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Feeling Sponginess: The Importance of Descriptive Gestures in 2- and 3-Year-Old Children's Acquisition of Adjectives

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Two experiments compared the role of tactile and deictic gestures in children's acquisition of adjectives. Children were taught novel adjective terms (e.g., *spongy*) pertaining to a target toy, accompanied for 1 group of children by a relevant descriptive gesture (e.g., squeezing) and by a point gesture for another group. Children then chose a toy from test sets consisting of a matching-property and nonmatching-property toy. The descriptive gesture group children chose the toy with the matching property significantly more often than the point gesture group children. Among point gesture group children, utterances on teaching and test trials suggested greater uncertainty and consideration of nontarget properties. These results underscore the role of nonverbal sociopragmatic factors in early word learning.

Understanding the meaning of adjective terms such as *slimy, crackly, shiny, furry,* and *minty* encompasses some, or even all, of our senses. For example, with our ears we hear the crinkly tissue paper, with our eyes we see the glittery gemstone, with our hands we feel the prickly cactus, with our nose we smell the garlicky pasta, and with our mouth we taste the creamy milk shake. It will be a challenge to understand how children learn the meaning of an adjective term when that meaning cannot be acquired in many cases without the involvement of several or all of our senses and moreover cannot always be extended correctly to new instances from visual inspec-

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tion alone. Understanding how children are able to successfully map a novel adjective to a certain property of an object may require us to consider the sensory information being communicated to the child beyond the utterance of the word itself and the visual appearance of the object. After all, an essential part of knowing what *mushy* means is knowing what *mushy* feels like. In this experiment, we explored the role played by tactile gestures, such as squeezing an object, in children's ability to infer the meaning of novel adjectives. We refer to such gestures as "descriptive" to distinguish them from deictic (i.e., referential) gestures such as pointing.

The first experiments to explore children's acquisition of adjective terms generally found that children up to 3 years of age tended to interpret novel adjectives as nouns (referring to the entire object) and only mapped a novel adjective to a property of an object in very limited situations (Gelman & Markman, 1985; Hall, Waxman, & Hurwitz, 1993; Taylor & Gelman, 1988). More recently, however, a number factors have been identified that appear to improve the performance of such young children in mapping novel adjective terms to their corresponding properties. Waxman and colleagues (Klibanoff & Waxman, 2000; Waxman & Markow, 1998) have shown that infants as young as 21 months of age can succeed in learning novel adjectives when the adjectives are first taught and tested with respect to multiple members of the same basic-level object category. In a further experiment, Waxman and Klibanoff (2000) showed that for 3-year-old children to extend novel adjectives to properties of objects from diverse basic-level categories, it is important to provide, at the time of teaching, objects with contrastive properties (e.g., one transparent and one opaque object) rather than objects with consistent properties (e.g., two transparent objects). Finally, Mintz and Gleitman (1998) provided evidence that 24- and 36-month-old children are successful at mapping novel adjective terms if, in addition to being given multiple examples of the mapping (e.g., "This is a *zav* doggie! This car is *zav* too! And here's a *zav* monkey!"), they are presented with the full noun phrase syntax (e.g., "This is a *zav* doggie.") rather than the standard syntactic frame, "This is a *zav* one," typically used in prior experiments (cf. Prasada, 1993).

The possible facilitative role played by descriptive gestures accompanying the teaching of novel adjective terms, as opposed to deictic referential gestures, has not been the direct focus of prior experiments, although there are a few findings that suggest their possible importance. First, Taylor and Gelman (1988) found that 2-year-old children handling an actual object made an adjective interpretation more often given the phrase "a zav one" and never with "a zav," whereas Hall et al. (1993), who presented children with the same task using actual objects but whose procedure did not give children opportunity to handle and tactilely explore the teaching and test objects, found no evidence that 2-year-old children were capable of making such adjective interpretations. Thus, it is possible that the opportunity for children to handle and tactilely explore the teaching and test objects in Taylor and Gelman may have facilitated adjective learning.

In another early experiment investigating children's understanding of material kinds, Prasada (1993, Experiment 2) demonstrated a substance-related property of the object to children, saying, for example, "Look, you can squeeze this ball." When children were subsequently asked to identify "the thing you can squeeze," 2½-year-old children performed above chance, choosing the object matching in substance kind rather than in shape. Prasada attributed this performance to the fact that children were given a demonstration of the property, although this conclusion was not directly tested in his experiment.

This conclusion was, however, put to the test by Kobayashi (1997) who examined whether 2-year-old children could make correct inferences about word meanings when two types of solid objects (rigid and flexible) were presented with two types of actions, namely shape-related or material-related actions. For example, a yellow, egg-shaped glass object was presented to children with either the shape-related action of rolling the object or the material-related action of looking through the object. These actions were each presented with an utterance of the form, for example, "See *muta*." Children's comprehension of the term *muta* was then tested by presenting them with a two-item test set in which one item shared the same shape as the original target but differed in material kind (e.g., yellow, egg-shaped styrofoam object), whereas the other was of the same material kind as the original target but differed in shape (e.g., yellow glass pyramid). Children's responses were found to be specifically influenced by the type of action demonstrated to them—children significantly more often chose the test item matching in shape when provided initially with a shape-related rather than material-related action and significantly more often chose the test item matching in material when provided initially with a material-related rather than shape-related action. In a second experiment, the children were shown to make use of this action information even when no label was provided during the initial demonstration (e.g., "Look what I do with this.").

Most interesting with respect to the influence on children's novel word learning of deictic versus more descriptive or demonstrative gestures, Kobayashi (1998) demonstrated that 2-year-old children were more likely to learn a novel part name of an unfamiliar object when an adult demonstrated an action on that part of the object in addition to simply pointing to it while naming the part. For example, in one case the novel word to be learned referred to a nut on a bolt. Children were more likely to demonstrate comprehension of the term *nut* when the adult acted on this part (i.e., turned the nut around the bolt) in addition to pointing to the nut and naming it than when only the latter two actions were carried out. Although the novel terms taught in this experiment were part terms rather than adjective terms, the results suggest that more descriptive or demonstrative gestures do play an important role in children's novel word learning, providing a pragmatic cue that children can exploit to infer the particular meaning of the novel term intended by the adult.

A number of observational experiments also suggest the possible importance of descriptive gestures to children when learning adjectives. Zukow-Goldring and

colleagues (e.g., see Zukow, 1990, and Zukow-Goldring & Ferko, 1994, for review) analyzed the methods by which caregivers directed attention to a topic or details of an ongoing event (e.g., "Look at the doll! ") when interacting with their child. Of particular interest in these experiments were the attention-directing gestures and actions used by parents accompanying their speech. Most relevant to the topic of adjectives, Zukow-Goldring and Ferks (1994) have noted the use by parents of what they called *demonstration* gestures such as traversing a rough texture like the bristles of a brush with a bouncing fingertip or demonstrating the consistency of beaten egg white by rubbing it across the fingertips. Such gestures, along with others such as showing and pointing, are argued by Zukow-Goldring and colleagues (e.g., Zukow-Goldring & Ferko, 1994) to be a means by which caregivers illustrate the conventional relation between speech and what it represents.

More generally, the argument that gestures may support the learning of adjectives receives support from previous experiments demonstrating that children's social and pragmatic knowledge contributes to word learning (for review, see, e.g., Baldwin & Tomasello, 1998; Bloom, 1998; Tomasello, 1992). In such experiments, children's word learning has been shown to be influenced by their sensitivity to cues produced by speakers signaling their intended referent when uttering a novel label (usually a novel count noun or verb in experiments to date). For example, 18-month-old children have been shown to use the direction of a speaker's eye gaze to determine the referent of a word (Baldwin 1991, 1993a, 1993b, 1995; Moore, Angelopoulos, & Bennett, 1999; Tomasello & Akhtar, 1995), as well to rely on affective cues such as a speaker's expressions of glee or disappointment to determine the referent of a novel object sought (Tomasello & Barton, 1994; Tomasello, Strosberg, & Akhtar, 1996). In addition, 2-year-old children appear to consider a speaker's knowledge state in word learning situations, as they have been shown to expect a speaker's utterance to refer to an object that is novel to the discourse context for that speaker (Akhtar, Carpenter, & Tomasello, 1996; but see Samuelson & Smith, 1998). Such sociopragmatic approaches to word learning are grounded in a view of language learning that emphasizes the importance of social-cognitive skills and cultural learning for language acquisition (Bruner, 1975, 1983; Tomasello, 1992, 2000). According to this approach, sociopragmatic cues such as eye gaze, gesture, and affective expression serve as means by which children can establish a joint focus of attention with an adult, which allows the child to determine the referent for a novel label intended by the adult (Tomasello, 1992).

