

# Teaching the Imitation and Spontaneous Use of Descriptive Gestures in Young Children with Autism Using a Naturalistic Behavioral Intervention

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**Abstract** Children with autism exhibit deficits in the imitation and spontaneous use of descriptive gestures. Reciprocal Imitation Training (RIT), a naturalistic imitation intervention, has been shown to increase object imitation skills in young children with autism. A single-subject, multiple-baseline design across five young children with autism was used to determine whether RIT could be adapted to target the imitation of descriptive gestures. All participants increased their imitation of gestures in the treatment setting and on a structured imitation assessment. Gains generalized to a novel therapist, setting, and materials and maintained at a 1-month follow-up. Three participants also increased their spontaneous use of descriptive gestures. These results provide support for the effectiveness of a naturalistic intervention for teaching gesture imitation.

**Keywords** Autism · Imitation · Gesture · Intervention · Social communication

## Introduction

Children with autism exhibit significant impairment in their use of gesture. A variety of studies has indicated that the imitation of gestures, including body movements and pantomime, is significantly impaired in children with autism (e.g., DeMyer et al., 1972; Stone et al., 1997). These deficits have been found in both the imitation of non-symbolic postures (e.g., Rogers et al.,

1996; Smith & Bryson, 1998) and meaningful gestures (Hammes & Langdell, 1981; Rogers et al., 1996) and do not appear to be accounted for by a lack of gesture recognition (Smith & Bryson, 1998). In children with autism, gesture imitation has been found to be highly correlated with concurrent language ability (Sigman & Ungerer, 1984), as well as predictive of language development 6 months later (Stone et al., 1997). In addition, some researchers have proposed that gesture or body imitation may be involved in the development of social interaction (Rogers et al., 2005; Rogers et al., 2003). These findings suggest that teaching gesture imitation may improve language and social outcomes (Rogers, 1999; Rogers et al., 2003), and thus, should be an important focus of early intervention programs (Rogers et al., 2000).

Children with autism also exhibit deficits in their spontaneous use of meaningful gestures (e.g., Bartak et al., 1975; Wetherby & Prutting, 1984). Deficits are seen both in the quantity and quality of gesture used. Children with autism use significantly fewer gestures than developmentally delayed and typical children (Buitelaar et al., 1991) and are developmentally less advanced in their gesture use (Mundy et al., 1986). This impairment is most pronounced for those gestures that involve joint attention or express affective states as opposed to those that serve instrumental needs (Attwood et al., 1988; Loveland & Landry, 1986). Spontaneous use of gesture, like imitation, has been closely associated with language development in children with autism (Mundy et al., 1986) and typically developing children (Özçaliskan & Goldin-Meadow, 2005).

It has been suggested that deficits in the imitation of gestures contribute to the difficulty that these children have in using gestures spontaneously during social

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interactions (Smith & Bryson, 1994; Wetherby & Prutting, 1984). Thus, interventions which target the imitation of gestures may have a substantial effect on both the development of spontaneous gesture use and, subsequently, language use in general.

Surprisingly little research has focused on increasing the imitation of meaningful gestures in children with autism. In particular, there is a lack of intervention techniques designed to teach the imitation of descriptive gestures, particularly conventional (e.g., shrugging to indicate “I don’t know”) and affective (e.g., hands on hips to indicate “angry”) gestures, and gestures describing objects, attributes, and actions (e.g., holding arms apart to indicate “big”). Most interventions which have focused on increasing the imitation of gestures have used a traditional behavioral approach (e.g., Lovaas et al., 1967; Maurice et al., 1996). In this approach, the learning environment is highly structured and controlled by the therapist. Imitative behavior is broken into a series of discrete subskills, which are presented in multiple, successive trials. Acquisition is facilitated by explicit prompting, shaping, and reinforcement.

This approach targets gesture imitation independent of communication; thus the targeted gestures are inherently non-meaningful. In addition, imitation is brought under the control of a specific discriminative stimulus (“Do this”) which many inhibit its spontaneous use (Carr, 1981). Thus, this intervention method may prevent the child from learning to imitate novel gestures in the natural environment and may impede the spontaneous use of those gestures.

Some recent interventions have targeted the spontaneous use of meaningful gestures. Whalen & Schreibman, (2003) used a combined structured and naturalistic behavioral approach to teach four children with autism to initiate showing and proto-declarative pointing. These skills successfully generalized to structured and unstructured assessments with the experimenter and the children’s mothers. The children also exhibited an increase in other social-communication skills, including social initiations, positive affect, imitation, play, and spontaneous speech (Whalen et al., 2006). This research suggests that joint attention gestures can be taught to children with autism and that teaching the use of commenting gestures can have an effect on the development of other social-communication behaviors.

