants; Ella reached learning criterion by the end of the 7th session, and Susan reached learning criterion by the end of the 8th session. The blocking effect was apparent for both participants, with both participants learning a maximum of three Kanji in the Blocking Condition, until the Remediation Phase was initiated, at which time both participants rapidly met learning criterion for the balance of the Kanji.

Similar to the previous participants, Robert and Brian learned the Kanji in the Control Condition at a faster rate than in the Blocking Condition. Brian reached learning criterion in the Control Condition quickly (by the end of the 4th session), and 3 out of 4 of his data points are in favour of the Control Condition. Robert, in contrast, displays no difference between the two conditions at the outset of the Compound Stimulus Training

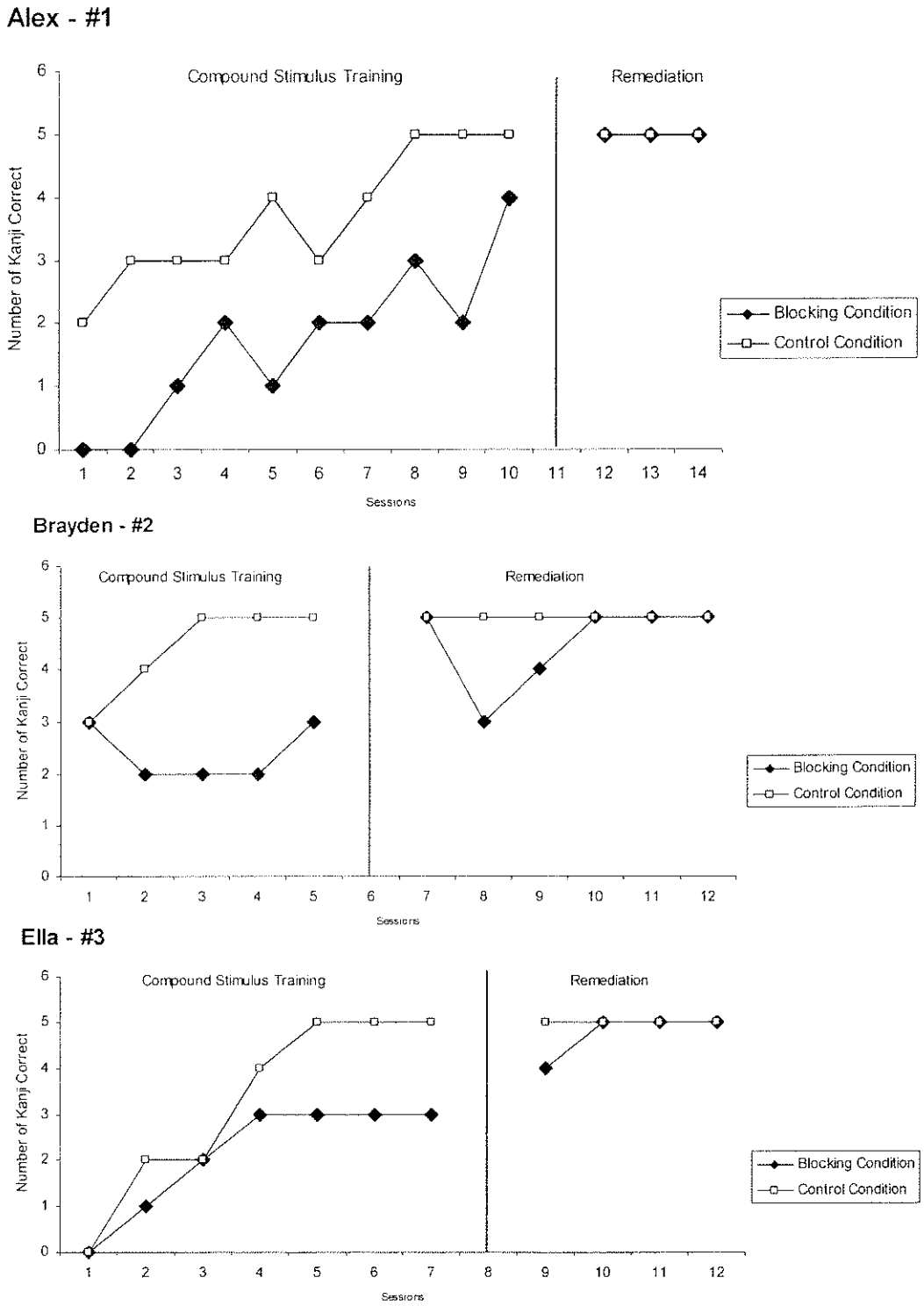
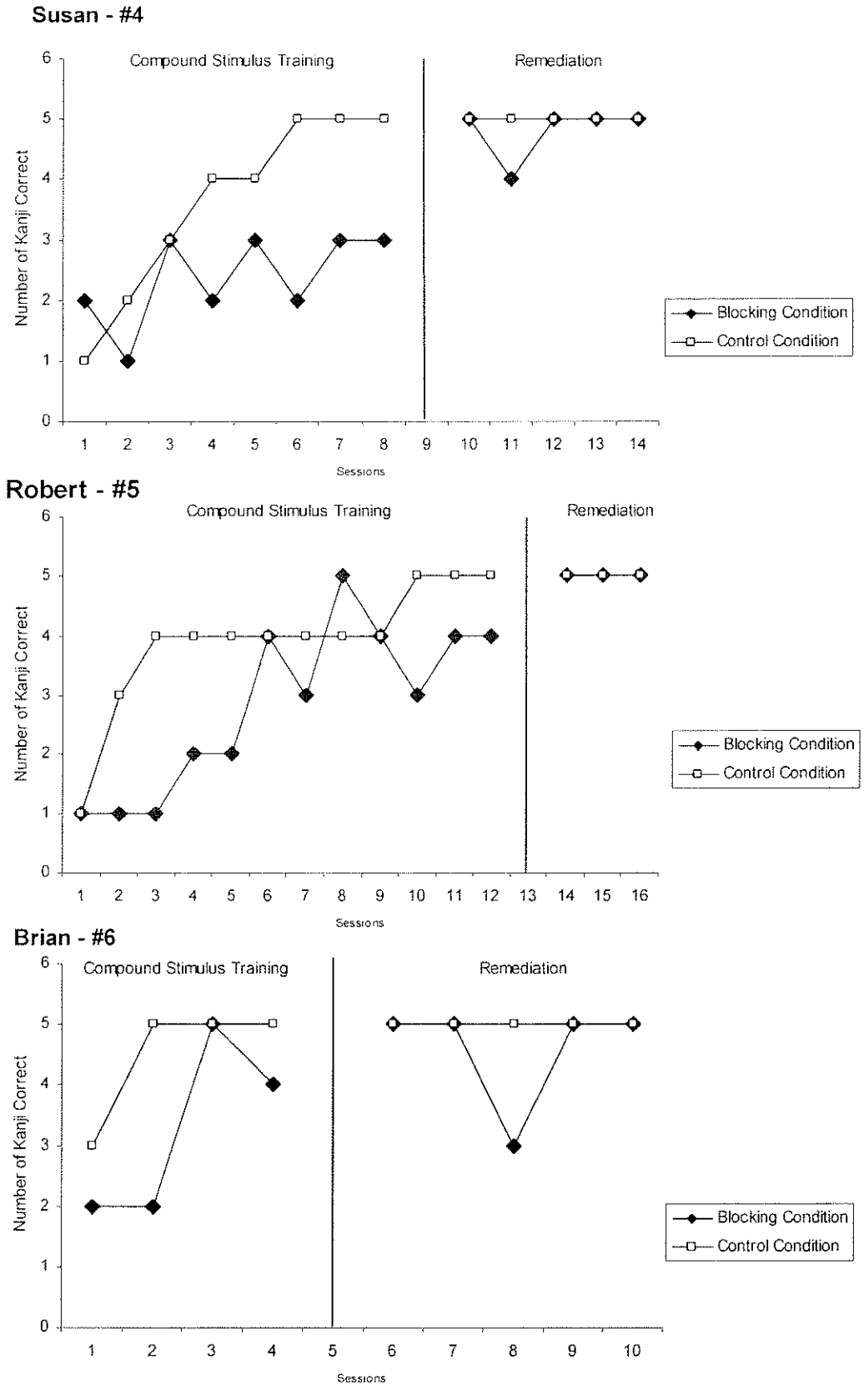


