STIMULUS RELATIONS ANALYSIS AND THE EMERGENCE OF NOVEL INTRAVERBALS

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In three experiments designed to analyze the emergence of untaught operants with a spoken response in normally developing 5- to 6-year-old children, verbal operants with the names of countries, cities, and parks were used as stimuli or responses—intraverbals. Children learned Country-City intraverbals and City-Park intraverbals. The authors then probed the emergence of novel intraverbals without reinforcement, which resulted from combining the stimuli and responses of the taught intraverbals. Experiment 1 demonstrated that the novel intraverbals might emerge without reinforcement. Experiment 2 showed that learning more basic operants facilitates the emergence of the novel intraverbals. Experiment 3 provided a within-participant replication and demonstrated that relations with novel stimuli of the same type emerge at a quicker pace as children learn novel sets. These results showed basic processes involved in complex verbal behavior, such as reasoning.

Researchers in two areas of behavior analysis have studied the appearance of complex verbal behavior: One area consists of research in stimulus equivalence and stimulus relations, and the other encompasses the study of independence and transfer among verbal operants according to Skinner's (1957) analysis of verbal behavior. Studies of stimulus equivalence and stimulus relations have shown that when typically developing human beings are taught a few stimulus-stimulus relations, other nontaught stimulus-stimulus relations typically emerge. The basic procedure of stimulus

equivalence and stimulus relations consists of teaching a few conditional discriminations and exploring the emergence of untaught conditional discriminations. Given certain teaching conditions, people demonstrate predicted responding in novel conditional discriminations without the explicit teaching or reinforcement of the responses. For example, after learning to relate stimulus A to stimulus B and stimulus B to stimulus C in conditional discriminations, a person typically relates A to A, B to B, C to C, B to A, C to B, A to C, and C to A. Responding to the probed conditional discriminations is a type of transfer from the taught conditional discriminations. In other words, the probed conditional discriminations emerge or participants show the emergence of novel relations. The stimulus equivalence outcome has been broadly documented (e.g., see Pérez-González & Moreno-Sierra, 1999, for a demonstration of the simple procedure; see Sidman, 1994, for a complete review; see Sidman, 2000, for a recent conceptualization; see Stromer, Mackay, & Remington, 1996, for the relations between stimulus equivalence and basic verbal behavior). The area of stimulus equivalence has expanded in the past decade. Many researchers have theorized and demonstrated cases of the emergence of novel relations that show stimulus relations different from equivalence relations (e.g., Dymond & Barnes, 1995; Hayes, 1991, 1994; Hayes, Barnes-Holmes, & Roche, 2001; Hayes & Hayes, 1989; Pérez-González, 1994, 2001; Pérez-González & Martínez, 2007; Pérez-González & Serna, 2003; Steel & Hayes, 1991). For that reason, it seems better to refer to the area that encompasses all of this research as that of stimulus relations.

Researchers who have used Skinner's (1957) analysis of verbal behavior to study complex verbal behavior have typically dealt with factors involved in teaching mands, tacts, intraverbals, and other verbal operants. Many of the studies of verbal behavior were designed to demonstrate the functional independence of verbal operants (e.g., Lamarre & Holland, 1985). For the most part, these studies did demonstrate such independence. Operants, however, are not always independent. Even studies that initially demonstrated functional independence sometimes showed that after the teaching and probing of several exemplars, the teaching of one operant affected the performance of untaught operants. For example, Lamarre and Holland taught 4-year-old children to mand or to tact placement of objects with the phrases "on the left" and "on the right." They initially observed that the children did not tact the objects they learned to mand and they did not mand the objects they learned to tact. This performance demonstrated functional independence. Lamarre and Holland demonstrated, however, that after some additional experience the children tacted the placement of objects they learned to mand, and vice versa. Thus their study showed a case of transfer from one verbal operant to another (or emergence of one verbal operant after learning another). Following Lamarre and Holland's study, others demonstrated instances of transfer from one operant to another one as well (e.g., Chase, Johnson, & Sulzer-Azaroff,

1985; Lipkens, Hayes, & Hayes, 1993; Luciano, 1986; Partington & Bailey, 1993; Pérez-González, García-Asenjo, Williams, & Carnerero, 2007; Polson & Parsons, 2000; Sundberg & Sundberg, 1990; Twyman, 1996; Watkins, Pack-Teixteira, & Howard, 1989). For example, Polson and Parsons taught college students to type English words in the presence of their corresponding French words (a skill of a paired-associates-type procedure that is an intraverbal) and probed whether the students typed the French words in the presence of the corresponding English words. They showed the emergence of one intraverbal after learning another. Also, Pérez-González, García-Asenjo, et al. observed emergence of intraverbals of the type "Name the opposite of cold" after teaching children with pervasive developmental delay the intraverbal with the terms in opposite stimulus-response functions ("Name the opposite of hot").

The areas of stimulus equivalence and stimulus relations are closely related, because they share the goal of studying verbal behavior processes. The stimulus equivalence paradigm may allow study of complex verbal behavior (e.g., Hall & Chase, 1991; Hayes, Barnes-Holmes, & Roche, 2001; Hayes & Hayes, 1993; Stromer, 2000). Hayes, Barnes-Holmes, and other developers of the relational frame theory (e.g., Hayes, 1991, 1994; Hayes, Barnes-Holmes, & Roche; Hayes & Hayes, 1989) also sought to study verbal behavior processes (e.g., Barnes-Holmes, Barnes-Holmes, & Cullinan, 2000; Dymond & Barnes, 1995; Hayes, Barnes-Holmes, & Roche; Steel & Hayes, 1991). Studies by these researchers have even analyzed the emergence of verbal operants (e.g., Barnes-Holmes, Barnes-Holmes, Roche, & Smeets, 2001a; 2001b). In spite of the vast research on stimulus equivalence and stimulus relations, however, few studies have focused such logic directly on language or verbal behavior. All studies in this area have involved conditional discrimination procedures, in which the participants selected among comparisons—they learned *selection-based* operants. In some studies selection-based conditional discriminations and tacts, textual responses, or other operants were combined with responses of varying topographies such as different vocal responses—*topography-based* operants, in Michael's (1985) terms (e.g., Sidman, 1971; Sidman & Cresson, 1973; Sidman, Cresson, & Willson-Morris, 1974). Still we have not found studies in the area of stimulus relations in which all the operants were topography-based. In contrast the studies in the area of verbal behavior cited here used topography-based operants but also combined topography-based with selection-based operants. The only exceptions were the studies by Pérez-González, García-Asenjo, et al. (2007) and by Polson and Parsons (2000) cited above, which were conducted exclusively with intraverbals. Moreover, researchers in the area of verbal behavior have not studied emergence of verbal relations with the A-B-C format of stimulus equivalence. In addition, they have studied few variables under which the emergence of novel behavior occurs.

Although it is often assumed that the basic processes in selection-based and in topography-based operants are identical, no empirical evidence supports this assumption, as Michael (1985) suggests. Therefore, the processes involved in typical studies of stimulus equivalence may differ from those involved in the emergence of verbal operants. For this reason, the main purpose of the present research was to explore the emergence of topography-based operants by using the methodology employed in stimulus equivalence studies. We selected topography-based intraverbals. The *intraverbal* is characterized by the emission of a verbal response after the presentation of a verbal stimulus

that shows no point-to-point correspondence with the response (Skinner, 1957). We selected intraverbals because the stimulus and the responses have the same form: They are spoken words emitted by the speaker or the listener. Thus it was possible to study properties such as symmetry, transitivity, and equivalence. Figure 1 shows the main characteristics of conditional discriminations used in typical studies on stimulus relations and intraverbals. The intraverbals consist of responses with specific topographies. In the presence of the stimuli "Name the *city* of Argentina," saying "Buenos Aires" is followed by a reinforcer; any other response is not reinforced. With the same stimuli "Name the *city* of" but with the stimulus "Uruguay," saying "Montevideo" is followed by the reinforcer; other responses are not reinforced. The stimulus "city" may also change across trials (e.g., we may ask "Name the *park* of Argentina") to be relevant. This term is necessary to indicate that we want to hear the name of a city on some occasions and the name of a park on other occasions. Notice that there are no comparison stimuli from which to choose. Even though the conditional discriminations and the intraverbals are related to the same terms (namely, "Argentina" and "Buenos Aires"), they have notable differences, given that the functions of the stimuli and the responses differ between the two operants and that terms such as "city" and "park" are necessary in the intraverbals.

Conditional Discrimination			
Conditional Stimulus	Discriminative Stimulus	Response	Consequence
Trial 1			
	Buenos Aires	Select	Reinforcer
Argentina	Montevideo	Select	None
		Other	None
Trial 2			
	Buenos Aires	Select	None
Uruguay	Montevideo	Select	Reinforcer
		Other	None

Intraverbal			
Antecedent Stimulus	Antecedent Stimulus	Response	Consequence
Trial 1			
Name the *city* of	Argentina	Buenos Aires	Reinforcer
		Other	None
Trial 2			
Name the *city* of	Uruguay	Montevideo	Reinforcer
		Other	None

Figure 1.   The operant components of a typical conditional discrimination (upper panel) and an intraverbal (bottom panel). The panels are adapted versions of Sidman's (1986, 2000) diagrams of 4-term contingencies.

The first goal of the present research was to demonstrate the emergence of relations only with intraverbals. In this vein, we designed two types of intraverbals for teaching. In one instance of the A-B Country-City intraverbals, the antecedent stimuli were "Name the city of Argentina" and the correct

response was "Buenos Aires." In one instance of the B-C City-Park intraverbals, the antecedent stimuli were "Name the park of Buenos Aires" and the correct response was "El Botánico." Then we probed the emergence of eight intraverbals. For example, in the B-A City-Country intraverbals, "Name the country of Buenos Aires" comprised the antecedent stimuli and "Argentina" was the correct response (see Table 1 and Figure 2). We will refer to the A-B and B-C intraverbals as the taught intraverbals and to the untaught intraverbals as the novel intraverbals or the novel relations. The A-B-C terminology served here, because, for example, we considered "Argentina" as a member of A and "Buenos Aires" as a member of B. Notice that "city" is necessary to indicate that the response of the A-B intraverbal must be a B stimulus.

