An Analog Study of First Language Dominance and Interference over Second Language

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The purpose of this study was to design a model for “first language” dominance over “second language” performance and the interference of one language over the other. Two sets of equivalence relations showing a common element (i.e., the reference) were established under different contextual conditions. One set (“first language”) was over trained relative to the other (“second language”). Dominance of the “first language,” as demonstrated in relations involving the common element, was determined by examining performances in the absence of contextual stimuli. Interference by one language over the other was modeled by examining the degree to which resurgence of “first language” and “second language” relations would occur in extinction, following a period of exposure to inconsistent test trials. In addition, both selection-based (i.e., copy text) and topography-based (i.e., intraverbal) equivalence were examined in these areas. The results demonstrated that the development of an analog for a bilingual repertoire, the domination of the “first language” over the “second language” and the interference of one language over the other, were established.

Key words: first language, second language, bilingual repertoire, dominance, interference.

Language as gestures, speech, or writing has originated as conventions in groups of people, and has been the medium of production, reproduction, and transformation of conventions (Inesta, 1991). More specifically, language is a repertoire involving shared stimulus functions between conventional linguistic forms and aspects of the nonlinguistic environment. Although an extreme simplification, language can be understood as equivalence relations between verbal and nonverbal stimuli, with additional relations obtaining between verbal stimuli.

Stimulus equivalence (or frames of coordination, as relational frame theorists prefer) has been one of the most studied examples of relational responding (i.e., Fields, Newman, Adams & Verhave, 1992; Hayes, Kohlenberg, & Hayes, 1991; Sidman, 1971; Sidman, 1986; Sidman, Cresson, & Willson-Morris, 1974; Sidman & Tailby, 1982; Steel & Hayes, 1991) and may prove useful in understanding first and second language learning. While learning any

language entails the establishment of all types of relational responding, learning a second language involves the establishment of relations between the verbal stimuli of the first language and those of the second language. For instance, equivalence among verbal stimuli of one language and those of another are what is commonly known as translation.

Given the above model for understanding language, the bilingual speaker is thought to have two repertoires available, and whichever one occurs on any given occasion depends on the prevailing context. For example, Figure 1 describes a situation in which a person who has learned two languages from two verbal communities learns given a ball, selects the written word “BALL” and the visual/verbal stimulus “ball” under one contextual stimulus (in this case, English speakers), and selects the written word “TOOP” and the visual/verbal stimulus “toop” under another contextual stimulus (in this case, Farsi speakers). In most cases, contextual variables are provided by ongoing verbal behavior as well as the presence of particular speakers, among other relevant variables.

Language Acquisition

A first language is acquired gradually over a long period of time. Improvements and modi-

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guage training. However, Ho (1986) acknowledges the direct role which the first language plays in the initial stages of second language acquisition. Therefore, this perspective takes into account the participation of the individual's history of the first language in the acquisition of the second language and thereafter (such as thinking in first language while speaking in second language). That is to say, the first and second languages are interrelated and the history of the first language is a participatory factor in the acquisition of the second language and its maintenance.

Given the long history of first language and its interrelation with second language, the bilingual repertoire may be such that the first language occurs under conditions of ambiguous contextual control. This phenomenon may be called "dominance" of the first language over the second language. Experimentally speaking, such dominance may be determined by eliminating the contextual cues and observing equivalence patterns with regard to common elements.

Kohlenberg, Hayes, and Hayes (1991) showed that an element of a class of arbitrarily related stimuli could acquire contextual control over equivalence relations, and that control would transfer without direct training, to other members of the class. In one experiment, they demonstrated the establishment of conditional equivalence classes under the control of contextual stimuli (three male and three female names) and when these equivalence classes were tested using new names not used in training (another set of three male and three female), contextual control remained intact (common element being gender-identified names). Another type of procedure consisted of testing for what is called second-order conditional control. More specifically, emergence of conditional discriminations among novel stimuli (or stimuli with no training history) without the contextual cue(s) may suggest that the contextual cue(s) have not entered into compounds with the visual stimuli, but instead have exerted second-order contextual control over the emergent equivalence relations (see Bush, Sidman, & de Rose, 1989; Steel & Hayes, 1991). Bush et al. (1989) stated that apparent second-order conditional stimuli (high and low tones) may have entered into a compound with the sample and thereby exerted control over conditional discriminations. In the study of

second language, the demonstration of contextual control in relational responding has implications for the selection by the speaker of one language form over another.

In addition to testing for the second-order conditional discrimination, the purpose of this study was to test for the "domination" of the "first language" over the "second language." Accordingly, the elimination of contextual cues (i.e., background color) was used to determine whether or not conditional discriminations learned as part of the "first language" repertoire would be reproduced more often than the "second language" conditional discriminations, where the two classes contained a common element.

Bilingual Repertoire & Interference

In reviewing the literature on second language training in children, McLaughlin (1977, 1984) makes a conclusive statement that "interference" from the first language is an inevitable participant in bilingualism. It is assumed by many authors in the second language acquisition literature that interference that usually results in a higher degree of difficulty is greatest when the languages involved are distinct in structure and system. For instance, Weinreich (1953) argues that: "The greater the difference between the systems, i.e., the more numerous the mutually exclusive forms and patterns in each, the greater is the learning problem and the potential area of interference" (pp. 1-2). Similarly, Lado (1957) states: "Those elements that are similar to his native language will be simple for him, and those elements that are different will be difficult" (p. 2).

The interrelation between first and second language may be demonstrated by interference on the second language by the first language. This interference may be detected in the failure of second language speakers to achieve native speaker competence. More specifically, it is assumed by researchers in the area of second language training that regardless of the amount of history with the second language, thinking in first language, inadvertent switching to the first language, occasional faltering, and long pausing may be observed under stressful, distractive, and fatigue inducing conditions (Ho, 1986). This interference has not been a subject of any empirical studies, however. The reappearance of old behavior patterns under

stressful conditions has been reported in the operant literature, however, suggesting that methods developed in this context may be useful in addressing first language interference empirically. The phenomenon of interest in the operant area is resurgence (Mechner, Hyten, Field, & Madden, 1996).

In resurgence literature, previously acquired behavior has been shown to occur as conditions of extinction with respect to ongoing responding (i.e., Epstein, 1985; Pettenger, Pavlik, Flora, & Kontos, 1988). As such, resurgence is a condition in which historically effective responses occur as a result of more recently acquired responses becoming ineffective in producing reinforcement. Mechner et al. (1996) trained participants to produce sequences of key board presses under the control of different stimuli on a computer screen. Changes in patterns of responding were subsequently tested during extinction. Instances of old responses (i.e., first-learned sequences) increased during this condition across participants.