Buffington et al., (1998) used a structured behavioral approach to teach 4-, 4–6-year-old children with autism to make a combined gestural and verbal response to specific stimuli. The authors targeted three categories of gestures: attention directing, affective, and descrip-

tive. During baseline and training, the children were seated across a desk from the therapist. The therapist began each trial by presenting the child with a specific non-verbal stimulus (e.g., toy dinosaur, helicopter) paired with a specific verbal stimulus (e.g., “Who would like the dinosaur?”; “Tell me how that moved.”). During training, children were taught a combined gestural and verbal response to each stimulus using modeling, physical prompting, and token reinforcement paired with praise. Generalization probes were conducted for each response using different non-verbal and verbal stimuli. With training, all of the children exhibited gains in their use of gestures. The children also exhibited these increases on the generalization probes. Social validity data suggested that the children’s communication was rated as more expressive during treatment than baseline, suggesting that teaching children with autism to use gestures leads to improvements in the quality of their social communication.

The findings from this study are promising and suggest children with autism can learn to produce meaningful gestures through the use of behavioral techniques. However, this highly structured approach has several limitations. First, the children were taught to produce specific gestural responses which were trained to criterion. Therefore, this study did not assess whether the children learned to produce generalized imitation of gesture. Second, the children were taught to use gestures only in response to specific discriminative stimuli. Thus, this study did not impact the children’s spontaneous gesture use. Third, this study did not include a follow-up measure; thus it is unknown whether these skills maintain over time. Finally, this study relied on previously learned gesture imitation ability to teach gestures. Therefore, the effect of this intervention for children who do not imitate gestures is unknown.

Reciprocal Imitation Training (RIT) is a naturalistic intervention that was developed to teach object imitation skills to young children with autism within ongoing play interactions. This intervention is drawn from the naturalistic behavioral literature and shares many common elements with interventions, such as incidental teaching (Hart & Risley, 1968; McGee et al., 1983), milieu teaching (Alpert & Kaiser, 1992), and pivotal response training (Koegel et al., 1987), designed to teach language skills in the natural environment. Research examining naturalistic behavioral techniques suggests they provide increased generalization through naturally occurring teaching episodes, the use of multiple exemplars, and a direct response–reinforcer relationship (Charlop-Christy & Carpenter,

2000; Kaiser et al., 1992; Spradlin & Siegel, 1982). In addition, they lead to increased spontaneity by following the child's lead (Kaiser et al., 1992), and reflect natural adult-child interactions because teaching is embedded in ongoing play interactions between the therapist and the child (Kaiser et al., 1992; Schreibman et al., 1991).

In the original study (Ingersoll & Schreibman, 2006), RIT was used to teach 5-, 2–3-year-old children with autism to imitate actions with objects. All participants increased their object imitation ability in the treatment setting, on a structured imitation assessment, and during a structured observation with the therapist and the caregiver. Four of the five participants maintained these gains after the removal of treatment and generalized them to novel play materials, a novel therapist, and a novel setting. All children maintained higher than baseline rates of object imitation at a 1-month follow-up. In addition, naïve observers rated the participants as exhibiting significantly more imitation and other social-communication skills, and looking more “typical” at post-treatment than pre-treatment suggesting this treatment led to socially valid changes for the participants.

Given the effectiveness of this approach for teaching spontaneous and generalized object imitation, it may be a potent intervention for targeting gesture imitation. First, gesture use is inherently communicative; thus the naturalistic adult-child interaction used during RIT may be particularly effective for teaching gesture. In addition, RIT can be modified to target the imitation of descriptive gestures within a meaningful context. This element may help promote the spontaneous use of gesture. Indeed, RIT has been shown to increase pretend play when targeting object imitation (Ingersoll & Schreibman, 2006), suggesting that it may also be an effective strategy for teaching spontaneous gesture use.

The purpose of this study was to assess whether immediate gesture imitation could be successfully taught using RIT and whether increases in imitation would lead to the spontaneous use of descriptive gestures.

## Methods

### Participants

Five boys with autism participated in this study. Participants were diagnosed by an outside professional with an expertise in autism using APA criteria (APA, 2000). Diagnoses were verified using the *Autism Screening Instrument for Educational Planning* (Krug

et al., 1993) or Autism Diagnostic Observation Schedule-Generic (Lord et al., 2000). The children ranged in age from 34 to 49 months, with mental ages of 16–31 months as measured on the *Bayley Scales of Infant Development, 2nd Ed.* (Bayley, 1993) or *Mullen Scales of Early Learning* (Mullen, 1995). The choice of developmental assessments was based on their availability. Autism severity ranged from mild-moderate to severe on the *Childhood Autism Rating Scale* (Schopler et al., 1980). The children's primary caregivers completed the *MacArthur-Bates Communicative Development Inventory* (Fenson et al., 1993) to determine language age. Language ages ranged from 16 to 29 months. All children exhibited deficits in spontaneous gesture imitation, as determined by parent report, and imitation of fewer than 10% of gestures presented during an informal baseline session with the experimenter. One child, Gage, received discrete trial training to target imitation prior to participating in this study. None of the other children had received prior imitation interventions. All parents gave informed consent for their children to participate in the study (see Table 1).