The aim of these experiments was to see whether 2- and 3-year-old children who are taught a novel adjective term accompanied by a descriptive gesture, such as squeezing, would show better learning of the novel term than children taught the same novel adjective term accompanied by only a deictic pointing gesture. That is, we investigated 2- and 3-year-old children's sensitivity to descriptive versus deictic point gestures as a source of information for disambiguating the meaning of the adjective term. Unique to these experiments, as we describe further in the Re-

sults section, was the inclusion of adjective terms referring to the nonvisible insides of objects. In all previous experiments (e.g., Gelman & Markman, 1985; Hallet al., 1993; Klibanoff & Waxman, 2000; Kobayashi, 1997; Prasada, 1993; Taylor & Gelman, 1988; Waxman & Klibanoff, 2000; Waxman & Markow, 1998) the adjective terms under investigation have referred to properties that could be identified through vision alone (e.g., color, texture, pattern, state such as dirty or clean). Adjective terms referring to properties that could not be identified visually and required tactile exploration were included in our first experiment and were the exclusive focus of Experiment 2.

In Part 1 of this article, we describe two experiments and their results with respect to the influence of descriptive versus deictic point gestures on children's acquisition of novel adjective terms. In Part 2, we discuss secondary findings resulting from an examination of children's utterances on teaching and test trials of the procedure in both experiments that offer further clues as to the nature of the influence of both gesture types.

PART 1: THE ROLE OF DESCRIPTIVE VERSUS POINT GESTURES IN CHILDREN'S ACQUISITION OF ADJECTIVE TERMS

Experiment 1

Each novel adjective was taught to 2-year-old children while they were exploring a target toy possessing that property. The five adjective terms we chose to teach—*lumpy, spongy, roughy,*[1] *spiny,* and *fleecy*—represented a broad variety of tactile sensations and corresponding descriptive gestures we thought were appropriate given that this topic had not been previously investigated. As a result, however, we faced the possibility that the properties picked out by our assortment of adjectives and the particular toys we used as stimuli might produce some variation in the relative salience of the target property across the toys. Consequently, we anticipated that the effect of our gesture manipulation might not be equally pronounced for every adjective/property used in the experiment.

To capitalize on factors already known to facilitate the ability of young children to map novel adjectives to object properties, each of the five novel adjective terms was presented to children accompanied by a full noun phrase (e.g., "It's a spongy cow") and applied to animal names (e.g., cow) familiar to children of this age (see Hall et al., 1993, for discussion of the effect of familiarity). Children's comprehension was tested with two types of test sets, which were each constructed to include

[1]Although the more accurate word to use in English would perhaps have been "rough," "roughy" was used to achieve consistency (e.g., number of syllables, "-y" ending) among the five terms taught.

one test toy that shared the target property with the target toy and one test toy that did not. The two test sets differed, however, with respect to whether the distracter toy was or was not from the same basic-level category as the target toy. In one case, the *across-basic* test set, both test toys were drawn from a common basic-level category different from the target toy. In the other case, the *within-across-basic* set, the test toy that shared the target property with the target toy was again drawn from a basic-level category different from the target toy. However, a potent distracter was present, namely, a test toy (lacking the target property) drawn from the same basic-level category as the target toy. From past research (e.g., Klibanoff & Waxman, 2000), it was expected that the within-across-basic test sets would be more difficult for children, as they would have to override competing visual similarity between the distracter and the target toy. These latter test sets were included, nevertheless, as a more stringent test of children's comprehension of the novel adjective term. As reviewed in the introduction, 2-year-old children have shown an ability to learn novel adjective terms only in very limited situations. Thus, if the type of gesture used is found to affect children's acquisition of novel adjective terms, this result would provide further evidence that 2-year-old children are indeed attuned to the possibility that a word might refer to a toy's property instead of its identity.

Method

Participants

Forty older 2-year-old children participated in this experiment and were recruited from a population of middle-class and lower middle-class families in Kitchener-Waterloo, Ontario, Canada. All were in the process of acquiring English as their first language. The mean age of the 20 participants (8 boys, 12 girls) randomly assigned to the descriptive gesture group was 33.9 months (SD = .98, range = 32–35 months). The mean age of the 20 participants (10 boys, 10 girls) randomly assigned to the point gesture group was 34.8 months (SD = 1.11, range = 33–36 months). Six more children were tested but were not included due to experimenter error (n = 3) and an inability to successfully complete the practice trials (n = 2). One child was also replaced who was reported by the parent (in the language measure we describe following) to be familiar with only 3 out of the 15 animal names used in the experiment.

Stimuli

The stimuli consisted of five separate series of five small, lightweight, animal toys that were easily manipulated by the children (see Table 1). In each of the five series (lumpy, spongy, roughy, spiny, and fleecy), one target toy animal was created that possessed the target property that was used during the teaching trial. We

TABLE 1
Target stimuli and descriptive gestures used during teaching of adjective in Experiment 1

Adjective	*Target Toy*	*Descriptive Gesture*
Lumpy	Felt cat filled with beans	Feel beans between thumb and first two fingers
Spongy	Very squeezable cow	Squeeze toy with whole hand
Roughy	Fish covered with Velcro™ stripes	Scratch Velcro with fingernail
Spiny	Elephant covered with rubber spines	Feel along spines with first two fingers
Fleecy	Mouse covered with fleece material	Rub first two fingers over fleece in petting motion

constructed these toys as follows: For *lumpy,* we filled a brown felt cat with beans; for *spongy,* we purchased a toy cow made of very squeezable, squishy material; for *roughy,* we attached black vertical Velcro™ stripes to a blue cotton fish; for *spiny,* we attached rubber spines to a rubber elephant; and for *fleecy,* we attached fleecy (i.e., soft, fuzzy-like) material to the body area of a rubber mouse. These particular properties and their corresponding adjective terms were selected such that each could be accompanied by a different, distinctive descriptive gesture (e.g., squeezing for the spongy cow; see the *Teaching trials* subsection following and Table 1).

Two sets of two test toys were created for each of the five series of toys, as shown in Table 2. Each test set was constructed to include one matching test toy that shared the same target property as the target toy and one nonmatching test toy that did not. The nonmatching property toys were constructed as follows for each novel adjective term. For *lumpy,* toys were filled with cotton wool instead of beans; for *spongy* rigid plastic toys were used; for *roughy,* stripes were made out of black cotton material instead of Velcro™; and for *spiny* and *fleecy,* smooth rubber toys were used. The test toys within each across-basic test set (e.g., two pink pigs) were the same color but different from the color of the target toy used during the teaching trial in each case (e.g., black and white cow). The within-across-basic test set

TABLE 2
Two Test Sets Used for Each of the Five Target Adjectives in Experiment 1

	Across-Basic Test Set		*Within-Across-Basic Test Set*	
Target Toy	*Matching*	*Nonmatching*	*Matching*	*Nonmatching*
Lumpy cat	Lumpy turtle	Smooth turtle	Lumpy rabbit	Smooth cat
Spongy cow	Spongy pig	Hard pig	Spongy penguin	Hard cow
Roughy fish	Roughy bee	Smooth bee	Roughy butterfly	Smooth fish
Spiny elephant	Spiny duck	Smooth duck	Spiny bear	Smooth elephant
Fleecy mouse	Fleecy dog	Smooth dog	Fleecy frog	Smooth mouse

toys were constructed to be as similar in color as possible to the target toy (e.g., black and white penguin and cow).

In addition to these stimuli, two toy cars, two airplanes, two blocks, two balls, a fire truck, a train, a baby shoe, and a ball were used in the practice trials. A chute was constructed into which children could throw the test toy selected as the correct response to the test question. The chute, approximately 14 cm in diameter, was attached to a box (46 × 30 × 22 cm) large enough to hold all the toys deposited into it during the course of the experiment. The length of the chute (70 cm) allowed its opening to be at the height of the table beside the child. Near the opening, we affixed a Big Bird puppet and a cloth that could be used to cover up Big Bird and the opening of the chute.

Design

Children were randomly assigned to a descriptive gesture or point gesture group (between-subjects variable). Each child received one across-basic test set and one within-across-basic test set for each of the five target toys (within-subjects variable). The counterbalancing with respect to the left or right positioning of the toys in the practice and test trials, the order of the adjectives taught, and the order of the test trials (across basic and within across basic) are described in more detail in the sections to follow.

Procedure

Children were tested individually in a laboratory playroom. Each session began with a brief period during which the child became acquainted with the laboratory and the experimenter. Following this introduction, the children were seated at a small table. Beside the child, to his or her left, was the chute with the Big Bird puppet attached near the opening at the top. Children were told that they were going to play a game with Big Bird. The experimenter sat at the opposite side of the table facing the child. Parents were seated about 2 m behind the child against the back wall of the playroom. Parents were asked not to talk to their children (or to the experimenter) or to influence in any other way their children's attention to the stimuli. The experimental sessions lasted approximately 15 min and were videotaped for later transcription.

