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Multiple Exemplar Instruction and the Emergence of Generative Production of Suffixes as Autoclitic Frames

JeanneMarie Speckman, Fred S. Keller School and Columbia University Teachers College
R. Douglas Greer, Columbia University Teachers College and the Graduate School of Arts and Sciences
Celestina Rivera-Valdes, Fred S. Keller School

We report 2 experiments that tested the effects of multiple exemplar instruction (MEI) across training sets on the emergence of productive autoclitic frames (suffixes) for 6 preschoolers with and without language-based disabilities. We implemented multiple exemplar tact instruction with subsets of stimuli whose ''names'' contained the suffix ''-er'' denoting the comparative form of adjectives. Subsets of stimuli included regular, irregular, and contrived tacts containing the target relational autoclitic frame in order to determine if our MEI procedure would induce the abstraction of the frame across all stimulus sets. In the second experiment, additional tasks were introduced to the participants to control for a possible sequence effect. A nonconcurrent multiple probe design was used to evaluate the functional relation between MEI and emergence of untaught tact responses containing the comparative adjective ''-er.'' The results of both experiments showed relations between MEI and novel, untaught tact responses containing the target autoclitic frame; the second experiment showing a functional relation. The results are discussed in terms of environmental sources for productive verbal behavior.

Key words: verbal behavior, autoclitics, multiple exemplar instruction, grammar, suffixes

By age 6, it is likely that a child will have a repertoire of thousands of words, and on average, children increase their vocabulary at a rate of five to eight words per day between the ages of 1 and 6 years (Wagner, 1985). A child's syntax, or grammatical structures (Catania, 1998; Freidin, 1992), progress throughout the first 6 years of life from single word utterances to multiple word utterances which are, at first, telegraphic, and then increase in complexity so that they are more similar to adult speech. As a child's language advances, it also becomes productive. Productivity refers to the novel utterances that are emitted by humans; forms and functions of language that have never been emitted by individuals in the past (Catania, 1998; Hayes, Barnes-Holmes & Roche, 2001). Both formal accounts of an innate predisposition for language development (Chomsky, 1957; Jackendoff, 2002; Pinker, 1999) and functional accounts of verbal behavior as operant behavior (Skinner, 1957) have included explanations as to why language is productive.

Roger Brown (1973) described five stages of language acquisition based on extensive data collected from the spontaneous speaker performance of three children over time (from 1 year, 6 months to 4 years). He set up these stages according to the mean length of utterances (MLU) of children who were learning the English language as their first language. Brown found that MLU, not age, was a good predictor of grammatical morpheme development. MLUs for these children were positively correlated with the acquisition of specific morphemes in a specific order. The morphemes studied included (a) ''-ing,'' denoting the present progressive tense as in ''she is walking,'' (b) ''-'s,'' denoting the possessive as in ''Justin's book,'' and (c) ''-ed,'' denoting past tense as in ''I walked to the store.'' These morphemes fall into Skinner's (1957) secondary verbal operant category of ''autoclitics'' provided that they have certain verbal functions.

Skinner's 1957 work *Verbal Behavior* provided a functional analysis of language

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Correspondence and requests for reprints should be addressed to JeanneMarie Speckman, Fred S. Keller School, 1 Odell Plaza Yonkers, New York 10701. (e-mail:jeannespeckman@optonline.net).

Table 1
Skinner's (1957) Classification of Autoclitics

Autoclitic category	Functional description (controlled by…)	Example
Descriptive	conditions under which the response is emitted; decreases the possibility of punishment from the audience	''I regret to inform you''
Qualifying	motivating operation (MO) to qualify a primary verbal operant—to extend, negate, assert	''That was not funny''
Quantifying	modify the behavior of the listener MO to quantify a primary verbal operant to sharpen meaning for the listener	''I will need all of the the documents''
Manipulative	MO to mand a listener to respond to the primary verbal operant in a certain manner	''Take this with a grain of salt''
Relational	MO to mand the listener to respond to relationships among primary verbal operants; may involve grammatical structure	the mother's voice

characterized by the relations between the behavior of individual speakers and the behavior of the individuals within a verbal community of which the speakers are a part. Verbal behavior is ''behavior reinforced through the mediation of other persons'' (Skinner, 1957, p. 2). Verbal behavior is operant behavior and, thus, must be explained in terms of an individual's history of reinforcement. Skinner's account was designed to describe the events that control the emission of the behavior of the speaker. Skinner organized verbal behavior by the functions of verbal operants, for example, mands specified reinforcers and were controlled by an individual's state of deprivation; tacts were occasioned by the presence of a stimulus and were controlled by the social reinforcement of the listener. Autoclitic behavior is verbal behavior that serves to qualify, quantify, assert, or negate other verbal behavior (Skinner, 1957). In contrast to primary verbal operants such as mands and tacts, both of which are defined by distinct controlling variables specific to each, the autoclitic is ''based on or depends on other verbal behavior'' (Skinner, 1957, p. 315). Autoclitic responses are not emitted by themselves, but instead accompany primary verbal behavior. When primary verbal behavior is accompanied by autoclitic behavior, or secondary verbal behavior, the effects of the primary operants are sharpened (Howard & Rice, 1988). Thus, the reinforcement for autoclitic behavior is the more precise effects on the listener, and the controlling variable for the autoclitic is ''some aspect of the controlling relation for the primary response'' (Howard & Rice, 1988, p. 45).

Autoclitics, according to Skinner, may be classified into five types, which are described in Table 1. Relational autoclitics may recombine with other known verbal responses when the appropriate context occasions this. For example, when a child learns that an ''-s'' tagged onto the end of a word denotes plurality, the child may combine the ''-s'' ending with a novel tact or mand when she encounters more than one of the items. The ''-s'' ending is an example of an autoclitic frame. At first, the tact + autoclitic may be acquired as primary and secondary behavior and may be controlled and reinforced accordingly. After a reinforcement history has then been established, the components may combine into one verbal operant, in which the entire structural unit functions as a tact or a mand.