Figure 4. The number of Kanji identified correctly during the Compound Stimulus Training Phase and the Remediation Phase for all six participants.

Figure 4 cont'd.



Phase. Over the course of the Compound Stimulus Training Phase, he demonstrated a stable and gradually increasing rate of learning in the Control Condition. In contrast, his responding in the Blocking Condition was more variable. Although he reached optimal performance in the Blocking Condition during the eighth session, he was not able to maintain this level of performance, and he did not reach learning criterion prior to the end of the Compound Stimulus Training Phase.

The results from Experiment 4 consistently reveal a faster rate of learning in the Control Condition, where discriminative control by the extra-stimulus prompts (i.e., the printed English words) had not been established, compared to the Blocking Condition, where such control had been established. These results contrast with the results from Experiment 3, where the blocking effect was not as clear or consistent, potentially because of overshadowing as an uncontrolled variable. Overshadowing was evaluated further in Experiment 4 by employing the more salient word stimuli as the A component of the AB compound, thereby adding to, rather than opposing, the blocking effect. Overall, the results from this experiment provide support for the role of blocking in the slower learning rate when the stimulus to be learned is paired with a second, redundant stimulus, where stimulus control has been previously established.

General Discussion

The first experiment provided a systematic replication of Singh and Solman's (1990) study, altering the sample by employing children without, instead of children with, development delays. The results from Experiment 1 were similar to those found by Singh and Solman. Namely, the slowest learning rates for all participants occurred when extra-

stimulus pictorial prompts were paired with words to be learned. In contrast, the majority of participants (3 out of 4) learned substantially faster when the stimuli to be learned were presented alone, rather than as compound stimuli.

In the second experiment potentially confounding variables present in the Singh and Solman experiment were controlled (i.e., enhanced size, rehearsal, repeated exposure). The results consistently, and even more convincingly, supported the efficacy of sight word learning when the word was presented alone, without a redundant pictorial prompt. All 4 participants had a faster rate of learning when the words were presented without a corresponding picture.

In both Experiment 1 and Experiment 2, the presence of pictorial prompts interfered with learning to sight word read. However, because the standard blocking paradigm was not incorporated, these experiments may have found superiority of single stimulus learning versus compound stimulus learning rather than necessarily the "blocking" of the word to be learned by a preconditioned stimulus.

My third and fourth experiments were conducted to investigate the blocking effect by implementing the standard blocking paradigm (i.e., by establishing a preconditioning history within the experiment). In Experiment 3 Kanji were preconditioned and then paired with the corresponding English word to be learned. In Experiment 4, stimulus materials were counterbalanced; the English words were preconditioned prior to being paired with the Kanji. Blocking was evident in both Experiments 3 and 4, although the effect was larger and more consistent in Experiment 4, suggesting that overshadowing also may have played a role.

Blocking occurs when preconditioning of one component interferes with conditioning of the second component of a compound stimulus when both components are presented simultaneously. In contrast, overshadowing occurs when one component of a compound stimulus acquires discriminative control over responding because of its physical characteristics (salience) relative to the other component of the compound stimulus. It is possible that the difference in the experimental effect between Experiment 3 and Experiment 4 may be best explained by overshadowing as an uncontrolled variable. Because the participants have had conditioning histories in their natural environments where they received frequent exposure to English word stimuli versus little or no exposure to Japanese symbols, it is possible that the word stimuli were more salient than the Japanese Kanji. Therefore, despite preconditioning of the appropriate verbal response to the Kanji in Experiment 3, the word stimuli were able to acquire discriminative control over responding for several participants.

By counterbalancing the stimulus materials in Experiment 4, overshadowing was added to, rather than in opposition to, the blocking effect. Specifically, discriminative control over responding by the more salient word stimuli was established prior to pairing the word stimuli with the stimuli to be learned (i.e., the Kanji). The blocking effect was more apparent in this fourth experiment when both preconditioning and salience (overshadowing) were manipulated in favour of the first component of the compound stimulus.

Ideally, to test the blocking effect, the preconditioning history only should be manipulated, with the salience (or relative strength) of the compound stimulus

components being equivalent. Future research that uses the standard blocking paradigm and provides equivalence in the stimulus materials would be a valuable contribution to current research. One possibility which is similar to the picture-word arrangement, would involve the development of abstract or arbitrary pictures or illustrations. These abstract pictures would be given labels of target words (i.e., words to be learned), with some pictures being preconditioned, and others remaining novel. The abstract pictures would then be paired in a compound stimulus arrangement with other arbitrary pictures that have been designated as corresponding stimuli, thereby eliminating overshadowing as a variable in the design.

