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Acquisition of English Number Marking: The Singular–Plural Distinction

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We present data from a preferential looking method to investigate when infants have mapped singular and plural markers in English onto the semantic distinction between singleton sets and sets with more than 1 individual. Twenty- to 36-month-old children heard sentences that marked number in 1 of 2 ways: (a) redundantly with verb morphology, lexical quantifiers, and noun morphology ("Look, there ARE SOME blicketS"/"Look, there IS A blicket") or (b) only with noun morphology ("Look at the blicketS"/"Look at the blicket"). Twenty-four-month-old infants, but not 20-month-old infants, looked at the screen that matched the carrier sentence with respect to singular–plural distinction when number was expressed on the verb, on the noun, and with quantifiers. Detailed looking-time analyses suggest that the arrays begin to be differentiated on the child's hearing *are* or *is.* Twenty-four-month-olds failed when number was marked on the noun alone, whereas 36-month-olds suc-

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ceeded in this condition. These data suggest that infants first come to understand the semantic force of the singular–plural distinction in the months just before their 2nd birthday and that the 1st linguistic expressions of the distinction they understand are on verbs and perhaps on quantifiers.

Language makes a principled distinction between *individuals* and *sets of individuals.* This distinction is expressed in the lexical quantifiers of all languages and is usually also expressed via the morphosyntactic properties of nouns, verbs, adjectives, and determiners (Cherchia, 1998; Corbett, 2000; Link, 1983). Thus, human adults across all cultures have the conceptual ability to distinguish individual objects (e.g., a single car) from sets of several objects (e.g., five cars or vehicles or objects). However, little is known about the earliest acquisition of linguistic expressions of number. For instance, it is unclear whether the distinction between individuals and sets of individuals is available prelinguistically, and it is unknown when toddlers first learn linguistic markers of it.

Indeed, although there is now massive evidence that infants extract quantity information from their representations of sets of objects (e.g., Carey, 2004; Clearfield & Mix, 1999, 2001; Feigenson, Carey, & Spelke, 2002; Feigenson & Halberda, 2004; Lipton & Spelke, 2003; Wynn, 1998; Xu & Spelke, 2000), there is no evidence for a prelinguistic equivalent to the singular–plural distinction. Infants' quantity computations have been attributed to two separate systems of representation: (a) analog magnitude representations of continuous quantities and of number and (b) object indexing and tracking systems (see Feigenson, Dehaene, & Spelke, 2004, for a review). Using analog magnitude, infants can distinguish large sets from one another on the basis of approximate number, given a large enough ratio difference (e.g., Lipton & Spelke, 2003; Xu & Spelke, 2000). Using object files, infants represent each individual as a discrete symbol (a file) and can compare the total number of individuals on the basis of one-to-one correspondence between object-file representations (e.g., Feigenson & Carey, 2003). However, there is no indication that infants treat analog magnitude representations that are greater than one as equivalent to one another for some purpose, nor that infants treat object-file representations of sets of two and three as equivalent to each other and different from the representation of a single object. Thus, there is no evidence that prelinguistic infants specifically distinguish "one" from "more than one."

In fact, recent studies by Feigenson and colleagues dealing with the set-size limit of object files have provided evidence that prelinguistic infants *fail* to draw on the singular–plural distinction (Feigenson & Carey, 2005). Consider the following experiment: Twelve-month-old infants watch while sets of crackers are placed into two different buckets (e.g., two in one bucket, three in another). In this case, infants then choose the bucket with more crackers. Nevertheless, when one set of crackers

exceeds three (in four vs. two, six vs. three, and crucially for present purpose on one vs. four comparisons), infants are at chance (Feigenson & Carey, 2005; Feigenson, Carey, & Hauser, 2002). This abrupt three-item limit is expected when infants encounter small object arrays, as the object-file system is assumed to rely on the same system of representations underlying midlevel attention in adults, and thus to be subject to the same working memory limit of three to four items (e.g., Carey & Xu, 2001; Cowan, 2001; Leslie, Xu, Tremoulet, & Scholl, 1998). However, the fact that infants fail even for one versus four comparisons also suggests that they do not have a prelinguistic equivalent to the singular–plural distinction. All infants would need to do to succeed on this comparison is to represent one as a singular individual and four as a plurality, but they fail to do so.

Similarly, in a paradigm in which infants reach into a box for objects they cannot see, one can assess their representation of the set placed in the box by surreptitiously removing some of the objects placed there (Feigenson & Carey, 2003, 2005; Van de Walle, Carey, & Prevor, 2000). Ten- to 20-month-old infants search for missing objects when they have seen two or three placed into the box and have only retrieved a subset of them. However, when they have seen four objects placed into the box and only retrieved one of them, 12- to 20-month-olds fail to search for any missing objects (Barner, Thalwitz, Wood, & Carey, 2005; Feigenson & Carey, 2005). Again, all infants would need to do to succeed on this last comparison is represent the set of four as a plurality, distinct from the singleton, but here also they fail to do so.

By the time children have learned the meanings of linguistic markers for the singular–plural distinction (e.g., *is/are; a/some; ∅/-s*), they *must* have distinguished between singletons and sets. Surprisingly, we do not know when in the course of language acquisition children have done so. The goal of this set of experiments is to develop a method to tackle this descriptive problem. With such a method in hand, in future work we can continue to explore the relations between the different sorts of singular–plural marking in language and the availability of that distinction to support nonlinguistic tasks such as those described above.

Much past research has concerned the production of plural noun morphology. A major focus has been the *U*-shaped developmental curve of children's plural marking, where children begin by correctly inflecting irregular nouns (e.g., *mice*), then progress through a stage of overregularization, (e.g., *mouses*), and then finally begin to demonstrate an adult-level knowledge of plural forms (e.g., Marcus et al., 1992; Pinker, 1999). The debate has centered on the causes of the *U*-shaped curve and children's overregularization with English plural nouns and past-tense verbs, and thus is orthogonal to our current concern with the semantic distinction between individuals and sets of multiple individuals that is expressed by singular–plural morphology.