Twyman's (1996) research demonstrated that when preschool participants with disabilities were taught autoclitics (whole, large, soft, and wooden) across independent verbal behavior functions (tacts and mands), the acquisition of autoclitics in one function did not lead to the abstraction of the autoclitics to the untaught functions. For example, if a participant was taught the autoclitic ''wooden'' in a mand function (mand a wooden block), he did not emit the untaught tact function as well (tact a wooden block). Howard and Rice (1988) studied the emer-

gent qualifying autoclitics of four preschool children classified as having average language skills. The autoclitics that were investigated in this experiment were described by the authors as ''those evoked by the weak stimulus control of a primary tact'' (Howard and Rice, 1988, p. 48). The investigators taught the participants to tact stimuli across a range of colors, shapes, and letters and then taught the participants to respond with the autoclitic + tact phrase ''like a _____'' to distorted exemplars of the stimuli. They conducted probes for untaught or emergent responses (autoclitic + tact phrases) to stimuli that had never been taught with the autoclitic + tact phrase. The results showed that all participants acquired generalized autoclitic behavior, or the abstraction of the autoclitic phrase. The authors concluded that ''autoclitic training needs to be conducted with more than one concept before generalization is likely to occur'' (Howard and Rice, 1988, p. 56).

When individuals are exposed to a variety of exemplars across different situational contexts, responses and the sources of stimulus control over them are refined. ''Contextual dimensions of the training tasks must vary… while reinforcement is maintained so that relevant features of the task can be discriminated'' (Hayes et al., 2001, p. 26). During intensive instruction or extensive incidental experiences, many exemplars and nonexemplars are presented and responding to a particular stimulus is differentially reinforced (Fields, et al., 2002). Using many within-class exemplars during discrimination training has been shown to increase the likelihood of perceptual class formation (Brown, Brown, & Poulson, 1995; Fields et al., 2002; Gena, Krantz, McClannahan, & Poulson, 1996), relational frame formation (Hayes & Barnes, 1997; Steel & Hayes, 1991; O'Hora, Roche, Barnes-Holmes, & Smeets, 2002) and transformation of stimulus function across functionally independent operants (Greer, Yuan, & Gautreax, 2005). Greer, Stolfi & Pistoljevic (2007) isolated the rapid rotation of multiple exemplars across response forms and found that it was functionally related to the induction of naming in several preschoolers with disabilities. The effects of MEI on the emergence of naming have been replicated across with typically and nontypically developing children of different ages (Fiorile & Greer, 2007; Gilic & Greer, 2011; Greer, Corwin, & Buttigieg, 2011; Greer, et al., 2007). A similar effect with different responses and stimuli were found for children who could not emit a written or spoken spelling response after being taught a single response. The results showed that the untaught responses emerged after rapidly rotated multiple exemplar experiences across different responses, written or oral, for both the original stimuli and novel stimuli (Greer & Keohane, 2005). These results exemplified transformation of stimulus function, or the property of a relational frame that is shown when, ''in a given context, if there is a mutual relationship between A and B, and A has some psychological functions, then in a context that selects the functions as relevant, the stimulus functions of B may be transformed consistent with its mutual relation to A'' (Hayes, Barnes-Holmes, & Roche, 2001, p. 11).

Luke, Greer, Singer-Dudek, and Keohane (2011) found that children with autism and language disabilities abstracted spatial autoclitic frames following a multiple exemplar instruction (MEI) procedure across different sets of stimuli containing the frame. In a second experiment, they demonstrated the same effect in typically developing bilingual preschool-age children. In the latter experiment, the children demonstrated untaught usage of mand or tact frames regardless of whether they were taught to respond only as listeners, only as speakers, or both as listeners and speakers. Thus, in the latter experiment, both abstraction of the autoclitic frame and transformation of stimulus function across speaker and listener functions were shown.

The way in which one learns language is by all accounts a socially significant area of inquisition, as we would argue that one's level of verbal behavior is a key determining factor in one's ability to access social reinforcement (Eby, 2011; Schmelzkopf, 2010). But more specifically, the source of abstraction for certain verbal operants that contribute to language productivity is of particular importance. Such verbal outcomes as abstraction (Greer & Yuan, 2008), transformation of stimulus function (Hayes & Barnes, 1997; Steel & Hayes, 1991; O'Hora et al., 2002), and naming (Fiorile & Greer,

Table 2
Description of Participants From Experiment 1

Participant	Age	Standardized scores	Verbal repertoires
A	5 years	REEL (2000) Expressive Language Age Equivalent—12 months Receptive Language Age Equivalent—14 months	– Followed directions – Generalized Imitation – Mands with autoclitics – Tacts with autoclitics – Intraverbal repertoire – Engaged in conversational units
B	4 years 5 months	Rosetti Infant Toddler Language Scale (1990) Skills solid at 15 months Scattered skills to 27 months	– Followed directions – Generalized Imitation – Mands with autoclitics – Tacts with autoclitics – Generalized matching – Intraverbal repertoire – Engaged in conversational units
C	4 years 3 months	No testing conducted—Typically developing preschooler	– Followed directions – Generalized Imitation – Mands with autoclitics – Tacts with autoclitics – Intraverbal repertoire – Engaged in conversational units – Tacted past events

2007; Greer & Longano, 2010; Greer et al., 2007; Horne & Lowe, 1996) have been induced via implementation of MEI.

The expansion of one's speaker repertoire is partially dependent on one's ability to abstract affixes (including relational autoclitic frames) and respond to one's environment (e.g., via tacts) and states of being (e.g., via mands) with previously unspoken verbal behavior. Although it is well documented that children without innate disabilities readily acquire productive language (Brown et al., 1995; Hart & Risley, 1995) given adequate verbal experiences, there has been limited research conducted on the precise language experiences necessary for the acquisition and abstraction of autoclitic frames. Thus, in the present two experiments, we sought to investigate the source of the abstraction of the autoclitic frame ''-er,'' denoting comparative form, by studying the effects of MEI on this dependent variable in preschoolers with and without disabilities. MEI was implemented following single-exemplar instruction (SEI), in which only one exemplar of the autoclitic frame was taught and abstraction did not occur.

EXPERIMENT 1
METHOD

Participants

Three male preschoolers participated in Experiment 1 (see Table 2). Participants were recruited from a preschool for children with and without special needs in the suburbs of a major metropolitan area. Participants A and B were described as having language delays by speech-language therapists, and Participant C was a typically developing preschooler.