Overall, the results from my four experiments confirm the finding (e.g. Didden, Prinsen, & Sigafoos, 2000, Harzem, Lee & Miles, 1976; Lang & Solman, 1979; Samuels, 1967, 1970; Saunders & Solman, 1984; Singh & Solman, 1990; Wu & Solman, 1993) that the most efficient means of sight word learning for beginning readers is when the target word is presented without a corresponding pictorial prompt, or, alternatively, without a preconditioned redundant extra-stimulus prompt. Such research has important applied relevance, given the dominant educational practice for beginning readers of pairing pictures with words to be learned. Where such effects can unambiguously be attributed to blocking (or overshadowing), generality of basic principles of stimulus control across species also is achieved.

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Appendices

Appendix A

Explanations Proposed to Account for the Effect of Extra-Stimulus Prompts on Sight Word Acquisition

According to the focal attention hypothesis (Samuels, 1967) a beginning reader "attends" to the picture stimulus, it being the more salient stimulus (due to familiarity, attractiveness, etc.), when presented concurrently with the word stimulus. Consequently, the reader's attention is diverted from focusing on the critical features of the printed word. To derive this theory, Samuels, using a simple, randomized groups design, assigned 10 kindergarten children to each of three reading conditions: a no-picture group, a simple-picture group, and a complex-picture group. In the no-picture condition the typed word was presented at the bottom of a card. In both picture conditions the picture and word were presented simultaneously, with the picture appearing above the typed word. The pictures in the simple-picture condition were basic black and white drawings portraying the visual stimulus corresponding to the printed word. In the complex-picture condition the pictures appeared in color and pictorially represented more than one object, such as a boy holding a dog while pointing to a horse in the background when the target word was "boy". The children in each group were asked to learn the appropriate spoken or textual response for four words (boy, bed, man, and car). Each training trial was immediately followed by a test trial. Training and test trials were alternated 10 times each. During the training trials, the experimenter presented the word or word/picture card and the child was asked to name the word. If the child did not provide the correct response, the

experimenter modeled the correct response. During test trials, words were presented alone (without pictures), and without corrective modeling.

Statistical analysis of the data revealed that participants in the no-picture condition read reliably more words than those in either the simple picture condition or the complex picture condition (which were not reliably different from one another). Samuels' (1967) concluded that the pictures indeed functioned as distracting stimuli that drew the participants' attention away from the features of the printed word.

Although there has been empirical evidence supporting the focal attention hypothesis (e.g. Braun, 1969; Ceprano, 1981; Singer, Samuels, & Spiroff, 1973; Harzem, Lee, & Miles, 1976), other researchers have failed to achieve improved performance with picture-word compound stimuli despite experimental manipulations devised to direct attention to the word stimulus during training (e.g., Arnold, 1968; King & Muehl, 1965; Kiraly & Furlong, 1974; Wu & Solman, 1993). For example, Wu & Solman (1993) conducted an experiment employing remedial procedures that were intended to create an active learning environment that would direct the participant's attention to the word stimuli. Using a paired-associate technique, Wu and Solman explored whether or not an active association process could facilitate sight word learning. The researchers exposed 12 kindergarten children to four experimental conditions in a repeated measures design. A total of 12 concrete, common nouns were selected, three per condition. Two of the conditions employed a matching procedure following training with the compound cards. For both matching conditions, the children had to match two sets of stimuli by physically pairing the picture with the corresponding word. In one of these two conditions

(Matching Only) the word-picture compound stimuli remained on the desk in full view while the participant matched a series of word and picture cards. After the participant completed each pairing, the experimenter reinforced the correct response or modeled the correct match in the case of an error. With the matched picture cards remaining on the desk the experimenter pointed to each word while asking the child to read the word. In the other matching condition (Matching with Fading), the experimenters attempted to shift stimulus control from the picture to the printed word by removing the word-picture compound stimuli prior to the participants engaging in the matching task. (As fading involves a gradual change in the stimulus that controls responding (Martin & Pear, 2003, p. 114; Miltenberger, 1997, p. 191), the term seems to have been misapplied.) Once the picture and word cards had been matched, the experimenter removed the corresponding picture card before the participants were asked to read the words just matched. A standard picture-word compound condition using picture-word compound cards only (no matching technique) and a word-alone condition also were included in the experimental design.

Statistical analyses were conducted comparing the proportion of correct naming responses in each condition. A statistically significant difference was found between the word-alone condition and the two matching conditions. The word-alone condition had the highest proportion of correct naming responses and the lowest mean number of trials required to reach criterion (i.e., to learn the words). Further analyses failed to show a statistically significant difference between the Matching Only condition and the Matching with Fading condition. Finally, statistical comparison between the standard picture-word compound condition and the other three experimental conditions showed that the

standard picture-word compound condition had the lowest mean proportion of correct naming responses among the experimental conditions.

The results of the Wu and Solman (1993) experiment are consistent with those from other studies demonstrating that sight word acquisition occurs fastest when the words are presented without extra-stimulus pictorial prompts. Despite efforts to ensure that attention was directed to the word portion of the paired-compound, the data favored learning single words without extra-stimulus prompts. Thus, Wu and Solman's data do not support the focal attention hypothesis.

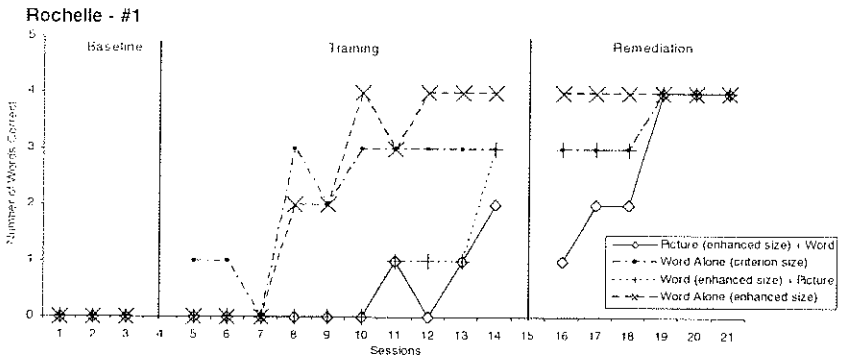
Another explanation for the deleterious effects that pictures can have on sight word acquisition is the limited processing capacity theory (Lang & Solman, 1979). The limited processing capacity theory purports that processing two separate stimuli at the same time overwhelms the child's information processing capacity. Consequently, the child is compelled to focus on one stimulus only, which will typically be the more salient stimulus. In the case of picture-word pairings, the picture stimulus is considered more salient due to factors such as familiarity and attractiveness (Wu & Solman, 1993).