Practice trials. The session then began with a set of four practice trials intended to familiarize children with the sequence of being shown a target toy, hearing it labeled, and then having to give Big Bird a toy, selected from two alternatives, that matched the target toy. For example, a car was presented to children who were told, "Look it's a car. Yeah, it's a car." Then, once the children had a chance to play with the car for a few seconds, and their interest had waned, the car was placed in the top right-hand corner of the table. The experimenter then held up two toys

(for example, another car and a fire truck) and told the children, "Big Bird would really like to play with the car! Can you give Big Bird the car?" The two toys were placed down on the table in front of the children and at the same time Big Bird, who had been covered up with a cloth so as not to present a distraction to children, was uncovered. Once children had thrown one toy into the chute, the other toy was taken away by the experimenter. Big Bird was covered up again "to go away and play with the toys," and the next practice trial began. In total, children were given four practice trials for which the target toys were a car, airplane, block, and ball. Children ($n = 2$) who did not complete at least three of the four practice trials successfully were excluded from the final sample. The left–right positioning of the toys was counterbalanced over the trials (50/50) to identify any left- or right-hand biases among the children. None of the children included in the final sample showed evidence of such a bias.

Teaching trials. The teaching trial for each adjective began with the experimenter holding up the toy and saying "Look!" The toy was then given to the child to explore, during which time the experimenter labeled the adjective five times according to a preset script. For example, the child was told, "Wow, it's a lumpy cat. Look, it's lumpy. Yeah, it's a lumpy cat. Look, it's a lumpy cat. Yeah, it's a lumpy cat."

In addition to labeling the adjective five times for the twenty 2-year-old children randomly assigned to the descriptive gesture group, each instance of labeling the adjective was accompanied by a gesture demonstrating the property. In the case of *lumpy,* for instance, each of the five labeling instances was accompanied by the experimenter feeling the beans between her thumb and two fingers. Table 1 shows the gesture used to demonstrate each adjective term. However, for the other twenty 2-year-old children randomly assigned to the point gesture group, the five instances of labeling the adjective during the teaching trial for each toy were accompanied by a deictic point gesture to the toy rather than a descriptive gesture demonstrating the property.

Note that for both gesture groups the experimenter's labeling of the adjective term and use of a descriptive or point gesture occurred while children were given the toys to explore manually and visually. Therefore, children in the descriptive gesture had the opportunity to imitate the experimenter's descriptive gesture if they chose to do so. At the end of the teaching trial for each adjective, the target toy was placed in the upper right-hand corner of the table, out of reach of the child but within view. The order in which the five adjectives were taught was counterbalanced according to a Latin Square design.

Test trials. After being taught a given adjective, children received two test trials (across basic and within across basic). On each test trial, the experimenter first held up the two toys and said, for example, "Big Bird would really like to play

with the lumpy toy." Then as the two toys were placed on the table in front of the children for them to explore manually if they wished to, the experimenter asked, for example, "Can you give Big Bird the lumpy toy?" The order of presentation of the two test trials was counterbalanced such that half the children always received the across-basic test set first and the other half received the within-across-basic test set first. The right–left placement of the two test toys on the table was counterbalanced across children, although for each child one location was represented three times and the other twice (because there were 5 trials in total). After the child had thrown one of the toys down the chute, the experimenter said, "Good job" and the trial ended. If a child held up a toy asking for confirmation (e.g., "This one?") and waited for a response without making a spontaneous decision himself or herself, the request (e.g., "Can you give Big Bird the lumpy toy?") was repeated. It should be noted that only on one occasion following the experimenter's repetition of the request did the child change their response.

Preference Control Experiment

An additional 21 younger 2-year-old children (11 boys and 10 girls; *M* age = 27.5 months, *SD* = 2.09, range = 24–30 months) participated in a preference control experiment to determine whether there was any preexisting preference to choose the toy with the target property from a given test pair. In this control experiment, children were first given the practice trials described previously. Following this, children were given each of the 10 test pairs of two toys and asked simply to "Give one to Big Bird." No significant preference for either test toy was noted, with children choosing the test toy with the target property 51% of the time overall and between 48% and 55% for any one adjective in particular.

Language Measure

To determine whether any of the adjective terms used were familiar to children, parents were given a questionnaire to complete during the testing session. This questionnaire was comprised of a list of the 15 animal names used (as a control that children were indeed familiar with these) and 12 adjective terms (the five target terms and seven distracters). For each term, parents checked whether the child "understands" or "says" it, or both. Following the test session, the experimenter looked over the list to see whether any of the target adjective terms had been marked as being understood or produced by the child. If so, the experimenter questioned the parent about the nature of the child's understanding or examples of the child's uses of the term. For both gesture groups, between 50% and 60% of the children were reported to produce none of the target adjective terms, and overall, only one child was reported to have said up to three of the terms. The results were similar when understanding was assessed, with 80% to 85% of the children reported to understand the meaning of at most two of the target terms. However, it is

important to note that in no case was the context of the children's use of the target term reported by parents identical to that used in the experiment (e.g., a child was said to understand *lumpy* in the context of a lumpy pillow not in the context of feeling the inside of a toy filled with something like beans). As a result, dropping these children was not deemed appropriate, especially as it could be argued they serve to put our hypothesis to a more stringent test. In addition, analyses conducted after the experiment confirmed that children's total score in terms of choosing the correct test toy was not significantly (nor even always positively) correlated with the number of target adjective terms reported to be understood or produced in either gesture group.

Coding

Toy chosen on test trials. The videotaped sessions were coded to identify which toy the child chose (i.e., threw down the chute) when given a test set. The coding was carried out by Jane Topolovec. A second undergraduate coder who was blind to the hypothesis of the experiment independently rated all the videotaped sessions. Intercoder agreement was computed as the proportion of the trials on which coders agreed. Agreement between coders was 98% for choice of toy.

Production of descriptive gestures on teaching and test trials. Among children in both gesture groups, it was coded whether they produced the relevant descriptive gesture (see Table 1) at least once with (a) the toy on each teaching trial and (b) the target toy on each test trial. For each teaching and test trial, children thus received a score of 1 if a descriptive gesture was produced and a score of 0 if no descriptive gesture was observed. This coding was carried out independently by two undergraduate coders blind to the hypothesis of the experiment. Disagreements were very rare: There were none in Experiment 2 (discussed later) and only 4 instances on test trials in Experiment 1 (each for a different adjective)..

Results

We first discuss the results with respect to the toy chosen on the test trials. Second, we examine the relation between children's performance on the test trials and their prior production of descriptive gestures with (a) the toy on the teaching trial and (b) the target toy on the test trials.

Children's Choice of Toy on Test Trials

Children were given a score of 1 for each test trial on which the correct test toy was thrown in the chute (i.e., toy with matching target property). The percentage of children who responded correctly on each test trial for each adjective in each gesture group (descriptive vs. point) is shown in Table 3. Over all five adjectives and

TABLE 3
Percentage of Children in Experiment 1 Who Responded Correctly on Test Trials for Each Adjective (By Gesture Group and Test Trial Type)

	Gesture Group	
Test Trial Type	*Descriptive*	*Point*
Across-basic		
Lumpy	75	60
Spongy	80	65
Roughy	65	50
Spiny	95	90
Fleecy	75	75
M	78	68
Within-across-basic		
Lumpy	75	60
Spongy	85	60
Roughy	65	65
Spiny	65	65
Fleecy	60	55
M	70	61

Note. Children in each gesture group ($N = 20$) received one trial of each test trial type.

the two test trial types combined, children in the descriptive gesture group chose the toy with the matching target property 74% of the time as compared to 64.5% for children in the point gesture group. We conducted an analysis of variance (ANOVA) with Adjective (*lumpy, spongy, roughy, spiny, fleecy*) and Test Trial (within across basic vs. across basic) as within-subject factors and Gesture Group (descriptive vs. point) as the between-subject factor. The analysis revealed that this difference in the performance between the gesture groups, although in the direction expected, was not statistically significant.

As predicted, however, children were found to perform significantly better on the across-basic test trials than on the within-across-basic test trials, $F(1, 38) = 4.16$, mean square error [MSE] = 0.56, $p < .05$. However, this main effect was qualified by a Test Trial × Adjective interaction, $F(4, 152) = 2.45$, $MSE = 0.42$, $p < .05$. Indeed, inspection of Table 3 reveals that it was not the case that for every adjective children performed better on the across-basic test trials. For example, performance was equal for *lumpy* in both test trial groups. Thus, it cannot be concluded that it was always easier for children to decipher the meaning of the adjective in the across-basic trials simply by virtue of their design (i.e., fewer competing properties such as color and shape)—the type of property involved may play a role (this is discussed further following). No significant effect for adjective was found.