Table 1
Stimuli and Response Components of the Intraverbals Taught and Probed in Studies 1 and 2

Antecedent Stimuli		Correct Response	
Teaching A-B Country-City			
Dime	la ciudad de	[A1] Argentina	[B1] (Buenos Aires)
Dime	la ciudad de	[A2] Uruguay	[B2] (Montevideo)
Name	*the city of*	*[A1] Argentina*	*[B1] (Buenos Aires)*
Name	*the city of*	*[A2] Uruguay*	*[B2] (Montevideo)*
Teaching B-C City-Park			
Dime	el parque de	[B1] Buenos Aires	[C1] (el Botánico)
Dime	el parque de	[B2] Montevideo	[C2] (el Lecoc)
Name	*the park of*	*[B1] Buenos Aires*	*[C1] (el Botánico)*
Name	*the park of*	*[B2] Montevideo*	*[C2] (el Lecoc)*
Probing B-A City-Country			
Dime	el país de	[B1] Buenos Aires	[A1] (Argentina)
Dime	el país de	[B2] Montevideo	[A2] (Uruguay)
Name	*the country of*	*[B1] Buenos Aires*	*[A1] (Argentina)*
Name	*the country of*	*[B2] Montevideo*	*[A2] (Uruguay)*
Probing C-B Park-City			
Dime	la ciudad de	[C1] el Botánico	[B1] (Buenos Aires)
Dime	la ciudad de	[C2] el Lecoc	[B2] (Montevideo)
Name	*the city of*	*[C1] el Botánico*	*[B1] (Buenos Aires)*
Name	*the city of*	*[C2] el Lecoc*	*[B2] (Montevideo)*
Probing A-C Country-Park			
Dime	el parque de	[A1] Argentina	[C1] (el Botánico)
Dime	el parque de	[A2] Uruguay	[C2] (el Lecoc)
Name	*the park of*	*[A1] Argentina*	*[C1] (el Botánico)*
Name	*the park of*	*[A2] Uruguay*	*[C2] (el Lecoc)*
Probing C-A Park-Country			
Dime	el país de	[C1] el Botánico	[A1] (Argentina)
Dime	el país de	[C2] el Lecoc	[A2] (Uruguay)
Name	*the country of*	*[C1] el Botánico*	*[A1] (Argentina)*
Name	*the country of*	*[C2] el Lecoc*	*[A2] (Uruguay)*

Note. The notation within brackets was not spoken. The English ranslation appears in *italics* below each intaverbal type

We conducted three studies to explore the emergence of intraverbals. Experiment 1 explored whether teaching a set of intraverbal operants with

a procedure that parallels those used in a typical equivalence study would result in the emergence of novel intraverbals that parallel the novel stimulus-stimulus relations of equivalence studies. Experiment 2 examined whether learning simpler intraverbals would facilitate the emergence of intraverbals. As stated before, the A-B-C intraverbals contain two stimuli (e.g., "city" and "Argentina"). It is likely that learning intraverbals with only one stimulus (e.g., "city") prior to learning the intraverbals with two stimuli facilitates the emergence of the novel A-B-C intraverbals. Experiment 3 directly replicated the results of Experiments 1 and 2 and explored whether novel sets of stimulus relations with the same country-city-park structure are learned faster. Thus Experiments 2 and 3 would provide additional evidence of the emergence of intraverbals. On the other hand, a secondary goal of the present research was to begin exploring the factors involved in this type of emergence.
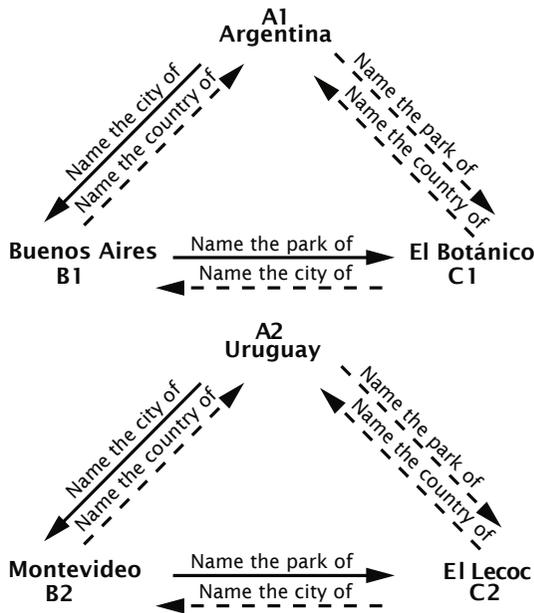

Figure 2. Outline of the intraverbals used in Studies 1 and 2. Each arrow points from one antecedent stimulus to the response defined as correct. The words over the arrows indicate the other stimuli of the intraverbal. Solid arrows indicate the taught intraverbals. Dashed arrows indicate the probed intraverbals.

The main goal of the three studies was to demonstrate emergence of relations with intraverbals. Because the procedures used and the processes found can be different from those of standard equivalence research, the present studies are better understood by readers free from previous conceptions. Doing so can facilitate the further comparison between the outcomes of the two paradigms.

Experiment 1

Experiment 1 explored intraverbal emergence. Paralleling some studies on stimulus equivalence, first we taught four intraverbals involving the A-B and B-C relations, and second we probed eight novel relations.

Method

Participants

Five normally developing children participated: Juana (female, 6 years 3 months old), Aroa (female, 6 years 2 months old), Pipo (male, 6 years 2 months old), Diana (female, 6 years, 3 months old), and Pelayo (male, 6 years 4 months old). They were Spanish speakers and attended a private school in Oviedo, Spain.

Stimuli and Procedure

Taught intraverbals. We designed four intraverbals for teaching (see "Teaching A-B Country-City" and "Teaching B-C City-Park" in Table 1). For example, in the A-B intraverbal, the antecedent stimuli were "Name the city of Argentina" and the correct response was "Buenos Aires"; in the B-C intraverbal, the antecedent stimuli were "Name the park of Buenos Aires" and the correct response was "El Botánico." The other two A-B and B-C intraverbals were analogous, referring to Uruguay, Montevideo, and the Lecoc park.

Probed intraverbals. We also designed another eight intraverbals, which resulted from combining some of the stimuli of the four intraverbals for teaching (see the probed intraverbals in Table 1). For example, in the "City-Country probe," the antecedent stimuli were "Name the country of Buenos Aires" and the correct response was "Argentina." We designated these eight intraverbals as the *probed intraverbals* or the *novel intraverbals.*

Setting. The research took place in a quiet room at the school. The experimenter (the second author) sat in front of the child. During the session, she presented each question aloud, waited 5 s for the child's response, presented the consequences, and recorded the child's responses. An observer sometimes recorded data independently, and the experimenter audiotaped some sessions so that a second observer could analyze the events later and thus compute interobserver agreement. In the three studies, 3,700 trials (44.41%) of a total of 8,330—from all participants—were observed, corresponding to 25 of the 59 sessions. The experimenter and the observer agreed on 3,675 trials; thus interobserver agreement was 99.32%. Each session lasted about 20 min, the time that was necessary to complete a probe-teaching-probe cycle (see "Procedure Overview" below). At the end of each session, the experimenter gave the child three or four collector-edition stamps for participating, regardless of the performance.

Instructions, stimulus presentation, and consequences. The study was conducted in Spanish. At the beginning of the first session, the experimenter told the child, "I am going to ask you some questions. Sometimes, I will tell you if you are right or not. Other times, I will not let you know anything. Try to respond as well as you can. I will record all the responses. If you respond correctly often, I will give you some stamps. Is that O.K.?" If he or she commented or questioned during the session, the experimenter said, "Keep going. We will talk after the game is over." During each trial, the experimenter read the question aloud to the child, waited about 5 s for her or his response, and provided the consequences (see below). Then she wrote down the child's response and moved on to the next trial. Only the first word was considered as the response. If the child incorrectly pronounced the first

syllable of the response or if there was not a response within 5 s, the response was considered incorrect. Correct responses were followed by expressions such as "Very good," "Excellent," "Well done," and "You are very clever." These expressions proved to function as reinforcers in the context of this research. Incorrect responses were followed by "No, [the correct response]," or just the correct response. (For example, responding "Lecoc" to "Name the city of Argentina" was followed by "No, Buenos Aires," or "Buenos Aires.") The experimenter did not provide consequences after responses on probe trials.

Procedure overview. We first probed the 12 intraverbals to ensure that the children did not know them at the start of the study. Second, we taught the A-B Country-City and the B-C City-Park intraverbals. Third, we probed the 12 intraverbals again and finished the session. We repeated this cycle several times, in successive sessions, to explore whether the novel intraverbals would emerge after repeated teaching-probing cycles (see Table 2). The study continued until the child made 12 correct responses in a 12-trial probe or until it was considered that the child would not show all the relations even after repeated cycles (around 14). Thus each session was conducted according to the order and characteristics that follow:

Table 2
Sequence of Phases in Experiment 1

Order	Operants Probed or Taught	Initial Cycle	Subsequent Cycles
1	24 trials of the 12 intraverbals	Probe	Probe
2	A-B and B-C	Teach	Review
3	24 trials of the 12 intraverbals	Probe	Probe

Probes of the 12 intraverbals. All 12 intraverbals shown in Table 1 were presented twice in a random sequence each time. The experimenter announced to the child, "I am not going to tell you whether your responses are right, but you should respond correctly. This way you are going to win more stamps at the end of the session." The experimenter did not present any consequence on these trials; she just asked the next question after any response from the child or after about 5 s.

Teaching A-B Country-City. We taught the Country-City operants in three phases. In Phase 1, the request was "Name the city of Argentina" [A1]. The experimenter provided the correct response ("Buenos Aires" [B1]) as a prompt in the first two trials. After three consecutive correct responses with no prompt, the experimenter moved to Phase 2. Phase 2 was identical to Phase 1, but the request was "Name the city of Uruguay" [A2] and the correct response was "Montevideo" [B2]. Starting on the second trial, the prompt was not provided when the child responded within 2 s. In Phase 3, the two questions of Phases 1 and 2 were randomly intermixed, with the requirement that two trials of each question appeared every four trials. The experimenter did not provide a prompt in any trial. After the child met the criterion of six correct consecutive responses, the experimenter moved to the next phase.

Teaching B-C City-Park. We taught the City-Park operants in 3 phases, exactly as we taught the Country-City operants. The stimuli were "Name the park of Buenos Aires" [B1] ("the Botánico" [C1] is the correct response) and "Name the park of Montevideo" [B2] ("the Lecoc" [C2] park is the correct response).

Teaching A-B Country-City and B-C City-Park mixed. Finally the experimenter presented the four Country-City and City-Park questions randomly intermixed, with the requirement that the four questions appeared every four trials. She terminated this phase after the child met the criterion of 12 consecutive correct responses. Then the session continued immediately with the probes.

Probes of the 12 intraverbals. These probes were identical to the probes conducted at the beginning of the session. Thus the experimenter reminded the child that there was no feedback but that he or she should try to respond correctly.

Results

Baseline Probe of the 12 Intraverbals

The results of the probe trials appear in Figure 3. No child responded correctly to any trial in the first probe phase, with the exception of Juana, who responded correctly to one question. Children typically were silent when questioned.
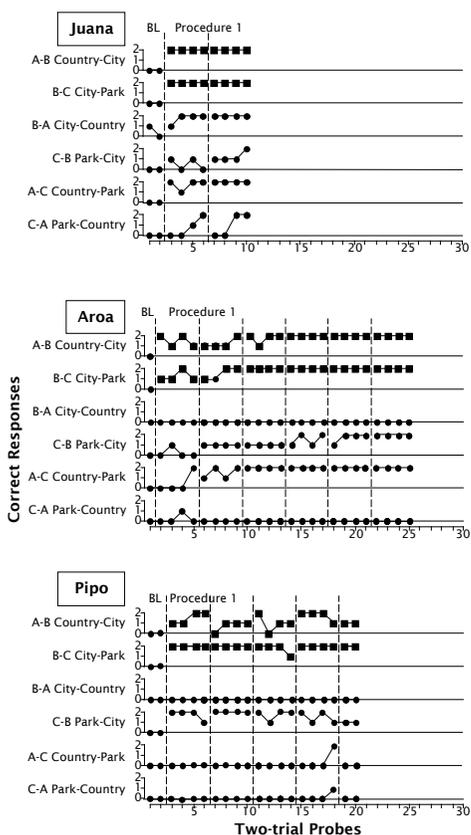

Figure 3. Correct responses to the probe of the 12 intraverbals in Experiment 1. Each point represents correct responses in two trials of a 12-trial block. Circles represent data of intraverbals that were not taught. Squares represent data in intraverbals after being taught (A-B and B-C). "BL" indicates baseline data. "Procedure 1" indicates the procedure used in Experiment 1. A session consisted of presenting the probe, with two 12-trial blocks (represented by two columns of data points), teaching or reviewing the A-B and B-C intraverbals (represented by dashed lines), and repeating the two 12-trial blocks (represented by two additional columns of data points). Teaching data are not presented in the figure. Notice that Diana learned the A-B and B-C intraverbals in two sessions; therefore, the data before and after the first dashed line correspond to two sessions.