### Setting and Materials

All assessments, baseline, treatment, and follow-up sessions were conducted in a small treatment room with a one-way mirror through which treatment was filmed. Generalization of setting sessions were conducted in a larger sitting room with a small table and an easy chair or in a larger waiting room with a small table and couch. Five pairs of identical play materials were used in all sessions. Toys were varied each 20-min session, totaling 15 sets of play materials per day. Generalization materials were not used during treatment.

**Table 1** Participant characteristics at intake

| Child  | Chronological age (months) | Mental age (months) | Language age <sup>a</sup> (months) | Autism severity <sup>b</sup> |
|--------|----------------------------|---------------------|------------------------------------|------------------------------|
| Noel   | 38                         | 26 <sup>c</sup>     | 25                                 | 36.5 (severe)                |
| Gage   | 49                         | 31 <sup>d</sup>     | 29                                 | 39.5 (severe)                |
| Zane   | 43                         | 22 <sup>c</sup>     | 19                                 | 44.5 (severe)                |
| Isaiah | 43                         | 27 <sup>d</sup>     | 28                                 | 32 (mild-moderate)           |
| Graham | 34                         | 16 <sup>d</sup>     | 16                                 | 37 (severe)                  |

<sup>a</sup> MacArthur-Bates Communicative Development Inventory

<sup>b</sup> Childhood Autism Rating Scale

<sup>c</sup> Bayley Scales of Infant Development, 2nd Ed.

<sup>d</sup> Mullen Scales of Early Learning

## Therapist Training

All therapy was conducted by the first author and undergraduate research assistants. The undergraduate research assistants had no prior intervention experience or experience working with children with autism, although some had prior experience caring for typically developing children. Assistants were trained to 90% correct implementation by the first author prior to working with the children. Overall, there were no differences in treatment fidelity between the first author and the undergraduate therapists. Each child worked with at least three different therapists throughout baseline and treatment. The generalization therapist did not provide treatment to the participants.

## Design and Procedure

A single-subject, multiple-baseline design was conducted across participants (Hersen & Barlow, 1976). Participants attended the center 2 days per week for three, 20-min sessions throughout baseline and intervention. Participants received baselines ranging from 2 to 6 weeks, followed by 10 weeks of intervention. Generalization probes were conducted once a week during baseline, toward the end of treatment, and at a 1-month follow-up.

## Baseline

Baseline sessions consisted of free play with a therapist. Every minute, on average, the therapist modeled a descriptive gesture and verbal marker related to the child's activity. For example, if the child placed a doll in a bed, the therapist might model placing a finger over his or her lips and say "Shh, baby's sleeping." Modeled gestures were adapted from descriptions provided by Acredolo & Goodwyn, (1988; see Table 2). Each action was modeled up to three times. Attempts were made to gain the child's attention during modeling by facing the child and/or saying the child's name. However, no feedback was provided

regarding the child's subsequent behavior. Although the therapist did not initiate additional interactions with the child, he or she responded to any initiation by the child with a short, appropriate response.

## Treatment

The intervention was adapted from techniques shown to be successful for teaching object imitation (Ingersoll & Schreibman, 2006), and included contingent imitation, linguistic mapping, following the child's lead, physical prompting, and contingent reinforcement. Contingent imitation involved imitating the child's actions and vocalizations. Linguistic mapping involved providing a running commentary of the actions that therapist and the child were performing.

Gesture imitation was taught using a prompting procedure. The therapist modeled a gesture and corresponding verbal marker related to the child's play up to three times, every minute on average. If the child imitated the gesture, the therapist praised him and allowed him continued access to the play materials. If the child did not imitate after the third model, the therapist physically prompted the child to imitate the gesture and then provided praise.

The goal of RIT is for the child to imitate the majority of actions of a play partner rather than to accurately produce specific actions in response to a model (Ingersoll & Schreibman, 2006). In addition, modeled gestures have to be meaningful to the child. Therefore, rather than teaching specific gestures to criterion, multiple gestures were targeted concurrently based on the context of the child's play. All modeled gestures involved the upper extremities or gross head movements (i.e., nodding, shaking head) to ensure that the therapist could physically prompt the correct response when necessary.