In a landmark longitudinal study investigating children's acquisition of English, Brown (1973) found that children begin producing the plural marker on nouns in 90% of obligatory contexts, between 24 and 34 months of age (see also

Cazden, 1968), whereas Mervis and Johnson (1991) presented one case study of a child who began marking nominal plurals at 20 months. A few other studies have attempted to systematically elicit production of the plural. For example, Berko (1958) gave preschool and first-grade children pictures of a single novel animal (or object) and provided its name in a singular context ("This is a wug"). Then Berko presented *pictures with two of the same nonsense animals* and asked children to produce the plural form ("Now, there is another one. There are two of them. There are two ___?"). Although children as late as 7 years still make morphological errors on this elicitation task, they have internalized English regular (plural) morphology and can apply it to words they have never heard before as young as 4 years. In a different type of elicitation task, Ferenz and Prasada (2002) investigated whether younger children are able to use both syntactic and referential information to determine the appropriate form of count nouns. After viewing a Big Bird doll performing certain actions on other animals, the children were asked to complete sentences that described the events they had just viewed. Children consistently marked the plural appropriately by 27 months, the youngest age tested in the study.

Although these studies are helpful in determining a general estimation of the age when children first produce the plural, they differ drastically in the ages tested and are based on small sample sizes. Moreover, very few studies have investigated the developmental origin of plural *comprehension.* As is the case with many aspects of language, it is likely that toddlers comprehend linguistic expressions of the distinction before they begin to produce them.

This prediction was partially confirmed by Fraser, Bellugi, and Brown (1963) who compared the performance of 40-month-olds on both production and comprehension measures. They found that comprehension was easier than production for various grammatical contrasts, including singular–plural. In addition, they found that comprehension of the singular–plural contrast marked only by inflection (e.g., "The boy draws" vs. "The boys draw") was more difficult than most of the other contrasts they tested (e.g., negative–affirmative, subject–object in active or passive voice), including singular–plural sentences contrasted by the verb *is/are*. Thus, although the children in this study were relatively old, their performance suggests that (a) comprehension precedes production of singular–plural markers, and (b) morphological marking on the verb *is/are* is mastered earlier than marking of inflectional morphology.

To address the question of plural understanding with younger children, a series of four recent unpublished studies have adapted the preferential looking paradigm introduced by Golinkoff, Hirsh-Pasek, Gordon, and Cauley (1987) and improved by Fernald, Swingley, and colleagues (Fernald, Pinto, Swingley, Weinberg, & McRoberts, 1998; Swingley, Pinto, & Fernald, 1998, 1999) to assess the time course of word recognition. Such a method has the advantage of measuring online sentence understanding without requiring participants to make metalinguistic judgments,

and thus it can be used to study language processing in children who are too young to perform explicit tasks such as in elicitation procedures (e.g., Swingley, 2003).

In these unpublished studies, 19- to 24-month-old infants were shown two arrays, one containing a single object and the other multiple objects, all of the same kind (e.g., a single ball vs. several balls), and were told "look at the ball" or "look at the balls." These studies have yielded conflicting results. Schnoor and Newman (2001) found that 20-month-old infants successfully interpret the distinction between singular and plural nouns, but for *-EZ* plural morphology only (e.g., "couch vs. couches"). In contrast, Soderstrom (2002) found that neither 19- nor 23-month-old infants succeeded in this paradigm. Using a similar procedure in two pilot studies, we also failed to find success even with 24-month-old infants, suggesting that Schnoor and Newman's unpublished result is not robust.

On reflection, it is not surprising that infants would fail with this task, even if they represent the numerical meaning of singular and plural inflections. After all, given that the single object on one side (e.g., a ball) was always identical to each of the multiple objects presented on the other side (e.g., several balls), when told to "look at the balls," infants' scanning back and forth between the two screens is a completely correct response. They are all balls; the balls are distributed over two screens. Similarly, both arrays contain a single ball, so when asked to "look at the ball," either array is technically correct.

In the present study we circumvent the problem with this design by making the arrays contain different types of *novel* objects (e.g., one big Object A vs. eight small Objects B). Now, when asked to look at the blickets, there is only one correct array (as depicted in Figure 1). Also, to strengthen the sensitivity of our measure, and because marking on the inflectional *-s* morpheme is less responsive than other cues such as the contrast within the verb *is/are* (Fraser et al., 1963), we expand the focus on plural marking in noun morphology to multiple linguistic cues to plurality (*is/are, some/a, -s/∅*).

THE PRESENT STUDY

We adapted the preferential looking paradigm (Fernald et al., 1998; Golinkoff et al., 1987; drawing especially on the paradigm of Halberda, 2003a). Two arrays of pictured objects were displayed simultaneously on two different screens, one depicting a single novel Object A on the one screen and one depicting a set of eight novel Objects B on the other screen. Infants were then told, for example, "Look, there are some blickets" or "Look, there is a blicket." The dependent measure was whether they looked at the array that matched the sentence with respect to the singular–plural distinction. Success consists of looking at the single Object A on hearing "Look, there is a blicket" and at the eight Objects B on hearing "Look, there are some blickets." This procedure allowed us to assess when infants have

mapped singular and plural markers in English onto the distinction between referents containing a single individual and referents consisting of multiple individuals.

On each trial, the single object on one side was always of a different kind from the multiple objects presented on the other side, as depicted in Figure 1 below. Unlike previous studies in which both arrays contained the same kind of object, in this study only one array may felicitously be described as "the blickets." Of course, the singular term "the blicket" is still strictly speaking ambiguous—both arrays contain a single novel object of a given kind, although in the eight-object array any single blicket is one of eight.