Other potentially resurgence-inducing variables are fatigue, abrupt decreases in the density or magnitude of reinforcement, punishment, certain pharmacological variables, and disruptive operations that might be surprising to the participant (Mechner et al., 1996). If these assumptions are correct, these variables may produce resurgence of previously reinforced responses as well as reflect the number of times these various patterns have occurred previously, the recency of their previous occurrence, the amount of reinforcement they had received, the schedules under which they had been reinforced, and the procedures by which they had been shaped (Mechner et al., 1996).

All of the published work on resurgence has shown its occurrence with respect to behavior shaped by direct exposure to experimentally manipulated or naturally occurring contingencies. Wilson and Hayes (1996) however, demonstrated resurgence of responses acquired by indirect means. Participants in this study first acquired a set of conditional discriminations. A second set of conditional discriminations consisting of a reorganized set of stimuli from the previous set was then trained. In a subsequent test for derived relations under conditions of extinction, most of the participants continued to produce the most recently reinforced conditional discriminations; that is to say, no resurgence was observed. However,

punishment of the most recently acquired conditional discriminations did produce resurgence of the earlier conditional discriminations. The importance of this research for the study of first language interference is owing to the fact that language is conceptualized by many in the operant tradition as involving equivalences among stimuli arising in the absence of direct training.

Disruptive Techniques

Few researchers have investigated the maintenance and/or modification of established equivalence relations. Most of the studies in this area (e.g., Pilgrim & Galizio, 1990, 1995; Spradlin, Saunders, & Saunders, 1992; Saunders, Saunders, Kirby, & Spradlin, 1988) have shown that already established equivalence relations are extremely resistant to disruption. These studies utilized disruption methods such as punishment of baseline conditional relations (Pilgrim et al., 1990) and reversal of the conditional selections that previously led to the development of classes (Saunders et al., 1988). Spradlin et al. (1973) demonstrated that changes in baseline discriminations may result in disruptions in both symmetrical and transitive relational responding.

Another variable that produces disruption of conditional discriminations is test inconsistency. Research (i.e., Harrison & Green, 1990) on equivalence indicates that most participants will develop conditional discriminations, and derive symmetric and transitive relations under conditions in which a correct comparison is included in the comparison set even in the absence of reinforcement for such selections (Harrison & Green, 1990; Saunders et al., 1988).

Hayes, Leonard and Hayes (1990) manipulated the consistency of test trials for participants who were directly trained in conditional discriminations allowing for the formation of three 4-member equivalence classes. Following this training, participants were exposed to one of two testing conditions. The first testing condition included testing trials that assessed the emergence of symmetry and equivalence. The second testing condition consisted of symmetry trials, equivalence trials, and trials in which no correct response was possible. Findings showed that testing with inconsistent comparison sets led to fewer formations of derived

Table 1

First Language

Training

Phase 1: A-B relations: A1: B1 B2 B3 A2: B2 B1 B3 A3: B3 B2 B1
(36 trials or 18 trial pairs)

Phase 2: A-C relations: A1: C1 C2 C3 A2: C2 C1 C3 A3: C3 C1 C2
(36 trials or 18 trial pairs)

Phase 3: Mixed A-B, and A-C (216 trials or 108 trial pairs): Each of the above trial pair types was presented eighteen times.

Context: The background color in each of the training trials (Phase 1-3) was yellow.

Testing for Symmetry, Equivalence and Transitivity

Phase 4: B-A, C-A, B-C and C-B relations:
(72 testing trial pairs, each presented 6 times)

Analog: Textual behavior in the "first language"

A-B relations: A1: B1 B2 B3 A2: B2 B1 B3 A3: B3 B2 B1
B-A relations: B1: A1 A2 A3 B2: A2 A1 A3 B3: A3 A1 A2

Analog: Tactual behavior in the "first language"

C-A relations: C1: A1 A2 A3 C2: A2 A1 A3 C3: A3 A1 A2
C-B relations: C1: B1 B2 B3 C2: B2 B1 B3 C3: B3 B1 B2

Analog: Orientation by verbal stimuli to nonverbal stimuli

A-C relations: A1: C1 C2 C3 A2: C2 C1 C3 A3: C3 C1 C2
B-C relations: B1: C1 C2 C3 B2: C2 C1 C3 B3: C3 C1 C2

Context: The background in each of the test trials (Phase 4) was yellow.

symmetrical or equivalence relations in subsequent testing. Inconsistency in this context could be considered as a disruptive variable which may bring about less efficiency in performance.

The purpose of the present study was to model first language dominance over and interference with second language forms and provide an empirical demonstration of what has been called resurgence in the experimental literature. Given the role that relational responding is theorized to play in language development, equivalence relations were trained in different contexts to model first and second language verbal responding. Upon establishing derived relations, it was assumed that the participant was engaging in language type behavior.

Following the establishment of these relations, disruptive techniques were then implemented to measure the emergence and maintenance of these relations under various conditions. A detailed methodology is offered below.

METHOD*Participants and Setting*

Twenty participants began this study. Of the 20 that participated, seven undergraduate students between the ages of 18 and 25 completed the study. All work was completed while seated at a personal computer in an 8 ft x 9 ft room. Participants were recruited via a sign-up sheet

Table 2

Second Language			
Training			
Phase 5: D-E relations:	D1: E1 E2 E3	D2: E2 E1 E3	D3: E3 E1 E2
(36 trials or 18 trial pairs)			
Phase 6: D-C relations:	D1: C1 C2 C3	D2: C2 C1 C3	D3: C3 C1 C2
(36 trials or 18 trial pairs)			
Phase 7: Mixed D-E and D-C relations (36 trials or 18 trial pairs): Each of these trial pair types was presented three times.			
Context: The background in each of the training trials was green.			
Testing for Symmetry, Equivalence and Transitivity			
Phase 8: E-D, C-D, C-E and E-C relations: (72 test trials pairs, each presented six times)			
Analog: Textual behavior in the “second language”			
D-E relations:	D1: E1 E2 E3	D2: E2 E1 E3	D3: E3 E1 E2
E-D relations:	E1: D1 D2 D3	E2: D2 D1 D3	E3: D3 D1 D2
Analog: Tactual behavior in the “second language”			
C-D relations:	C1: D1 D2 D3	C2: D2 D1 D3	C3: D3 D1 D2
C-E relations:	C1: E1 E2 E3	C2: E2 E1 E3	C3: E3 E1 E2
Analog: Orientation by verbal stimuli to nonverbal stimuli			
D-C relations:	D1: C1 C2 C3	D2: C2 C1 C3	D3: C3 C1 C2
E-C relations:	E1: C1 C2 C3	E2: C2 C1 C3	E3: C3 C1 C2
Context: The background color in each of the testing trials (Phase 8) was green.			

located in the psychology department of a state university and were given research credit for participation.