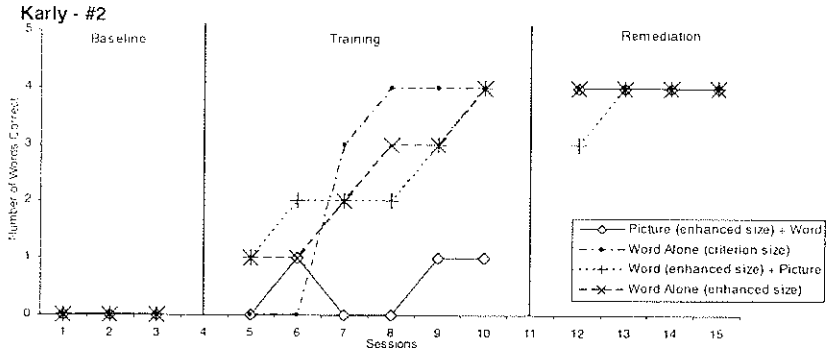
Saunders and Solman (1984) designed an experiment to test the limited processing capacity hypothesis. Five groups of kindergarten children (n=14) viewed the same five words. Four of the groups were shown the words together with the corresponding pictures, and the fifth group viewed the words only. Two of the picture/word groups were instructed to associate the word and the picture (association conditions); the other two groups did not receive these instructions. One of the association groups viewed the word 1 s prior to viewing the picture (spaced condition).

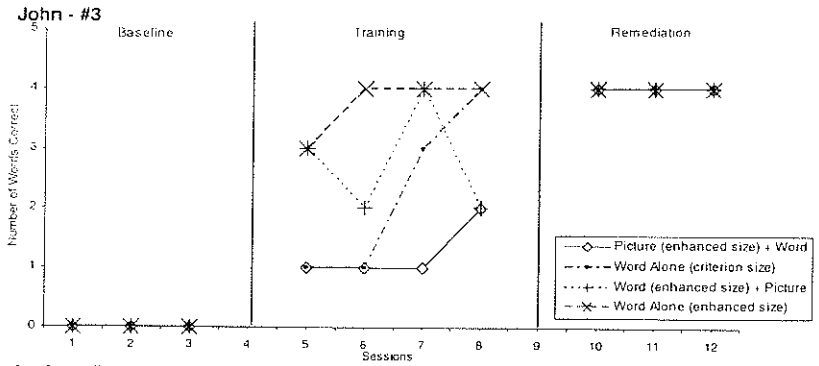
All other groups viewed the picture and the word simultaneously. Consistent with the previously reviewed research, statistical analysis revealed that children who learned the words without the presence of pictorial stimuli learned the words more rapidly than did children in any of the other groups. Central to the limited processing capacity hypothesis, viewing the word prior to viewing the presentation of the picture did not improve reading performance. Therefore it was concluded that the limited processing capacity hypothesis was not an explanation for the deleterious effect of extra-stimulus prompts on sight word learning. These findings suggest that the inhibitory effect of extra-stimulus pictorial prompts cannot be attributed to overloading the children's processing capacity, given that efforts were made to counteract this problem by spacing the presentation of the two stimuli.