To ensure that infants would remain engaged in the task, especially at ages where they have previously been seen to fail in preferential looking measures of singular–plural comprehension, we included filler trials with known objects (e.g., eight cups vs. one ball). Note that these trials were fillers because success on them could be driven by simply comprehending the known noun regardless of its plurality. Thus, only success on the trials with novel objects will be taken as evidence that infants comprehend singular–plural marking in English.

In Experiments 1 and 2, we provided 24- and 20-month-olds with linguistic markers of number on the verb (*are* vs. *is*), on the quantifier (*a* vs. *some*), and on the noun (*-s* vs. ∅). Infants heard either "Look, there are some blickets" or "Look, there is a blicket." Experiments 1 and 2 were methodologically identical and allowed a direct comparison of performance at 24- and 20-months of age. In Experiments 3 and 4, 24- and 36-month-olds received only morphological cues on nouns (e.g., "Look, at the blickets" or "Look at the blicket"). Experiments 3 and 4 were

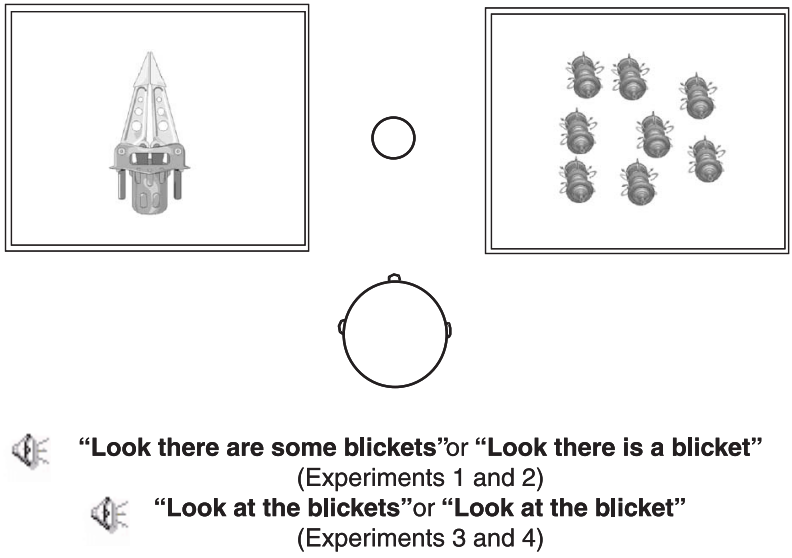

FIGURE 1 Schematic presentation of the preferential-looking procedure used in this study.

methodologically identical and allowed us to compare the comprehension of noun morphology at 24- and 36-months of age. Thus, the only factors that varied across experiments were the labeling act and the age of the children; trial structure and visual stimuli were identical across the four experiments.

GENERAL METHOD

Stimuli

Photographic renderings of 24 objects served as the visual stimuli in this study. They consisted of 12 novel objects that were used on critical trials, and 12 known objects that were used as filler trials (with 2 of them serving also as familiarization trials). For each type of object we constructed a 1-object array and an 8-object array (see Figure 1 for examples). To avoid size-based preference, the 1- and 8-object arrays were matched for total surface area.

Auditory stimuli consisted of carrier sentences containing 10 pseudowords (for novel objects) and 12 words (for known objects) recorded in a singular or plural morphological form by a male native English speaker. To keep the singular determiner in the form of *a* (rather than *an*), all of the nouns referring to the objects had a consonant-initial structure. Three of the pseudowords required the phonetically conditioned allomorph of the English nominal plural /əz/ (hereafter *-EZ*; e.g., spinge/spingEZ). Four required /z/ (hereafter *-Z*; e.g., pyzer/pyzerZ), and three required /s/ (hereafter *-S*; e.g., blicket/blicketS). The complete list of word and pseudowords is given in Table 1.

On each trial, we presented a sentence containing either singular or plural number marking, followed by a repetition of the label with an amplification rate of 150% after 500 msec (e.g., "Look at the blickets. BLICKETS!"). In Experiments 1 and 2, the carrier phrase was always either "Look, there IS A ___." or "Look, there ARE SOME ___." In Experiments 3 and 4, we created four different sentences in which the noun alone conveyed singular–plural information: "Look at the ___?" "Find the ___," "Show me the ___," and "Watch the ___."

Trial Procedure

Each trial of the experimental session consisted of simultaneously presenting a one-object and an eight-object array, one on each monitor (as in Figure 1). The single object on one screen was always of a different kind from the multiple objects presented on the other screen. All children received both trials with novel object labeled with pseudowords and trials with known objects labeled with known words. However, as explained previously, only novel trials were included in the analyses, because children could succeed on the known label trials with no use of singular–plural information.

TABLE 1
List of Pseudowords and Known Words Used in
Experiments 1 Through 4 in Their Singular and Plural Forms

Novel Words		*Known Words*	
Singular	*Plural*	*Singular*	*Plural*
Blicket	BlicketS	Truck	TruckS
Loopite	LoopiteS	Cup	CupS
Pyzer	PyzerZ	Car	CarZ
Foony	FoonyZ	Apple	AppleZ
Spinge	SpingEZ	Shoe	ShoeZ
Ratch	RatchEZ	Chair	ChairZ
Plunck	PlunckS	Key	KeyZ
Nool	NoolZ	Bear	BearZ
Douch	DouchEZ	Spoon	SpoonZ
Vole	VoleZ	Airplane	AirplaneZ
		Ball	BallZ
		House	HouseEZ

After being displayed, the objects remained static, in silence, for 3 sec. Following these 3 sec, the speech stimulus that labeled either the singular or the plural form was played through a speaker located between the two monitors. On half the trials, the sentence described the one-object array (e.g., "Look there is a blicket"), and in the other half it described the eight-object array (e.g., "Look there are some blickets"). The two displays remained visible for 6 sec after the first plural information in the sentence (i.e., *is/are* in Experiments 1 and 2; *s/∅* in Experiments 3 and 4). Then, the correct display danced on the screen to music, and the other display disappeared.