Procedure

Overall, the procedure used during this experiment employed 14 distinct phases. Phases are described in detail below; however, please refer to Figure 2 for an outline of phases and their order.

“First language” match to sample training (Phase 1). During Phase 1, three 3-member stimulus classes were trained. All stimuli were three-letter nonsense syllables taken from Underwood and Schulz (1960) and will be referred to here as A1-A3, B1-B3, and C1-C3. During match-to-sample training, two differ-

ent trial types were employed in alternating fashion, thus yielding trial pairs. Differing trial types were employed to include both types of verbal behavior as described by Michael (1985). First, a selection/topography procedure was used. Participants were shown a three-letter nonsense syllable (sample stimulus) in the upper part of the monitor screen. After pressing the “space bar” key on the key board, an additional three 3-letter nonsense syllables (comparisons) appeared at the bottom section of the computer screen. Out of the three comparisons, one was correct and two were incorrect. Responses were completed by typing one of the comparisons into a text-box located underneath the comparison stimuli on the computer screen and then pressing the “enter” key. A high-pitched tone followed each correct re-

Figure 2. Diagram of the phases employed in this study to model language and test for domination and interference.

sponse and a low-pitched tone followed each incorrect response. Following the completion of each training trial, a subsequent trial was started by pressing the “enter” key on the keyboard.

Each selection/topography-based training-trial (and test-trials described below) was followed by another training trial (referred to from now on as “topography-based”) in which the sample from the previous testing trial appeared

Table 3
Testing for Complex Derived Relations (Phase 9).

This Phase consisted of 72 trials. Each relation (i.e., A1-D1) will be presented three times.

Analogue: Direct translation from the “first language” to the “second language”

Context: Green A-D relations: A1: D1 D2 D3 A2: D2 D1 D3 A3: D3 D2 D1
 Context: Green B-E relations: B1: E1 E2 E3 B2: E2 E1 E3 B3: E3 E2 E1

Analogue: Indirect translation from the “first language” to the “second language”

Context: Green A-E relations: A1: E1 E2 E3 A2: E2 E1 E3 A3: E3 E2 E1
 Context: Green B-D relations: B1: D1 D2 D3 B2: D2 D1 D3 B3: D3 D2 D1

Analogue: Direct translation from the “second language” to the “first language”

Context: Yellow D-A relations: D1: A1 A2 A3 D2: A2 A1 A3 D3: A3 A2 A1
 Context: Yellow E-B relations: E1: B1 B2 B3 E2: B2 B1 B3 E3: B3 B2 B1

Analogue: Indirect translation from the “second language” to the “first language”

Context: Yellow D-B relations: D1: B1 B2 B3 D2: B2 B1 B3 D3: B3 B2 B1
 Context: Yellow E-A relations: E1: A1 A2 A3 E2: A2 A1 A3 E3: A3 A2 A1

on the computer screen. After pressing on the space bar key located on the key board, an empty box appeared adjacent to the sample stimulus box. In order to progress to the next trial, the participant was required to type a response into the text box and then press enter. Correct responses were followed by a high tone and incorrect responses were followed by a low tone.

Stimuli (sample and comparison) were each presented in their own individual boxes. The computer screens in all training and testing trials (Phases 1-3) had a yellow background color. This color served as a contextual cue for the establishment of a distinction between “first language” and “second language.”

In Phase 1, participants were trained to select one of three comparisons (B1, B2, B3) in the presence of one of the three sample (A1, A2, A3) stimuli (A1→B1, A2→B2, A3→B3). This phase consisted of 36 trials presented in random order, resulting in 18 trial pairs as described above. Participants who achieved 90% accuracy or higher during Phase 1 moved onto Phase 2. Participants who did not achieve 90% completed Phase 1 a second time. This was repeated until the participant achieved 90% accuracy or higher. All participants who did not achieve 90% accuracy or higher by the end of the third repetition were informed that the experiment was completed and were thanked for their time. Table 1 summarizes the relations

trained and tested in phases 1 through 4.

“First language” match-to-sample training (Phase 2). Phase 2 was identical to Phase 1 except that the C stimuli were presented as the comparisons (A1→C1, A2→C2, A3→C3). The purpose of this was to train an additional set of stimuli conceptualized as synonymous response forms.

“First language” match-to-sample training (Phase 3). Phase 3 consisted of 216 trials (108 trial pairs) in which Phase 1 and Phase 2 trials were mixed. These mixed trials were presented in a random order. Each of the trial types during this phase occurred 18 times (all of which were presented in a paired combination of selection/topography-based and topography-based trials). As in Phases 1 and 2, the background color was yellow and correct responses were followed by a high-pitched tone while incorrect responses were followed by a low-pitched tone. Phase 3 provided 600% over-learning for each trial type, relative to training in the “second language” relations as described below. The purpose of this phase was to provide additional training in the above-mentioned response forms.

Testing “first language” (Phase 4). In Phase 4, 144 testing trials (72 trial pairs) were presented randomly. Each test trial type was presented four times in paired format. Test trials were presented in a pseudo-random order such that no pair was presented twice successively

Table 4
Training and Testing for the Context-Specific Responding (Phases 10 & 11).

120 training and testing trials (60 trials pairs) which consisted of the following relations, each presented twice. Stimuli K – R represent novel stimuli:

Context: Yellow	A-B relations:	A1: B1 D1 K1	A2: B2 D2 K2	A3: B3 D3 K3
Context: Green	A-D relations:	A1: D1 B1 K1	A2: D2 B2 K2	A3: D3 B3 K3
Context: Yellow	A-C relations:	A1: C1 E1 M1	A2: C2 E2 M2	A3: C3 E3 M3
Context: Green	A-E relations:	A1: E1 C1 M1	A2: E2 C2 M2	A3: E3 C3 M3
Context: Yellow	B-A relations:	B1: A1 D1 N1	B2: A2 D2 N2	B3: A3 D3 N3
Context: Green	B-D relations:	B1: D1 A1 N1	B2: D2 A2 N2	B3: D3 A3 N3
Context: Yellow	B-C relations:	B1: C1 E1 L1	B2: C2 E2 L2	B3: C3 E3 L3
Context: Green	B-E relations:	B1: E1 C1 L1	B2: E2 C2 L2	B3: E3 C3 L3
Context: Yellow	C-A relations:	C1: A1 D1 I1	C2: A2 D2 I2	C3: A3 D3 I3
Context: Green	C-D relations:	C1: D1 A1 I1	C2: D2 A2 I2	C3: D3 A3 I3
Context: Yellow	C-B relations:	C1: B1 E1 J1	C2: B2 E2 J2	C3: B3 E3 J3
Context: Green	C-E relations:	C1: E1 B1 J1	C2: E2 B2 J2	C3: E3 B3 J3
Context: Yellow	D-A relations:	D1: A1 E1 O1	D2: A2 E2 O2	D3: A3 E3 O3
Context: Green	D-E relations:	D1: E1 A1 O1	D2: E2 A2 O2	D3: E3 A3 O3
Context: Yellow	D-B relations:	D1: B1 C1 Q1	D2: B2 C2 Q2	D3: B3 C3 Q3
Context: Green	D-C relations:	D1: C1 B1 Q1	D2: C2 B2 Q2	D3: C3 B3 Q3
Context: Yellow	E-B relations:	E1: B1 C1 P1	E2: B2 C2 P2	E3: B3 C3 P3
Context: Green	E-C relations:	E1: C1 B1 P1	E2: C2 B2 P2	E3: C3 B3 P3
Context: Yellow	E-A relations:	E1: A1 D1 R1	E2: A2 D2 R2	E3: A3 D3 R3
Context: Green	E-D relations:	E1: D1 A1 R1	E2: D2 C2 R2	E3: D3 A3 R3