Setting

This experiment took place in a center-based preschool for both children with disabilities and typically developing children. The school was located outside a major metropolitan area. The school follows a comprehensive behavioral model of schooling.

The participants all attended a half-day special class or a class comprised of typically developing children and children with developmental delays. Sessions took place in the

children's classrooms at small child-sized tables, while other children received individual instruction, small group instruction, or engaged in free-play opportunities. The experimenter sat across from the participant and both the participant and the experimenter sat in child-sized chairs. When a second observer was present, she sat approximately 3 feet behind or next to the experimenter so that she could both view the stimuli and hear the participants' responses.

Instructional Stimuli

The stimuli that were presented to the participants were laminated pictures measuring 7 to 10 cm^2 (see Table 3). The pictures included both photographs and drawn exemplars. The pictures that were used were created from educational software (The Big Box of Art, 2002). Some of the pictures were manipulated in the software program in order to exaggerate features.

During pre-experimental instruction, the participants were taught to tact the following attributes in pictures: big, thin, tall, wet, rainy, small, long, hot, wide, cloudy, flat, sunny, dark, crooked, colorful, open, and far. These target responses were selected because they were positive forms of descriptive adjectives, all of which had a comparative form (i.e., big-bigger; far-farther). An additional set of stimuli consisted of four drawn pictures with the nonsense names blooby, frook, dilly, and shump. These pictures each had a particular attribute that was magnified or accented to exemplify contrived comparative forms that were labeled bloobier, frooker, dillier, and shumper, respectively. In coining these nonsense names, the experimenters made sure that they did not rhyme with any of the target words in the other sets so that none of the nonsense words sounded similar to words in the other sets. Also, the words needed to easily form a comparative via the addition of an ''-er'' ending. For each stimulus set, the stimuli included two exemplars of each adjective (e.g., two exemplars of tall; two exemplars of long).

The stimulus sets also included two-dimensional pictures that exemplified the comparative form of each adjective; also with two exemplars per adjective. The comparative forms of the chosen adjectives

Table 3
Experimental Design and Stimuli Sets for Experiment 1. Multiple Exemplar Instruction Was Time Lagged Following the MEI I Phase

Participant	Pre-Exp Teach positive, probe comparative	SEI Teach/Probe	MEI I T/P	MEI II T/P	MEI III	Novel
A	Set 1: thinner, wetter, rainier, taller Set 2: longer, smaller, hotter, wider Set 3: sunnier, cloudier, darker, flatter Set 4 (irregular): crooked-er, open-er, far-er, colorful-er Set 5: diller, frooker, shumper, bloobier	Bigger/All sets	Set 1/2,3,4,5	Set 3/4,5	Set 6/4,5 Set 6: higher, windier, stormier, shorter	lower, starrier, winding-er, gaf-er
B	Same	Same	Set 2/1,3,4,5	Set 1/3,4,5	n/a	
C	Same	Same	Set 3/1,2,4,5	n/a	n/a	

were, respectively: bigger, thinner, taller, wetter, rainier, smaller, longer, hotter, wider, cloudier, flatter, sunnier, darker, more crooked, more colorful, more open, farther, bloobier, frooker, dillier, shumper. The pictures that exemplified the comparative forms were created by manipulating the original pictures within the software program (users are able to lengthen, widen, shorten, heighten, and manipulate the overall size of the picture). Prior to laminating the pictures, the experimenter made other alterations to the pictures by hand, using colored markers, pens, and colored pencils. For example, to exemplify the comparative form ''rainier,'' additional raindrops were added to a picture exemplifying ''rainy,'' and to exemplify the comparative form ''wetter,'' a larger pool of water was added to a picture exemplifying ''wet.'' For the tact ''blooby,'' a circle with smaller circles surrounding it was made ''bloobier'' by the addition of more small circles. For the tact ''frook,'' an oval with lines protruding from it was made ''frooker'' by the addition of more lines. For the tact ''dilly,'' a line with tick marks through it (resembling a number line) was made ''dillier'' by the addition of more tick marks. The tact ''shump'' was exemplified by 3–4 *s*-shaped lines on a card, and was made ''shumper'' by the addition of 3–4 more *s*-shaped lines.

In addition to the stimuli described above, participant A received MEI with one additional stimulus set (Set 6 in Table 3). Finally, as also shown in Table 3, following MEI, all participants were exposed to tact training and comparative form probes involving a novel set of stimuli that contained two regular adjectives (lower, starrier), one irregular adjective (winding-er), and one nonsense comparative (gaf-er).

Response Definitions

In this study, correct responses to comparative form stimuli were defined as vocal responses that included the target tact + the autoclitic frame ''-er'' and that were emitted by the participants within 2 s of the presentation of a picture. No vocal stimulus was presented; therefore, the participant was required to respond to the presentation of the picture stimulus alone. An example of a correct response was as follows: when the participant was presented with two lines of differing lengths, he would tact ''long'' when the experimenter pointed to the long line. A longer line would then be placed next to the long line. A correct response would be scored if the participant responded ''longer'' when the experimenter pointed to the longer line. The participants had all previously mastered the positive forms (in this example, ''long'') in the pre-experimental instruction phase; however, if the participant tacted ''long'' incorrectly, the experimenter provided a correction procedure (described in the next section) and no opportunity was provided to tact the comparative form. Incorrect tacts were recorded when the participant responded with a nontargeted vocalization to a comparative form or if the participant emitted no response within a 2-s latency to a comparative form. Important to note is that the responses ''crooked-er,'' ''colorful-er,'' ''open-er,'' and ''far-er'' were considered correct because we were testing for the abstraction of the autoclitic frame; not grammatically correct utterances. Therefore, if a participant had emitted a grammatically correct utterance, the data would have reflected an incorrect response for the abstraction of the frame.

Data Collection and Interobserver Agreement

Data were recorded on data collection forms. Following each session, the number of correct responses were counted, recorded, and then plotted on a graph. We recorded the participants' responses to probe trials (i.e., trials with no consequences) and learn units (i.e., instructional presentations that included reinforcement or correction operations) throughout the experiment.