## Generalization and Follow-up Probes

Ten-minute generalization sessions were conducted once a week during baseline, toward the end of treatment, and

**Table 2** Behavioral definitions for session data

|                                  |  |
|----------------------------------|--|
| Descriptive gesture              | Gestures which convey conventional (e.g., "Where is it?" palms upturned) or affective (e.g., "Oh no" hands on face) themes and or describe objects (e.g., "Airplane" arms out), attributes (e.g., "Big" raise arms), and actions (e.g., "Spin" finger in circle) |
| Total gesture imitation          | Child imitates descriptive gesture within 10 s of the model. Imitation does not have to be exact, but must look distinctly like the action   |
| Combined gesture imitation       | Child combines gesture imitation with verbal imitation of all or part of adult's verbal marker   |
| Total spontaneous gesture use    | The child spontaneously uses descriptive gesture. May not be prompted by physical manipulation, command, or be an immediate imitation of a model   |
| Spontaneous combined gesture use | The child spontaneously uses descriptive gesture paired with a verbal marker   |

at a 1-month follow-up. The number of sessions per child ranged from three to six and was based on the availability of generalization materials. These sessions were identical to baseline and included novel materials, a novel setting, or a novel therapist. These sessions were used to assess generalization to untrained environments and maintenance of skills over time.

### Fidelity of Implementation

To ensure correct implementation of the procedure, fidelity of implementation was scored from videotape for 10% of all sessions using 30-s interval scoring. The percent of intervals in which each technique was implemented correctly was 86.3% for modeled action, 99.5% for contingent imitation, 100% for linguistic mapping, 97.5% for prompting, and 94.6% for contingent reinforcement.

### Dependent Measures

#### *Session Data*

Child outcome was determined by changes in performance during daily sessions. The first 10 min of the first session of each day and all generalization sessions were videotaped and scored for total gesture imitation, combined gesture imitation, total spontaneous gesture use, and spontaneous combined gesture use. Behaviors were scored using 30-s interval scoring. Scoring was completed by undergraduate research assistants trained to 80% accuracy on practice tapes (see Table 2). Inter-rater reliability was obtained for 25% of the observations. Cohen's Kappa, which corrects for chance agreement, was calculated for each dependent measure yielding, .73 for total gesture imitation, .71 for combined gesture imitation, .66 for total spontaneous gesture use, and .69 for combined spontaneous gesture use. These Kappa scores reflect good reliability. Some raters also worked as therapists with the children in this study; however, for the most part, they did not score the children with whom they worked. In cases where the primary coder had worked with the child, the reliability coder had not.

#### *Assessment Data*

The *Motor Imitation Scale* (MIS; Stone et al., 1997) was administered at pre- and post-treatment to determine generalization of acquired skills. The MIS is a structured imitation assessment that includes eight object and eight gesture imitation tasks. Each action is modeled up to three times and the child is instructed, "You

do it." Participants receive 0 for no imitation, 1 for partial imitation, and 2 for complete imitation. Scores were converted to a percentage of the highest possible score (16).

### Social Validity

To determine the social validity of the intervention, 36 college students in psychology were shown a 2-min videotaped sample of each participant taken during the first 2 min of a randomly selected baseline session and a generalization probe conducted during treatment (Schreibman et al., 1981). The first 18 observers saw two of the children during baseline and three of the children during treatment and the second group of 18 observers saw the same children at opposite points in treatment so that each rater only saw each child once. Consent was obtained from parents to allow individuals to rate their children's behavior. Raters were kept blind to the children's point in treatment. After viewing each segment, the participants completed a brief questionnaire about the child's imitation, gesture, language, play, and social behavior. Observers were asked to rate the children on a 5-point scale ranging from *strongly disagree* to *strongly agree* (see Table 3).

## Results

### Session Data

#### *Total Gesture Imitation*

Rates of total gesture imitation during baseline were low and remained stable for all children. Noel, Gage, and Zane exhibited almost no episodes of gesture imitation, while Isaiah and Graham exhibited low rates of gesture imitation, averaging 2 and 3% of the intervals across baseline, respectively (see Fig. 1).

With the onset of treatment, all participants increased their rate of imitative behavior in the treatment setting. Noel, Gage, and Graham also exhibited a substantial increase in total gesture imitation on all the generalization probes. Isaiah exhibited generalization to novel materials and a novel setting and Zane exhibited generalization to the novel therapist. At follow-up, all children exhibited higher than baseline rates of gesture imitation. Given that these probes included a novel therapist, setting, and materials, the follow-up data also suggest that the children's imitation continued to generalize to untrained environments after 1 month.