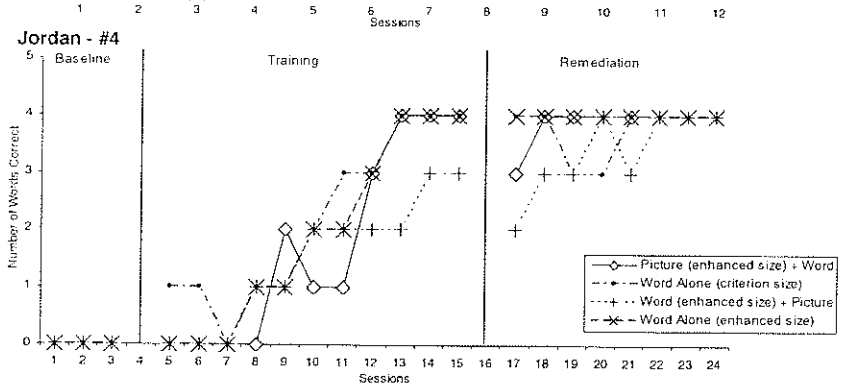
Appendix B

Graphed Data for all Conditions in Experiment 1



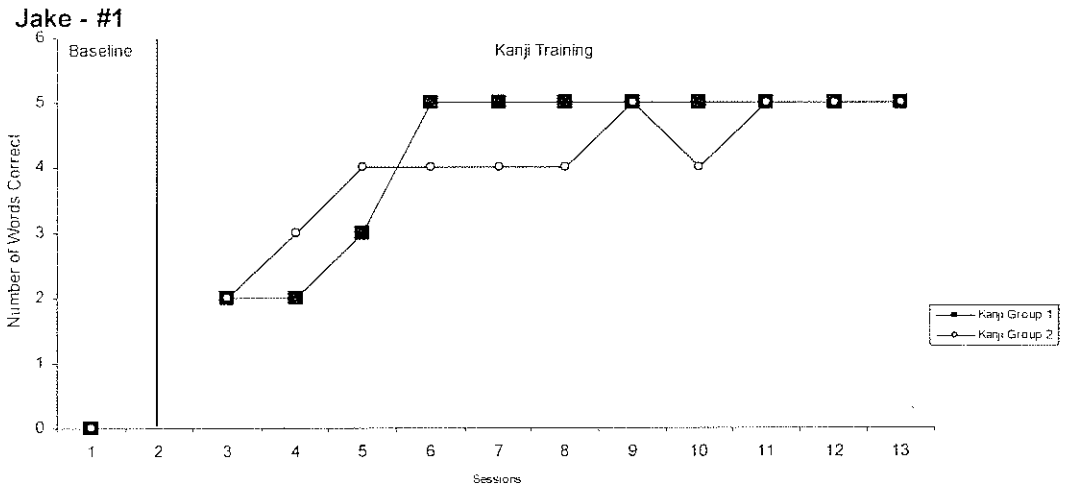


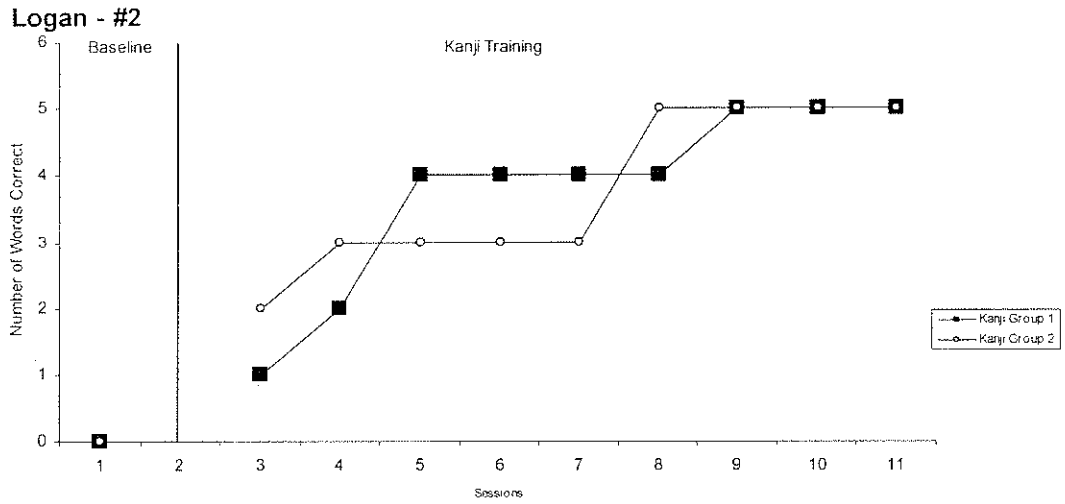


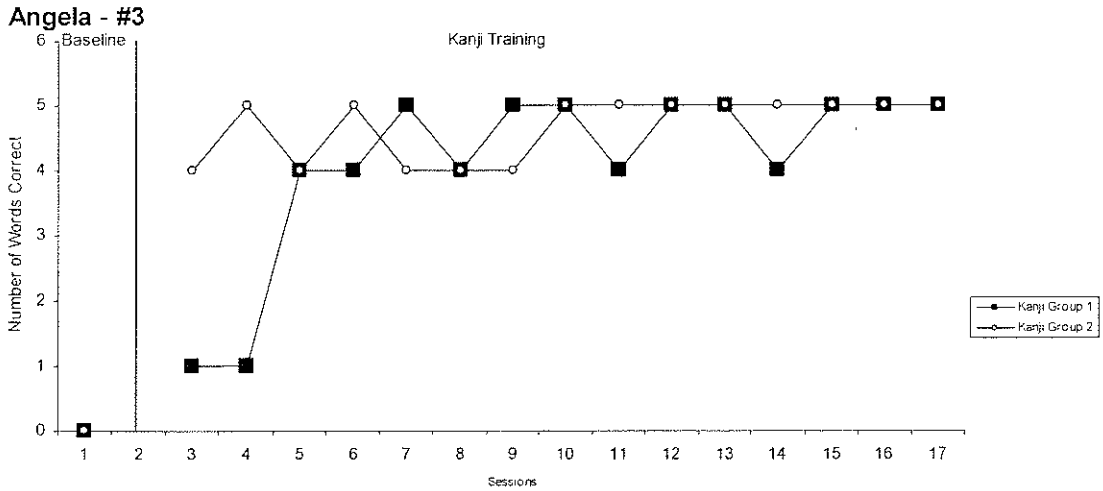


Appendix C

Experiment 3 – Graphed Data for Baseline and Preconditioning Phases







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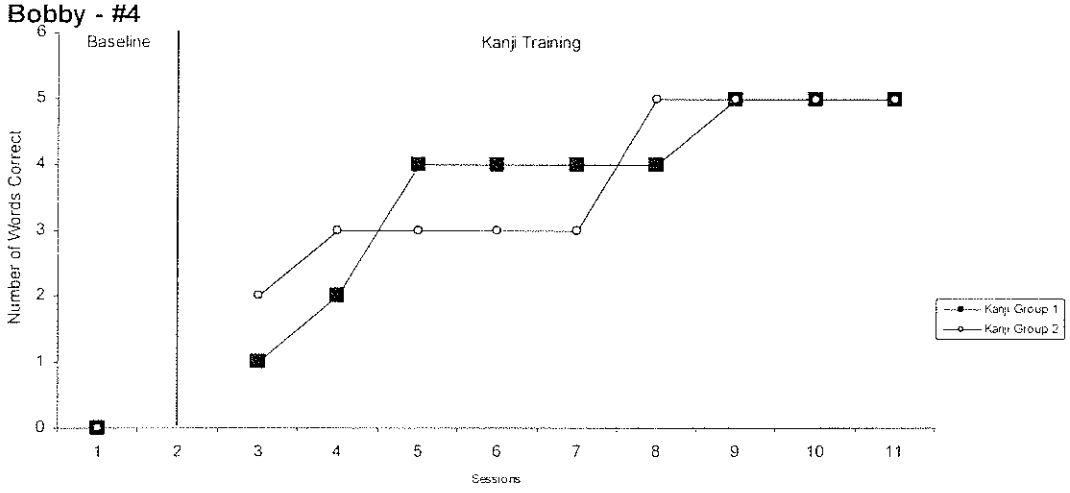

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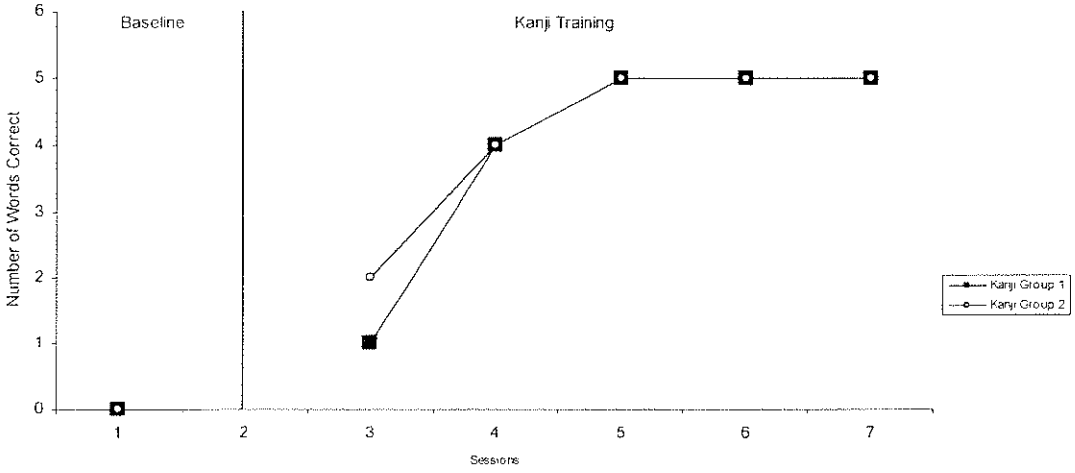