This dancing created a pragmatically natural labeling context (Arriaga, Xu, & Carey, 1996; Halberda, 2003a). That is, the child was instructed to look at something, and this provided information about where something interesting would happen. The dancing displays were also included to help maintain infant attention throughout the study. Analyses of trial order (see the Analysis section below) will establish whether children *learn* the association between plural marking and set size during the experiment. In a previous study on infants' use of known labels to fix the referent of a newly heard word that used this pragmatically natural version of the preferential looking method, infants did not improve over the course of the study due to the positive reinforcement (Halberda, 2003a). There were age differences in success, but the older children who succeeded did so equally on the first trials as on the last ones and those who failed, failed throughout.

Stimulus presentation was controlled by a Macintosh computer using the PsyScope software (Cohen, MacWhinney, Flatt, & Provost, 1993). Infants' looking was recorded by a video camera concealed between the two monitors.

Session Procedure

Infants were tested in a sound-attenuated room. They were seated on a parent's lap facing two computer monitors (17 in.) approximately 200 cm away. The parents were instructed to close their eyes, hold infants in the center of their laps, and not cue infants verbally or physically. If a parent violated these instructions, we excluded the infant from the final sample. Children received the trials in the following order:

1. Familiarization block: The experiment started with the display of 4 pictures of familiar objects (i.e., trucks and keys) appearing in silence on the left and right side to familiarize them with the two screens. These images appeared one at a time and were displayed for 3 sec each. The four pictures consisted of an image of one key, an image of one truck, an image of eight keys, and an image of eight trucks.
2. Experimental session: After the familiarization phase, infants saw two test blocks for a total of 10 critical trials (novel objects) and 6 filler trials (known objects). During the first block, infants saw 6 critical trials (12 novel objects) and 4 filler trials (8 known objects). In the second block, infants saw 4 critical trials (8 novel objects) and 2 filler trials (4 known objects). All the 12 novel objects were displayed during the first block. Thus, the novel objects used in the second block had appeared earlier during the experiment. In the second block, both the correct choice and the distracter had previously been distracters. For example, when infants received the novel objects A-winner versus B-distracter and C-winner versus D-distracter during the first block, they received B versus D during the second block. This manipulation ensured that novel objects of the second block had been equally displayed, were not already labeled, and did not receive positive feedback. Therefore, success on these trials must be driven by the singular–plural distinction.

The two blocks were separated by a 2-min resting period during which a song was played along with a set of known objects (not used in the test blocks), which danced on the displays to the music. During this break, parents were allowed to encourage their child's continued participation. The trial order for the experimental session was 2 known → 2 novel → 1 known → 2 novel → 1 known → 2 novel → resting period → 1 known → 2 novel → 1 known → 2 novel.

Design

We constructed four versions of each experiment that counterbalanced two variables for each object: (a) whether an object appeared in a one-object array or in an eight-object array and (b) whether it appeared as the correct display or the distracter display. Correct side (left or right) was randomized with the constraint that the correct display did not appear on the same side more than two times in a row.

Analysis

Looking was coded from video, frame-by-frame, at 30 frames per second using MacSHAPA (Sanderson, 1994) and QuickFRAME software (Halberda, 2003b). Coders were blind as to the location (left–right) of the displays, and so they had no way of knowing which side had the display that matched the sentence. For each frame, coders assessed whether the infant was fixating the left monitor, the right monitor, or neither.

Looking to the two screens was coded during the 3.5 sec before and after the first plural marker. In Experiment 1 and 2 (singular–plural marked on verbs, quantifiers, and the noun), this was the onset of *is/are.* In Experiments 3 and 4 (noun morphology only), it was the onset of the nominal plural marker (e.g., the "s" in blickets) or the offset of the label for singular terms. For each measurement period we calculated the percentage time the child was looking at the correct display out of the total time he or she was looking at either display. We excluded looking times if they were not directed at either screen. The preplural marker measurement period provided a measure of within-trial baseline preference for the two images; children were expected to prefer neither array during this period. Comprehension of the labeling phrase was measured as increased looking, above baseline preference, to the target screen following the plural markers in the sentence. Subtracting baseline preference from target preference during the comprehension period gives a difference score. Success on our task consists of a positive difference score, significantly different from the chance level (0).

To explore whether infants learned from the positive feedback given on each trial (correct display dancing on the screen to music), measures of comprehension were correlated with trial number to see whether performance improved during the experiment. Also, success or failure in a given experiment was analyzed on its first trials, before there was any positive feedback on them. Both analyses bear on the question of whether the feedback in this study was sufficient to *teach* children to associate the linguistic cues provided with the contrast between singleton sets and sets of eight objects.

EXPERIMENT 1

24-Month-Olds: Singular–Plural Cues on Verbs, Lexical Quantifiers, and Nouns

Participants. The participants were 14 full-term 24-month-old infants (7 boys and 7 girls; *M* age = 23 months 28 days; range = 23 months 3 days to 24 months 28 days). Three additional infants were tested but not included in the final sample due to fussiness ($n = 2$) and inattention ($n = 1$).

Results and discussion. Planned *t* tests compared participants' difference scores to the chance level (0) for both plural and singular novel label trials. As can be seen in Figure 2, 24-month-olds significantly increased looking to the correct display above their baseline preference on both plural and singular trials, $t(13) = 2.47$, $p < .05$, and $t(13) = 2.29$, $p < .05$, respectively.

More important, 24-month-olds succeeded on the very first plural and singular novel trials they were exposed to, before they had received any positive feedback for these novel trials, $t(13) = 2.29$, $p < .05$, and $t(13) = 2.45$, $p < .05$, respectively. Moreover, a linear regression on trial number revealed that, if anything, children tended to get *worse* along the course of the experiment, although this negative correlation was not significant—that is, the slope of the regression line was negative but not significantly different from zero, $F(1, 193) = .009$, $p = .927$. Thus, there is no evidence that positive feedback played any role in children's success in Experiment 1.