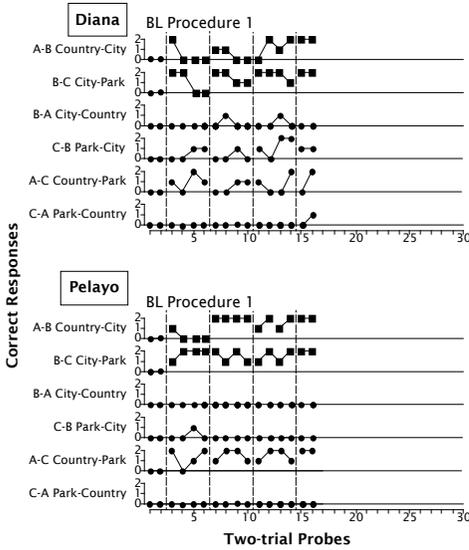*(Figure 3 continues on following page.)*

Figure 3, continued.

Learning the A-B Country-City and B-C City-Park intraverbals

Juana underwent two sessions, Aroa underwent six sessions, Pipo and Diana underwent five sessions each, and Pelayo underwent four sessions. The participants' performance in the teaching phases appears in Table 3. Juana learned the A-B and B-C relations in 85 trials (with only nine errors). She responded correctly to all trials in the second session. Aroa learned the A-B and B-C relations in 130 trials (with 44 errors). In subsequent sessions, she typically went through the phases of the A-B and B-C relations in 36 trials, with no errors. Pipo learned the A-B and B-C relations in 132 trials (with 30 errors). During the second session, he failed to meet criterion on the A-B and B-C teaching phases; therefore the experimenter repeated these phases and subsequently he met the mastery criterion. In ensuing sessions, he mastered the reviewed A-B and B-C phases with 0 to 19 errors. Diana learned the A-B and B-C relations in 229 trials (with 58 errors) in two sessions. In subsequent sessions, she reviewed the A-B and B-C relations in 47 to 105 trials (with 2 to 19 errors). Pelayo learned the A-B and B-C relations in 103 trials (with 27 errors). In subsequent sessions, she reviewed the A-B and B-C relations in 47 to 90 trials (with 9 errors or fewer).

Table 3
Correct and Total Responses Made by Each Participant in the Learning Phases of the A-B and B-C Intraverbals of Experiment 1

| | Session | | | | | | |
	1	2	3	4	5	6	Total
Juana	76/85	36/36					112/121
Aroa	86/130	37/37	57/65	36/37	36/36	36/36	288/341
Pipo	102/132	74/92	41/60	58/68	36/36		311/388
Diana	92/131*	79/98	84/100	89/105	45/47		389/481
Pelayo	76/103	81/90	41/42	39/39			237/274

* The participant did not reach the mastering criterion in this session.

We initially analyzed incorrect responses and found that in the initial phases, some errors consisted of a child's saying any word that was taught in

the same phase (for example, if in Phase 3 of the Teaching A-B Country-City, "Buenos Aires" and "Montevideo" were correct responses across trials, some children said one of these words). When trials of the A-B Country-City and B-C City-Park intraverbals were mixed, none of the children made incorrect responses with a consistent response pattern (i.e., they did not respond with cities to the requests with cities or to words of the same country as the country in the question).

Postteaching Probes of the 12 Intraverbals

Juana showed emergence of the B-A intraverbals in the first session, after learning the four taught operants (point 4 in the graph of Figure 3). Thereafter, by the second session she demonstrated the emergence of the A-C intraverbals but did not show the emergence of the other two intraverbals. Finally, by the fourth probe (points 9 and 10) the C-B and C-A operants emerged.

Aroa did not respond correctly to the probed intraverbals in the first probes. During successive probes, the A-C Country-Park intraverbals emerged; thereafter, the C-B Park-City also emerged. The B-A and C-A intraverbals, however, did not emerge, even after 12 probes (points 2 to 25 in Figure 3). When she made errors, she was quiet or answered with words corresponding to other intraverbals. Sometimes she spoke a word from the same country as the correct one; for example, when presented with the C-A Park-City request, "Name the country of el Lecoc," she spoke the name of the city, "Montevideo," instead of the country, "Uruguay."

Pipo demonstrated the emergence of the C-B intraverbals, yet he responded with occasional errors to these intraverbals. He also failed many trials of the A-B intraverbals, even though we conducted the probes after he demonstrated mastery of these relations during the review of A-B and B-C. After five sessions (which involved 20 data points), he refused to collaborate and the experimenter discontinued his part of the study.

Diana responded inconsistently across sessions. For example, in the first session, she failed to learn A-B and B-C. Consequently, data of the initial probe of Session 2 do not appear on Figure 3. She responded correctly to approximately half of the trials of the A-C intraverbals. She also responded correctly in half of the trials of the C-B intraverbals during the last two sessions. As for the B-A intraverbals, she responded correctly in two trials, and with the C-A intraverbals, once. Yet during the probe in which she responded correctly she spoke a word in most incorrect trials; thus this correct response could be coincidental. Across sessions Diana often spoke a word of the same country as the correct one, as did Aroa.

Pelayo responded correctly to the A-C intraverbals during eight 12-trial probes, and he typically responded correctly 50% of the time in the remaining trial probes. He responded correctly once in the C-B intraverbals and incorrectly in all the B-A and C-A intraverbals. As in the last teaching phase, except for what was indicated for Aroa and Diana, the participants did not demonstrate a pattern in their errors.

Discussion

One participant (Juana) demonstrated the emergence of the eight untaught intraverbals in the second session. Another participant (Aroa)

showed the emergence of four untaught intraverbals. Yet another one (Pelayo) showed the emergence of two untaught intraverbals. The two other children showed the emergence of some intraverbals, but they did not consistently maintain these untaught relations in all probe sessions.

Juana's results demonstrated the emergence of all novel intraverbals: After learning the four A-B and B-C intraverbals, she responded accurately to the eight B-A, C-B, A-C, and C-A untaught intraverbals. She responded correctly in one of the four probe trials of the B-A relations; although this isolated correct response may not be taken as evidence of previous acquisition of this operant, still there is some possibility that she had acquired the operant previous to the experiment. Considering that three incorrect responses could indicate that she had not acquired the operants before the experiment, it is possible to conclude that the eight novel intraverbals appeared as a result of teaching the first four intraverbals and repeating the probes. Thus Juana's performance demonstrated this type of behavioral emergence with verbal operants. The four remaining participants' results demonstrated transfer of some novel relations. Specifically, three of them showed the emergence of the C-B intraverbals. Moreover, three showed the emergence of the A-C intraverbals, yet with some inconsistencies across sessions for some participants. Thus the procedure used in Experiment 1 facilitated the emergence of intraverbals in these 6-year-old children. Intraverbals C-B and A-C emerged in most of them. The two other intraverbals, B-A and C-A, emerged in only one of the five children.

Participants Aroa and Diana failed to demonstrate the emergence of the B-A and C-A relations, in which they were to name the country. These failures suggest that some relations among the words and the categories to which they belong may have a function in the emergence of novel intraverbals with the use of this procedure. For any taught or probed intraverbal used in this experiment, the correct response was dependent on two stimuli: An A, B, or C stimulus and a word that specified the category of the correct response. For example, in the intraverbal "Name the city of Argentina"— "Buenos Aires," the two relevant antecedent stimuli are "Argentina" (A1) and "city" (which specifies the category of the correct response "Buenos Aires"). It is possible that the A-B and B-C teaching facilitates control of correct responding by the stimuli of the same class as stimulus A1. Yet perhaps additional teaching facilitates control by the stimulus of the categories (e.g., "city") over correct responding. Two operants are related to the relations among the A, B, and C stimuli and the categories to which they belong: First, responding with the word given the category; second, telling the category given the word. Namely, to respond "Buenos Aires" to the request "Name the city of Argentina," it may be requisite to be able to respond "Buenos Aires" to the request "Name a city." Also it may be important to be able to respond "A city" to the question "What is Buenos Aires?"

Experiment 2

The first goal of Experiment 2 was to seek additional demonstrations of the emergence of intraverbals. We taught the children to name the A, B, or C stimuli when told to name exemplars of the category "country," "city," or "park." Moreover, we taught them to name the categories to which the A, B,

or C stimuli belong. We taught the A-B and B-C intraverbals and probed the emergence of the novel relations. The second goal of Experiment 2 was to explore whether these two basic intraverbals might facilitate the emergence of the untaught intraverbals.

Method

Participants

Three experimentally naïve, normally developing children participated: Ana (female, 5 years 8 months old), Lalo (male, 6 years 0 month old), and María (female, 6 years 1 month old). Aroa (female, 6 years 2 months old), whose performance in the emergence probes was inconsistent in Experiment 1, also participated.

Stimuli and Procedure

We designed, in addition to the operants used in Experiment 1, two other types of intraverbals: Categories and Exemplars.

Categories. The Categories were six intraverbals (see top of Table 4). The spoken antecedent stimuli were "What is . . ." followed by "Argentina," "Buenos Aires," "El Botánico," "Uruguay," "Montevideo," or "Lecoc." The correct responses were "A country," "A city," or "A park" (see Table 4 for details). For example, we asked the child "What is Argentina?" (The correct response is "A country.")

Exemplars. The Exemplars were six intraverbals (see bottom of Table 4). The spoken antecedent stimuli were "Name a . . ." followed by "country," "city," or "park." The correct responses were either one of the six exemplars of these categories used in the A-B and B-C operants. For example, the experimenter said, "Name a country," and either "Argentina" or "Uruguay" was correct. On the next trial, she said, "Name another country," and the remaining country was the only correct response. (E.g., if the child said "Uruguay" in the first trial, only the response "Argentina" was considered correct in the next trial.)

Procedure overview. The procedure was identical to that of Experiment 1, with the exception that teaching the Categories and Exemplars followed the initial probe of the 12 intraverbals and preceded teaching or reviewing the A-B and B-C intraverbals. Thus the cycle consisted of (a) probing the 12 intraverbals, (b) teaching or reviewing the Categories, (c) teaching or reviewing the Exemplars, (d) teaching or reviewing the A-B Country-City and B-C City-Park intraverbals used in Experiment 1, and (e) probing the 12 intraverbals (see Table 5). The cycle was repeated several times.