If we return to consider the five adjective terms taught to the children, it is evident that one of the differences existing between the five properties examined was that some were visually more obvious than others. For example, the properties of spininess and fleeciness were definitely perceptible from visual inspection alone. The properties of roughness, sponginess, and lumpiness, however, were more dependent on tactile manipulation, perhaps least so for roughness (as the Velcro™ could be detected with close visual inspection) and more so for both sponginess and lumpiness. It could therefore be hypothesized that gesture may play a more important role in the learning of less visually detectable properties.

Our data do, in fact, support this hypothesis. Children's performance showed the largest decrement between the gesture groups for the two least visually detectable properties—lumpy and spongy—regardless of type of test trial (see Table 3). Indeed, an analysis carried out with only these two adjectives confirms that children in the point gesture group chose the test toy with the matching target property significantly less often than the children in the descriptive gesture group, $F(1, 38) = 4.09$, $MSE = 1.22$, $p < .05$. When the adjective *roughy* was also included in the analysis, this difference in performance was found to be marginally significant, $F(1, 38) = 3.06$, $MSE = 1.20$, $p = .09$.

The Test Trial (across basic vs. within across basic) × Adjective interaction discussed previously may also be interpretable in light of whether the property was visually salient or not. The performance of children was not found to differ significantly between two types of test trials for the less visually detectable adjectives *lumpy*, *spongy*, and *roughy*, but did differ significantly for *spiny*, $t(38) = 3.44$, $p < .001$. For *fleecy*, the difference in performance was only marginally significant, $t(38) = 1.86$, $p = .07$. Thus, for the less visually detectable adjective terms, children performed similarly on both types of test trials. It was only with respect to the more visually salient adjective terms that children were found to perform better on the across-basic trials as reported in previous experiments (e.g., Klibanoff & Waxman, 2000).

Children's Production of Descriptive Gestures on Teaching and Test Trials: Relation to Performance on Test Trials

In this next section, we address children's own production of descriptive gestures on teaching and test trials and the relation of these behaviors to their performance on test trials (i.e., whether the correct target toy is chosen or not). These findings provide further support for the claim that the use of descriptive gestures influenced children's ability to learn the target adjective term intended and to choose the correct target object.

Production of descriptive gestures with the toy on teaching trials. Table 4 shows the frequency with which children produced at least one descriptive gesture with the toy presented to them on the teaching trial for each adjective. As is evident from Table 4, such descriptive gestures were produced by children in both gesture groups, despite the fact that they were modeled only to children in the descriptive gesture group. The overall frequency with which descriptive gestures were observed was, nevertheless, significantly higher among children in the descriptive gesture group than among children in the point gesture group (95% vs. 66% of trials, respectively), $t(198) = 5.53$, $p < .001$. However, it should be noted that this overall difference is largely due to the *roughy* and *fleecy* teaching trials because it was only on these trials that the production of descriptive gestures was significantly greater among children in the descriptive gesture group than among children in the point gesture group; *roughy*, $t(38) = 5.38$, $p < .001$; *fleecy*, $t(38) = 5.58$, $p < .001$. For the other three adjective terms, an approximately equal number of children were observed to produce the descriptive gesture with the toy during teaching. These results are not unexpected, as it could be anticipated that in playing with the spongy cow, for example, children could discover on their own that it could be squeezed and proceed to do so.

TABLE 4
Number and Percentage of Children in Each Gesture Group Producing a Descriptive Gesture With the Teaching Toy for Each Adjective in Experiment 1[a] and Experiment 2[b]

	Gesture Group			
	Descriptive		*Point*	
Adjective	*No.*	*%*	*No.*	*%*
Experiment 1				
Lumpy	20	100	17	85
Spongy	20	100	18	90
Roughy	18_a	90	5_b	25
Spiny	18	90	20	100
Fleecy	19_a	95	6_b	30
Total	95_a	95	66_b	66
Experiment 2				
Globby	16	100	14	88
Cushy	16_a	100	9_b	56
Springy	15_a	94	10_b	62
Fleecy	16	100	14	88
Total	63_a	98	47_b	73

Note. For a given row, numbers with different subscripts represent significant differences in frequency between the descriptive and point gesture groups at $p < .05$, two-tailed.

[a] $N = 20$. [b] $N = 16$.

Relation of children's production of descriptive gestures with the toy on teaching trials to their performance on test trials. As just described, for *lumpy, spongy,* and *spiny,* almost all the children in each gesture group produced a descriptive gesture with the toy and therefore no significant difference in the production of these gestures was observed. Thus, for these adjectives, it is not informative to examine the relation between such gestures and children's performance at test. For *roughy* and *fleecy,* the relation between children's scores with respect to the production of a descriptive gesture on the teaching trial and their scores on the corresponding test trials (collapsed over the across-basic and within-across-basic test trials) was measured by calculating Kendall's τ correlation coefficient. For *fleecy,* a significant positive correlation was found among the children in the point gesture group (Kendall's $\tau = .482$, $p < .03$) but not among children in the descriptive gesture group. Note, however, that the significant correlation found is based on only 25% of children in the point group who produced a descriptive gesture during teaching. For *roughy,* a significant positive correlation was found among the children in the descriptive gesture group (Kendall's $\tau = .479$, $p < .03$). In contrast, among children in the point gesture group a significant negative correlation was found. Overall, these results provide little evidence for a correlation between the production of descriptive gestures during teaching and children's performance when choosing the toy demonstrating the property at test. Next we turn to consider the relation between children's production of descriptive gestures with the target toy on the test trials and their subsequent choice of toy.

Production of descriptive gestures with the target toy on test trials. Table 5 shows the incidence of descriptive gestures produced with the target toy for each of the adjectives on each of the two test trials (across basic and within across basic). As observed on teaching trials, such descriptive gestures were produced by children in both gesture groups. Overall, however, children in the descriptive gesture group produced descriptive gestures on significantly more test trials than children in the point gesture group (54% vs. 33%, respectively), $t(198) = 3.63$, $p < .001$. When each adjective was examined separately, children in the descriptive gesture group were found to produce significantly more descriptive gestures than children in the point gesture group for the adjectives *lumpy,* $t(38) = 3.11$, $p < .005$; *spongy,* $t(38) = 2.46$, $p < .02$; and *roughy,* $t(38) = 3.34$, $p < .005$. On the test trials for *spiny,* descriptive gestures were observed on half the test trials among both gesture groups. For *fleecy,* descriptive gestures were almost never observed among either gesture group. Thus, these frequency measures suggest that descriptive gestures were more likely to occur with the adjectives for which the effect of gesture group was found to be strongest (i.e., *lumpy, spongy,* and *roughy*). We present the test of this relation directly in the next section.

TABLE 5
Number of Trials in Which Children in Each Gesture Group Produced a Descriptive Gesture With the Target Toy on Each Test Trial for Each Adjective in Experiment 1

	Gesture Group							
	Descriptive				*Point*			
Adjective	*AB*	*WAB*	*Total*	*%*	*AB*	*WAB*	*Total*	*%*
Lumpy	16	15	31_a	78	7	9	16_b	40
Spongy	18	18	36_a	90	13	12	25_b	62
Roughy	8	7	15_a	38	2	1	3_b	8
Spiny	11	9	20	50	13	7	20	50
Fleecy	3	4	7	18	1	1	2	5
Total	56	53	109_a	54	36	30	66_b	33

Note. AB = across-basic test trial; WAB = within-across-basic test trial. For a given row, numbers with different subscripts represent significant differences in frequency between the descriptive and point gesture groups at $p < .05$, two-tailed.

Relation of children's production of descriptive gestures with the target toy on test trials to their performance on test trials. Kendall's τ correlation coefficients were calculated to examine the relation, for each adjective, between children's scores with respect to the production of a descriptive gesture with the target toy on each test trial (across basic and within across basic) and their score on each of the two test trials. Among the children in the descriptive gesture group, a significant positive correlation was found for both test trials for the adjectives *lumpy* and *spongy* and for the within-across-basic test trial for *spiny* (see Table 6 for correlation coefficients and *p* values). Among the children in the point gesture group, a significant positive correlation was found only for the within-across-basic test trial for *spongy* and the across-basic test trial for *spiny.* Overall, the results support, especially for the adjectives *lumpy* and *spongy,* the fact that the better test performance of children in the descriptive gesture group was related to their production of descriptive gestures with the target toy at test. For the adjective *roughy,* the situation was less clear, as no significant relation was observed among either group, possibly due to the less frequent production of descriptive gestures. The properties for *fleecy* and *spiny* could easily be assessed visually, and thus a relation would not necessarily be expected between children's performance of the descriptive gesture with the target toy and their choice at test. Indeed, for *fleecy* no significant relation was found among either gesture group. It was somewhat unexpected that a significant positive correlation was found for *spiny* with one test trial among each gesture group, and this finding may be related to the equally unexpected finding that descriptive gestures were produced with the target toy on half the test trials in both gesture groups.