Experiment 1 showed that 24-month-olds understand that a plural sentence refers to a multiple-object referent array, whereas a singular sentence refers to a single-object array. However, this analysis leaves open the question of which cues to singularity–plurality drive infants' success. The coding of percentage looking frame-by-frame provides additional data concerning exactly where in the sentence infants' looking to the target array diverged from baseline (on hearing *is/are, a/some,* or the end of *blicket/blickets*). In Figure 3, we see children's pattern of looking on plural novel trials. An example of the speech stream is displayed along the *x* axis with the line at *0* marking the onset of the word *are*. The position of each word along the *x* axis approximates where it occurred during the trial. The onset of *some* was about

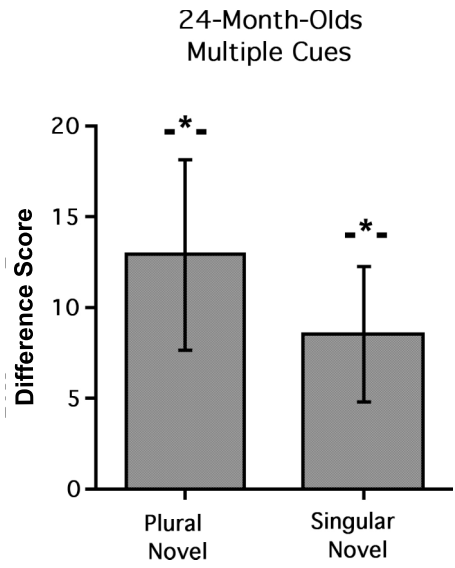

FIGURE 2 Percentage looking difference score (i.e., comprehension minus baseline preference) to the target screen for the plural and singular trials from Experiment 1 (± 1 *SE*). *$p < .05$.

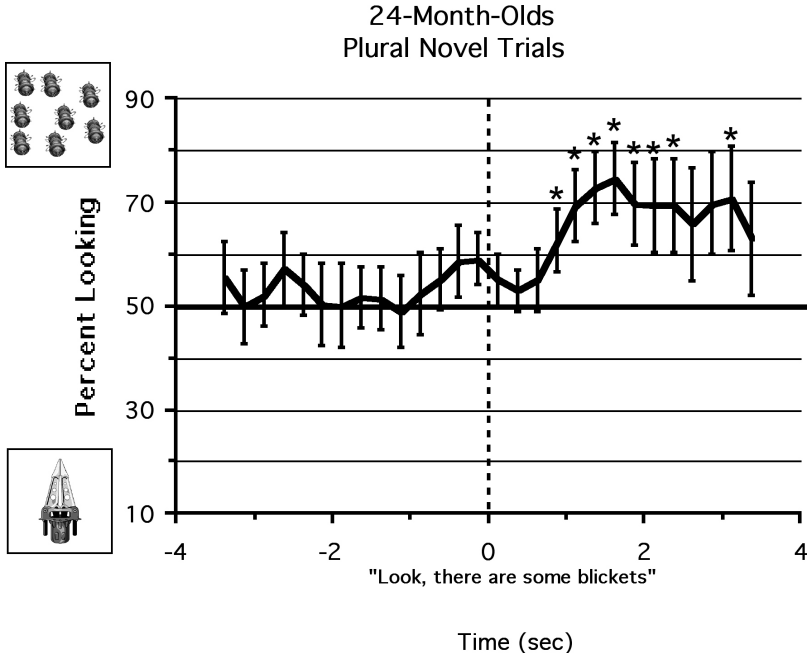

FIGURE 3 Percentage looking is displayed for the plural trials from Experiment 1 (± 1 *SE*). The line at *0* marks the onset of the word *are* in the labeling phrase. The position of each word along the *x*-axis approximates where it occurred during the trial. Percentage looking was compared to the chance level (i.e., 50%). *$p < .05$.

205 msec after the onset of *are*, determining its placement below the *x* axis. Because different pseudowords were used on different trials, the onset of the nominal plural marker differed from trial to trial. The placement of the *-s* on the *x* axis represents the average onset of the plural morpheme. The *y* axis displays the percentage looking at the target array in each 250-msec time period. The percentage looking during each 250 msec time period was compared to the chance level (i.e., 50%). As can be seen in Figure 3, the infants began to preferentially attend to the target screen significantly at 875 msec after the onset of *are* in the labeling act. We know that it takes 24-month-olds on average 675 msec to initiate a switch in gaze to a familiar object when processing that object's name in a labeling act (e.g., "Where's the bear?" Fernald et al., 1998). In our Figure 3, percentage looking will only become significant when children have both initiated and *completed* a shift in gaze to the correct screen (recall that looking nowhere was not coded). Thus, we can be fairly certain that it is comprehension of the word *are* and perhaps *some* in the labeling act that drives this switch in gaze. This suggests that by 24 months, children know that *are,* and perhaps *some,* are used to refer to a plurality of objects and that it is these cues to plurality that are driving success on this task.

Further support for the conclusion that the singular–plural status of the verb and possibly the quantifier drove infants' success in Experiment 1 comes from the frame-by-frame coding of the looking pattern on singular novel trials. Figure 4 shows that the infants tended to look at the target array before the onset of *is a* in the speech stream. This may reflect random variation in scanning the two arrays, or it may be an effect of coarticulation. Perhaps, some information about *is a* is already present in the speech stream at the end of the word *there*. In any case, infants maintained this preference above their baseline to attend to the singular array following *is a,* suggesting that it is this singular information (and not merely noun morphology "ratch") that drives children's success on these trials. Children are significantly attending the correct array at 625 msec after the onset of *is a,* and the noun (e.g., "ratch") did not reach completion until well after this point.