Teaching Categories. We taught the Categories in 11 phases. In Phase 1, the stimuli were "What is Uruguay?" and the correct response was "A country." In the first two trials but not after, the experimenter provided the correct response as a prompt. After the child emitted three consecutive correct responses with no prompt, the experimenter moved to Phase 2. Phase 2 was identical to Phase 1, but the stimuli were "What is Buenos Aires" and the correct response was "A city." In Phase 3 the two questions of Phases 1 and 2 were randomly intermixed, with no prompts and with the restriction that two questions of each type appeared every four trials. Phase 3 continued until the participant made six consecutive correct responses.

Table 4
Stimuli and Response Components of the Intraverbals Inserted in Experiment 2

	Antecedent Stimuli	Correct Response
Categories		
	¿Qué es Argentina?	(Un país)
	¿Qué es Uruguay?	(Un país)
	¿Qué es Buenos Aires?	(Una ciudad)
	¿Qué es Montevideo?	(Una ciudad)
	¿Qué es el Botánico?	(Un parque)
	¿Qué es el Lecoc?	(Un parque)
	What is Argentina?	*(A country)*
	What is Uruguay?	*(A country)*
	What is Buenos Aires?	*(A city)*
	What is Montevideo?	*(A city)*
	What is the Botánico?	*(A park)*
	What is the Lecoc?	*(A park)*
Exemplars		
	Dime un país	(Argentina)
	Dime un país	(Uruguay)
	Dime una ciudad	(Buenos Aires)
	Dime una ciudad	(Montevideo)
	Dime un parque	(el Botánico)
	Dime un parque	(el Lecoc)
	Name a country	*(Argentina)*
	Name a country	*(Uruguay)*
	Name a city	*(Buenos Aires)*
	Name a city	*(Montevideo)*
	Name a park	*(el Botánico)*
	Name a park	*(el Lecoc)*

Note. The English translation appears in *italics* below each intraverbal type.

Phases 4, 5, and 6 were identical to Phases 1 to 3 except for the stimuli. These were "What is Lecoc?" ("A park") and "What is Argentina?" ("A country"). Phases 7, 8, and 9 were identical to Phases 1 to 3, except for the stimuli. These were "What is Montevideo?" ("A city") and "What is the Botánico?" ("A park").

Table 5
Sequence of Phases in Studies 2 and 3

Order	Operants Probed or Taught	Initial Cycle	Subsequent Cycles
1	24 trials of the 12 intraverbals	Probe	Probe
2	Categories	Teach	Review
3	Exemplars	Teach	Review
4	A-B and B-C	Teach	Review
5	24 trials of the 12 intraverbals	Probe	Probe

In Phase 10 the four operants taught in Phases 1 to 6 were randomly intermixed. In Phase 11 the six operants taught in Phases 1 to 9 were intermixed. Each of these phases continued until the participant made 12 consecutive correct responses.

Teaching Exemplars. While teaching the Exemplars, each question had two correct responses. Thus each spoken antecedent stimulus was presented for two consecutive trials. On the first trial, any response with either exemplar was correct. On the second trial, the remaining correct exemplar was the correct answer. For example, on the first trial, we requested, "Name a country." If the child responded "Argentina" or "Uruguay," the response was correct. Let us suppose that the child responded "Uruguay"; that response was correct. Then we requested again, "Name another country." Now the correct response was "Argentina"; then on this trial, answering "Uruguay" was incorrect.

Because the Exemplars were taught immediately after the child learned the Categories, we first taught the three requests of the Exemplars intermixed, with two consecutive trials for each question. If the child responded correctly for 12 consecutive trials in fewer than 36 trials, we moved on to teaching the four A-B Country-City and B-C City-Park operants. Only one child (Lalo) failed to make 12 consecutive correct responses within the first 36 trials; thus the teaching of the Exemplars required five phases for him.

In Phase 1 the request was "Name a country." There was no prompt at this time, but the experimenter provided the correct answer after each incorrect response. Phase 1 continued until the child responded correctly for six consecutive trials. Phase 2 was identical to Phase 1, except that the request was "Name a city." In Phase 3, pairs of trials with the Phases 1 and 2 stimuli were intermixed. This phase continued until the child made 12 consecutive correct responses. Phase 4 was identical to Phase 1, but the question was, "Name a park." Phase 5 was similar to Phase 3, but pairs of trials with the three stimuli from Phases 1, 2, and 4 were intermixed.

Results

Baseline Probe of the 12 Intraverbals

The results for the untaught relations A-B and B-C appear in Figure 4. Ana, Lalo, and María, who were experimentally naïve, responded incorrectly to every trial in the first probe phase. Aroa, who was carried over from Experiment 1, demonstrated the emergence of C-B and A-C but responded incorrectly in the probes of the B-A and C-A relations.

Teaching of Categories, Exemplars, A-B Country-City, and B-C City-Park

Ana participated in seven sessions, Lalo in two, Maria in four, and Aroa in two. The results of the children's performance in the teaching phases appear in Table 6. Ana learned the Categories in 223 trials (with 29 errors), in two sessions. Then she learned the Exemplars in 24 trials (with three errors). Subsequently, she learned the A-B and B-C intraverbals in 227 trials (with 63 errors), in three sessions. In the last two sessions, she performed almost without errors. (She made only one and two errors per session.)

Lalo learned the Categories in 109 trials (with 19 errors). Then it was necessary for him to work through all the phases of the Exemplars; he learned them in 76 trials (with 15 errors). Next he learned the A-B and B-C intraverbals in 73 trials (with 12 errors). In the following session, he reviewed
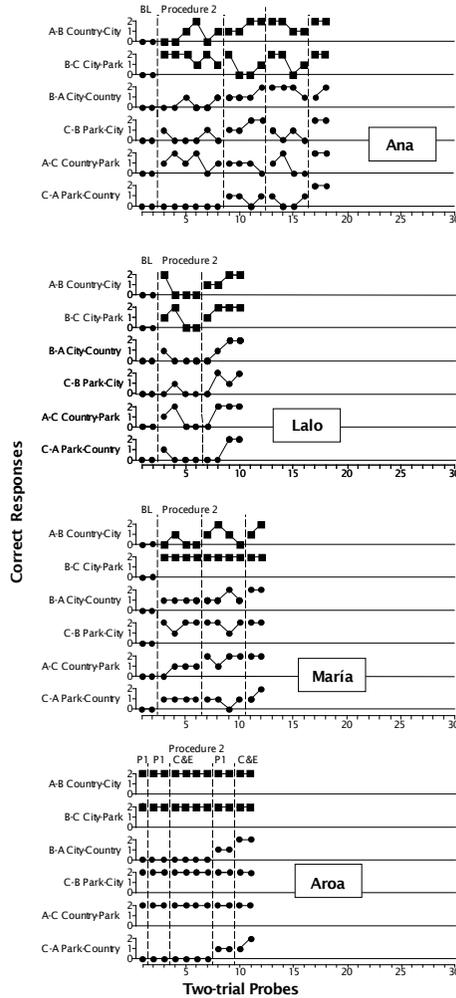
Figure 4. Correct responses to the probe of the 12 intraverbals in Experiment 2. Each point represents correct responses in two trials of a 12-trial block. Circles represent data of intraverbals that were not taught. Squares represent data in intraverbals after being taught (A-B and B-C). "BL" indicates baseline data. "C&E" indicates Categories and Exemplars. "Procedure 2" indicates the procedure used in Experiment 2. "P1" indicates Procedure 1, used with Aroa during Experiment 1. The points of that period are data from her last session during Experiment 1. A session consisted of presenting the probe, with two 12-trial blocks (represented by two columns of data points), teaching or reviewing the Categories, the Exemplars, and the A-B and B-C intraverbals (represented by dashed lines), and repeating the two 12-trial blocks (represented by two additional columns of data points). Ana and María did not reach criterion in the A-B and B-C intraverbals in the session corresponding to the first dashed line shown in the graph. Thereafter, they underwent three and two more sessions, respectively, indicated by six data points, before mastering A-B and B-C (see text for details). Teaching data are not presented in the figure.

the Categories, the Exemplars, A-B, and B-C; he made only one error with each one of these three types of intraverbals.

Table 6
Correct and Total Responses Made by Each Participant in the Learning Phases of the Categories, the Exemplars, and the A-B and B-C Intraverbals

| | Session | | | | | | | |
	1	2	3	4	5	6	7	Total
Ana								
Categories	109/132*	85/91	60/60	60/62	60/60	60/60	60/60	494/525
Exemplars		21/24	12/12	12/12	12/12	12/12	12/12	81/84
A-B & B-C		54/83*	39/55*	—	71/89	36/37	40/42	240/306
Lalo								
Categories	90/109	67/68						157/177
Exemplars	61/76	21/22						82/98
A-B & B-C	61/73	40/41						101/114
María								
Categories	76/84	60/60	60/60	61/61				257/265
Exemplars	12/12	12/12	12/12	12/12				48/48
A-B & B-C	26/33*	38/40	54/65	36/36				154/174
Aroa								
Categories	63/67	65/68						128/135
Exemplars	14/16	13/14						27/30
A-B & B-C	36/36	36/36						72/72

Note. Aroa participated previously in Experiment 1.
*The participant did not reach the mastering criterion in this session.

María learned the Categories in 84 trials (with eight errors). Then she learned the Exemplars in 12 trials (with no errors). Next she underwent 33 trials of the A-B relations (with seven errors) at which time the experimenter interrupted the session. In the next session, she learned the A-B and B-C relations in 40 trials (with two errors). In two subsequent sessions, she responded with no errors in the Categories and the Exemplars. She responded correctly to most trials during the A-B and B-C instructional phases. (She made 11 errors in one session and none in the other.)

Aroa, who learned A-B and B-C relations in Experiment 1, responded correctly in all trials of the A-B and B-C relations, just as she did in the last sessions of Experiment 1. She learned the Categories in 67 trials (with four errors) and the Exemplars in 16 trials (with two errors). In the subsequent session, she made only three errors in the Categories trials and one error in the Exemplars.

Postteaching Probes of the 12 Intraverbals

Ana responded correctly to most of the trials of the B-C relations and about half the trials of the A-C untaught relations during the first six 12-trial probes (the 6 dots after "Procedure 2" in Figure 4; these correspond to the initial probes conducted in Sessions 3 to 5, during which she had not yet mastered the A-B and B-C relations). After learning the A-B and B-C relations, she gradually performed more correctly to the untaught relations. Finally she responded correctly to all the relations in the 16th 12-trial probes.

Lalo responded correctly in most trials of the B-C and A-C relations during the first two 12-trial probes (the two first dots after teaching in Figure 4), but he responded incorrectly in most trials of the remaining four relations. On the initial 12-trial probes of the next session, he failed to answer any untaught question correctly. After reteaching, Lalo increased gradually his correct responses to untaught relations. On the second 12 trials of the initial probe of the third session, he responded correctly to all of the taught and the untaught relations.

María gradually increased her number of correct responses to the untaught relations. At the 10th 12-trial probe, after learning the Exemplars and the Categories, she responded correctly to all the untaught relations.

Aroa responded correctly in all trials of the A-B, B-C, C-B, and A-C intraverbals, as she did during Experiment 1. Because Aroa had been in Experiment 1, the experimenter first reviewed the A-B and B-C intraverbals; second, she introduced the probes of the 12 intraverbals; third, she taught Aroa the Categories and the Exemplars; and fourth, she presented the probe again. During the first five 12-trial probes, after having learned the Exemplars and the Categories, Aroa responded incorrectly to the B-A and C-A intraverbals. In the second session, she increased her correct responses and responded correctly to all the intraverbals by the 10th 12-trial probe block.