TABLE 6
Kendall's τ Correlation Coefficients for Relation Between the Production of a Descriptive Gesture With the Target Toy on Each Test Trial and Children's Performance at Test in Experiment 1

	Gesture Group			
	Descriptive		*Point*	
Adjective	*AB*	*WAB*	*AB*	*WAB*
Lumpy	.577**	.467*	.171	.328
Spongy	.667***	.793***	.121	.583**
Roughy	.385	.319	.333	−.313
Spiny	.254	.664***	.454*	.319
Fleecy	.243	.408	.132	.208

Note. AB = across-basic test trial; WAB = within-across-basic test trial.
*$p < .05$. **$p < .02$. ***$p < .005$.

Discussion

The results of Experiment 1 suggest that descriptive gestures play an important role in the learning of novel adjective terms, especially in cases involving a property that is nonvisible. That is, for the adjective terms *lumpy* and *spongy,* children in the descriptive gesture group chose the test toy with the matching target property significantly more often than children in the point gesture group. For these two adjectives, among children in the descriptive gesture group, the production of descriptive gestures with the target object on test trials was also associated with their choice of the correct matching toy at test. Thus, the use of descriptive gestures (as opposed to deictic point gestures) during teaching appears to have helped children to zero in on the particular property intended by the speaker when using a particular adjective term (i.e., achieve mutual reference). A second study, Experiment 2, was designed to provide further support for this claim.

EXPERIMENT 2

The design and procedure of Experiment 2 were identical to Experiment 1 with four important exceptions. First, all the novel adjective terms taught referred to the nonvisible insides of the toys used, which, given the results of Experiment 1, was expected to reveal a greater difference in performance between the gesture groups. Second, the particular adjective terms taught were chosen so as to be novel to all the children (i.e., they were low-frequency English words). Third, to simplify the task for children, all the test trials involved across-basic test sets. Fourth, given that

the 2½-year-old children in Experiment 1 had found the across-basic trials involving nonvisually salient properties quite difficult, it was decided that the task in Experiment 2 was more appropriate for a slightly older group of children and thus the participants were young 3-year-old children.

Method

Participants

Thirty-two young 3-year-old children participated in this experiment and were recruited from a population of middle-class and lower middle-class families in Kitchener-Waterloo, Ontario, Canada. All were in the process of acquiring English as their first language. The mean age of the 16 participants (8 boys, 8 girls) assigned to the descriptive gesture group was 39.8 months (SD = 1.76, range = 37–43 months). The mean age of the 16 participants (8 boys, 8 girls) assigned to the point gesture group was 40.6 months (SD = 1.75, range = 37–43 months). Five more children were tested but were not included due to parental involvement at time of test (n = 2) and extreme fussiness (n = 3).

Stimuli

The stimuli consisted of four separate series of four small, lightweight, animal toys that were easily manipulated by the children (see Table 7). In each of the four series—*globby, cushy, flimsy, springy*—one target toy animal was created that possessed the target property taught on teaching trials. We constructed these toys as follows: For *globby,* we filled a gray plush mouse with soft plastic grapes; for *cushy,* we purchased a black and white toy cow made of very squeezable, squishy material; for *flimsy,* we filled a blue felt dog with semolina (a fine, grainy substance); and for *springy,* we filled a cotton monkey with elastic bands. These particular properties and their corresponding adjective terms were selected, as in Ex-

TABLE 7
Target Stimuli and Descriptive Gestures Used During Teaching of Adjective in Experiment 2

Adjective	*Target Toy*	*Descriptive gesture*
Globby	Plush mouse filled with plastic grapes	Feel grapes between thumb and first two fingers
Cushy	Very squeezable cow	Squeeze toy with whole hand
Flimsy	Felt dog filled with fine grains	Bend dog back and forth between fingers
Springy	Cotton monkey filled with elastic bands	Push down with palm on top of monkey (so it springs back up)

periment 1, such that each could be accompanied by a different, distinctive descriptive gesture (e.g., squeezing for the cushy cow; see Table 7).

Two sets of two test toys were created for each of the four series of toys. Each test set was constructed to include one matching test toy that shared the same property as the target toy and one nonmatching test toy that did not. Unlike in Experiment 1, both test sets constituted across-basic sets in which the two toys were from the same animal category but one that differed from the target toy in kind and color (e.g., two yellow ducks in the case of *globby* in which the target toy was a gray mouse). The two test set toys were identical in appearance and only their insides differed. The animal categories used for the two test sets were fish and duck (*globby*), pig and bee (*cushy*), cat and rabbit (*flimsy*), and frog and turtle (*springy*). The insides of the two nonmatching property toys for each test trials consisted of the following: cotton wool for *globby,* rigid plastic material for *cushy,* a wood cutout in the shape of the animal for *flimsy,* and a hard foam core for *springy.* In addition to these stimuli, two toy cars, two airplanes, two blocks, two balls, a fire truck, a train, a baby shoe, and a ball were used in the practice trials.

Design

As in Experiment 1, children were randomly assigned to the descriptive gesture or point gesture group (between-subjects variable). Each child received only across-basic test sets for each of the five target toys.

Procedure

Practice trials. These trials were identical to those used in Experiment 1 except that Big Bird was not used and children were instead simply asked to find the toy (e.g., "Can you find the car?"). Once children had indicated one of the toys by handing it to the experimenter, the other toy was taken away. In total, children were given four practice trials for which the target toys were a car, airplane, block, and ball. The left–right positioning of the toys was counterbalanced over the trials to identify any left- or right-hand biases among the children. None of the children included in the final sample showed evidence of such a bias.

Teaching trials. The teaching trial for each adjective proceeded as in Experiment 1 with the identical preset script (e.g., "Wow, it's a flimsy dog. Look, it's flimsy. Yeah, it's a flimsy dog. Look, it's a flimsy dog. Yeah, it's a flimsy dog.") As in Experiment 1, for the 16 children randomly assigned to the descriptive gesture group, each of the four instances of labeling the adjective was accompanied by a gesture demonstrating the property. For the other 16 children randomly assigned to the point gesture group, the four instances of labeling the adjective during the teaching trial for each toy were accompanied by a deictic point gesture. At the end

of the teaching trial for each adjective, the target toy was placed in the upper right-hand corner of the table, out of reach of the child but within view.

Test trials. After being taught a given adjective, children received two test trials. On each test trial, the experimenter first held up the two toys and said, "Here are two toys." Then, as the two toys were placed on the table in front of the children, the experimenter asked, for example, "Can you find the cushy pig?" After the child had given one of the toys to the experimenter, she said, "Good job," and the trial ended. If the child first held up a toy asking for confirmation, for example asking, "This one?," the request was repeated.

Language Measure

As in Experiment 1, parents were given a questionnaire to complete during the testing session. This questionnaire comprised of a list of the 12 animal names used (as a control that children were indeed familiar with these) and 28 adjective terms (the four target terms and 24 distracters). For each adjective term, parents checked whether the child "understands" or "says" it, or both. Only one child was reported to have produced a maximum of two of the target adjective terms. Three children were reported to have produced one of the target adjective terms. However, as expected, the majority of children in both gesture groups (n = 12–13) were reported to neither understand nor say any of the four adjective terms. Moreover, as in Experiment 1, in no case was the reported context of use of the target term identical to that used in the experiment. In addition, analyses conducted after Experiment 2 confirmed that children's total score in terms of choosing the correct test toy was not significantly correlated with the number of target adjective terms reported to be understood or produced in either gesture group.

Coding

Toy chosen on test trials. This coding procedure was identical to that described for Experiment 1. Intercoder agreement was computed as the proportion of the trials on which coders agreed. Agreement between coders was 100%.

Production of descriptive gestures on teaching and test trials. This coding procedure was identical to that described for Experiment 1. Agreement between coders was 100%.

Results

As in Experiment 1, we first discuss the results with respect to the toy chosen on the test trials. Second, we examine the relation between children's performance on the test trials and their prior production of descriptive gestures on teaching and test trials.