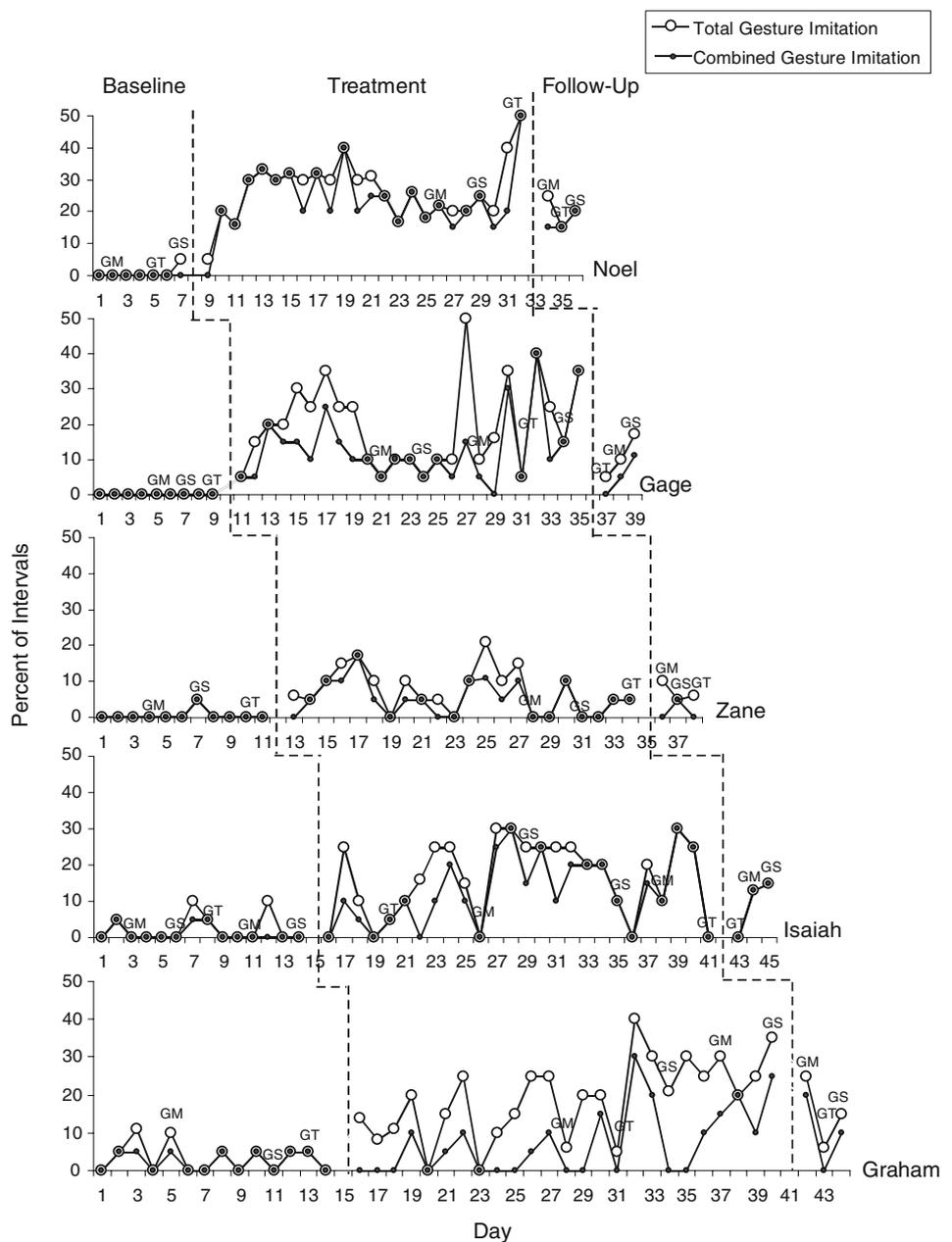
**Table 3** Means and SDs of observer ratings on the social validity measure from baseline and treatment

|   | Baseline, M (SD) | Treatment, M (SD) |
|---|------------------|-------------------|
| The child imitates actions with toys modeled by the therapist                   | 2.68 (.85)       | 3.64 (1.20)*      |
| The child imitates gestures modeled by the therapist                            | 2.18 (.75)       | 3.43 (1.15)**     |
| The child uses appropriate gestures in his or her own play and/or communication | 2.99 (.77)       | 3.63 (.96)**      |
| The child shows an interest in the therapist                                    | 2.74 (.86)       | 3.69 (.82)**      |
| The child plays with toys appropriately   | 3.30 (.63)       | 3.89 (.86)*       |
| The child uses language appropriately   | 2.43 (.67)       | 3.38 (1.06)**     |

1 strongly disagree, 2 disagree, 3 neither agree nor disagree, 4 agree, 5 strongly agree

\*  $p < .005$ , \*\*  $p < .001$

**Fig. 1** Imitation of descriptive gestures for baseline, treatment, and follow-up. *GM* generalization materials, *GT* generalization therapist, *GS* generalization setting



### Combined Gesture Imitation

During baseline, all children exhibited little to no combined gesture imitation. With the onset of treatment, all participants exhibited substantial increases in their rate of combined imitations. Noel and Gage's use of combined imitation generalized to all probes. Isaiah and Graham's use of combined gesture imitation generalized to the novel materials and setting, and Zane's use generalized to the therapist. At follow-up, all of the children exhibited higher than baseline rates of combined gesture imitation.

### Total Spontaneous Gesture Use

Gage, Zane, and Graham exhibited no episodes of spontaneous descriptive gestures during baseline, while Isaiah and Noel exhibited only one instance each. With the onset of treatment, Noel, Zane, and Graham immediately increased their total use of spontaneous gestures. Gage and Isaiah exhibited small increases in their total use of spontaneous gestures during their third week of treatment; however, since the increases did not occur concurrently with the onset of treatment, they must be interpreted cautiously (see Fig. 2).