Interobserver agreement was assessed for 16% of the SEI sessions, 27% of the MEI sessions and 57% of the probe sessions, by comparing the records of two independent observers and determining the percentage of trials or learn units that both scored as correct or both scored as incorrect. Interobserver agreement was 100% for all instructional and probe sessions. Procedural fidelity was monitored by Teacher Performance Rate Accuracy (TPRA) (Ingham & Greer, 1992) observation protocol during 10% of the training sessions and was 100% for all monitored sessions.

Procedure

Experimental design. The experimental design was a delayed multiple-probe design. The multiple-probe design was implemented after the MEI 1 phase took place for each participant. The dependent variable was participant correct tact + autoclitic responses to probe trials conducted throughout the experiment before and after SEI and MEI.

Pre-experimental instruction. The participants were first taught to tact the following attributes in pictures: big, thin, tall, wet, rainy, small, long, hot, wide, cloudy, flat, sunny, dark, crooked, colorful, open, blooby, frook, shump, and dilly. The participants were taught to tact these attributes using instructional trials that met the criteria for learn units until they could do so with 90% accuracy across two consecutive sessions or 100% accuracy for one session. For each session, each target stimulus was presented twice for a total 40 trials. The pictures were presented in the presence of a negative exemplar in order to make the relevant feature of the target stimulus more salient. For example, a big dog and a small dog were presented and the experimenter pointed to the small dog to occasion the tact ''small.'' Trials consisted of the presence of an unambiguous stimulus and the attainment of the child's attention to the stimulus, the avoidance of unwitting prompts by the experimenter, an opportunity to respond, and one of two teacher consequences for responses. A correct response for this example was the participant's vocalization ''small.'' For correct responses, items and events that functioned as reinforcers for each child's responses to instruction were delivered immediately. Incorrect responses, which included responses other than the target response or no response (e.g., ''I don't know''), were followed by re-presentations of the stimulus with the experimenter stating the correct response and the child repeating the correct response while attending to the stimulus. Corrected responses were not reinforced, consistent with learn unit protocol (Emurian, Hu, Wang, & Durham, 2000; Greer & McDonough, 1999).

Probes. We conducted initial probes to test for the presence or absence of tacts of the comparative forms in the participants' repertoires and found them not be present. For each trial, an exemplar of a tact that had been taught during pre-experimental instruction (e.g., tall, rainy, small) and a negative exemplar (e.g., not tall, not rainy, not small, respectively) was presented to the participant and the participant was required to tact the target positive exemplar in the presence of the negative exemplar. No vocal directions were given to the participant. Once the participant tacted the positive form (e.g., rainy in the presence of ''not'' rainy), the comparative exemplar was placed next to it (e.g., rainier). Each stimulus set contained two exemplars of each of four different tact forms. During each probe session, each exemplar was presented once. Thus, for each stimulus set, two exemplars of each of the four target forms were presented, which totaled 8 trials per set. No reinforcement or correction procedures were used during these or any of the subsequent probes for untaught relations.

Single exemplar instruction. During SEI, only one exemplar of a tact with the target autoclitic frame (''bigger'') was taught. Twenty-trial sessions were conducted until the participants achieved the mastery criterion of 90% correct responding for two consecutive sessions or 100% for one session. For each trial, a picture of a ''big'' dog, brush or circle was presented to the participants individually on a table in front of them next to a picture of a ''not big'' exemplar of these objects. A correct response for the participants occurred when they tacted the picture ''big'' within 2 s when the experimenter gestured to it. Next, a picture of ''bigger'' was placed next to the picture of ''big.'' The participant had 2 s to respond with the vocal tact ''bigger.'' If the participants emitted a correct response, the teacher delivered social praise (e.g., ''You're right!''; ''That's correct''). Tokens were delivered to participants for whom tokens functioned as reinforcers, and edibles or preferred items were delivered to children for whom tokens did not function as reinforcers. If the participant did not respond at all, emitted a different response or responded after the 2-s latency had elapsed, the experimenter presented a vocal correction (''bigger''). The participant was required to echo the vocal model correction, but no reinforcement was provided for correction responses.

After the participants completed SEI, we again conducted probes that tested for the

comparative forms in Sets 1 through 4. When this procedure showed that the participants could not emit the comparative forms for the untaught stimuli, we introduced the multiple exemplar procedure with a training set of stimuli.

Multiple exemplar instruction. During the MEI procedure, participants received instruction at different times so that probes that followed (following the MEI 1 phase) were time-lagged across participants. Different participants were taught the comparative forms of a different set of stimuli (Set 1, Set 2, or Set 3) so that the order in which the sets were taught varied across participants. MEI was implemented in the same manner as SEI, except that four target stimuli were presented 5 times per session each during this phase (both exemplars of each adjective were presented). Following MEI tact instruction for a single set (Set 1, Set 2, or Set 3 stimuli), probes were conducted for the remaining sets that had not been taught. These probes were conducted to determine if abstraction of the autoclitic frame ''-er'' to novel tact forms emerged, including abstraction of the autoclitic frame to irregular and nonsense adjectives. During the MEI I phase, Participant A received MEI for Set 1 stimuli, Participant B received MEI for Set 2 stimuli, and Participant C received MEI for Set 3 stimuli according to the counterbalancing scheme used to control for item difficulty. We then tested for their responses to all untaught sets using unconsequated probe trials. If the participants did not show the abstraction, we taught additional sets in MEI format and we probed all untaught sets again. The probes were conducted in the same manner as the pre-experimental probes.

RESULTS AND DISCUSSION

During pre-SEI probes and post-SEI probes, none of the participants emitted any correct responses to any of the untaught sets (see Figure 1). After the first MEI sessions, Participants A and B emitted some correct responses to the probed sets but required additional MEI instruction. Participant C emitted six or more out of eight possible correct responses to each probed set. Participants A and B underwent another MEI session in which Participant A received MEI for Set 3 stimuli and Participant B received MEI for Set 1 stimuli. Following the second MEI phases, Participant A emitted one out of eight correct responses to Set 4 stimuli and two out of eight correct responses to Set 5 stimuli. Participant B emitted seven out of eight correct responses to Set 3, eight out of eight correct responses to Set 4, and six out of eight responses to Set 5. Participant A received a third MEI phase with the following taught stimuli: high-higher, windy-windier, stormy-stormier, short-shorter. Following the MEI III phase, when tested, he emitted two out of eight responses to Set 4 and eight out of eight responses to Set 5.