Context: The background color in each of the testing trials was relation specific. Yellow for the “first language,” and green for the “second language.”

and with no more than one presentation of a given test trial pair. The background color in all trials was yellow, as in Phases 1-3. These test trials assessed the emergence of symmetrical, transitivity, and equivalence relations (12 derived relations were tested: $B \rightarrow A$, $C \rightarrow A$, $B \rightarrow C$, $C \rightarrow B$). No feedback was provided during this phase. Participants who made correct selections on 90% of the trials advanced to Phase 5. Any participant who failed to reach the 90% criterion repeated Phases 3 and 4, which provided additional mixed $A \rightarrow B$ and $A \rightarrow C$ training. These two phases were repeated up to three times in order to provide the par-

ticipants with enough opportunity to achieve the 90% criterion. If any participant did not achieve 90% accuracy by the end of the third repetition, that participant was informed that the experiment was completed. This process provided the basis for three 3-member classes consisting of the sets A1/B1/C1, A2/B2/C2, and A3/B3/C3. From this point forward, Phases 1 through 4 are referred to as “first language training.”

“Second language” match-to-sample training (Phases 5, 6 & 7). The purpose of these phases was to establish a second-language repertoire similar to that established in Phases 1

Table 5
Test for Domination (Phase 12).

120 training and testing trials (60 trial pairs) from both the first language and the second language conditions. In this Phase contextual ambiguity will be established by the elimination of contextual stimuli (yellow and green). Training and testing trials were as follows:

Analog: Textual behavior in the first language			
A-B relations:	A1: B1 B2 B3	A2: B2 B1 B3	A3: B3 B2 B1
B-A relations:	B1: A1 A2 A3	B2: A2 A1 A3	B3: A3 A1 A2
Analog: Tactual behavior in the first language			
C-A relations:	C1: A1 A2 A3	C2: A2 A1 A3	C3: A3 A1 A2
C-B relations:	C1: B1 B2 B3	C2: B2 B1 B3	C3: B3 B1 B2
Analog: Orientation by verbal stimuli to nonverbal stimuli in the first language			
A-C relations:	A1: C1 C2 C3	A2: C2 C1 C3	A3: C3 C1 C2
B-C relations:	B1: C1 C2 C3	B2: C2 C1 C3	B3: C3 C1 C2
Analog: Textual behavior in the second language			
D-E relations:	D1: E1 E2 E3	D2: E2 E1 E3	D3: E3 E1 E2
E-D relations:	E1: D1 D2 D3	E2: D2 D1 D3	E3: D3 D1 D2
Analog: Tactual behavior in the second language			
C-D relations:	C1: D1 D2 D3	C2: D2 D1 D3	C3: D3 D2 D1
C-E relations:	C1: E1 E2 E3	C2: E2 E1 E3	C3: E1 E3 E2
Analog: Orientation by verbal stimuli to nonverbal stimuli in the second language			
D-C relations:	D1: C1 C2 C3	D2: C2 C1 C3	D3: C3 C1 C2
E-C relations:	E1: C1 C2 C3	E2: C2 C1 C3	E3: C3 C1 C2
Analog: Direct translation from the first language to the second language			
A-D relations:	A1: B1 D1 N1	A2: B2 D2 N2	A3: B3 D3 N3
B-E relations:	B1: C1 E1 Q1	B2: C2 E2 Q2	B3: C3 E3 Q3
Analog: Indirect translation from the first language to the second language			
A-E relations:	A1: C1 E1 O1	A2: C2 E2 O2	A3: C3 E3 O3
B-D relations:	B1: A1 D1 S1	B2: A2 D2 S2	B3: A3 D3 S3
Analog: Direct translation from the second language to the first language			
D-A relations:	D1: C1 A1 T1	D2: C2 A2 T2	D3: C3 A3 T3
E-B relations:	E1: C1 B1 P1	E2: C2 B2 P2	E3: C3 B3 P3
Analog: Indirect translation from the second language to the first language			
D-B relations:	D1: C1 B1 R1	D2: C2 B2 R2	D3: C3 B3 R3
E-A relations:	E1: D1 A1 U1	E2: D2 A2 U2	E3: D3 A3 U3

through 3. Training and testing phases for the “second-language” are summarized in Table 2. In Phase 5, participants received training for the following relations in 36 trials: D1→E1, D2→E2, and D3→E3. D and E stimuli (non-sense syllables) were topographically different from A, B, C stimuli.

In Phase 6, the following relations were trained: D1→C1, D2→C2, and D3→C3 in 36 trials. Each of these phases was repeated only three times to provide the participant an opportunity to achieve 90% accuracy. The background color in all training and testing trials during Phases 5 and 6 and 7 was green. The

purpose of the change in background color was to establish contextual control over the “second language.”

Phase 7 consisted of 36 trials (18 trial pairs) in which Phase 5 and Phase 6 trials were mixed. These mixed trials were presented in a random order. Each of the trial types during this phase occurred six times (all of which were presented in paired combinations of selection/topography-based and topography-based trials) during this phase. This phase was repeated only three times to provide the participant an opportunity to achieve 90% accuracy. The training on the “first language” relations involved three times

Table 6
Inconsistency Phase (Phase 13).

600 trials (300 trial pairs) out of which 480 (240 trial pairs) were inconsistent with the previous training and testing trials and 120 (60 trial pairs) were consistent with the previous training and testing trials.