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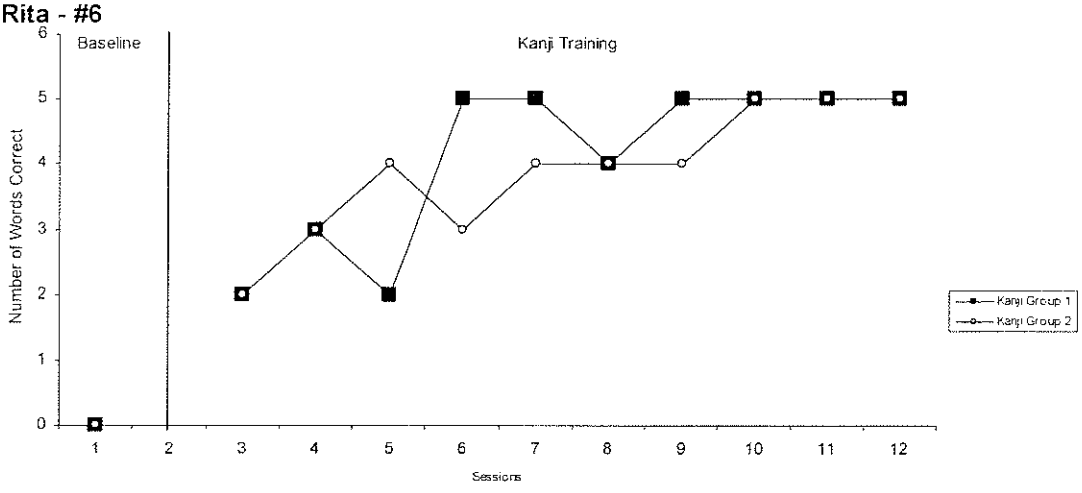

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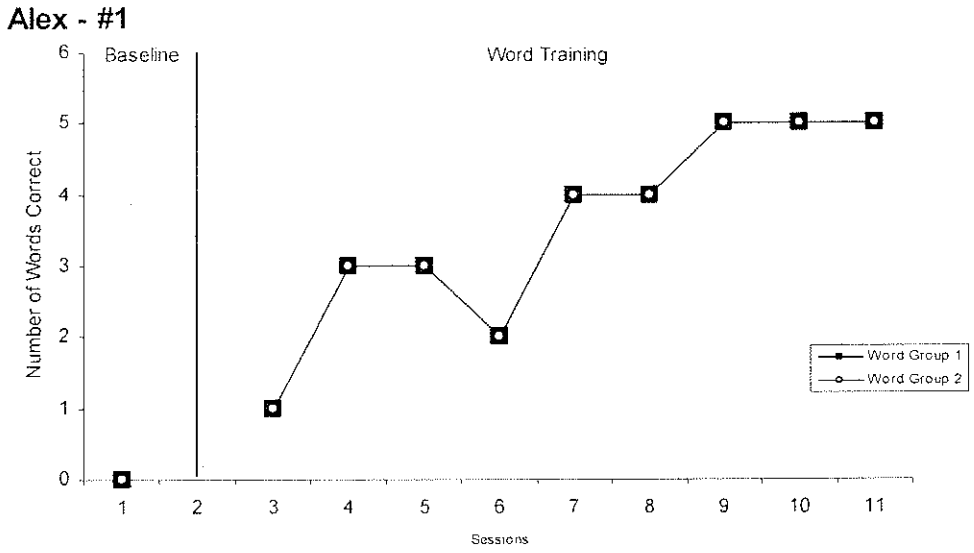