Discussion

The first goal of Experiment 2 was to seek additional demonstrations of this type of emergent relations with intraverbals. After repeated probing and reteaching of the basic relations, as well as the Categories and the Exemplars, the four children responded accurately to all the untaught relations. Therefore the results provide evidence of this process. The procedure used in Experiment 2 that included teaching the Categories and the Exemplars together with the A-B and B-C intraverbals was useful in facilitating the emergence of all the probed intraverbals.

The second goal was to explore the influence of teaching Categories and Exemplars in the emergence of the intraverbals. In Experiment 1, we did not teach the five children with the Categories or the Exemplars; only one child demonstrated all the untaught relations. In Experiment 2 we taught the four children the Categories and the Exemplars; all of the children demonstrated the emergence of the untaught relations. The positive effects of learning the Categories and the Exemplars to facilitate the emergence of the intraverbals appears even more plausible it is considered that all children in Experiment 2 demonstrated the emergence of the novel relations after fewer than 17 probes, whereas two children of Experiment 1 who did not show the novel relations received 18 to 24 12-trial probes. In other words, four of five participants of

Experiment 1 who did not learn the Categories and the Exemplars also failed to demonstrate the emergence of all relations within five and six sessions. In contrast the four participants of Experiment 2 who learned the Categories and the Exemplars demonstrated the emergence of all relations within two to three sessions.

Moreover, Aroa failed to show the B-A and C-A emergent relations in Experiment 1 but showed all emergent relations after learning the Categories and the Exemplars in Experiment 2. Thus Aroa's results provide a within-participant replication of the results obtained with the other children.

In summary, though the results of Experiment 1 showed that teaching the Categories, the Exemplars, or both, is not necessary for the emergence of the untaught operants with all children, the results of Experiment 2 indicate that teaching these operants facilitates emergence of the untaught relations.

Experiment 3

The purpose of Experiment 3 was to seek additional within-participant replication of the results from Experiments 1 and 2. We also sought to explore whether successive relations with novel sets of country, city, and park stimuli are learned more rapidly. Learning set (Harlow, 1949) occurs in conditional discriminations when a person learns successive conditional discriminations, even with different stimuli in each. Under these conditions, successive novel conditional discriminations are learned more quickly or with fewer errors (Pérez-González, Spradlin, & Saunders, 2000; Saunders & Spradlin, 1990, 1993). Pérez-González et al. obtained a learning set outcome with second-order conditional discriminations. In the study of these operants, comparison selection was dependent on two antecedent stimuli present in each trial: the contextual stimulus and the sample. Given that the operants in the present research have two relevant antecedent stimuli, it is possible that the children learned faster with new sets. To test this hypothesis, we designed new sets with countries, cities, and parks and probed the emergence of the novel relations with these relations. We observed whether these relations would emerge and whether they would emerge with fewer teaching phases and with fewer repeated probes each time. The emergence would provide within-participant replication of the results of Experiments 1 and 2. Savings in teaching phases and in emergence probes would indicate learning-set effects. In addition to the studies in the classic tradition of stimulus equivalence, studies conducted under the theoretical view of the relational frame theory also have shown facilitation of emergent relations, as the same relations are learned with successive stimulus sets. Actually, this is one main assumption of relational frame theory (e.g., Hayes, Barnes-Holmes, & Roche, 2001).

A third goal was established for the participant of Experiment 1 who demonstrated the emergent relations without being taught the Categories or the Exemplars. The goal was to investigate whether teaching the Categories or the Exemplars would facilitate the emergence of the novel relations.

Method

Participants

The four children who demonstrated the emergence of the novel relations

in Experiments 1 and 2 participated: Ana, Lalo, and María, from Experiment 2, and Juana, from Experiment 1.

Stimuli

Two novel stimulus sets were used. In Set 2, the countries were Colombia and Peru, the cities were Bogotá and Lima, and the parks were El Salitre and La Leyenda (see Tables 7 and 8). In Set 3 the countries were Brazil and Chile, the cities were Sao Paulo and Santiago, and the parks were El Trianón and El O'Higgins (see Tables 9 and 10).

Table 7
Stimuli and Response Components of the Intraverbals Taught and Probed in Set 2 of Experiment 3

Antecedent Stimuli			Correct Response
Teaching A-B Country-City			
Dime	la ciudad de	Colombia	(Bogotá)
Dime	la ciudad de	Perú	(Lima)
Name	*the city of*	*Colombia*	*(Bogotá)*
Name	*the city of*	*Peru*	*(Lima)*
Teaching B-C City-Park			
Dime	el parque de	Bogotá	(el Salitre)
Dime	el parque de	Lima	(la Leyenda)
Name	*the park of*	*Bogotá*	*(the Salitre)*
Name	*the park of*	*Lima*	*(the Leyenda)*
Probing B-A City-Country			
Dime	el país de	Bogotá	(Colombia)
Dime	el país de	Lima	(Perú)
Name	*the country of*	*Bogotá*	*(Colombia)*
Name	*the country of*	*Lima*	*(Peru)*
Probing C-B Park-City			
Dime	la ciudad de	el Salitre	(Bogotá)
Dime	la ciudad de	la Leyenda	(Lima)
Name	*the city of*	*the Salitre*	*(Bogotá)*
Name	*the city of*	*the Leyenda*	*(Lima)*
Probing A-C Country-Park			
Dime	el parque de	Colombia	(el Salitre)
Dime	el parque de	Perú	(la Leyenda)
Name	*the park of*	*Colombia*	*(the Salitre)*
Name	*the park of*	*Peru*	*(the Leyenda)*
Probing C-A Park-Country			
Dime	el país de	el Salitre	(Colombia)
Dime	el país de	la Leyenda	(Perú)
Name	*the country of*	*the Salitre*	*(Colombia)*
Name	*the country of*	*the Leyenda*	*(Peru)*

Note. The English translation appears in *italics* below each intraverbal type.

Procedure

We used the same procedure we had used in Experiment 2 with Set 2 for Ana, Lalo, and María from Experiment 2. Thus we probed the 12 intraverbals; taught the Categories, the Exemplars, the A-B Country-City and B-C City-Park intraverbals; and probed the 12 intraverbals again. Reviews were not necessary for any child. After showing the emergence of the novel relations, we performed the same procedure with Set 3.

Table 8
Stimuli and Response Components of the Intraverbals Inserted in Set 2 of Experiment 3

Antecedent Stimuli	Correct Response
Categories	
¿Qué es Colombia?	(Un país)
¿Qué es Perú?	(Un país)
¿Qué es Bogotá?	(Una ciudad)
¿Qué es Lima?	(Una ciudad)
¿Qué es the Salitre?	(Un parque)
¿Qué es the Leyenda?	(Un parque)
What is Colombia?	*(A country)*
What is Peru?	*(A country)*
What is Bogotá?	*(A city)*
What is Lima?	*(A city)*
What is the Salitre?	*(A park)*
What is the Leyenda?	*(A park)*
Exemplars	
Dime un país	(Colombia)
Dime un país	(Perú)
Dime una ciudad	(Bogotá)
Dime una ciudad	(Lima)
Dime un parque	(el Salitre)
Dime un parque	(la Leyenda)
Name a country	*(Colombia)*
Name a country	*(Perú)*
Name a city	*(Bogotá)*
Name a city	*(Lima)*
Name a park	*(the Salitre)*
Name a park	*(the Leyenda)*

Note.   The English translation appears in *italics* below each intraverbal type.

Because Juana had shown the emergent relations without being taught with the Categories or the Exemplars, we taught her the four A-B and B-C relations with Set 2 and probed the four novel relations (the procedure of Experiment 1). After two 24-trial probes, we taught the Categories and the Exemplars. After Juana demonstrated the emergence of the novel relations with Set 2, we repeated the procedure with Set 3.

Because the children of Experiments 1 and 2 typically did not respond correctly in the initial probe of the 12 intraverbals and owing to time constraints, we considered that one 12-trial probe would suffice. As a result, we did so with two children with Set 2 and with all children with Set 3.

Learning set in the emergence of relations was measured in number of errors to criterion in the probes, because the goal was to observe speed in the emergence. Other measures such as blocks of probes to criterion would provide less precise information.

Table 9
Stimuli and Response Components of the Intraverbals Taught and Probed in Set 3 of Experiment 3

Antecedent Stimuli			Correct Response
Teaching A-B Country-City			
Dime	la ciudad de	Brasil	(Sao Paulo)
Dime	la ciudad de	Chile	(Santiago)
Name	*the city of*	*Brazil*	*(Sao Paulo)*
Name	*the city of*	*Chile*	*(Santiago)*
Teaching B-C City-Park			
Dime	el parque de	Sao Paulo	(el Trianón)
Dime	el parque de	Chile	(el O'Higgins)
Name	*the park of*	*Sao Paulo*	*(the Trianón)*
Name	*the park of*	*Chile*	*(the O'Higgins)*
Probing B-A City-Country			
Dime	el país de	Sao Paulo	(Brasil)
Dime	el país de	Santiago	(Chile)
Name	*the country of*	*Sao Paulo*	*(Brazil)*
Name	*the country of*	*Santiago*	*(Chile)*
Probing C-B Park-City			
Dime	la ciudad de	el Trianón	(Sao Paulo)
Dime	la ciudad de	el O'Higgins	(Santiago)
Name	*the city of*	*the Trianón*	*(Sao Paulo)*
Name	*the city of*	*the O'Higgins*	*(Santiago)*
Probing A-C Country-Park			
Dime	el parque de	Brasil	(el Trianón)
Dime	el parque de	Chile	(el O'Higgins)
Name	*the park of*	*Brazil*	*(the Trianón)*
Name	*the park of*	*Chile*	*(the O'Higgins)*
Probing C-A Park-Country			
Dime	el país de	el Trianón	(Brasil)
Dime	el país de	el O'Higgins	(Chile)
Name	*the country of*	*the Trianón*	*(Brazil)*
Name	*the country of*	*the O'Higgins*	*(Chile)*

Note. The English translation appears in *italics* below each intraverbal type.

Results

Baseline Probe of the 12 Intraverbals

The results for the untaught relations appear in Figure 5. None of the four children responded correctly to any request during the initial probe with the 12 intraverbals in Sets 2 or 3.