Inconsistent Trials:

A-B	A1: A3 B2 B3	A2: A1 B1 B3	A3: A2 B1 B2
A-C	A1: A3 C2 C3	A2: A1 C1 C3	A3: A2 C1 C2
C-D	C1: C3 D2 D3	C2: C1 D1 D3	C3: C2 D1 D2
C-E	C1: C3 E2 E1	C2: C1 E1 E3	C3: C2 E1 E2
B-A	B1: B3 A2 A3	B2: B1 A1 A3	B3: B2 A1 A2
C-A	C1: C3 A2 A3	C2: C1 A1 A3	C3: C2 A1 A2
B-C	B1: B3 C2 C3	B2: B1 C1 C3	B3: B2 C1 C2
C-B	C1: C3 B2 B3	C2: C1 B1 B3	C3: C2 B1 B2
D-C	D1: D3 C2 C3	D2: D1 C1 C3	D3: D2 C1 C2
E-C	E1: E3 C2 C3	E2: E1 C1 C3	E3: E2 C1 C2
D-E	D1: D3 E2 E3	D2: D1 E1 E3	D3: D2 E1 E2
E-D	E1: E3 D2 D3	E2: E1 D1 D3	E3: E2 D1 D2
A-D	A1: A3 D2 D3	A2: A1 D1 D3	A3: A2 D1 D2
D-A	D1: D3 A2 A3	D2: D1 A1 A3	D3: D2 A1 A2
A-E	A1: A3 E2 E3	A2: A1 E1 E3	A3: A2 E1 E2
E-A	E1: E3 A2 A3	E2: E1 A1 A3	E3: E2 A1 A2
E-B	E1: E3 B2 B3	E2: E1 B1 B3	E3: E2 B1 B2
B-E	B1: B3 E2 E3	B2: B1 E1 E3	B3: B2 E1 E2
D-B	D1: D3 B2 B3	D2: D1 B1 B3	D3: D2 B1 B2
B-D	B1: B3 D2 D3	B2: B1 D1 D3	B3: B2 D1 D2

Contextual stimulus (i.e., background color) was randomized in the inconsistent trials and was repertoire specific in the consistent trials.

more training than the “second language” relations. When compared to the “first language” training, the shorter history of training for the “second language” was intended to model this history in bilingual speakers.

Second language” testing (Phase 8). In this phase, 144 test trials (72 trial pairs) were presented randomly. Each test trial type was presented 4 times in paired format (each consisting of one selection/topography-based trial and one topography-based trial). Test trials were presented in a random order. The background color in all trials was green (identical to Phases 5-7). These testing trials were designed to assess the emergence of symmetrical, transitivity, and equivalence relations (12 derived relations were tested: $C \rightarrow D$, $E \rightarrow D$, $C \rightarrow E$, $E \rightarrow C$). No feedback was provided to the participants during the testing trials. If the participant made correct selections on 90% of the trials, he or

she advanced to Phase 9. If the participant failed to reach the 90% criterion, he or she returned to Phase 7, which provided additional mixed $D \rightarrow C$ and $D \rightarrow E$ training. The participant had three opportunities to achieve 90% accuracy. Upon not achieving 90% accuracy at the end of the third repetition, the participant was informed that the experiment was completed and was thanked for his or her time. This process established three 3-member classes ($D1/C1/E1$, $D2/C2/E2$, and $D3/C3/E3$). From this point forward, Phase 5 through 8 will be referred to as “second language training.”

Testing for complex derived relations (Phase 9). In Phase 9, 144 test trials (72 trial pairs) were presented randomly with no more than one presentation of a given testing trial pair. Each test trial type was presented 4 times in paired format (each consisting of one selection/topography-based trial and one topogra-

phy-based trial). The background color was yellow in trials where the correct response was of the “first language” type and was green in trials where the correct response was of the “second language” type. Participants were provided with no feedback during this phase.

The testing trials in this phase assessed the emergence of symmetrical, and more complex transitivity and equivalence relations across different nodal distances (42 derived relations were tested: $A \rightarrow D$, $A \rightarrow E$, $B \rightarrow D$, $B \rightarrow E$, $C \rightarrow A$, $C \rightarrow B$, $C \rightarrow D$, $C \rightarrow E$, $D \rightarrow A$, $D \rightarrow B$, $E \rightarrow A$, $E \rightarrow B$, $E \rightarrow C$, $E \rightarrow D$). This procedure provided the basis for three 5-member classes consisting of the sets D1/C1/E1/A1/B1, D2/C2/E2/A2/B2, and D3/C3/E3/A3/B3. This process may have prevented the recency effect of the “second language” training in subsequent phases. If the participant made correct selections on 90% of the trials, he or she advanced to Phase 10. If the participant failed to reach the 90% criterion, he or she repeated Phase 9. To achieve the 90% criterion, the participant had three opportunities to repeat Phase 9. When not achieving 90% accuracy by the end of the third repetition, the participant was presented with a computer screen that informed the participant that the experiment was completed and thanked him or her for participating in the experiment. Table 3 summarizes Phase 9, including the types of trials presented and the analog to first and second language relations that each represents.

Test for context-specific responding phase (Phase 10). Table 4 provides a summary of Phase 10. In this phase, each sample had an acquired history with two of the three comparisons presented in the array on any given trial. One comparison was of the “first language” set and the other was of the “second language” set. The third comparison in each set was a novel stimulus.

The context-specific type of responding was established by presenting pairs of identical trials except for the contextual stimulus. In one trial pair, the green contextual stimulus was present, in the other trial pair, the yellow contextual stimulus was present. Contextual stimuli alternated randomly within trials. The correct response in the presence of the yellow screen was of the “first language” type and the correct response in the presence of the green screen was of the “second language” type. Each test trial type was presented four times in blocks

of two paired presentations (each consisting of one selection/topography-based trial and one topography-based trial) such that there were 120 trials (60 trial pairs). Test trials were presented in a random order with no more than one successive presentation of a given test trial pair. Participants were provided with no feedback during this condition. If the participant made context-specific selections on 90% of the trials, he or she advanced to Phase 11. If the participant failed to reach the 90% criterion, he or she repeated Phase 10. To achieve the 90% criterion, the participant had three opportunities to repeat Phase 10. Upon not achieving 90% accuracy by the end of the third repetition, the participant was presented with a computer screen which informed him or her that the experiment was completed and thanked the participant for being in the experiment.

Test for context-specific responding (Phase 11). This phase was identical to Phase 10 except that each trial (representing a given relation) was presented only once and was not alternated with a matched trial. In other words, where in Phase 10 the presentation of the A1 sample in the yellow context would be immediately followed by the presentation of A1 in the green context, in Phase 11 these were completely randomized. As in Phase 10, movement to the next phase of the experiment was contingent on 90% response accuracy. Failure to meet the 90% criterion resulted in the repetition of Phase 11. Failure to meet the 90% criterion following the third repetition resulted in the termination of the experiment.