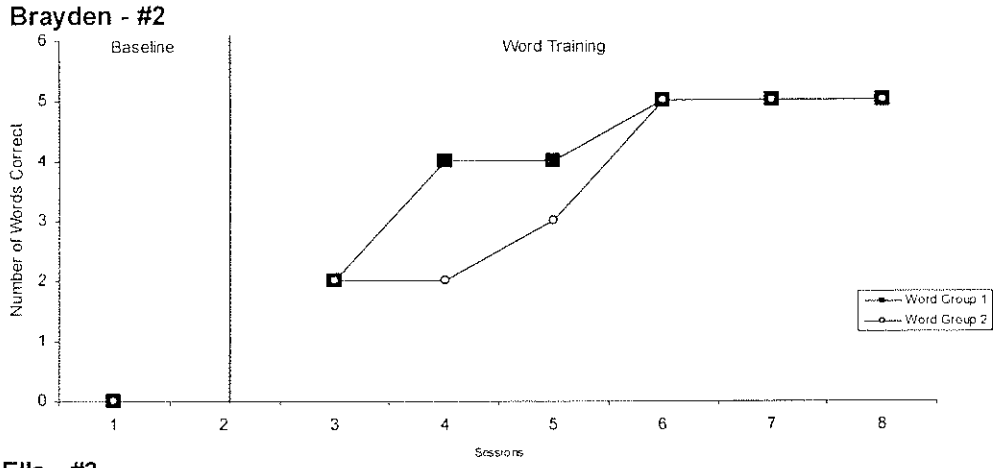

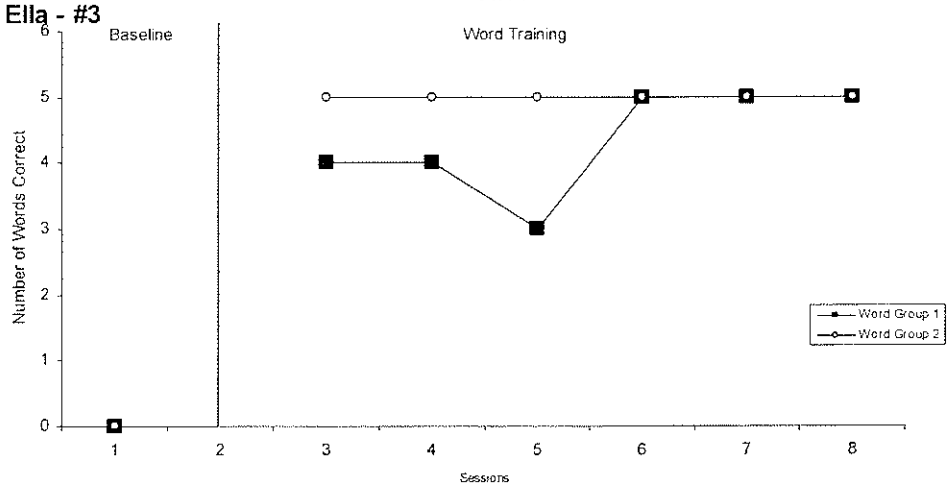

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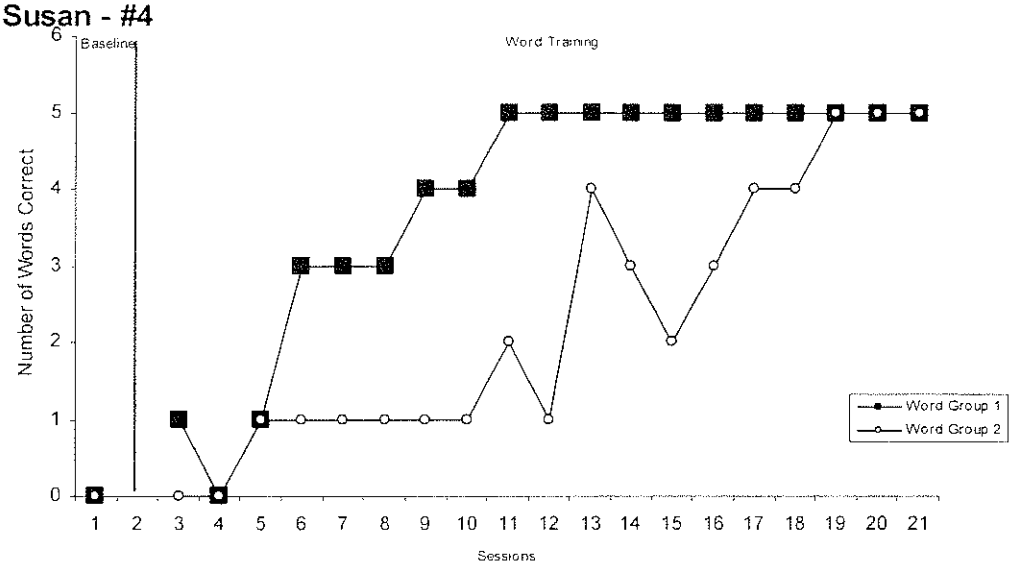

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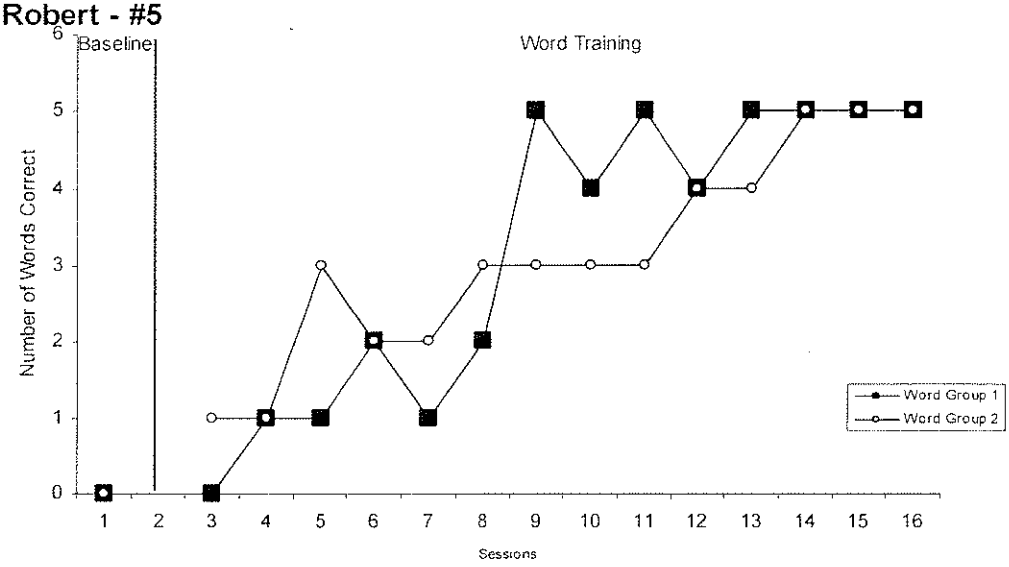

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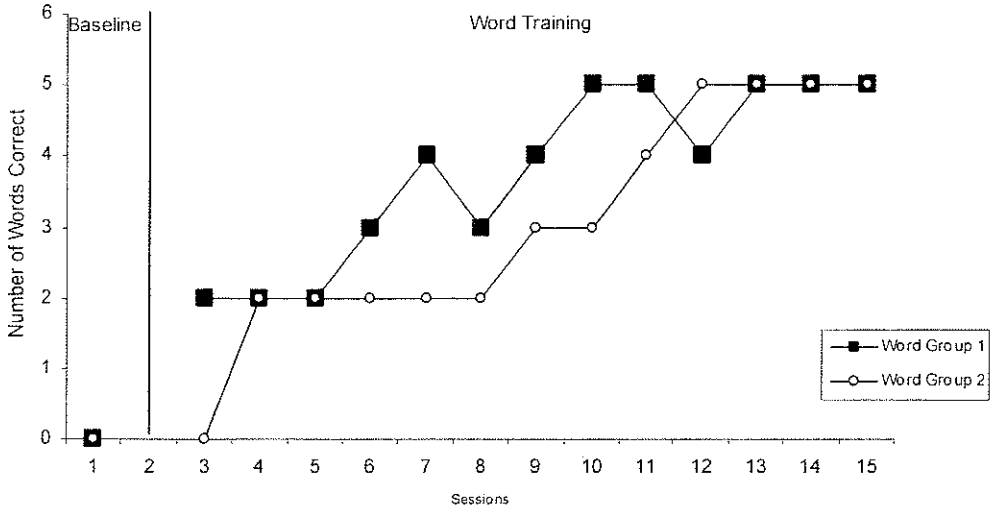

Appendix E

PROJECT DESCRIPTION & CONSENT FORM

For PARENTS & LEGAL GUARDIANS

Project Title: Analysis of the effect of pictures on learning to read.

This project is being conducted by Terri Otto, a Ph.D. student at the University of Manitoba. The research supervisor is Dr. Stephen Holborn, Professor of Psychology at the University of Manitoba. This project has been approved by the Psychology/Sociology Research Ethics Board (PSRED) and any complaints regarding procedures may be reported to Dr. Stephen Holborn at 474-8245 or the Human Ethics Secretary at 474-7122.