In sum, Experiment 1 revealed that 24-month-old infants use the distinction between the singular and the plural form of the copula, *is/are,* and perhaps also between singular and plural quantifiers, *a/some,* to determine whether a sentence re-

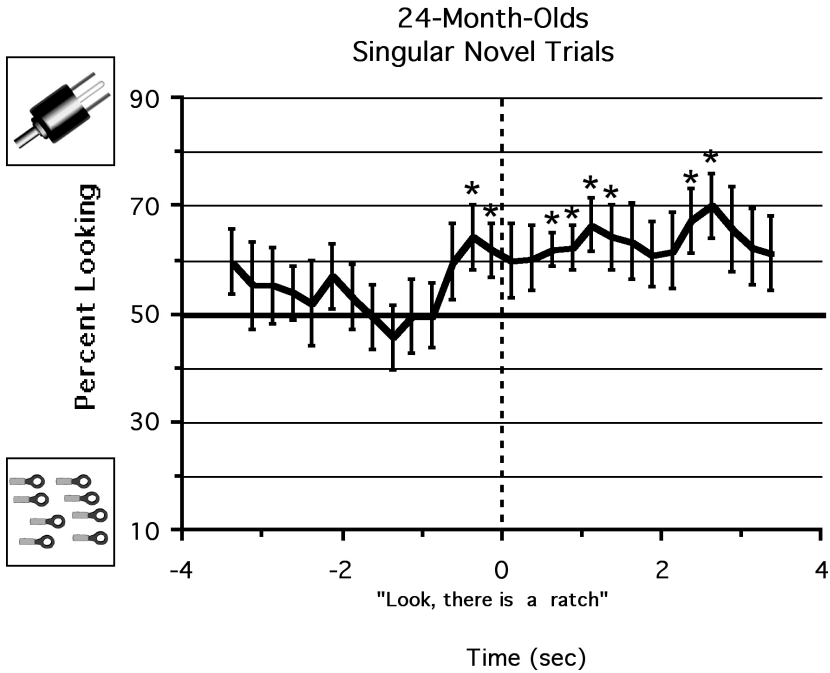

FIGURE 4 Percentage looking is displayed for the singular trials from Experiment 1 (± 1 *SE*). The line at *0* marks the onset of the word *is* in the labeling phrase. The position of each word along the *x*-axis approximates where it occurred during the trial. Percentage looking was compared to the chance level (i.e., 50%). *$p < .05$.

fers to a single or to multiple objects. The possibility that they can use noun morphology alone to determine whether a referent array should be a single object or a set with more than one object will be addressed in Experiment 3. In Experiment 2, we begin to explore the minimum age at which infants first map the singular–plural linguistic markers of Experiment 1 onto the semantic distinction between individuals and sets with more than one individual. We repeated the procedure of Experiment 1 with 20-month-old infants.

EXPERIMENT 2

20-Month-Olds: Singular–Plural Cues on Verbs, Lexical Quantifiers, and Nouns

Participants. The participants were 16 full-term 20-month-old infants (8 boys and 8 girls; *M* age = 20 months 2 days; range = 19 months 2 days to 20 months 26 days). No infants were excluded from this sample.

Results and discussion. Planned *t* tests compared participants' difference scores to the chance level (0) for both plural and singular novel trials. As can be seen in Figure 5, these *t* test revealed that 20-month-olds did not increase looking to the target screen above their baseline preference for either plural or singular novel trials, $t(15) = -1.67$, $p = .116$, and $t(15) = -.10$, $p = .925$, respectively.

Children did not succeed on either the first plural novel trial or the first singular novel trial they saw, $t(15) = -.463$, $p = .650$, and $t(15) = -1.62$, $p = .127$, respectively, and a linear regression on trial number revealed that performance did not change during the experiment, $F(1, 234) = .138$, $p = .711$.

In contrast to Experiment 1, infants failed to map linguistic plural markers to the correct referent display (see Figure 5). There was absolutely no hint of an increase in looking to the target array, relative to baseline, in the 3,500 msec after the onset of the first cues to number. Taken together, these results suggest that 24-month-old infants, but not 20-month-olds, comprehend the plural markers used in these sentences. This interpretation is supported with the observation of a significant main effect in an analysis of variance (ANOVA) that examined the effects of experiment (Experiment 1 vs. Experiment 2) and trial type (singular vs. plural) on the difference scores presented in Figures 2 and 5, $F(1, 28) = 9.319$, $p < .005$. No other main effects or interactions were significant: trial type, $F(1, 28) = .141$, $p = .710$; Trial Type × Experiment interaction, $F(1, 28) = 2.239$, $p = .146$. Given that we presented infants with sentences that marked the singular plural distinction redundantly on the verb, the quantifier, and the noun, and given that these contrasts are frequent in the child's input, these results suggest that children first learn the semantic force of number marking in English between the age of 20 and 24 months.

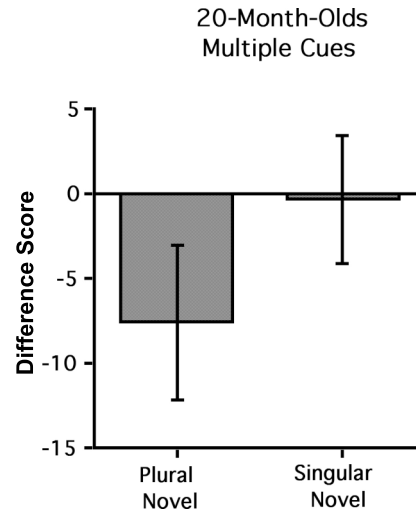

FIGURE 5 Percentage looking difference score (i.e., comprehension minus baseline preference) to the target screen is displayed for plural novel and singular novel trials from Experiment 2 (± 1 *SE*).