All children generalized their total spontaneous gesture use to some novel situations. Graham used spontaneous gestures in all novel situations. Noel used spontaneous gestures with the novel materials and setting and Zane used spontaneous gestures with the novel materials and therapist. Both Gage and Isaiah used spontaneous gestures in the novel setting. At follow-up, Graham maintained his increased use of spontaneous gesture in all generalization sessions. Zane maintained his increased use of spontaneous gestures with the generalization therapist and Gage and Isaiah maintained their increased use in the generalization setting. Noel did not maintain his spontaneous gesture skills at follow-up.

### Spontaneous Combined Gesture Use

During baseline, all children used little to no spontaneous combined gestures. During treatment, Noel, Zane, and Graham increased their spontaneous use of combined gestures. Gage and Isaiah exhibited several episodes of combined gestures during treatment but these gains were not substantially different from baseline. Noel, Zane, Isaiah, and Graham generalized their use of combined gestures to some novel situations. At follow-up, only Graham and Isaiah maintained their spontaneous use of combined gestures.

### Assessment Data

#### Motor Imitation Scale

At pre-treatment, the children's ability to imitate gestures in a structured context varied considerably, with Noel imitating almost all and Zane imitating none correctly. At post-treatment, all participants improved their gesture imitation performance on the MIS. Across children, the increase from pre-treatment ( $M = 45.8$ ,  $SD = 38.5$ ) to post-treatment ( $M = 82.5$ ,  $SD = 26.9$ ) was significant [ $t(4) = -3.62$ ,  $p < .02$ ] using a two-way paired  $t$ -test. The children also increased their object imitation performance on the MIS from pre-treatment ( $M = 72.6$ ,  $SD = 27.3$ ) to post-treatment ( $M = 88.8$ ,  $SD = 21.8$ ); however, this change only approached significance [ $t(4) = -2.12$ ,  $p = .10$ ] using a two-way paired  $t$ -test (see Table 4).