Learning Categories, Exemplars, A-B Country-City, and B-C City-Park

The participant's performance in the teaching phases appears in Table 11. Ana learned the Categories of Set 2 in 121 trials (with 15 errors). In the second session, she did not master the criterion for learning the Exemplars within 36 trials; thus the experimenter presented all the teaching

Table 10
Stimuli and Response Components of the Intraverbals Inserted in Set 3 of Experiment 3

Antecedent Stimuli	Correct Response
Categories	
¿Qué es Brasil?	(Un país)
¿Qué es Chile?	(Un país)
¿Qué es Sao Paulo?	(Una ciudad)
¿Qué es Santiago?	(Una ciudad)
¿Qué es el Trianón?	(Un parque)
¿Qué es el O'Higgins?	(Un parque)
What is Brazil?	*(A country)*
What is Chile?	*(A country)*
What is Sao Paulo?	*(A city)*
What is Santiago?	*(A city)*
What is the Trianón?	*(A park)*
What is the O'Higgins?	*(A park)*
Exemplars	
Dime un país	(Brasil)
Dime un país	(Chile)
Dime una ciudad	(Sao Paulo)
Dime una ciudad	(Santiago)
Dime un parque	(el Trianón)
Dime un parque	(el O'Higgins)
Name a country	*(Brazil)*
Name a country	*(Chile)*
Name a city	*(Sao Paulo)*
Name a city	*(Santiago)*
Name a park	*(the Trianón)*
Name a park	*(the O'Higgins)*

Note. The English translation appears in *italics* below each intraverbal type.

phases of the Exemplars. Then she learned the Exemplars in 74 trials (with 16 errors). Thereafter she learned the A-B and B-C intraverbals in 39 trials (with no errors). With Set 3, Ana learned the Categories in 80 trials (with eight errors). Then she underwent 36 trials of Exemplars but did not reach mastery criterion of 12 consecutive correct responses (she made 27 errors). During the following session, she responded correctly to 61 trials of the Categories (with one error). Then she learned the Exemplars in 18 trials (with two errors). Thereafter she learned the A-B and B-C intraverbals.

Lalo learned the Categories of Set 2 in 176 trials (with 16 errors). Then he failed to learn the Exemplars in 36 trials. During the subsequent session he learned the Categories, Exemplars, and the A-B and B-C intraverbals with two errors each. With Set 3, Lalo learned the Categories and the Exemplars within three sessions (with 2 to 27 errors per session). Next he learned the A-B and B-C intraverbals.

María learned the Categories and the Exemplars of Set 2 within four sessions (with 8 to 34 errors per session). Afterward she learned the A-B and B-C intraverbals with no errors. With Set 3, María learned the Categories and the Exemplars within three sessions (with 20 and 61 errors in the first and second sessions). In the third session she learned the Categories, the Exemplars, and the A-B and B-C intraverbals with only one error.
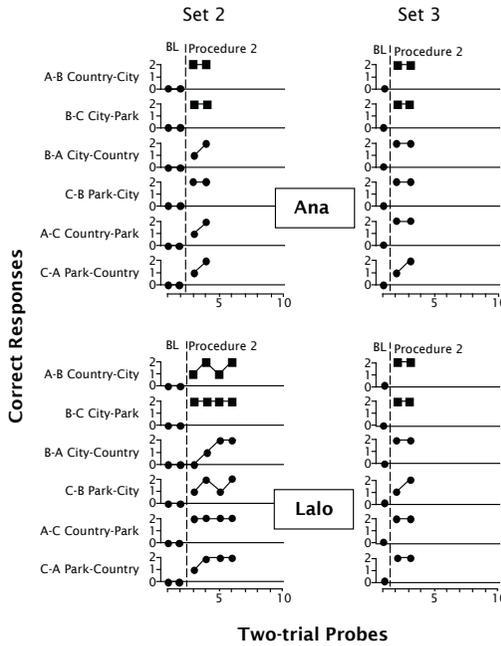

Figure 5. Correct responses to the probe of the 12 intraverbals in Experiment 3. Each point represents correct responses in two trials of a 12-trial block. Circles represent data of intraverbals that were not taught. Squares represent data in intraverbals after being taught (A-B and B-C). "Procedure 1" indicates the procedure used in Experiment 1. "Procedure 2" indicates the procedure used in Experiment 2. In the graphs for Juana, "P1" indicates that the A-B and the B-C intraverbals were taught (as in Procedure 1), "C" indicates that she learned the Categories; "C&E" indicates that she learned the Categories and the Exemplars. As she did not master criterion for the Exemplars in the first session, she did not receive the probes in that session (see text for details).

Juana received the protocol of Experiment 1 first. For Set 2 Juana learned the A-B and B-C intraverbals in 46 trials (with two errors). After a probe with the 12 intraverbals she learned the Categories in 78 trials (with three errors) but failed to learn the Exemplars in 36 trials. In the subsequent session she learned the Categories, the Exemplars, and the A-B, and B-C intraverbals with only two errors. For Set 3 Juana learned the A-B and B-C intraverbals in 52 trials (with nine errors). From then on, she learned the Categories and Exemplars with no errors.

Postteaching Probes of the 12 Intraverbals

Ana. On Set 2 this child responded correctly on 9 trials of the first 12-trial block and responded correctly to the 12 trials of the second block of the emergence probe, just after learning the Categories, the Exemplars, and the basic relations. On Set 3 she responded correctly to all but one question in the first 12-trial probe block and to all questions on the second block.
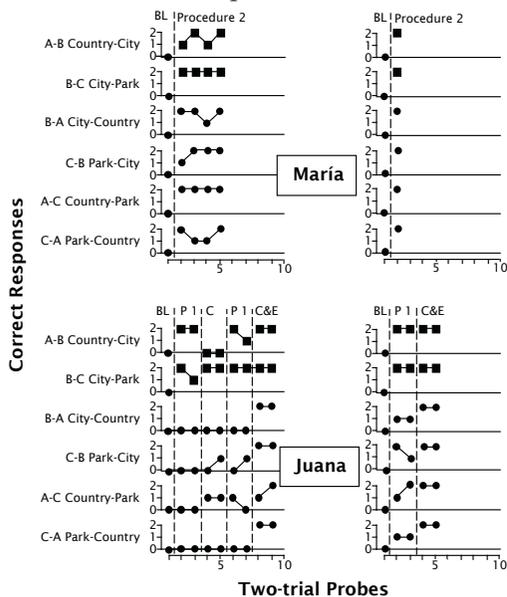

Figure 5 continued.

Lalo. On Set 2 this child responded correctly to all trials of a 12-trial probe on the fourth presentation, just after learning the Categories, the Exemplars, and the A-B and B-C relations. On Set 3 he responded correctly to all the trials of a 12-trial probe on the second presentation.

María. The performance of this child was similar to Lalo's. On Set 2 María responded correctly to all 12 probe trials on the fourth presentation, once she had learned the Categories, the Exemplars, and the A-B and B-C relations. On Set 3 she responded correctly to all trials of a 12-trial probe on the first presentation.

Juana. The experimenter taught Juana the A-B and B-C relations first, because she had already participated in Experiment 1. After two 12-trial probes the experimenter taught her the Categories and the Exemplars. She failed to learn the Exemplars in the first session; thus the experimenter did not administer the final 12-trial probe. In the second session, she demonstrated the emergence of the novel relations, just after reviewing the Categories and learning the Exemplars. We repeated the procedure with Set 3. Juana responded correctly to eight relations in each one of the first two probes. Thereafter the experimenter taught the Categories and the Exemplars, and Juana responded correctly on all 12-probe trials.

We analyzed the number of 12-trial probes administered before all responses to the 12 trials of the probe were correct for the three children who

learned under the procedure of Experiment 2 alone (see Figures 4 and 5). We found that the three children required fewer probes with Set 2 in Experiment 3 than with Set 1 in Experiment 2 and they required fewer probes with Set 2 than with Set 3 in this study. Ana's performance was the exception, because she mastered the criterion by the second probe with Sets 2 and 3. She also made more correct responses in Set 3 than in Set 2.

Table 11
Correct and Total Responses Made by Each Participant in the Learning Phases of the Categories, the Exemplars, and the A-B and B-C Intraverbals in Each Session and in All Sessions of Experiment 3

	Session							
	Set 2				Set 3			
	1	2	3	4	1	2	3	Total
Ana								
Categories	106/121	73/77			72/80	60/61		311/339
Exemplars		58/74			9/36*	16/18		83/128
A-B & B-C		39/39				40/40		79/79
Lalo								
Categories	160/176	68/70			117/133	75/82	56/58	476/519
Exemplars	29/36	16/18				16/36*	12/12	73/102
A-B & B-C		45/47					40/40	85/87
María								
Categories	77/84	48/49	18/19	74/78	112/132	72/74	56/56	457/492
Exemplars	9/36*	17/36*	82/112	18/22	9/36	77/136	12/12	224/390
A-B & B-C				38/38			39/40	77/78
Juana								
A-B & B-C	44/46	37/39			43/52			124/137
Categories	75/78	60/60			60/60			195/198
Exemplars	24/36*	12/12			12/12			48/60

We also analyzed errors to criterion made during probe phases by the three children who learned under the Experiment 2 procedure alone. For a better comparison of the savings in successive probes, we present data from Experiments 2 and 3 in Figure 6. Errors to criterion decreased for all children from Set 1 (which was used in Experiment 2) to Set 2 and from Set 2 to Set 3.

Discussion

In all four children, the novel intraverbals emerged with the two stimuli sets. These results replicated the within-participants results obtained in Experiment 2. They provide additional evidence for the emergence of the novel intraverbals of this type.

The three children who participated in Experiment 2 demonstrated each new set of relations with successively fewer probes and errors in Experiment 3. These results demonstrate that teaching and probing with some stimulus

relations transferred positively to successive new stimulus relations.

Juana, who participated in Experiment 1, first learned the A-B and B-C operants alone. We introduced the Categories and the Exemplars after probing unsuccessfully the novel intraverbals. The effect of teaching the Categories and the Exemplars was dramatic: With Set 2 Juana responded correctly by the second session; with Set 3 she responded correctly to all the trials of the first probe just after learning the Categories and the Exemplars. Moreover,
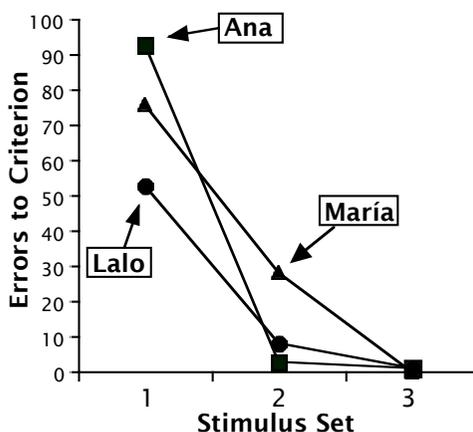

Figure 6. Errors to criterion made during probe phases by the children that learned under Procedure 2 alone. Participants learned Set 1 during Experiment 2 and Sets 2 and 3 during Experiment 3.

the effect of teaching the Categories and the Exemplars was more evident in Juana's performance than in the performance of the children who participated in Experiment 2. This finding may be due to her having learned the relations of Experiment 1 without learning the Categories and Exemplars. These data additionally support the hypothesis that Categories and Exemplars play an important role in the emergence of the novel intraverbals. Moreover, the three children who learned the Categories and the Exemplars showed the emergence of all novel relations within the first four 12-trial probes with Set 2 and within the first two 12-trial probes with Set 3. In contrast, Juana, the only child who did not learn the Categories and the Exemplars at the outset, did not demonstrate the emergence of all novel relations within that amount of probes with Sets 2 and 3. These data provide additional support to the possibility that teaching the Categories and the Exemplars facilitates the emergence of the novel relations.