Test for dominance of “first language” over “second language” (Phase 12). Table 5 provides a summary of Phase 12. In this phase, all of the trained and tested relations in the “first language” and the “second language” which involved common elements across both languages were presented under ambiguous contextual stimuli. This ambiguity was established by the elimination of the contextual stimuli (white instead of yellow or green background color). This manipulation tested for the context-specific responding.

Phase 12 consisted of 60 training and testing trial pairs from both the “first language” and the “second language” relations (120 total trials). There was one presentation of each trial type pair. The context-specific responding and the domination of the “first language” over the “second language” were tested in this phase.

Participants received no feedback during this phase.

Inconsistency phase (Phase 13). Trial types presented during Phase 13 are presented in Table 6. In Phase 13, participants were exposed to 600 trials (300 trial pairs). During this phase, 480 (240 trial pairs) were inconsistent with the previous training and testing trials and 120 (60 trial pairs) were consistent with the previous training and testing trials. The trial configurations were such that on 80% of the trials, no comparison was correct with respect to the training history. The inconsistency was achieved by manipulations of both the contextual stimuli and the comparison sets for given samples. With regard to contextual stimuli, background colors were randomized in the inconsistent trials and were repertoire specific in the consistent trials. No feedback regarding accuracy or inaccuracy of responding was provided during this condition.

Test for interference (Phase 14). Phase 13 was followed by the "test for interference" phase (Phase 14) that consisted of 180 topography-based testing trials. This phase examined the resurgence of "first language" over "second language" relations. In this block of trials, samples A, B, C, and D, each appeared 36 times on the computer screen in random order. The percentages of responses reflecting the first and second language relations were recorded. Further, the background color was eliminated in this phase. Participants received no feedback during this phase.

Dependent Measures

The following were the dependent measures utilized in this study:

Percent correct. Percent correct was calculated as the number of correct responses in each phase divided by total number of responses multiplied by 100. Higher percentages of correct responses suggest a higher level of mastery.

Latency to response. Latency to response was calculated as the time required to complete one trial sequence from observing the response on the sample (pressing the "space bar") to pressing the enter key in order to move to the next trial (average within and across phases).

Percent of the "first language" and the "second language" related responses during the test for dominance of the "first language" over the "second language." More selections of the

"first language" related responses during trials in which responses appropriate to both "languages" may suggest the dominance of the "first language" over the "the second language."

Percent of the "first language" and the "second language" related responses during the "test for interference" phase. More selections of the "first language" related responses may suggest interference of the "first language" over the "second language."

RESULTS

This study sought to answer several research questions. The first question was whether or not "first language" and "second language" repertoires could be established and brought under contextual control. Second, we investigated the likelihood of dominance of a "first language" over a "second language" during contextually ambiguous conditions. Finally, in order to test for interference we examined the resurgence of earlier patterns of relational responding following inconsistent testing conditions. Answers to these questions are discussed with respect to the dependent measures listed below.

Percent of Correct Responses during Testing for the "First Language" Phase and Testing for the "Second Language" Phase (Phases 4 & 8)

Percent correct responding during selection based and topography based responding conditions with respect to "first" and "second language" is shown in the two left-most columns of Figures 3 and 4 respectively. Four participants (Participants 1, 3, 5, and 6) repeated either one or both training sets in the "first language" prior to achieving the 90% criterion required for completion of testing. Participant 6 could be considered a special case in that in addition to the first two training phases, he repeated the Testing Phase and the Mix Training Phase (Phases 3 & 4) twice before reaching the 90% criterion required during the "first language" test. Five participants (1, 3, 4, 5, and 6) repeated either one or both training sets in the "second language" prior to reaching the 90% criterion for the "second language" test. Overall, these results demonstrated the successful training of both language repertoires.

Figure 3. Percent correct selection based responding as measured by the emergence of equivalence relations during test conditions (Phases 4 & 8).

Figure 4. Percent correct topography-based responding as measured by the emergence of equivalence relations during test conditions (Phases 4 & 8).

Percent Correct Responses during the Complex Derived Relations Phase (Phase 9)

Percent correct responding during complex derived relational responding conditions are shown in the third columns of Figures 3 and 4 respectively. This phase was designed to establish complex derived relations of the equivalence type (i.e., across two nodes) across the developed repertoires of “first language” and “second language.” As such, this demonstrated a combination of first and second-language stimuli into a broad equivalence class. All participants except Participants 1 and 3 achieved the 90% criterion required for completion of the Complex Derived Relations Phase in the first exposure. Participants 1 and 7 repeated this phase three times before reaching the 90% criterion for responding. Overall, the results indicated the establishment of complex relational responding across two repertoires.

Percent Correct Responses during the Indirect Training for Context-Specific Responding Phase and Testing for Context-Specific Responding Phase (Phases 10 & 11)

The fourth columns of Figures 3 and 4 show participant performance with respect to selection-based (see Figure 3) and topography-based (see Figure 4) responding in the Context Specific Responding Phase. Four participants (Participants 1, 2, 6, and 7) repeated the Indirect Training for Context Specific Responding Phase twice prior to achieving the 90% criterion for completion. In addition, all participants except Participant 6 participated in the Testing for Context-Specific Responding Phase only once before reaching the 90% criterion for completion. Participant 6 repeated this phase three times prior to achieving the 90% criterion. Overall, these results showed the establishment of context-specific responding with respect to two repertoires, “first language” and “second language.”

Figure 5 compares the percentage of correct responses constituting the “first language” with correct responses constituting the “second language” during the test for domination. Participants 1, 2, 3, 5, and 6 showed a higher percentage of “first language” responding than “second language” responding. This distinction was more apparent for Participants 2, 3, and 5 than for Participants 1 and 6. Participant

7 showed a higher percentage of “second language” responses. Participant 4 selected the novel comparison on almost every trial thereby showing neither “first language” nor “second language” dominance.

Only Participants 2 and 7 completed the experiment in one session. For the rest of the participants, the second experimental session provided additional training in the “first language” and the “second language.” These differences in training histories did not appear to affect participants’ performances in a consistent way. In general, the results suggest the dominance of the “first language” over the “second language.” However, this effect was not observed for all participants.