Children's Choices on Test-Set Trials

Children were given a score of 1 for each test trial on which the correct test toy (i.e., toy with matching target property) was given to the experimenter. Thus, each child could receive a possible total score of 2 for each adjective (and a possible total score of 8 over all four adjectives). Table 8 shows the percentage of test trials per adjective on which each of the 16 children in the descriptive gesture and point gesture groups chose the correct toy. Overall, children in the descriptive gesture group chose the toy with matching target property on 74.2% of all trials ($M = 5.9, SD = 1.91$) compared to 57.8% ($M = 4.63, SD = 1.03$) for children in the point gesture group. This effect of gesture group was indeed confirmed as significant, $F(1, 30) = 5.85$, $MSE = 3.45$, $p < .03$ in an ANOVA conducted with adjective (*globby, cushy, springy, flimsy*) as the within-subject factor and gesture group (descriptive vs. point) as the between-subject factor. A significant effect of adjective was also found, $F(1, 30) = 3.43$, $MSE = 3.45$, $p < .03$, which can be attributed to the fact that children's performance was much poorer for *globby* overall than for any other adjective.

The lack of a significant interaction effect suggests that the effect of the gesture manipulation did not vary significantly among the adjective terms taught. That is, for each of the four adjective terms taught, the same pattern of performance was observed, with children in the point gesture group performing more poorly than children in the descriptive gesture group.

Children's Production of Descriptive Gestures on Teaching and Test Trials: Relation to Performance on Test Trials

Production of descriptive gesture with the toy on teaching trials. Table 4 shows the frequency with which children produced at least one descriptive ges-

TABLE 8
Percentage of Correct Test Trials for Each Adjective Among Children in Descriptive and Point Gesture Groups

	Gesture Group	
Adjective	*Descriptive*	*Point*
Globby	59	53
Cushy	88	72
Flimsy	75	53
Springy	79	53
M	74	58

Note. Children ($N = 16$) in each gesture group received two test trials for each adjective.

ture with the toy presented to them on the teaching trial for each adjective. As in Experiment 1, such descriptive gestures were produced by children in both gesture groups, despite the fact that they were modeled only to children in the descriptive gesture group. Among children in the descriptive gesture group, descriptive gestures were produced on almost all the teaching trials and significantly more often than among children in the point gesture group (98% vs. 73% of trials, respectively), $t(126) = 4.33, p < .001$. However, it should be noted that this overall difference is largely due to the *cushy* and *springy* teaching trials because it was only on these trials that the production of descriptive gestures was significantly greater among children in the descriptive gesture group than among children in the point gesture group; *cushy*, $t(30) = 3.42, p < .003$; *springy*, $t(30) = 2.24, p < .05$. For *globby* and *fleecy*, all or almost all the children were observed to produce the descriptive gesture with the toy during teaching in each gesture group.

Relation of children's production of descriptive gestures with the toy on teaching trials to their performance on test trials. As just described, for *globby* and *fleecy* almost all the children in each gesture group produced a descriptive gesture with the toy and no significant difference in the production of these gestures was therefore observed. Thus, the relation between children's score with respect to the production of descriptive gestures on teaching trials to their score on test trials was only examined for *cushy* and *springy*, for which a significant difference in production was found between the two gesture groups. No significant correlations were found among children in either gesture group when Kendall's τ correlation coefficients were calculated. Overall, these results provide no evidence for a correlation between the production of descriptive gestures during teaching and children's performance when choosing the toy demonstrating the property at test. Next we turn to consider the relation between children's production of descriptive gestures with the target toy on the test trials and their subsequent choice of toy.

Production of descriptive gesture with the target toy on test trials. Table 9 shows the incidence of descriptive gestures produced with the target toy on test trials for each of the four adjectives. As observed on teaching trials, such descriptive gestures were produced by children in both gesture groups. Overall, however, descriptive gestures were produced significantly more often among children in the descriptive gesture group than children in the point gesture group, $t(126) = 4.34, p < .001$. Children in the descriptive gesture group also produced significantly more descriptive gestures that children in the point gesture group on the test trials for the adjectives *globby*, $t(30) = 2.18, p < .05$, and *cushy*, $t(30) = 2.71, p < .02$. On the test trials for *springy* and *fleecy*, descriptive gestures were produced more often by children in the descriptive gesture group, but these differences were only marginally significant; *springy*, $t(30) = 1.94, p = .06$; *fleecy*, $t(30) = 1.85, p = .07$. Thus, these frequency measures suggest that descriptive gestures were more likely to oc-

TABLE 9
Number and Percentage of Trials in Each Gesture Group on Which Children Produced a Descriptive Gesture With the Target Toy on Test Trials for Each Adjective in Experiment 2

	Gesture Group			
	Descriptive		*Point*	
Adjective	*No.*	*%*	*No.*	*%*
Globby	24_a	75	14_b	44
Cushy	27_a	84	15_b	47
Springy	28	88	20	63
Flimsy	23	72	13	41
Total	102_a	80	62_b	48

Note. Children in Experiment 2 ($N = 16$) each received two test trials for each adjective term. For a given row, numbers with different subscripts represent significant differences in frequency between the descriptive and point gesture groups at $p < .05$, two-tailed.

cur on test trials among children in the descriptive gesture group and could be related to the better performance of these children when choosing the target toy at test. We examined this relation directly and report on it in the next section.

Relation of children's production of descriptive gesture with the target toy on test trials to their performance on test trials. Kendall's τ correlation coefficients were calculated to examine, for each adjective separately, the relation between the children's scores with respect to the production of a descriptive gesture with the target toy on each test trial and their scores on each test trial. As each child received two test trials, these analyses were conducted on 32 observations in total for each of the 16 children in each gesture group. When each adjective was examined separately, a significant positive correlation was found for all four adjectives among children in the descriptive gesture group (see Table 10). In contrast, a significant positive correlation relation was observed only for the adjective *cushy* among the point gesture group. These results strongly suggest that children who were provided with a descriptive gesture during teaching utilized this information when choosing the toy at test that exhibited the same tactile property.

Discussion

The results of Experiment 2 further support our claim that descriptive gestures play an important role in the learning of novel adjective terms. When taught novel adjec-

TABLE 10
Kendall's τ Correlation Coefficients for Relation Between the Production of a Descriptive Gesture With the Target Toy on Test Trials and Children's Performance at Test in Experiment 2

	Gesture Group	
Adjective	*Descriptive*	*Point*
Globby	.364*	.071
Cushy	.358*	.448**
Springy	.436**	.081
Flimsy	.701***	.139

*$p < .05$. **$p < .02$. ***$p < .005$.

tives referring to the nonvisible insides of toys, children provided with a descriptive gesture during teaching chose the toy with matching target property significantly more often than children provided with only a point gesture. Moreover, for all four adjectives among children in the descriptive gesture group, the production of descriptive gestures with the target toy at test was found to be significantly correlated with their choice of the correct toy at test. Thus, the use of descriptive gestures during the teaching of novel adjective terms appears, as in Experiment 1, to have helped children to isolate the particular property intended by the speaker in a manner not possible when point gestures were used instead.

PART II: CHILDREN'S TALK ON TEACHING AND TEST TRIALS IN EXPERIMENTS 1 AND 2

Secondary, post hoc analyses of children's utterances during the teaching and test trials revealed interesting differences between children in the two gesture groups that may further illuminate how descriptive versus point gestures influenced children's performance. Given these differences, we carried out a full transcription and coding of children's utterances in both experiments. We now discuss these analyses and their results across both experiments.

METHOD CODING OF FOUR ASPECTS OF CHILDREN'S UTTERANCES

Children's utterances in both experiments were independently transcribed by Jane Topolovec and a second undergraduate coder. Minor differences in wording were re-

solved through discussion. Four aspects of children's utterances were examined as described following. The first three pertained to the teaching trials and the fourth pertained to the test trials.

Repetitions of Target Adjective Term During the Teaching Trials

One aspect of children's utterances tallied on teaching trials consisted of repetitions of the target adjective term such as "it's roughy." Children received a score of 1 per teaching trial for repetition if they repeated the target term being taught. The maximum score a child could earn per trial was 1, ensuring that multiple mentions by one child would not artificially inflate the total. Thus, each child received a total score between 0 and 5 in Experiment 1 or 0 and 4 in Experiment 2 for this measure.

Utterances Synonymous in Meaning With Target Term During the Teaching Trials

A second aspect of children's utterances noted during each teaching trial consisted of the use of adjective terms or phrases that were synonymous in meaning to the target term being taught. For example, in Experiment 1 on a *spiny* trial, one child uttered "prickly." Similarly, on a *spongy* trial in Experiment 1 and a *cushy* trial in Experiment 2, two children referred to the "squishiness" of the toy ("can squish it," "it's squishy"). In Experiment 2, these comments often took the form of describing the different insides of the toys. For example, on a *globby* trial, one child uttered, "tiny balls in it." As mentioned previously, children received a maximum score of 1 per teaching trial for this aspect and a total score between 0 and 5 in Experiment 1 or 0 and 4 in Experiment 2 for this measure.