General Discussion

The five 6-year-old children of Experiment 1, plus three experimentally naïve 6-year-old children who participated in Experiment 2, showed the emergence of novel intraverbals. Moreover, one child of Experiment 1 and three children of Experiment 2 demonstrated the novel intraverbals with two additional stimulus sets. The phenomenon was robust, as was shown by the eight participants and the within-participants replication with two additional

stimulus sets. Thus the experiments demonstrated that some intraverbals emerge from teaching other intraverbals with the arrangement used in the present research. After participants learn the four A-B Country-City and B-C City-Park operants with complex stimuli and a topography-based response (of the type of the intraverbal), other operants that share the stimuli and the responses of the taught intraverbal emerge. For example, the A-C Country-Park intraverbals, which share stimuli from the A-B intraverbal (e.g., "Argentina") and B-C intraverbal (e.g., "park"), emerge with the production of a response of the B-C intraverbal (e.g., "El Botánico").

One child from Experiment 1 demonstrated the emergence of all novel stimulus-response relations. The three experimentally naïve children of Experiment 2 and another child who participated in Experiment 1 also demonstrated the emergence of all novel stimulus-response relations after additional teaching with the Exemplars and the Categories in Experiment 2. Experiment 3 replicated the emergence of relations with new stimuli twice at a progressively faster pace with the participants of Experiments 1 and 2. As a result, those three studies demonstrated the emergence of all novel stimulus-response relations with verbal stimuli. After learning the four A-B Country-City and B-C City-Park intraverbals, participants of the present research responded accurately to eight other novel stimulus combinations, the B-A City-Country, C-B Park-City, A-C Country-Park, and C-A Park-Country relations.

The first goal of this sequence of experiments was to explore behavioral emergence with intraverbals. In reference to studies of equivalence and stimulus relations, the present experiments demonstrated for the first time a type of emergent relations with topography-based responses with the A-B-C protocol of stimulus equivalence. Because of these facts, this study opens the door for further study of emergent relations with topography-based responses of the type of the intraverbal.

Factors Involved in the Emergence of the Novel Relations

The secondary goal of this research was to analyze emergence of relations with intraverbals of the A-B-C type. Four of the five children who demonstrated the emergence of these relations did so after learning with more basic relations: the Categories and the Exemplars. One child demonstrated the emergence of the relations without being taught more basic relations. On one hand, these results indicate that the more basic operants are not necessary for the relations to emerge; at least they are not necessary for all children. On the other hand, these results indicate that learning these more basic relations facilitates the emergence of the novel relations; hence it seems that learning these basic relations is sufficient for most children to demonstrate the novel intraverbals. In addition, three children of Experiment 3 who learned the Categories and the Exemplars showed the emergence of all relations, whereas the fourth child failed to show the emergence of all intraverbals within the same number of probes, before learning the Categories and the Exemplars, as well in Set 2 as in Set 3. These results support the hypothesis that the more basic relations facilitate the emergence of all relations.

One interesting question is why learning Categories and Exemplars play a key role in the emergence of the novel, more complex relations? To answer this question, it is necessary to analyze the elements that constitute the

antecedent stimuli. The more basic relations are composed of fewer stimuli than the novel relations. For example, one instance of the Exemplars was "Name a city," while an instance of the novel intraverbal was "Name the city of El Botánico." In both cases the correct response is "Buenos Aires." The more basic relation, the Exemplars, has one less relevant stimulus than the novel relation. The situation is similar for the Categories; for example, "What is El Botánico?" has also only one relevant stimulus, "El Botánico." Thus it seems that teaching relations with one relevant stimulus may facilitate the learning of the relations with two relevant stimuli. Kennedy and Laitinen found a similar case (1988; see also Pérez-González & Martínez, 2007) when they studied the learning of conditional discriminations. They found that humans learn conditional discriminations easily with contextual stimuli (that make up a total of two antecedent stimuli plus the comparisons) after learning the simple conditional discriminations (that have only one antecedent stimulus plus the comparisons). Three of three participants in their study failed to learn the conditional discriminations with the contextual stimuli when the experimenters presented the conditional discriminations without subjects' previous experience with the simple conditional discriminations.

We do not know which specific factor from our study—the Categories, Exemplars, or the combination of both types of relations—is key to the emergence of novel relations. That both relation types were introduced at the same moment is due in part to time constraints for the research. Therefore it is possible that the Categories or the Exemplars alone will suffice to facilitate emergence of the novel relations.

Experiment 3 illustrated that the novel relations of each successive set of stimuli emerged at a faster pace than did the previous ones. These results indirectly replicated those found in conditional discriminations (Pérez-González, Spradlin, & Saunders, 2000; Saunders & Spradlin, 1990, 1993). There were, however, two differences among those studies and this research: In those studies on conditional discriminations, all the stimuli varied across sets. In this research some stimuli were constant; for example, the instructions, "Name a . . ." and "What is . . .?" were the same in Sets 1, 2, and 3. The stimuli, "country," "city," and, "park," also were the same. The other relevant stimuli, corresponding to countries, cities, and parks, on the contrary, varied across sets, just as stimuli did in the studies on conditional discriminations. Furthermore, in the former studies all conditional discriminations were taught, whereas in this research the relations we analyzed were emergent.

The results in Experiment 3 may also be related to Juana's performance in Experiment 1. This child demonstrated the emergence of the novel relations without learning more basic operants. Her performance may be due to her previous experience with some of the relations established among the stimuli of the study. Though pilot studies showed that most children of the same age as those in this study do not respond to these questions, even if the questions refer to Spain, some children respond to some questions such as "Name the country of Madrid"—"Spain." According to these studies, previous experience with countries, cities, or parks, or even other interrelated intraverbals, could have affected Juana's performance in the emergence probes. Juana may have had experience with the relations among countries, cities, and parks but not with the particular stimuli we used, because the initial probe showed that Juana did not respond to the questions correctly.

Limitations of the Present Research

This pioneer research has methodological limitations, including that most of its conclusions about the influence of Categories and Exemplars were based on interparticipant comparisons. An intraparticipant design, such as one that involves multiple baselines, would have provided a stronger case for the influence of the studied variables. When using a multiple baseline design, however, there is the risk that too many repeated probes might decrease the likelihood that 6-year-old children would change their responses. If that were the case, the chances of observing emergence would decrease.

The reinforcement contingencies were appropriate for the culture of Spain. The consequences for correct responses, such as saying "Very good!," increased behaviors in these experiments, as well as in many previous studies conducted in our laboratory: They were reinforcers. During probes, however, some participants made errors in the taught intraverbals. This finding indicates that the procedure did not maintain a quasi-errorless performance, as it did in other studies, including most of these conducted in our lab. It is likely that the complexity of the task, rather than the type of reinforcer, could have produced these errors. This circumstance could have delayed the emergence but could not prevent it. We have frequently found that repeated probing produces emergent performance: delayed emergence (Layng & Chase, 2001). Future research should consider a gradual reduction in the rate of reinforcement during the phases previous to the probes and the interspersion of reinforcement of responses that correspond to previously taught intraverbals.

Emergence of Intraverbals and of Selection-Based Operants

One of the justifications for these studies was the need to inquire whether the processes involved in typical studies of stimulus equivalence are similar to the processes involved in the emergence of the intraverbals. The results are remarkably dissimilar. Symmetry, transitivity, and equivalence emerge without difficulty in stimulus equivalence studies (e.g., Boelens, van den Broke, & van Klarenbosch, 2000, who obtained symmetry with two-year-old children; Sidman & Tailby, 1982, who obtained symmetry, transitivity, and equivalence). On the contrary, only one of five children who did not learn the Categories and the Exemplars showed the emergence of the B-A, C-B, A-C, and C-A relations. Thus, with the intraverbals it is somehow difficult that all relations emerge. The C-B intraverbals emerged in three children, yet some children's performances were inconsistent. The other intraverbals that inverted the stimulus-response terms of one taught intraverbal, the B-A intraverbal—which is similar to symmetry—emerged in only one child. Consequently it seems that the emergence of a type of "symmetrical" intraverbals, similar to C-B, is more likely than the other symmetrical intraverbals—similar to B-A. The A-C intraverbal also emerged in four of five children. The remaining intraverbals, the C-A intraverbals, emerged with difficulty, that is, they emerged in only one of the five participants of Experiment 1 and were the last to emerge in all participants of Experiments 2 and 3. Thus a comparison between the outcomes obtained in stimulus equivalence with selection-based conditional-discrimination procedures results in notable differences. There are also some common points: for instance, the fact that the intraverbal relations equivalent to the symmetry (B-A and C-B) in these experiments emerged before or during the same probe session as C-A in most children, just as it happens in studies on stimulus equivalence (e.g.,

Adams, Fields, & Verhave, 1993; Fields et al., 2000). In conclusion, the processes observed in stimulus equivalence and those observed with intraverbals differ enough to indicate that it is worthwhile to investigate the new phenomenon of the emergence of intraverbals. At the same time, the commonalities of the two paradigms permit researchers to incorporate a great number of strategies used in stimulus equivalence and stimulus relations research into the study of the emergence of intraverbals. The present investigation should be replicated and extended. It implies a myriad of procedures that will promote interesting research and could benefit from the publication of studies about stimulus equivalence and stimulus relations.

The following theoretical descriptions and assumptions constitute theoretical backgrounds with which the present results can be analyzed: Skinner's (1957) analysis of verbal behavior; relational frame theory (e.g., Hayes, 1991, 1994; Hayes, Barnes-Holmes, & Roche, 2001; Hayes & Hayes, 1989); Sidman's (1986, 1994, 2000) analysis in terms of stimulus equivalence; analyses based on contextual control (e.g., Dymond & Barnes, 1995; Gatch & Osborne, 1989; Griffee & Dougher, 2002; Lynch & Green, 1991; Meehan & Fields, 1995; Pérez-González & Martínez, 2007; Pérez-González & Serna, 1993, 2003; Serna & Pérez-González, 2003; Steel & Hayes, 1991); naming theory (e.g., Horne & Lowe, 1996); analyses in terms of intersecting classes (Sidman, 1994, pp. 528–530 & epilogue; see also Alonso-Álvarez & Pérez-González, 2003, 2006, and Mackay, Wilkinson, Rosenquist, & Farrell, 2003); and joint control (Lowenkron, 1997, 1998). The present data, however, are difficult to interpret within the limitations of most of these theoretical frameworks.

Applications

The potential applications of the paradigm of the present research are enormous, in addition to the applications of the relations that were shown with countries, cities, and parks. Part of the potential derives from the operants used in the present research are those that children learn at school and are public knowledge. Many stimulus relations in everyday life have the same structure, such as the relations among composers, instruments, and musical periods and those among architectural styles, types of columns, and monuments. Teachers of normally developing students may benefit from knowing the conditions in which such operants emerge.

Applications of this model in special education are also obvious. For example, under certain conditions, teaching children with autism to respond to intraverbals is simple. A qualitative step is produced, however, when the children are taught with a few intraverbals and they respond consistently to novel questions: Novel intraverbals emerge (Pérez-González et al., 2007). These children would also demonstrate evidence of reasoning when taught with the appropriate procedure.

One of the reasons that these studies have so many applications is that we used topography-based operants that occur often in everyday life. The conditional discriminations used in conditional discrimination studies are not so common in everyday life, because they are selection-based responses. Our research shows, in any case, that the research on stimulus relations has important practical applications.

References

ADAMS, B. J., FIELDS, L., & VERHAVE, T. (1993) Effects of test order on inter-subject variability during equivalence class formation. *The Psychological Record*, 43, 133–152.