Next, a novel set of positive adjective forms (low, starry, winding, gaf) was taught, and probes for novel comparative forms were conducted. We use the term *novel* to refer to this set because the positive adjective forms were not taught pre-experimentally, nor were comparatives tested during any of the probe sessions. This novel set consisted of two regular adjectives, two one irregular adjective and one nonsense comparative. All 3 participants emitted seven out of eight or more correct responses to the novel set. These data showed that when taught novel positive adjective forms and then presented with the comparative forms, all 3 participants showed abstracted control of the autoclitic frame ''-er'' to regular, irregular, and nonsense adjectives.

In summary, the results of Experiment 1 showed that no participants emitted any correct novel responses containing the autoclitic frame ''-er'' after SEI. Following MEI for either two or three sets of comparative adjectives, all participants showed an increase in correct novel responses containing the autoclitic frame ''-er'' across regular, irregular, and nonsense adjective forms. When taught a novel set of positive adjective forms comprised of two regular adjectives (low; starry), one irregular adjective (winding) and one nonsense adjective (gaf), all 3 participants emitted 90% or greater correct responses to the comparative forms by tagging the ''-er'' ending onto the taught positive forms.

A limitation to Experiment 1 was that probes for the abstraction of the autoclitic frame ''-er'' with novel tact forms were not conducted immediately prior to MEI for Participants B and C. Therefore, the relationship between MEI and the emission of novel tact and autoclitic responses may not have been functional (although it is likely based on

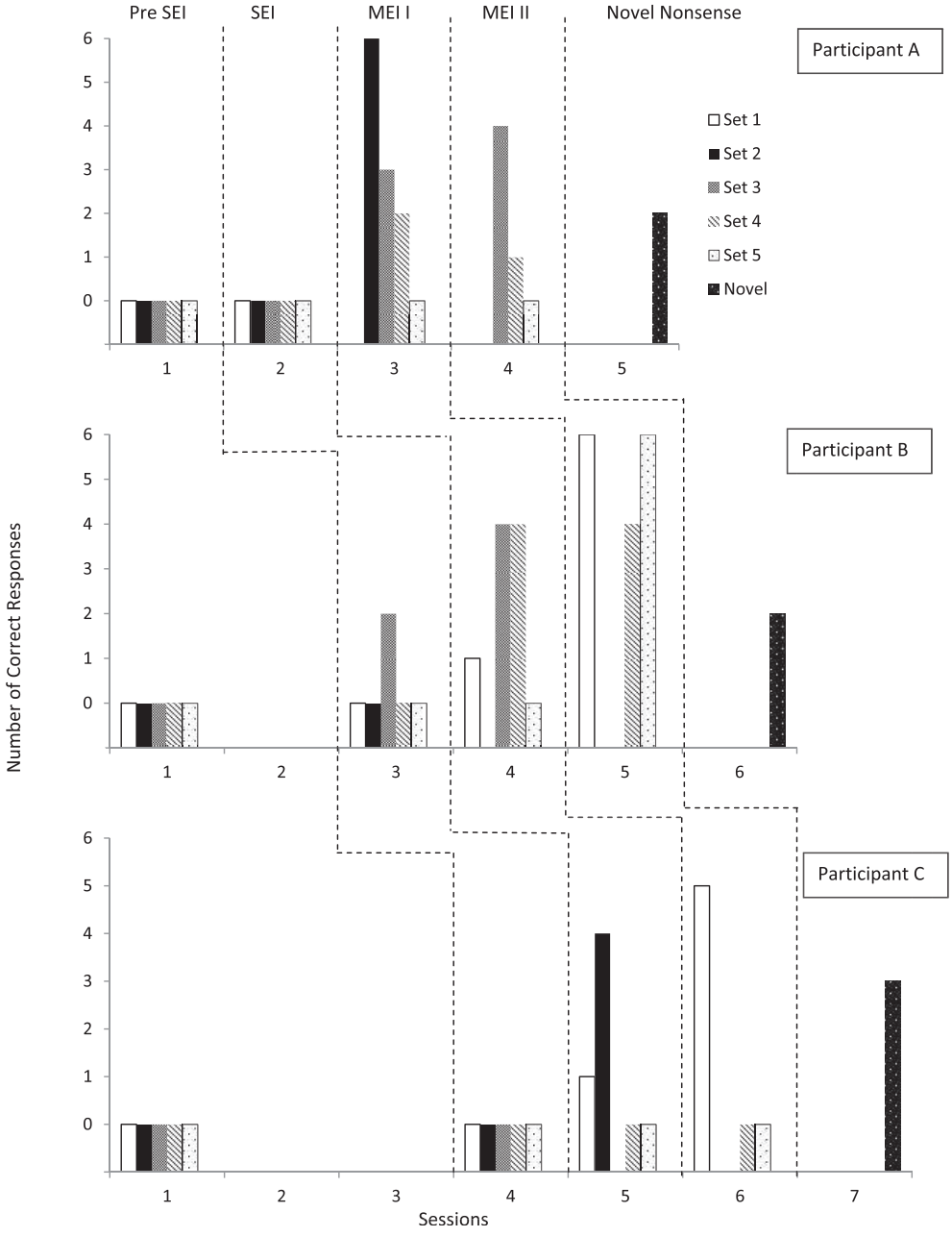

Figure 1. Novel Autoclitic + Tact Responses Emitted by Participants During Probe Sessions in Experiment 1.

the latter data in this experiment). Another limitation of the experiment was that the stimulus presentations could have served as the discriminative stimuli for the target responses, or they may have been intraverbal responses. In Experiment 1, the stimuli were always presented to the participants in the same manner, for example, the ''non-tall'' picture was presented first, followed by the ''tall'' picture to which the participants responded ''tall.'' Then, the comparative form was presented and the target response was ''taller.'' This could have occasioned what one would call ''rote responding.'' The

Table 4
Description of Participants From Experiment 2

Participant	Age/Gender	Standardized scores	Verbal repertoires
D	4.2 years old Female	No testing conducted no developmental delays noted	– Tacts – Mands – Intraverbals – Sequelics – Conversational units – Self-talk
E	4 years old Male	Clinical Evaluation of Language Fundamentals Preschool (CELF-2) (2004) Average scores in expressive and receptive language skills Anecdotal report of poor pragmatic skills and dysfluent speech patterns	– Tacts – Mands – Intraverbals – Self-talk
F	3.8 years old Female	No testing conducted no developmental delays noted	– Tacts – Mands – Intraverbals – Sequelics – Conversational units

additional stimuli presented to the participants in Experiment 1, along with the change in the presentation of the target stimuli (all stimuli on one page and not always in the same positions), were included to eliminate these potential threats to the internal validity of the experiment.