Response Allocation during the Test for Dominance Phase (Phase 12)

Figure 6 shows the percentage of directly trained, symmetrical and equivalence (1 node and 2 nodes) types of responses measured across selection-based and topography-based responding. These data demonstrated that for the majority of the participants (Participants 1, 2, 5, 6, and 7 in “first language” and Participants 1, 2, 3, 5, 6, and 7 in “second language”), responding of the directly trained was more probable than symmetrical or equivalence responding in either language. With regard to the equivalence type of responding, the 1 node type was much more probable than the 2 nodes types. This pattern of responding was similar across the “first language” and the “second language” repertoires. Few differences were observed between the selection-based and topography-based type of responding. Only one participant (4) selected the novel comparison on each trial during this test, thereby showing no directly trained, symmetrical or equivalence relations of either the first or second language type.

Patterns of Responding in the Inconsistency Phase (Phase 13)

In order to examine the effect of a participant’s exposure to the inconsistent trials on responding during the consistent trials in the Inconsistency Phase, each participant’s percent correct selection-based responses (see column 5, Figure 3) and topography-based re-

Figure 5. Percent of responses allocated to stimuli presented during a particular training condition when no contextual cues were presented.

Figure 6. Percent of responding during test conditions as measured by directly trained, symmetrical, and derived responding during the Test for Domination phase.

sponses (see column 5, Figure 4) were compared to those in the previous Test for Context-Specific Responding Phase (see column 4, Figures 3 & 4). The effect of the inconsistent trials procedure was to disrupt equivalence relations of both the 1 node and 2 node types. The results show an abrupt decrease in the percent of the equivalence type of responding for

a majority of participants. It is not known if 1 node or 2 nodes equivalence relations were affected in the same way. One node equivalence relations were assessed in 30% of the equivalence trials, while 2 nodes equivalence relations were assessed in 40% of trials. Symmetrical responding was not affected for either type of responding.

Figure 7. Type of responses following the disruptive condition. “Earliest” refers to first language type responding, “earlier” refers to second language type responding, and “later” refers to complex derived relations.

Percent “First Language” Type and “Second Language” Type Responding during the Test for Interference Phase (Phase 14)

We examined the degree to which resurgence of earlier patterns of relational responding, established as the “first language” and “second language” would occur under extinction and in the absence of contextual stimuli (see Figure 7). More specifically, the percentage of correct responses in the “first language,” referred to as the *earliest* type of responses, was compared to percentage of correct responses in the “second language,” referred to as the *earlier* type of responses, and complex derived relations, referred to as the *later* type of responses. In addition, these percentages were analyzed across different types of responses (i.e., directly trained, symmetrical, 1 node equivalence, and 2 nodes equivalence.)

The relation between the history of acquisition and resurgence of earlier patterns of responding was analyzed in terms of the degree to which the first set of trained relations (earliest or “first language” responses), the second set of trained relations (earlier or “second language” responses), and the third set of com-

plex derived relations (later or complex derived responses) would occur under extinction and in the absence of contextual stimuli. As is demonstrated in Figure 7, resurgence to earlier patterns of responding which were trained as the “first language” (earliest) and the “second language” (earlier) prior to the establishment of complex derived relations (later) occurred for all the participants. This resurgence, however, was dominated by the earliest (“first language”) type of responses (Participants 1, 2, 3, 5).

In addition, the resurgence data were further analyzed for node C, which was the shared node and thus represented the shared stimulus (i.e., the common referent) between the two established repertoires. More specifically, compared to other nodes, node C was comprised of the most balanced relations across both established repertoires. As is demonstrated in Figure 8, all participants except Participant 2 showed a higher percentage of the “first language” over the “second language” responses. Further, the percentage of correct responses comprising the “first language” was compared to that comprising the “second language.” As is demonstrated in Figure 9, a majority of the participants were engaged in more symmetri-

Figure 8. Percent responding in the absence of other contextual cues during the presence of "C" stimuli, conceptualized here as a non-verbal stimulus.

cal types of responses than 1 node equivalence responses in both languages.

Figure 9 also shows that with regard to the symmetrical responses, there were more occurrences of the "first language" type of responses than the "second language" type (Participants 1, 2, 3, 4, 5, and 6). In the case of the 1 node equivalence type of responses, there were more occurrences of the "second language" type of responses than the "first language" type (Participants 2, 4, 5, 6, and 7).

Average Response Duration

Average response duration was measured across four response types, directly trained, symmetrical, and equivalence (1 node and 2 nodes), in the Test for Context-Specific Responding Phase and the Test for Interference Phase. As is demonstrated in Figure 10, the average response duration for 2 nodes equivalence responses was the highest average of the four types of responses, 1 node equivalence was the second highest, symmetrical was the third highest and the directly trained type had the lowest average.

A different pattern was observed during the Test for Interference Phase. As is demonstrated in Figure 10, the highest average response duration was for 2 nodes equivalence type of responses. The second highest response duration

was for the directly trained type of responses and the third highest response duration was for the symmetrical type of responses. The lowest average response duration was for 1 node equivalence type of responses.

DISCUSSION

This study was designed to model first language dominance and interference on second language performance. Two sets of equivalence relations showing a common element (i.e., the referent) were established under different contextual conditions. One set (i.e., "first language") was over trained relative to the other (i.e., "second language"). Dominance of the first language, as demonstrated in relations involving the common element, was investigated by examining performances in the absence of contextual stimuli.

Interference by one language with the other was modeled by examining the degree to which resurgence of relations constituting both language repertoires with respect to the common element would arise in extinction, following a period of exposure to inconsistent test trials. In addition, both selection-based (i.e., copy text) and topography-based equivalence (i.e., intraverbal responding) were examined in these areas. Each of these issues will be discussed separately.

Figure 9. Percent of symmetrical type and equivalence type responding during test conditions following the disruptive phase.

Establishment of the "First Language" Repertoire and "Second Language" Repertoire

The establishment of a bilingual repertoire was measured and examined in terms of participants' percent correct responding during the following phases: Testing for the "First Language," Testing for the "Second Language," Complex Derived Relations Test Phase, and Testing for Context-Specific Responding Phase. The main goal was to establish context-specific responding reflecting two types of repertoires, the "first language" and the "second language."

The above-mentioned process was successfully completed by the participants in this study. In addition, the development of the contextual control over these repertoires provided an analog for audience control in the analysis of speaking behavior.

The analog of a bilingual repertoire may become more obvious if the various stimuli sets are described in terms common to language events. For this purpose, these sets may be characterized as follows: Set A was representative of visual/verbal stimuli in the "first language," B was representative of written stimuli in the "first language," C was representative of non-verbal stimuli, D was representative of visual/

verbal stimuli in the "second language" and E was representative of written stimuli in the "second language" (see Figure 1). Accordingly, textual behavior in the "first language" is represented by $A \rightarrow B$ and $B \rightarrow A$ responding while textual behavior in the "second language" would be represented by $D \rightarrow E$ and $E \rightarrow D$ responding. Additionally, orientation by verbal stimuli to nonverbal stimuli in the "first language" was modeled by $A \rightarrow C$, $B \rightarrow C$ relations, while similar behavior in the "second language" was modeled by $D \rightarrow C$ and $E \rightarrow C$ relations.