Mention of Nontarget Properties or Parts of the Toys During the Teaching Trials

This aspect of children's utterances was of most interest and consisted of comments on teaching trials that included mention of properties other than the target property (using adjectives other than the target term being taught or not synonymous with the target term, or both) or mention of parts of the toys not related to the target property, as demonstrated in the following utterance: "Yeah, it has a tail on it. And it's happy." We termed such utterances *nontarget property/part* utterances. Further examples of such utterances are shown in Table 11. Children received a score of 1 per trial for nontarget property/part if any mention was made of a property or adjective other than the target term being taught (e.g., "*big* elephant") or a part of the toy not related to the property in question (e.g., "he got a *big hole*"). As

TABLE 11
Examples of Nontarget Part/Property Utterances Occurring on Teaching Trials in Experiments 1 and 2

Adjective Trial	*Children's Utterances During Teaching*
Lumpy cat	"His tail is gray."
	"And it has something in it. It has a scarf on. It has a scarf on."
Spongy cow	"Look it. The spongy cow is pretty good. He has funny little spots."
	"It walks. It has a mouth. It has a nose and it has a chin. And it has a butt. This thing on it."
Roughy fish	"It matches the blue box."
	"It goes in the water. It swims. And it goes on the paper. Yeah, and it has a mouth on it. And, it has eyes on it. It has a tail on it. And he has a, he has happy faces on it."
Spiny elephant	"Big elephant."
	"Spiny. It's elephant. He's blue like paper."
Fleecy mouse	"Does he got a tail? There's a hole. It doesn't squeak. It doesn't squeak."
	"Yeah, it has a tail on it. And, and it's happy."
Globby mouse	"With his little mouse tail."
Cushy cow	"He looks like a big squirrel. But, he looks like a round circle."
Springy monkey	"Monkey, monkey, hoppy, hoppy. His tail's sticking up. Fling."
	"A springy monkey. No, climbs trees. He climbs trees."

previously, children received a maximum score of 1 per teaching trial for this aspect and a total score between 0 and 5 in Experiment 1 or 0 and 4 in Experiment 2 for this measure.

With respect to the three aspects just described relating to children's utterances on teaching trials, children's utterances on any given trial could have encompassed more than one of these aspects. If this was the case, the child was credited with each aspect in turn.

Expressions of Uncertainty on Test Trials

In many cases on the test trials, children expressed uncertainty regarding their choice. Questions such as the following were not uncommon: "This one the lumpy toy?"; "Is this the fleecy doggie?"; and "This spiny toy?" From the transcript data, children were assigned a score of 1 if they asked specifically whether a chosen toy possessed the target property in question as illustrated in the previous examples. Children received a maximum score of 1 per test trial for this measure and, therefore, given that there were two test trials per adjective in both

Experiments 1 and 2, could receive a maximum score of 10 in Experiment 1 and 8 in Experiment 2.

EXPERIMENT 1: RESULTS

The analyses following pertain, in Experiment 1, to a total of 100 teaching trials and 200 test trials per gesture group.

Repetition of Target Term on Teaching Trials

Interestingly, the frequency of repetitions of the target term was almost equivalent in the two experimental groups (23 vs. 24 instances for the descriptive and point gesture groups, respectively), as shown in Table 12. The fact that the frequency of repetition of the novel adjective term did not differ significantly among children in both gesture groups suggests that simple repetition of a novel term may not be a valid indicator of the level at which children are encoding the meaning of a novel term, as might be expected. Moreover, this finding suggests that children's errors in choosing the toy with the matching property on test trials were not due to a lack of attention to the novel adjective term during teaching trials.

TABLE 12
Frequency of Utterance Types per Adjective Trial and Total as Percentage of All Teaching or Test Trials in Experiment 1

	Adjective					*Total*	
Trial Type	*Lumpy*	*Spongy*	*Roughy*	*Spiny*	*Fleecy*	*Frequency*	*%*
Descriptive gesture group							
Teaching trials[a]							
Repetition	4	5	4	5	5	23	23
Synonymous	0	4	1	4	0	9	9
Part/property	4	3	3	5	6	21	21
Test trials[b]							
Uncertainty	4	0	4	0	2	10	5
Point gesture group							
Teaching trials[a]							
Repetition	3	3	5	5	8	24	24
Synonymous	1	2	0	4	0	7	7
Part/property	4	7	9	5	8	33	33
Test trials[b]							
Uncertainty	5	7	6	8	2	28	14

[a]$N = 100$. [b]$N = 200$.

Utterances Synonymous in Meaning With Target Term on Teaching Trials

The overall frequency of such utterances was quite low (16 trials) compared to instances of repetition or the mention of nontarget properties/parts during teaching. Their use did not differ significantly between the two gesture groups.

Mention of Nontarget Properties or Parts of the Toys on Teaching Trials

The frequency of utterances mentioning parts of the toy or other properties of the toy was greater among children in the point gesture than in the descriptive gesture group, occurring on 33 versus 21 trials, respectively (see Table 12). This increase in frequency was only marginally significant when all five adjectives were considered, $t(38) = 1.40$, $p = .09$, one-tailed. However, when the occurrence of such comments about parts and properties was compared between gesture groups with respect to the three least visually salient properties (*lumpy, spongy,* and *roughy*), such comments were found to be produced on a significantly greater number of point gesture trials than descriptive gesture trials (20 vs. 10 instances, respectively), $t(38) = 1.95$, $p < .03$, one-tailed.

Expression of Uncertainty at Test

No significant difference was found with respect to the frequency of such expressions on across-basic versus within-across-basic test trials; therefore, children's scores were collapsed across the 10 trials in total. It was found that children in both the descriptive gesture and point gesture group asked such questions, but children in the point gesture group did so on approximately three times as many trials overall (28 trials; 14% of total trials) as children in the descriptive gesture group (10 trials; 5% of total trials). This difference was only marginally significant but suggests that children in the point gesture group were experiencing more uncertainty regarding the nature of the property referred to by the adjective term, $t(38) = 1.42$, $p = .08$, one-tailed.

EXPERIMENT 2: RESULTS

The analyses following pertain, in Experiment 2, to a total 64 teaching trials and 128 test trials per gesture group. Overall, it should be noted that among the young 3-year-old group of children in Experiment 2, the four types of utterances were observed to occur at much lower rates than in Experiment 1 (see Table 13).

TABLE 13
Frequency of Utterance Types per Adjective Trial and Total as Percentage of All Teaching or Test Trials in Experiment 2

	Adjective				*Total*	
Trial Type	*Globby*	*Cushy*	*Springy*	*Flimsy*	*Frequency*	*%*
Descriptive gesture group						
Teaching trials[a]						
Repetition	3	1	4	1	9	14
Synonymous	2	2	0	2	6	9
Part/property	5	1	5	2	13	20
Test trials[b]						
Uncertainty	0	0	0	0	0	0
Point gesture group						
Teaching trials[a]						
Repetition	5	5	2	3	15	23
Synonymous	0	0	0	0	0	0
Part/property	3	4	2	3	12	19
Test trials[b]						
Uncertainty	0	0	3	0	3	2

[a]$N = 64$. [b]$N = 128$.

Repetition of Target Term on Teaching Trials

The frequency of repetitions of the target term did differ significantly between the two experimental groups in Experiment 2 (14% vs. 23% in descriptive and point gesture groups, respectively). However, it should be noted that the greater number of repetitions occurred in the point gesture group in which children chose the correct test toy significantly less often than in the descriptive gesture group. This finding suggests, as was noted in the discussion of the results of Experiment 1 previously, that simple repetition of a novel term is not a good indicator of the level at which children are encoding the meaning of a novel term, as might be expected.

Utterances Synonymous in Meaning With the Target Term on Teaching Trials

These utterances were quite infrequent, occurring on only six trials (9%). However, of interest, all such synonymous utterances were observed on descriptive gesture trials. None were observed on point gesture trials. This finding might be another further indication (beyond children's toy choice at test) that in the descriptive gesture group children's attention was drawn more successfully to the insides of the toys than in the point gesture group. However, given the small number of such utterances, such an interpretation remains tentative.

Mention of Nontarget Properties or Parts of the Toys on Teaching Trials

Such comments were less frequent in Experiment 2 and, contrary to Experiment 1, were found to occur with approximately the same frequency among both groups (20% vs. 19% of trials in descriptive and point gesture groups, respectively).

Expression of Uncertainty at Test

Such utterances were rare and occurred on only three trials among children in the point gesture group.