In Experiment 3 we investigate further the specific linguistic cues infants first use to mark the distinction between individuals and sets of multiple individuals. The analyses of the timing of the looking preferences depicted in Figures 3 and 4 showed that looking to the correct referent array was begun on hearing *is* and *are*, and perhaps was entirely driven by the verb or the verb and the lexical quantifier. However, because infants' looking at the correct array was maintained through the end of the presentation of the noun as well, we do not know whether 24-month-olds also comprehend the nominal morphological markers for singular–plural. Experiment 3 explores this question by providing 24-month-old infants with sentences in which the only linguistic cue to the singular–plural status of the referent was from noun morphology (e.g., "Look at the blicket/blicketS.").

EXPERIMENT 3

24-Month-Olds: Singular–Plural Cues Only on Nouns

Participants. The participants were 16 full-term 24-month-old infants (7 boys and 9 girls; *M* age = 24 months 3 days; range = 23 months 5 days to 24 months 30 days), none of whom participated in the previous experiments. One infant was tested but not included in the final sample due to fussiness.

Results and discussion. Planned *t* tests compared participants' difference scores to the chance level (0) for both plural and singular novel label trials. As can be seen in Figure 6, these *t* tests revealed that 24-month-olds did not increase looking to

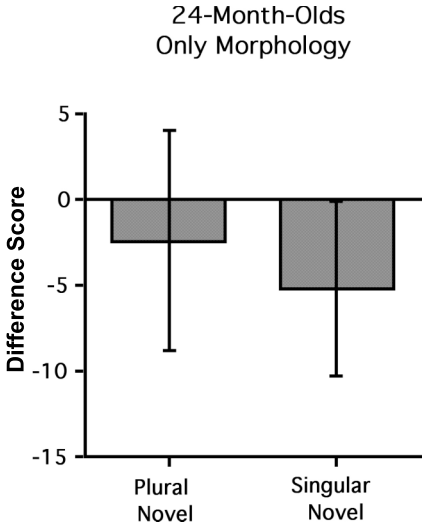

FIGURE 6 Percentage looking to the target screen is displayed for the plural novel and singular novel trials from Experiment 3 (± 1 *SE*).

the target screen above their baseline preference when nominal suffixes were the only cues to plurality, $t(15) = -.38$, $p = .708$, and $t(15) = -1.02$, $p = .323$, respectively.

Children did not succeed on either the first plural novel trial or the first singular novel trial they saw, $t(15) = 1.54$, $p = .144$, and $t(15) = .233$, $p = .819$, respectively, and a linear regression on trial number revealed that children got nonsignificantly worse over the course of the experiment: Slope of the regression line is –.805, $F(1, 215) = 2.99$, $p = .085$.

Experiment 3 allows for additional analyses. The novel label trials included instances of each of the three forms of English plural morphology (i.e.,*-S,-Z,-EZ*; see Table 1). Motivated by the unpublished finding of Schnoor and Newman (2001), who found that 20-month-olds succeeded on their task only with words containing the *-EZ* suffix, we investigated whether the 24-month-olds in our study may comprehend a subset of the English morphological plural markers.

Displayed in Figure 7 are the difference scores for the novel label trials, singular and plural, arranged by the kind of morphological suffixes used. Although no morphological suffixes appeared on singular novel label trials (e.g., "Look at the ratch," "Look at the pizer"), these trials have been arranged according to what their correct plural endings would be (e.g.,*-EZ, -S,-Z*). Planned *t* tests on these subsets all failed to reach significance, although there was a marginal trend to increase looking to a plural target on *-S* plural novel label trials, $t(15) = 1.85$, $p = .084$, suggesting that 24-month-olds may have some comprehension of the plural morpheme *-s*.

These data suggest that 24-month-olds do not, in general, comprehend the semantic force of singular–plural noun morphology in English, although there is some suggestion that 24-month-olds may be beginning to work it out for the plural marker *-s*. These results support the inferences made from the frame-by-frame

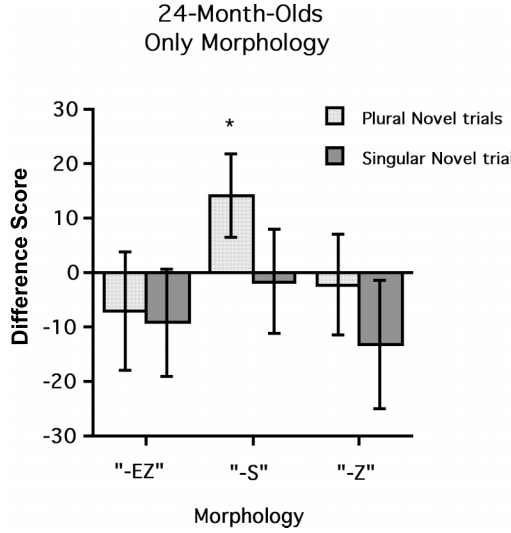

FIGURE 7 Percentage looking difference score (i.e., comprehension minus baseline preference) to the target screen is displayed for plural and singular novel label in Experiment 3 trials arranged by the type of morphology used (i.e., *-EZ -S, -Z*; ± 1 *SE*). **p* = .085.

coding of looking time in Experiment 1, that comprehension of the verb *is/are* and perhaps the quantifier *a/some* drove the success observed there (Figures 3 and 4). Taken together with Experiment 1, the results of Experiment 3 suggest that 24-month-olds can rely on plural information when presented with multiple cues but not when presented with noun morphology alone. Consistent with this interpretation, we found a main effect of Experiment in a 2 (experiment: Experiment 1 vs. Experiment 3) × 2 (trial type: singular vs. plural) ANOVA, with the difference scores depicted in Figures 2 and 6 as the dependent variable, $F(1, 28) = 6.069$, $p < .02$. No other main effects or interactions were significant (all Fs < 1).

In sum, whereas 24-month-old infants are sensitive to number marking in English, they cannot rely on noun plural morphology on its own. These results raise a question concerning the sensitivity of this measure to morphological marking on the noun at all. To explore whether children can succeed at this task, we tested older children (36-month-olds) using the same methodology as Experiment 3.