EXPERIMENT 2
METHOD

In Experiment 2, the following components remained the same as in Experiment 1: the setting, definitions of dependent variables, data collection, and the calculation of interobserver agreement. Three new participants participated and some control stimuli were introduced during the multiple exemplar sessions and probe sessions. Also, the number of stimuli presented in each set and the manner in which the stimuli were presented to the participants were changed. These differences between the first and second experiment are described in the following paragraphs.

Participants

One male and 2 female preschoolers between the ages of 3.8 years and 4.2 years participated in Experiment 2 (see Table 4). All attended the same school as participants in Experiment 1. All 3 participants were recruited from the same class: an integrated preschool class with one teacher, two teaching assistants, 6 participants identified as having educational disabilities, and 6 participants who were considered typically developing. Participants D, E, and F are described in Table 4.

Instructional Stimuli

Target stimuli. For this experiment, we introduced 5 sets of three stimuli to test for the abstraction of the target autoclitic ''-er.'' We changed the sets to include only three stimuli so that we could begin the experiment with more sets in case additional instruction across sets was deemed necessary to induce the abstraction of the autoclitic frame. We taught the positive forms of these comparative adjectives during the pre-experimental instruction phase of the experiment. For pre-experimental instruction, pictures representing the positive forms of adjectives were represented on a page along with the negative exemplar of the adjective. For example, a ''non-sunny'' picture would be on a page with a picture representing ''sunny.'' The

order in which the two pictures were presented on the page (above-below, left-right) varied. Each set of stimuli contained three forms and there were two exemplars for each form. See Table 5 for stimulus sets and experimental design.

Control stimuli. In an effort to control for a possible sequencing effect or ''rote responding,'' control stimuli were introduced during Experiment 2. Prior to the collection of any baseline data, the participants' classroom teacher tested them for a ''same/different'' repertoire. In order to test for a ''same/different'' repertoire, the classroom teacher presented two pictures and asked the question ''Are these the same or different?'' or ''Are these different or the same?'' The teacher presented 20 trials per session. Criterion for having this skill in repertoire was 90% accuracy across two sessions or 100% accuracy for one session. If participants demonstrated that they had mastered ''same/different'' discriminations, the teacher continued the program, but now if the participant responded correctly to ''different'' stimuli, the teacher added the question ''Why are they different?'' Some examples of correct responses were ''this one is red and this one is blue,'' ''this is one is wearing a hat and this one isn't,'' and ''this man is carrying a flag and this one has an umbrella.'' Again, the criterion for mastery of tacting differences between pictures was 90% accuracy across two sessions or 100% accuracy for one session.

The control stimuli that were rotated with the target stimuli during MEI and probe sessions were similar to target stimuli in that three pictures were presented on one page. The vocal cue ''Are these the same or different?'' and ''Why?'' were faded out during the training phase for ''same and different'' so the antecedents for control stimuli were the same as for the target stimuli. Once the vocal cues were faded, the participants were required to respond only to the visual stimuli with such a statement as ''these are the same/different because....'' For half of the control stimuli these pictures were identical (so that when they were presented to the participant, the participant would tact ''these are the same'' or some variation of the statement). For the other half of the stimuli, the pictures that were presented on the pages differed (i.e., by

Table 5

Experimental Design and Stimuli Sets for Experiment 2. Multiple Exemplar Instruction Was Time Lagged to Control for Maturation

Participant	Pre-Exp Teach positive, probe comparative	SEI Teach/Probe	MEI I Teach/Probe	MEI II Teach/Probe	Set 6 Novel Teach/Probe
D	*Set 1*: rainier, taller, wider *Set 2*: longer, wetter, cloudier *Set 3*: sunnier, starrier, darker *Set 4*: (irregular) crooked-er, open-er, far-er *Set 5*: diller, frooker, shumper	Bigger/ All sets	Set 1/ 2,3,4,5	Set 2/ 3,4,5	Positive form/ Comparative form all participants *Set 6*: latch-ier, insect-ier, window-ier
E	Same	Same	Set 2/ 1,3,4,5	Set 3/ 1,4,5	
F	Same	Same	Set 3/ 1,2,4,5	Set2/ 1,4,5	

color, three different animals, three different shapes). The participants had been taught to tact the pictures as ''different'' and then tell the reason why they were different (as they were required to tact the difference in the target stimuli as, for example, ''this one is tall''). Control stimuli were presented following every four target stimuli on average, in the same manner as target stimuli. Participant responding to these stimuli was above 99% accuracy.

The purpose of teaching the participants this skill was to rotate opportunities to respond to stimuli that differed in varying ways so that the tact + autoclitic frame ''-er'' was not the correct response in every trial. In this way, we could show that the attributes of the picture and not the context of the training session were controlling the novel responses of our participants.

Interobserver Agreement

Interobserver agreement was conducted for 20% of the instructional sessions and 80% of the probe sessions. Interobserver agreement was 100% for all instructional and probe sessions. Procedural fidelity was monitored by Teacher Performance Accuracy Rate (TPRA) (Ingham & Greer, 1992) observation protocol for 10% of the instructional sessions and was 100% for all monitored sessions.

Experimental Design

The experimental design was a nonconcurrent multiple-probe design (Table 5). All participants were tested for novel responses to sets of stimuli immediately preceding introduction of each instructional set.

Pre-instructional and post-instructionalp-robes. We conducted probes in the same manner as in the previous experiment with the exception of the addition of the control stimuli. Unconsequated probes were conducted before and after SEI and following each MEI phase. MEI was staggered across participants to control for maturation. Probe sessions contained six trials each, which were made up of two opportunities to respond to each of the three tact + autoclitic forms. In addition, three control trials were randomly presented with the probe trials.