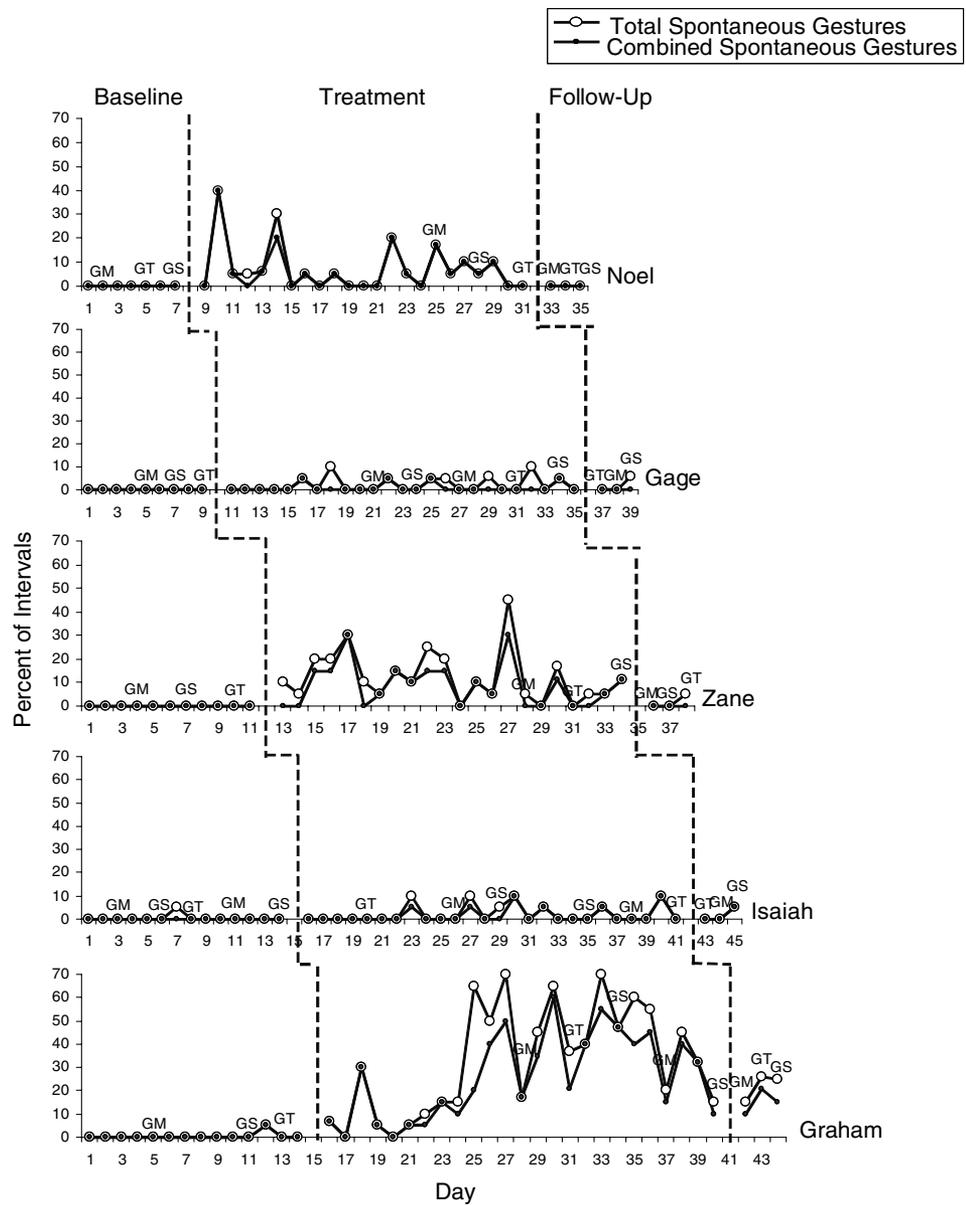
#### Social Validity

Observers' average ratings of children during baseline were compared to their average ratings of children during treatment for each behavioral category using two-way paired sample  $t$ -tests. Observers rated the children significantly better during treatment than baseline in all categories [imitates actions with objects— $t(35) = -3.23$ ,  $p < .003$ ; imitates gestures— $t(35) = -4.44$ ,  $p < .0001$ ; uses gestures appropriately— $t(35) = -3.63$ ,  $p < .001$ ; shows interest in adult— $t(35) = -3.67$ ,  $p < .001$ ; plays with toys appropriately— $t(35) = -3.27$ ,  $p < .002$ ; uses language appropriately— $t(35) = -4.4$ ,  $p < .0001$ ; see Table 3].

### Discussion

The results indicate that RIT can be effectively adapted to teach gesture imitation skills to young children with autism. All children increased their spontaneous imitation of descriptive gestures in the treatment setting and in at least some of the untrained environments. Their spontaneous gesture imitation ability maintained and continued to generalize to novel environments over time. Increases in gesture imitation were also seen on the structured imitation assessment. In addition, three of the children exhibited robust changes in their spontaneous use of descriptive gestures with the onset of treatment. Changes were also seen in these children's use of combined imitations and gestures. Finally, naïve observers rated the children as using more appropriate imitation, gestures, play, social engagement, and language during treatment than baseline, indicating that

**Fig. 2** Spontaneous use of descriptive gestures for baseline, treatment, and follow-up. *GM* generalization materials, *GT* generalization therapist, *GS* generalization setting



**Table 4** Child performance on the MIS at pre- and post-treatment

| Child     | Gesture imitation (% correct) |              | Object imitation (% correct) |               |
|-----------|-------------------------------|--------------|------------------------------|---------------|
|           | Pre                           | Post         | Pre                          | Post          |
| Noel      | 94                            | 100          | 100                          | 100           |
| Gage      | 19                            | 88           | 81                           | 100           |
| Zane      | 0                             | 38           | 38                           | 50            |
| Isaiah    | 69                            | 100          | 94                           | 100           |
| Graham    | 50                            | 100          | 50                           | 94            |
| Mean (SD) | 46.4 (37.7)                   | 85.2 (26.9)* | 72.6 (27.3)                  | 88.8 (21.8)** |

\*  $p < .02$

\*\*  $p = .10$

the intervention led to socially valid changes in the children’s social-communication skills.

Imitation on the structured assessment at intake did not predict the children’s use of gesture imitation during baseline. For example, even though Noel imitated most of the gestures on the MIS, he imitated almost no gestures during baseline. In contrast, Graham imitated 50% of the gestures on the MIS, but imitated the most gestures during baseline. This finding suggests the ability to imitate in a structured setting may not generalize to a naturalistic setting, a finding consistent with other research (Stone et al., 2004). After learning to imitate using RIT, however, all children increased

their performance on the gesture imitation scale on the MIS. This finding suggests that learning to imitate in a naturalistic setting *does* generalize to a structured setting and underscores the importance of teaching skills in the natural environment.

Although the children's gesture imitation performance on the MIS was not predictive of their gesture imitation during baseline, it was somewhat predictive of their response to treatment. Noel had the highest performance on the MIS at intake and the highest rate of gesture imitation during treatment. Zane had the lowest performance on MIS and the lowest rate of gesture imitation during treatment, with Gage, Isaiah, and Graham falling in between on both measures.

None of the children used spontaneous gestures during baseline. However, after learning to imitate gestures, the majority of children began using gestures spontaneously. This finding provides preliminary support for the idea that children learn to use gestures through imitation during natural interactions (Smith & Bryson, 1994). However, the amount of gesture imitation and spontaneous gestures that the children used were not directly related. For example, Graham had the highest rate of spontaneous gestures during treatment despite the fact that he did not imitate as consistently as Noel. This finding suggests that while the ability to imitate gestures during play may be necessary for the development of spontaneous gesture use, it does not correspond directly.