ALONSO-ÁLVAREZ, B., & PÉREZ-GONZÁLEZ, L. A. (2003, July). *Joint control by two samples in conditional discriminations.* Poster presented at the First Conference of the European Association of Behaviour Analysis, Parma, Italy.

ALONSO-ÁLVAREZ, B., & PÉREZ-GONZÁLEZ, L. A. (2006). Emergence of complex conditional discriminations by joint control of compound samples. *The Psychological Record*, 56, 447–463.

BARNES-HOLMES, D., BARNES-HOLMES, Y., & CULLINAN, V. (2000). Relational frame theory and Skinner's *Verbal Behavior*: A possible synthesis. *The Behavior Analyst*, 23, 69–84.

BARNES-HOLMES, Y., BARNES-HOLMES, D., ROCHE, B., & SMEETS, P.M. (2001a). Exemplar training and a derived transformation of function in accordance with symmetry. *The Psychological Record*, 51, 287–308.

BARNES-HOLMES, Y., BARNES-HOLMES, D., ROCHE, B., & SMEETS, P.M. (2001b). Exemplar training and a derived transformation of function in accordance with symmetry: II. *The Psychological Record*, 51, 589–603.

BOELENS, H., VAN DEN BROKE, M., & VAN KLARENBOSCH, T. (2000). Symmetric matching to sample in 2-year-old children. *The Psychological Record*, 50, 293–304.

CHASE, P. M., JOHNSON, K. R., & SULZER-AZAROFF, B. (1985). Verbal relations within instruction: Are there subclasses of intraverbal? *Journal of the Experimental Analysis of Behavior*, 43, 301–313.

DYMOND, S., & BARNES, D. (1995). A transformation of self-discrimination response functions in accordance with the arbitrarily applicable relations of sameness, more than, and less than. *Journal of the Experimental Analysis of Behavior*, 64, 163–184.

FIELDS, L, VARELAS, A., REEVE, K. F., BELANICH, J., WADHWA, P., DEROSSE, P., & ROSEN, D. (2000). Effects of prior conditional discrimination training, symmetry, transitivity, and equivalence testing on the emergence of new equivalence classes. *The Psychological Record*, 50, 443–466.

GATCH, M. B., & OSBORNE, J. G. (1989). Transfer of contextual stimulus function via equivalence class development. *Journal of the Experimental Analysis of Behavior*, 51, 369–378.

GRIFFEE, K., & DOUGHER, M. J. (2002). Contextual control of stimulus generalization and stimulus equivalence in hierarchical categorization. *Journal of the Experimental Analysis of Behavior*, 78, 433–447.

HALL, G. A., & CHASE, P. N. (1991). The relationship between stimulus equivalence and verbal behavior. *The Analysis of Verbal Behavior*, 9, 107–119.

HARLOW, H. F. (1949). The formation of learning sets. *Psychological Review*, 56, 51–65.

HAYES, S. C. (1991). A relational theory of stimulus equivalence. In L. J. Hayes & P. N. Chase (Eds.) *Dialogues on verbal behavior* (pp. 19–40). Reno, NV: Context Press.

HAYES, S. C. (1994). Relational frame theory: A functional approach to verbal

events. In S. C. Hayes, L. J. Hayes, M. Sato, & K. Ono (Eds.), *Behavior analysis of language and cognition* (pp. 9–30). Reno, NV: Context Press.

HAYES, S. C., BARNES-HOLMES, D, & ROCHE, B. (2001). *Relational frame theory: A post-Skinnerian account of human language and cognition.* New York: Plenum Publishers.

HAYES, S. C., & HAYES, L. J. (1989). The verbal action of the listener as a basis for rule governance. In S. C. Hayes (Ed.), *Rule-governed behavior: Cognition, contingencies, and instructional control* (pp. 153–190). New York: Plenum Press.

HAYES, S. C., & HAYES, L. J. (1993). Applied implications of current JEAB research on derived relations and delayed reinforcement. *Journal of Applied Behavior Analysis*, 26, 507–511.

HORNE, P. J., & LOWE, C. F. (1996). On the origins of naming and other symbolic behavior. *Journal of the Experimental Analysis of Behavior*, 65, 185–241.

KENNEDY, C. H., & LAITINEN, R. (1988). Second-order conditional control of symmetric and transitive stimulus relations: the influence of order effects. *The Psychological Record*, 38, 437–446.

LAMARRE, J., & HOLLAND, J. G. (1985). The functional independence of mands and tacts. *Journal of the Experimental Analysis of Behavior*, 43, 5–19.

LAYNG, M. P., & CHASE, P. N. (2001). Stimulus-stimulus pairing, matching-to-sample testing, and emergent relations. *The Psychological Record*, 51, 605–628.

LIPKENS, R., HAYES, S. C., & HAYES, L. J. (1993). Longitudinal study of the development of derived relations in an infant. *Journal of Experimental Child Psychology*, 56, 201–239.

LOWENKRON, B. (1997). The role of joint control in the development of naming. *Journal of the Experimental Analysis of Behavior*, 68, 244–247.

LOWENKRON, B. (1998). Some logical functions of joint control. *Journal of the Experimental Analysis of Behavior*, 69, 327–354.

LUCIANO, M. C. (1986). Acquisition, maintenance, and generalization of productive intraverbal behavior through transfer of stimulus control procedures. *Applied Research in Mental Retardation*, 7, 1–20.

LYNCH, D. C., & GREEN, G. (1991). Development and crossmodal transfer of contextual control of emergent stimulus relations. *Journal of the Experimental Analysis of Behavior*, 56, 139–154.

MACKAY, H., WILKINSON, K., ROSENQUIST, C., & FARRELL, C. (2003, July). *Variables influencing stimulus class merger and intersection.* Poster presented at the First Conference of the European Association of Behaviour Analysis, Parma, Italy.

MEEHAN, E. F., & FIELDS, L. (1995). Contextual control of new equivalence classes. *The Psychological Record*, 45, 165–182.

MICHAEL, J. (1985). Two kinds of verbal behavior plus a possible third. *The Analysis of Verbal Behavior*, 3, 1–4.

PARTINGTON, J. W., & BAILEY, J. S. (1993). Teaching of intraverbal behavior to preschool children. *The Analysis of Verbal Behavior*, 11, 9–18.

PÉREZ-GONZÁLEZ, L. A. (1994). Transfer of relational stimulus control in conditional discriminations. *Journal of the Experimental Analysis of Behavior*, 61, 487–503.

PÉREZ-GONZÁLEZ, L. A. (2001). Concept formation based on the relations

among values of multi-component figures. *Behavioural Processes,* 56, 1–14.

PÉREZ-GONZÁLEZ, L. A., GARCÍA-ASENJO, L., WILLIAMS, G., & CARNERERO, J. J. (2007). Emergence of intraverbals with antonyms as responses in children with pervasive developmental disorder. *Journal of Applied Behavior Analysis*, 40, 697–701.

PÉREZ-GONZÁLEZ, L. A., & MARTÍNEZ, H. (2007). Control by contextual stimuli in novel second-order conditional discriminations. *The Psychological Record*, 57, 117–143.

PÉREZ-GONZÁLEZ, L. A., & MORENO-SIERRA, V. (1999). Equivalence class formation in elderly persons. *Psicothema*, 11, 325–336.

PÉREZ-GONZÁLEZ, L. A., & SERNA, R. W. (1993). Basic stimulus control functions in the five-term contingency. Experimental Analysis of Human Behavior Bulletin, 11, 52–54.

PÉREZ-GONZÁLEZ, L. A., & SERNA, R. W. (2003). Transfer of specific contextual functions to novel conditional discriminations. *Journal of the Experimental Analysis of Behavior*, 79, 395–408.

PÉREZ-GONZÁLEZ, L. A., SPRADLIN, J. E., & SAUNDERS, K. J. (2000). Learning-set outcome in second-order conditional discriminations. *The Psychological Record*, 50, 429–442.

POLSON, D. A. D., & PARSONS, J. A. (2000). Selection-based versus topography-based responding: An important distinction for stimulus equivalence? *The Analysis of Verbal Behavior*, 17, 105–128.

SAUNDERS, K. J., & SPRADLIN, J. E. (1990). Conditional discrimination in mentally retarded adults: The development of generalized skills. *Journal of the Experimental Analysis of Behavior*, 54, 239–250.

SAUNDERS, K. J., & SPRADLIN, J. E. (1993). Conditional discrimination in mentally retarded adults: Programming acquisition and learning set. *Journal of the Experimental Analysis of Behavior*, 60, 571–585.

SERNA, R. W., & PÉREZ-GONZÁLEZ, L. A. (2003). An analysis of generalized contextual control of conditional discriminations. *Journal of the Experimental Analysis of Behavior*, 79, 383–393.

SIDMAN, M. (1971). Reading and auditory-visual equivalencies. *Journal of Speech and Hearing Research*, 14, 5–13.

SIDMAN, M. (1986). Functional analysis of emergent verbal classes. In T. Thompson & M. D. Zeiler (Eds.) *Analysis and integration of behavioral units* (pp. 213–245). Hillsdale, NJ: Lawrence Erlbaum.

SIDMAN, M. (1994). *Equivalence relations and behavior: A research history.* Boston: Authors Cooperative.

SIDMAN, M. (2000). Equivalence relations and the reinforcement contingency. *Journal of the Experimental Analysis of Behavior*, 74, 127–146.

SIDMAN, M., & CRESSON, O. (1973). Reading and crossmodal transfer of stimulus equivalences in severe retardation. *American Journal of Mental Deficiency*, 77, 515–523.

SIDMAN, M., CRESSON, O., & WILLSON-MORRIS, M. (1974). Acquisition of matching to sample via mediated transfer. *Journal of the Experimental Analysis of Behavior*, 22, 261–273.

SIDMAN, M., & TAILBY, W. (1982). Conditional discrimination vs. matching to sample: An expansion of the testing paradigm. *Journal of the Experimental Analysis of Behavior*, 37, 5–22.

SKINNER, B. F. (1957). *Verbal behavior.* Englewood Cliffs, NJ: Prentice-Hall.

STEEL, D., & HAYES, S. C. (1991). Stimulus equivalence and arbitrarily applicable relational responding. *Journal of the Experimental Analysis of Behavior*, 56, 519–555.

STROMER, R. (2000). Integrating basic and applied research and the utility of Lattal and Perone's *Handbook of Research Methods in Human Operant Behavior*. *Journal of Applied Behavior Analysis*, 33, 119–136.

STROMER, R., MACKAY, H. A., & REMINGTON, B. (1996). Naming, the formation of stimulus classes, and applied behavior analysis. *Journal of Applied Behavior Analysis*, 29, 409–431.

SUNDBERG, C. T., & SUNDBERG, M. L. (1990). Comparing topography-based verbal behavior with stimulus selection-based verbal behavior. *The Analysis of Verbal Behavior*, 8, 31–41.

TWYMAN, J. S. (1996). The functional independence of impure mands and tacts of abstract stimulus properties. *The Analysis of Verbal Behavior*, 13, 1–19.

WATKINS, C. L., PACK-TEIXTEIRA, L., & HOWARD, J. S. (1989). Teaching intraverbal behavior to severely retarded children. *The Analysis of Verbal Behavior*, 7, 69–81.