SEI and MEI. We conducted SEI and MEI in the same manner as in the previous experiment, except for (a) a slight change to the presentation of the target stimuli, (b) the addition of the control stimuli, and (c) a change in the criterion for mastery of SEI and MEI. Instead of three pictures being presented to the participants in the same order each time (e.g., not-rainy, rainy, rainier), three pictures were presented on one page and the order and/or position of the stimuli varied. The participants were required to point to each picture and tact with the target autoclitic. The tact + autoclitic targeted for SEI was once again ''bigger,'' and probes for responses to all untaught sets followed. For MEI, during the MEI I phase, Participant D received MEI for Set 1 stimuli, Participant E received MEI for Set 2 stimuli and Participant F received MEI for Set 3 stimuli. We then probed their responses to all untaught sets. If the participants did not show the abstraction, we taught additional sets in MEI format and we probed all untaught sets again. Presentations of control stimuli were interspersed with presentations of the target stimuli during both SEI and MEI, and data were recorded to ensure that the participants were responding correctly to the relevant features of the presented stimuli. Criterion for mastery for each set was 90% for one session or 10 consecutive correct responses (see Table 5).

RESULTS AND DISCUSSION

For all SEI and MEI sessions, the 3 participants mastered the tact forms in the presented sets within two sessions; therefore, the data are not reported in detail in this section. During pre-SEI probes and post-SEI probes, Participants D and F did not emit any correct responses to any of the untaught sets (see Figure 2). Participant E did not emit any correct responses during pre-SEI probes but did emit 2 correct responses to Set 3 stimuli during the post-SEI probes. After the first MEI sessions (MEI 1), all 3 participants emitted more correct responses during probe sessions; however, they all required additional MEI instruction. Following the second MEI session (MEI 2), Participant D emitted four correct responses to Set 3 stimuli, one correct response to Set 4 stimuli and zero correct responses to Set 5 stimuli. Participant

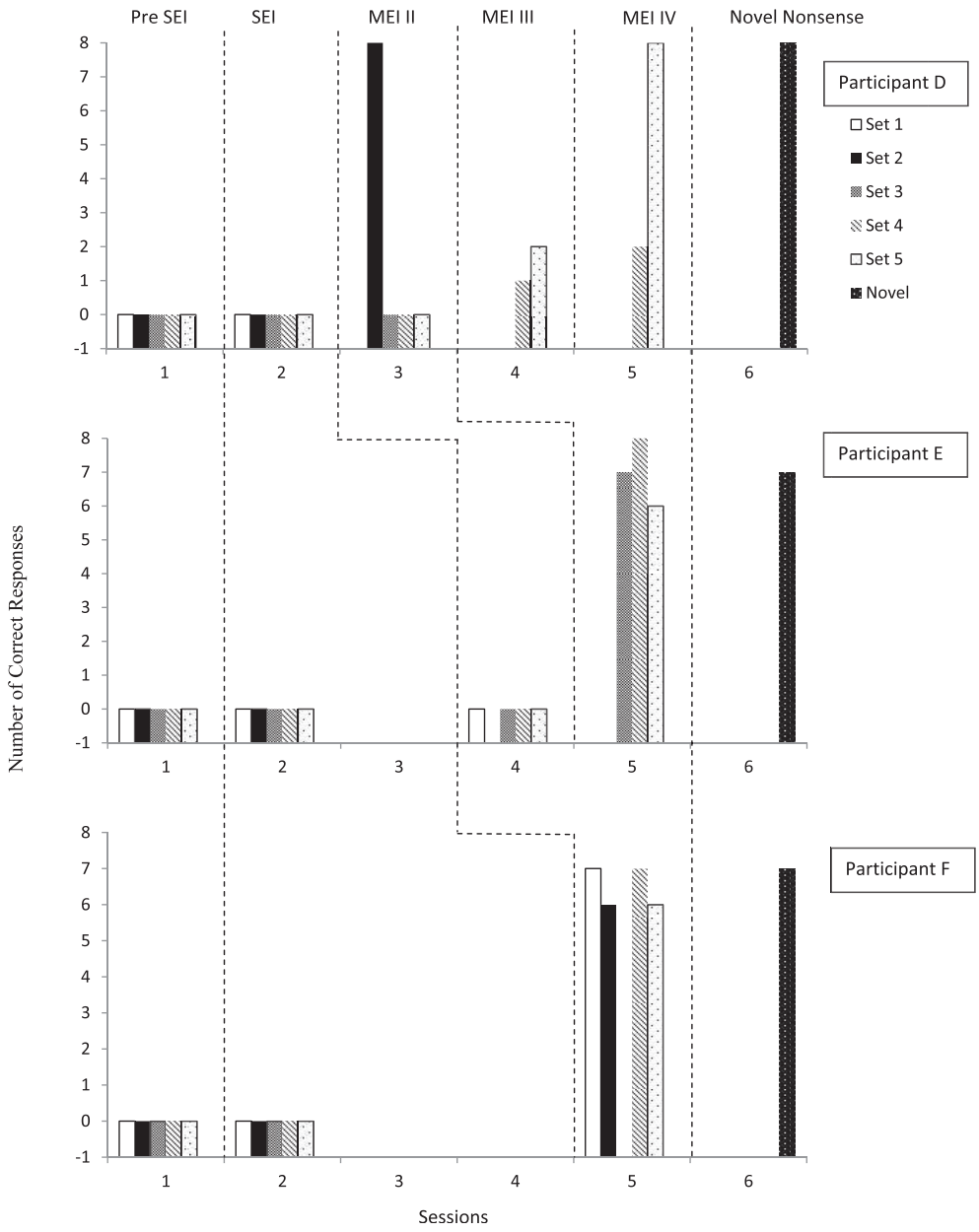

Figure 2. Novel Autoclitic + Tact Responses Emitted by Participants During Probe Sessions in Experiment 2.

E emitted six correct responses to Set 1 stimuli, four correct responses to Set 4 stimuli, and six correct responses to Set 5 stimuli. Participant F emitted five correct responses to Set 1 stimuli, zero correct responses to Set 4 stimuli, and zero correct responses to Set 5 stimuli.