Discussion

The analysis of children's utterances on teaching trials suggests that children in the point gesture group may have been less certain regarding the property being referred to with the novel adjective term, accounting for their poorer performance on test trials in choosing the correct toy. Supporting this claim, in Experiment 1, children in the point gesture group were significantly more likely overall to ask whether the toy they chose possessed the relevant property at test than children in the descriptive gesture group and were also significantly more likely, when the least visually detectable adjective terms *lumpy, spongy,* and *roughy* were considered, to mention nontarget properties/parts of the toy on teaching trials. The frequency of all utterance types was much lower in Experiment 2, and therefore the results are harder to interpret, but this claim may also be supported in this experiment by the fact that utterances synonymous in meaning with the target term were only observed in the descriptive gesture group, possibly suggesting that children in this group had been able to zero in on the intended property more easily than children in the point gesture group.

GENERAL DISCUSSION

Our findings support the claim that descriptive gestures can play an important role in the learning of adjective terms, in particular when those terms refer to properties that cannot be easily detected (or detected at all) through visual inspection alone, such as the properties of *spongy* and *lumpy* used in Experiment 1 and all adjectives referring to nonvisible properties in Experiment 2 (i.e., *globby, spongy, flimsy, springy*). For these adjectives, it was found that children provided with a descriptive gesture during teaching chose the target toy with the matching property significantly more often than children provided with only a point gesture. In addition, in both experiments, particularly among children in the descriptive gesture group, the

choice of the correct target toy at test was found to be significantly associated with the production of a descriptive gesture with the target toy presented in the test set. These latter results suggest that children in the descriptive gesture group were indeed utilizing the gestural information presented to them during the teaching trial when choosing the matching toy at test.

These experiments are indeed the first word-learning experiments to present children with tactile properties that were not discernible through visual inspection alone. The observation that even 2-year-old children were able to extend the novel adjectives across basic-level categories, in contrast to the findings of previous research (e.g., Waxman & Markow, 1998), may also be an indication of the powerful role gestures play in helping young children to identify the intended property. That is, the use of descriptive gestures appears to have made it possible for even 2-year-old children to display their ability to interpret a novel adjective term as referring to a property rather than adopting a noun interpretation, as has often been found with children this young (as reviewed previously). Although it may appear remarkable that children this young are already sensitive to the fact that some adjective terms may refer to properties that are not visually obvious (i.e., that pertain to insides or tactile qualities), our results complement a number of findings in a variety of domains challenging the view that young children focus only on external appearances and suggest instead that children can attend to nonobvious aspects of things well before school age (see Wellman & Gelman, 1988, for review).

As we argued in the introduction, adjective terms may constitute a unique class of words in that their meaning may require in many cases taking into account experiences from senses other than vision. For example, to know what *globby* meant in this experiment, children had to feel the little balls inside the fish. That means, in effect, children had, in some way, to realize that what the speaker was trying to convey to them was how *globby* felt and not anything else about the shape or look of the toy. The learning of adjectives in such cases poses very interesting questions with respect to how children are able to ascertain the particular perspective that the speaker means to convey—in the case of *globby,* a tactile rather than a more common visual perspective. Clark (1997) argued that adult speakers offer children pragmatic directions that highlight different and specific properties (i.e., establish different perspectives) for children to assign the correct meaning to unfamiliar words. These pragmatic directions, Clark argued, can involve, for example, the use by both addressee and speaker of nonlinguistic information including eye gaze, gestures, and physical stance or orientation. Our results, we believe, demonstrate that descriptive gestures were an external, nonlinguistic, pragmatic cue (i.e., a pragmatic direction in Clark's terminology) exploited by children when attempting to determine the meaning of adjective terms. Also, more particularly, we argue that our results suggest that descriptive gestures were used by children in our experiments as a means by which to determine the relevant perspective or focus of attention intended by the speaker, as discussed by Bloom (1998), Tomasello (1988),

and Zukow-Goldring (Zukow-Goldring & Ferko, 1994). Indeed, we point out that in our experiments the tactile detection of the intended property was not enough for children to demonstrate an understanding of the property being referred to by the novel adjective term at test. Rather, such an understanding was demonstrated only when the property was felt manually in conjunction with the experimenter demonstrating the descriptive gesture during teaching. That is, it should be remembered that, in both gesture groups, descriptive gestures with the toy during teaching were often produced at similar rates (e.g., *lumpy* and *globby*). However, it was only among children in the descriptive gesture group that strong evidence was found for a significant relation between the production of descriptive gestures with the target toy at test and the correct choice of the toy at test. This suggests that although children in the point gesture group may have often detected the relevant tactile property on their own, this was not enough for them to utilize this information to infer the intended meaning of the novel adjective term and utilize this tactile information to find the toy with this property among the test-set objects.

We believe our secondary findings related to children's utterances during the teaching and test trials offer some even more specific clues as to the nature of the influence of the point versus descriptive gestures used. First, the finding that children in the point gesture group were more likely (significantly so in Experiment 1) to express uncertainty regarding their choice at test (e.g., "Is this the fleecy doggie?") and significantly less likely in both experiments to choose the toy with the matching target property on test trials suggests that their poor performance was attributable to poorer learning and greater confusion over the meaning of the novel adjective term taught to them. That is, children in the point gesture group appear to have been less able to encode the particular meaning of the novel adjective term used by the adult. Indeed, if one were to adopt a sociopragmatic approach, one might say that children in this group were less able to enter into a joint focus of attention with the adult and to discern the particular property to which the adult was intending to refer.

We also believe the results of our analyses of children's utterances may help to elucidate the reason for children's greater uncertainty regarding the meaning of the novel adjective term in the point gesture group. In Experiment 1, in which children were observed to produce quite a large amount of talk on teaching trials, it was found that children in the point gesture group were much more likely to talk about properties and parts of the toys not related to the target adjective. If one grants that these utterances are, at minimum, indicative of children's own focus of attention, then these results suggest that when presented with a point gesture children's attention was more likely to wander to other parts and properties of the toys such as the spots on the cow, the mouse's tail, the blueness of the elephant, and the funny eyes of the fish, especially in cases in which the target property was not visible. Indeed, it is possible that 2- and 3-year-old children's default assumption on hearing a novel adjective term may be that it refers to a visual property and that these utterances are a reflection of this.

Given that such utterances were not observed as frequently among children in the descriptive gesture group, one possible interpretation of this is that children's attention was drawn more specifically to the intended property and that, consequently, their attention was less likely to wander to other irrelevant aspects of the toys. That is, in these experiments descriptive gestures may have helped children to zero in on the property intended by the adult in a manner that was much less likely than when only a deictic point gesture accompanied the novel adjective term. Descriptive gestures may have helped children, in a sense, to adopt the specific perspective on the toy taken by the speaker and labeled using the adjective. It should be noted that a simpler argument, namely, that it was only with the descriptive gestures that children were able to identify any difference between the two test-set items in the case of the nonvisible target properties, cannot account for these results because children in both gesture groups were observed to produce descriptive gestures with the toy during teaching, as discussed earlier.

The finding that descriptive gestures appeared to facilitate children's acquisition of novel adjectives, particularly with respect to properties that one would normally best ascertain through touch rather than vision, raises the question of whether such gestures may also play an important role in the acquisition of substance and material kind terms. Such terms (e.g., *wood, metal*) often require an appreciation of nonvisual properties such as texture, density, or felt weight (Smith, Carey, & Wiser, 1985). Certainly, the use of material-related gestures has been shown by Kobayashi (1997) to play an important role in children's understanding and extension of novel terms referring to the material kinds of objects, as reviewed in the introduction. However, such previous investigations of material kind or substance terms, including work investigating the use of gestures (Kobayashi, 1997) and the use of syntactic distinctions constraining children's hypotheses about the meaning of such terms (e.g., Dickinson, 1988; Kobayashi, 1997; Soja, Carey, & Spelke, 1991), have not encompassed situations in which the material kind or substance kind is detectable solely through tactile means (and not visual means) and in which descriptive gestures might provide a particularly important cue to the meaning of the material or substance term. Indeed, another question open for further research is whether certain descriptive gestures might be more helpful than others depending on the type of adjective, substance, or material term being taught.

Almost a hundred years ago, Tolstoy wrote (as cited in Vygotsky, 1934/1986, p. 151):

> It is not a word that is difficult to comprehend, but the concept behind the word which the child does not understand. The relation of word to thought, and the creation of new concepts is a complex, delicate, and mysterious process.

We believe that our experiments have provided a further small step forward in understanding the cues children are using, when encountering a speaker who uses an ad-

jective term that is novel to them, to hone in on the speaker's intended meaning from among the numerous properties to which the term could possibly refer.

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