With respect to tactual behavior, this process was modeled in the "first language" by $C \rightarrow A$ relations and $C \rightarrow B$ relations, and in the "second language" by $C \rightarrow E$ and $C \rightarrow D$ relations. Finally, translation was modeled through $A \rightarrow D$, $B \rightarrow E$, $B \rightarrow D$, $A \rightarrow E$, $D \rightarrow A$, $E \rightarrow B$, $E \rightarrow A$, and $D \rightarrow B$ relations.

In summary, the results demonstrated the establishment of a bilingual repertoire which consists of different stages of acquisition, starting with tact of the non-verbal stimuli and ending with translation from one language to another. All the stages of acquisition were designed to model the stages of language acquisition in the "first language" and the "second language" by way of exposure to visual, ver-

Figure 10. Time in seconds from the appearance of a stimulus to completion of a response during the “test for interference” phase.

bal, and non-verbal stimuli. It is possible that had some of these stimuli been of the auditory sort, different patterns of responding would be observed. In that regard, the primary difference would be associated with the fleeting characteristics of the auditory stimuli which might be overcome by addition of training trials. Furthermore, there is no reason in principle why formal characteristics of stimuli (e.g., visual vs. auditory) should undermine their participation in the development of trained and derived relations.

Dominance

The phenomenon of dominance was measured and examined in terms of the percentage of “first language” and “second language” responses occurring under ambiguous contextual control (i.e., no background color). The results showed that the percentage of the “first language” responses was higher than the percentage of “second language” responses. This difference was not shown in a consistent manner, however. Accordingly, a dominance of “first language” over “second language” may be suggested, but not in a decisive manner. The participation of more participants might have resulted in findings that are more concrete.

In general, the data indicated a disruption in the patterns of responding as a result of an exposure to an ambiguous context (i.e., no background color). Further, the data demonstrated that in the absence of contextual stimuli, participants selected comparison stimuli that were separated from the sample stimuli by fewer nodes. In summary, the results of this study demonstrated the establishment of a model for “first language” dominance over “second language” performance. Here, the absence of contextual stimuli provided an analog for the ambiguous audience variables such as speaking in the presence of a new and unfamiliar audience with whom the bilingual speaker has no prior history.

Establishment of a Disruptive Condition

A disruptive condition was established by a random presentation of a set of inconsistent and consistent trials. This disruption was measured as changes in the patterns of responding during the consistent trials in this condition. The results showed an abrupt decrease in the percent of the equivalence type of responding for a majority of participants.

As mentioned earlier, previously acquired behavior has been shown to recur as conditions

of extinction and/or disruption with respect to ongoing responding are implemented (Mechner *et al.*, 1996; Epstein, 1985; Pettenger *et al.*, 1988). In this study, the inconsistent trials under extinction are held to constitute a disruptive condition as evidenced by poorer equivalence responding. Furthermore, this disruption is considered analogous to ambiguous audience control whereby earlier repertoire (*i.e.*, first language) would be expected to emerge and dominate over more recently acquired repertoire (*i.e.*, second language).

Interference by One Language over Another

The phenomenon of interference was modeled by examining the degree to which resurgence of an earlier type of relational responding would occur following the above disruptive condition. The results indicated the occurrences of earlier patterns of responding, with the dominance of the "first language" type over the "second language" type. In addition, the older the type of response pattern ("first language"), the more probable and apparent became the resurgence of the simpler relations of that pattern. These findings support the literature (Bentall, Dickins, & Fox, 1993; Fields *et al.*, 1992; Fields, Adams, Verhave, & Newman, 1990; Kennedy, 1991; Saunders, Wachter, & Spradlin, 1988; Steel & Hayes, 1991; Wulfert & Hayes, 1988) by indicating that the stronger relations were of the type constituting fewer or no nodes.

In summary, the above findings demonstrated the establishment of an analog model for the interference of one language over the other. This interference was demonstrated under disruptive conditions and it was analogous to what researchers in the area of second language training refer to as occasional faltering and inadvertent switching from one language to another by a bilingual speaker in disruptive, stressful, or fatigue inducing situations (Ho, 1986).

Response Duration

As mentioned earlier, average response duration was measured across four types of responses (directly trained, symmetrical, 1 node equivalence and 2 nodes equivalence) in the Test for Context-Specific Responding and Test for Interference Phases. The results showed that

as the responses became more complex (2 nodes equivalence and 1 node equivalence), response duration became longer in the Test for Context-Specific Responding Phase. These findings support the results from Steel and Hayes (1991) and Wulfert and Hayes (1988), which indicate that as the degree of complexity (number of nodes) in relations among the stimuli involved in each testing situation increases, reaction times increase.

The data in the above phases could be described in terms common to language acquisition. Accordingly, they demonstrate the establishment of an analog for what could be referred to as longer pausing on the part of the bilingual speaker when participating in more complex interactions such as translation from one language to another or tact in the "second language" than when writing in either language.

The results in the Test for Interference Phase were not consistent with the results in the Test for Context-Specific Responding Phase. More specifically, the average response duration was higher for the most complex relations (2 nodes equivalence) than the other three types of relations. However, with regard to the other types of relations, the simpler the responses were, the longer the average response duration became. In terms of the history of response training, these results demonstrate that the older the types of response, the longer the average response duration became.

In general, data taken from the Test for Interference Phase showed the establishment of an analog for faltering and long pausing by a bilingual speaker when switching from one language to another. This pause was more apparent in the case of translation from one language to another. Within the language specific types of interactions, the pausing seems to have occurred with respect to the older types of responses.

In conclusion, this study demonstrated the establishment of an analog for first and second language acquisition, audience control over these repertoires, first language dominance over second language, and interference of the earlier established repertoire over the subsequent one. Though these findings do lend experimental support to more descriptive accounts of phenomena encountered in first and second-language interactions, it is important to note that they are by no mean inclusive of all

historical and contextual conditions that may influence linguistic behavior at any given moment. If anything, these findings are preliminary and highlight the need for further research that might further isolate these variables in order to offer a more precise description of the variables impacting first and second language interactions.

In short, the established analog, while not reflecting all of the variables involved in the actual events of language acquisition and use in complex cultural circumstances, may nonetheless serve to isolate some of the factors participating in such circumstances. These factors may then be examined in actual language circumstances for the purpose of understanding the conditions under which multiple language repertoires may become disrupted or otherwise ineffective.

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