What is this study about?
Past research has shown that when an unfamiliar word is presented together with a corresponding picture reading acquisition is poorer than when the word is presented alone (e.g., Harzem & Lee, 1976; Hu & Solman, 1993, Saunders & Solman, 1984; Singh and Solman, 1990). This study is designed to confirm that this phenomenon occurs within a mainstream population of kindergarten children under experimental conditions that have previously been tested using a population of individuals diagnosed with developmental delays (see Singh & Solman, 1990). Once this phenomenon has been found to occur, the next step will be to determine the reasons for this interference.

What will the project include, and how long will it last?
Sessions will occur 2 to 3 times a week for approximately 3 months. Each session will last approximately 15 minutes. A series of experiments will be conducted, however each child will participate in one experiment only. Materials used in the experiments will vary. Some children will be presented with a white card showing a picture alone, a word alone, or both a picture and the corresponding word. Other children will be presented with a white card showing a Japanese symbol. These children will be taught the English names for these simple Japanese symbols (e.g., the Japanese symbol for tree will be shown and the children will learn that this symbol means "tree"). Once learned the Japanese symbols will then be paired with the corresponding printed English word. The children will be asked to name the symbol or word.

Is participation voluntary?
Yes. Consent will be obtained from both you and your child. Participation is completely voluntary. Desire to participate, or the lack thereof, will in no way have any bearing on the classroom environment, now or in the future. We want this to be a fun and positive

experience for your child, one with the added benefit of individual reading instruction of target words.

What personal information will be obtained?
The teacher will be asked to recommend children whom she feels will most enjoy participating in this experiment. Your child's name and age (date of birth) will be the only personal information that will be collected for the purposes of this study.

Will personal information be kept confidential?
Yes. Individual results will be kept strictly confidential. Children will be identifiable by participant numbers which will be known only by the researchers. All data collected during the student will be kept in a secure place and will be available only to the researchers. Data will be maintained for a five-year period. At the end of the five-year period, all data will be destroyed. Any presentations, reports, or publications as a result of this project will not contain any identifying information.

Are there risks to taking part in this study?
There are no risks.

Are there benefits in taking part in this study?
Yes. Your child will receive individual attention in learning to read the words used in the study. The most effective learning technique will be used to help each child learn all of the words presented. In addition, new insight may be found regarding how to teach reading in a more effective manner.

Will participation cost anything?
No.

Is there any compensation for participating?
No. There is no financial compensation for participation.

Whom should I call if I have questions or concerns about the project?
If you have any questions or concerns about the project, please call Terri Otto
or Dr. Stephen Holborn

What should I do if I am interested?
On one of the copies provided, please complete the next sections and return it in your child's school folder. The duplicate copy is for your records.

By signing this form, I give consent for _____ to participate in the above-described research project. I am aware that he or she may stop at any time. I

acknowledge and consent to the use of the results in publications, reports, and presentations, so that others may learn from this project. The child's identify, however, will not be disclosed.

_____ _____

Print name of guardian/parent Signature of guardian/parent

_____

Date

Please provide the following information:

Child's Name: _____

Date of Birth: _____

I would like to receive a summary of the experimental results via:

Please check one:

____ Email: (Address) _____

____ Mail: (Home address) _____

____ School Mail

Appendix F

Dear Parents/Guardians,

Re: Summary of Experimental Results for Research Project
Entitled "Analysis of the effect of pictures on learning to read"

Thank you for consenting to the involvement of your child in this project. The children participated enthusiastically, and provided valuable data that enhances research in the area of sight word acquisition, and learning, more generally.

Past research has shown that when an unfamiliar word is presented together with a corresponding picture, sight word learning is slower than when the word is presented alone (e.g., Harzem & Lee, 1976; Hu & Solman, 1993, Saunders & Solman, 1984; Singh and Solman, 1990). One explanation that has been proposed to account for the interference that pictures can have on sight word learning is the "blocking effect". Blocking can be defined as the inhibitory effect that a familiar stimulus (in this case, a picture) has on the establishment of control by a subsequently presented novel stimulus (in this case, the corresponding word) when the two are presented together. In other words, the familiar picture interferes with or "blocks" learning of the corresponding word with which it is paired.

My first experiment was a systematic replication of Singh and Solman's (1990) blocking experiment. Despite the change in population from children with developmental delays to children without developmental delays, the results from this first experiment were similar to those found by Singh and Solman. Namely, the slowest learning rates for all participants occurred when pictures were paired with words to be learned. In contrast, the majority of participants learned substantially faster when the words to be learned were presented alone, rather than with the corresponding picture.

In my second experiment, potentially confounding variables present in the Singh and Solman experiment (i.e., enhanced size, rehearsal, repeated exposure) were controlled. The results consistently, and even more convincingly, supported the efficacy of sight word learning when the word was presented alone, without corresponding pictures. All participants had a faster rate of learning when the words to be learned were presented without pictures.

In both Experiment 1 and Experiment 2, the presence of pictures interfered with sight word learning. However, because the standard blocking paradigm had not been used in these experiments, conclusions regarding the superiority of word alone learning versus picture plus word learning only could be made (as opposed to "blocking" of the word to be learned by the picture).

Therefore, Experiments 3 and 4 were conducted to investigate the blocking effect by implementing the standard blocking paradigm (i.e., by establishing a preconditioning or learning history within the experiment, and including an appropriate control condition). In Experiment 3 children first learned Japanese symbols alone, and then these symbols were paired with the corresponding English words to be learned. In Experiment 4, stimulus materials were counterbalanced; children learned the printed English words first, and then these words were paired with the corresponding Japanese symbols to be learned. Blocking was evident in both Experiments 3 and 4, although the effect was larger and more consistent in Experiment 4. In general, the children learned the words and the Japanese symbols more quickly when they were paired with unknown (i.e., novel) corresponding stimuli rather than with the previously learned corresponding stimuli.

Overall, the results from my four experiments confirm the finding (e.g. Didden, Prinsen, & Sigafoos, 2000, Harzem, Lee & Miles, 1976; Lang & Solman, 1979; Samuels, 1967, 1970; Saunders & Solman, 1984; Singh & Solman, 1990; Wu & Solman, 1993) that the most efficient means of learning sight words for beginning readers is to present the target word without a corresponding picture or, alternatively, without a preconditioned picture. Such research has important applied relevance, given the dominant educational practice for beginning readers of pairing pictures with words to be learned.

If you have any questions or comments regarding the information provided above, please feel free to contact me at .

Thank you.

Terri Otto.