One interesting finding was that the children's use of spontaneous gestures was associated with their language age, with children with lower language ages using *more* spontaneous descriptive gestures. In addition, the two children who made little gains in their spontaneous use of gestures had the highest expressive language age at intake. This finding is consistent with literature on typical development that suggests as children age, they rely less on gestures and more on spoken words (Namy & Waxman, 2002). Perhaps the use of descriptive gestures improves communicative competency in children with lower language ages; however, as children become more verbally fluent, they rely significantly less on gestures to clarify their communication.

Interestingly, even those children with less developed language skills did not augment their communication with gesture until they had received specific training in gesture imitation. This finding is consistent with research that indicates, unlike typically developing children and children with language delay, children with autism do not tend to use gestures to compensate for language difficulties (Wetherby & Prutting, 1984). These observations might suggest gesture imitation would be most beneficial as a treatment target for

children with limited language. Clearly, additional research using more direct assessments of language skills is needed to verify this hypothesis. In addition, research that examines the benefit of teaching gestures to children with autism with different language profiles (e.g., expressive versus receptive skills) and changes in gesture use over time as language age increases would be informative.

In this study, joint attention and instrumental gestures were not targeted. The children were taught to imitate gestures that described actions and objects during an interaction with the therapist. Thus, the modeled gestures may have served a similar function as joint attention gestures, in that they directed the partner's attention to some aspect of the action or object. Therefore, this approach might be used to target joint attention gestures (e.g., pointing and showing). Since the toys were freely available, the modeled gestures did not serve a requesting function; however, with certain modifications, such as withholding toys, it is likely that this intervention could be used to target instrumental gestures as well. Additional research is needed to investigate whether this approach could be successfully used to teach these other classes of gestures.

Although we did not use a standardized measure of language or measure overall language use during sessions, our combined imitation and gesture use data, as well as our social validity data, suggest that the children's language improved as a result of treatment. Previous research using RIT to target object imitation (Ingersoll & Schreibman, 2006) also found that children made gains in language and other social-communication skills as a result of treatment, suggesting that this approach may lead to collateral changes in social communication. However, it is unclear whether teaching imitation skills, either object or gesture, promotes the use of social communication directly or whether other components of the intervention, such as contingent imitation, linguistic mapping, following the child's lead, and teaching within play, are the active change agents. It is also unclear whether teaching object and gesture imitation would lead to changes in the same social-communication skills. Research comparing the effects of teaching object versus gesture imitation would provide important information in this regard.

Several limitations of this study are acknowledged. First, RIT targets multiple gestures concurrently during play. This strategy places the modeled gestures within a meaningful context and provides multiple exemplars to promote generalization. Although attempts were made to present a wide variety of gestures from each category, it is unlikely that each child received that same number of specific gestures because

gestures were presented based on the individual child's play. For example, a child who preferred play with miniatures might receive more presentations of gestures related to pretend play actions (i.e., "sleeping," "eating"), while a child who preferred to play with balls might receive more presentations of gestures related to ball play (i.e., "roll," "spin," "up"). In addition, since we did not record which gestures the children imitated or used spontaneously, it is unknown whether each child learned a wide variety of gestures or only several. Thus, the data do not indicate whether certain gestures are easier to learn than others or whether children with autism can learn to develop a wide range of gestures.

Second, since typically developing children were not included in this study, it is unknown which gestures children of a similar language age would be most likely to imitate or use spontaneously, nor the rate at which they would be likely to do so. Therefore, it is unclear whether the type of gestures targeted and the rate of gesture use achieved by the participants were developmentally appropriate. Our social validity measure attempted to control for this by asking naïve observers to rate the degree to which the children imitated and used appropriate gestures. Our social validity findings indicate the children imitated more and looked more appropriate in their gesture use during treatment than baseline, suggesting that the gestures targeted were appropriate and changes in gesture use were clinically meaningful. However, future research establishing the type of descriptive gestures typical children use, as well as their rates of imitation and gesture use would provide a better standard against which to compare gains as a result of treatment.

Third, although three of the children exhibited substantial gains in their spontaneous gesture use, the other two exhibited only modest changes, and did not increase their combined gesture use. Thus, while this study provides preliminary support for the theory that children with autism can be taught to use descriptive gestures spontaneously via gesture imitation (Smith & Bryson, 1994), additional research is needed.

In conclusion, the findings reveal that RIT can be adapted to target the imitation of gestures in children with autism. This procedure also leads to increases in some children's spontaneous use of gestures, and may lead to improvements in other social-communication skills. Future research using a larger sample of children with varying language levels will provide additional information regarding for whom this intervention is most likely to be effective.

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