Next, a novel set of experimenter-created positive adjective forms was taught. Because 2 of the 3 participants had not responded correctly to any of the nonsense tact forms, a new set was introduced. Instead of creating nonsense words that had no ''true word'' basis, the experimenter created stimuli and

then named these stimuli with words derived from their true names. The three stimuli were ''insect-y'' (8–10 bugs), ''window-y'' (6–8 windows) and ''latch-y'' (8–10 locks), for which we tested for the abstractions ''insect-ier,'' ''window-ier,'' and ''latch-ier'' respectively. Participants all received training for the positive forms of the tacts (window-y, insect-y, latch-y). This training, unlike training for the other positive forms, occurred immediately before MEI for that set so we have referred to the set as novel. Next, MEI for this set was presented and then the participants were tested for the comparative forms (insect-ier, window-ier, and latch-ier). Participant D had two out of six correct responses for the comparative forms, Participant E had two correct responses, and Participant F had three correct responses during the probes.

GENERAL DISCUSSION

This series of experiments tested for relations between a specific instructional procedure, which was MEI, and the emergence of untaught verbal behavior or language. Experiments 1 and 2 investigated the effects of MEI on the emergence of productive suffixes as autoclitic frames. MEI has been described as an individual's exposure to a subset of exemplars across different situational contexts, while reinforcement is maintained and contextual dimensions of the tasks vary so that the relevant task features are discriminated (Hayes et al., 2001). MEI has been shown to be functionally related to the emergence of derived contextually controlled responses. Experiments 1 and 2 evaluated the effects of a multiple exemplar tact procedure on novel combinations of known operants. In these experiments, the responses of interest were comparative adjective forms, or tacts containing the autoclitic frame ''-er.'' Both regular and irregular adjective forms were chosen to determine whether an abstraction, if formed, would extend to both regular adjective forms and irregular adjective forms (i.e., tall-taller; far-farrer) the latter of which would be considered grammatically incorrect (a correct production would be ''farther''). A set of nonsense words was also created in order to determine if the abstraction would extend to a set of stimuli with which the participants could not have had any previous experience. In Experiment 2 we sought to control for possible confounding variables that may have affected the participants' responding in Experiment 1. Specifically, it seemed possible that the context with which the stimuli were presented to the participants, instead of the relevant features of the stimuli themselves, had set the occasion for the participants to respond with the novel recombined tact forms in Experiment 1.

Berko (1958) studied the novel production of ''nonsense'' words involving plural formations via the addition of ''-s'' in young children (i.e., wug-wugs.) According to Berko, the findings suggested that by age 5, children convert singular nouns into plural nouns by adding an ''-s'' ending. Hayes et al. (2001) suggested that the children who participated in this study already had the relational frame of coordination that was controlled by the contextual cues present during testing (''This is a _____, and these are two_____''). In other words, through experiences, these children had already learned that in the presence of these contextual cues, an ''-s'' is added to a word. Nonetheless, the instructional history of these children was not known and could only be inferred via the abstractions that were present in their current repertoires. In addition, the interpretation of the results of this experiment suggested that age serves as a determining factor of specific verbal functions. The results of the current experiment suggest that although these types of abstractions may frequently emerge at specific age ranges, multiple exemplar experiences are functionally linked to their emergence. Howard and Rice (1988) showed that as children learned more combinations of tact + autoclitic frames, the more likely they were to combine the autoclitic frames with novel tact forms. The results of the current experiments support this finding.

Both participants with disabilities and participants who were considered typically developing participated in these experiments. Because the participants had similar verbal repertoires and our selection criteria were based mainly on verbal repertoires, we included both groups of participants. Gorham, Barnes-Holmes, Barnes-Holes, and Berens

(2009) also included children with and without disabilities in their research and found few differences in their performance on emergent relational responding tasks. The current research, however, did find differences between the responses of participants with and without disabilities.

In Experiment 1, all 3 of the participants abstracted the ''-er'' autoclitic frame and combined it with experimenter-created words in response to experimenter-created corresponding images. In Experiment 2, abstraction did not initially occur for 2 of the participants. The 2 participants for whom the abstraction did not occur were participants who were not classified with language disabilities. The experimenter created new stimuli and derived the names of these images from their true names (insect-y, window-y, latch-y) and the participants who did not show the abstractions initially with nonsense stimuli now responded correctly (insect-ier, window-ier, latch-ier) to 33% and 50% of the probe trials. A possible reason for this occurrence was that these 2 participants had verbal repertoires that were more advanced than those of the other participants, and thus, had more of an established context for productive verbal responding. It may be that participants at their level of verbal behavior do not readily combine words (attached to images) with which they are unfamiliar. Once they were more familiar with the stimuli and the contrived names, the abstractions did occur. A limitation to the present study was the participant pool. Although preschoolers serve as appropriate candidates for the investigation of early emergent verbal behavior, future research might include even younger participants, such as 2- and 3-year-old children.

The results of Experiment 2 were not as robust as those that were seen in Experiment 1. This may be in part due to a possible confound in the first experiment; that is, the consistent and predictable presentation of the stimuli may have aided the participants in producing the abstractions. This was corrected in Experiment 2 with the change in the presentation of the stimuli and the addition of the control stimuli. It may be that the results of the second experiment are more representative of the manner in which children learn to abstract relational autoclitic frames. It is possible that the results would have been comparable to those seen in the first experiment if more MEI sets had been trained. In other words, more multiple exemplars might have led to a higher number of correct abstracted responses for the participants. Also, there is a limitation to the current SEI procedure. Because the participants mastered the tact + autoclitic frame ''bigger'' in two sessions or fewer, it is possible that SEI might have led to the abstraction of the autoclitic frame if more trials had been presented. This may be unlikely given that the results of probes following MEI sessions were clearly different from those that followed SEI sessions; however, attempts should be made in future research to control for this limitation.

The controlled multiple exemplar experiences provided to the 6 participants across the 2 current experiments were effective in increasing most productive verbal responses. This research is significant because it provides additional evidence of a functional link between certain language experiences and increased language capabilities, specifically productivity, for children with language delays and typically developing children. Future areas of research should include replications of these procedures across different response categories and different participant groups at varying levels of verbal behavior (Greer, 2002) as well as the role of observational learning in the acquisition of irregular grammatical forms.

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