EXPERIMENT 4

36-Month-Olds and Singular–Plural Cues Only on Nouns

Participants. The participants were 12 full-term 36-month-old toddlers who did not participate in the previous study (7 boys and 5 girls; *M* age 35 months 29 days; range = 35 months 3 days to 36 months 24 days). Two additional toddlers were tested but not included in the final sample due to experimenter error.

Results and discussion. As can be seen in Figure 8, planned *t* tests revealed that 36-month-olds did increase looking to the target screen above their baseline preference on both plural and singular trials, even though nominal morphology was the only cue to number, $t(11) = 4.62$, $p < .001$ and $t(11) = 3.50$, $p < .005$, respectively.

Children succeeded on the very first plural and singular novel trials they were exposed to, before they had received any positive feedback for these novel trials, $t(11) = 3.26$, $p < .01$ and $t(11) = 2.95$, $p < .05$, respectively. A linear regression on trial number revealed that performance did not change over the course of the experiment: Slope is –.09, $F(1, 185) = .023$, $p = .881$. Thus, there is no evidence that positive feedback played a role in children's success in Experiment 4.

As the novel label trials included instances of each of the three forms of English plural morphology (i.e., *-S, -Z, -EZ*), we investigated whether 36-month-olds may perform better with a subset of the English morphological plural markers. Displayed in Figure 9 are the difference scores for the novel label trials, singular and plural, arranged by the kind of morphological suffixes used. Planned *t* tests on these subsets revealed that 36-month-olds succeeded on *-S* singular and plural trials, significantly increasing looking to the labeled screen above baseline preference: singular *-S,* $t(10) = 3.545$, $p < .01$; plural *-S,* $t(10) = 2.657$, $p < .05$. Although 36-month-olds tended to increase looking to the labeled screen on all trial types, including trials using *-EZ* and *-Z* morphology, as with the 24-month-olds in Experiment 3, children did best on trials that involved the *-S* morphology.

When compared to Experiment 3, the results of Experiment 4 suggest that, contrary to 24-month-olds, 36-month-olds can rely on noun plural morphology alone to distinguish singleton sets and sets with more than one individual. Indeed, we observed a significant main effect of Experiment in a 2 (experiment: Experiment 3 vs. Experiment 4) × 2 (trial type: singular vs. plural) ANOVA, with the difference scores depicted on Figures 6 and 8 as the dependent measure, $F(1, 26) = 10.610$, $p < .003$. No other main effects or interactions were significant: trial type, $F(1, 26) = 1.312$, $p = .262$; Trial Type × Experiment Interaction, $F(1, 26) = .314$, $p = .580$. Thus, although we found in Experiment 3 that 24-month-olds fail when presented with noun morphology alone, Experiment 4 shows that our measure is sensitive enough to elicit success, at least in older children.[1]

[1]The pattern of results in this study was identical whether looking preference during the comprehension period (the 3½ sec after the first plural information) was compared to chance (50%) or was compared to the looking preferences during the baseline measurement period (the measures reported in the text). That is, when compared to chance, infants succeeded on both plural and singular trials in both Experiment 1 and Experiment 4, and infants failed on both plural and singular trials in both Experiment 2 and Experiment 3.

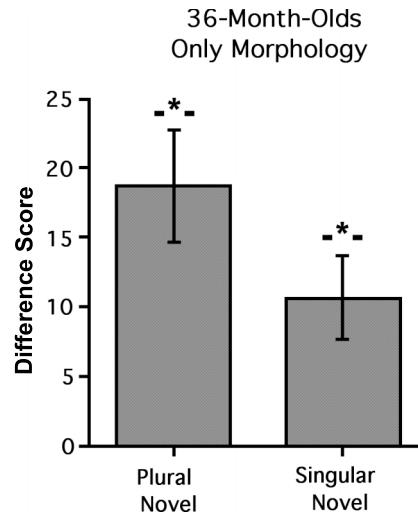

FIGURE 8 Percentage looking difference score (i.e., comprehension minus baseline preference) to the target screen is displayed for plural novel and singular novel trials from Experiment 4 (± 1 *SE*).

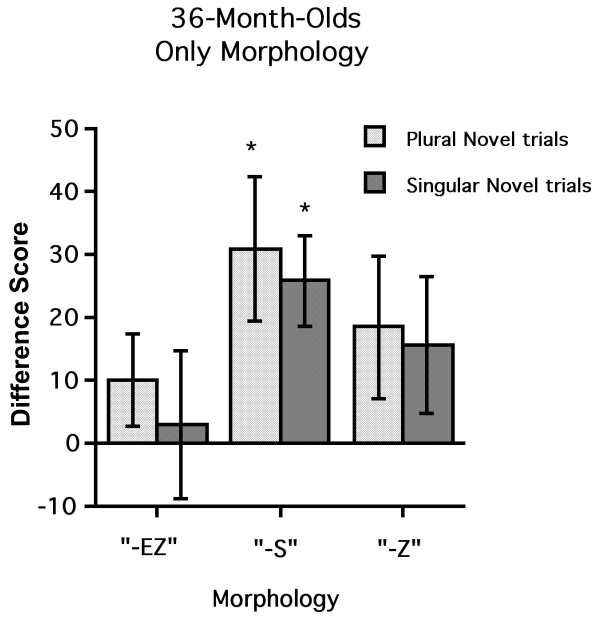

FIGURE 9 Percentage looking difference score (i.e., comprehension minus baseline preference) to the target screen is displayed for plural and singular novel label trials in Experiment 4 arranged by the type of morphology used (i.e., *-EZ, -S, -Z*) (± 1 *SE*). *$p < .05$.

GENERAL DISCUSSION

The experiments presented in this article introduce a new method for the study of plural comprehension. What is new is not the dependent measure (preferential looking) or the frame-by-frame analyses of looking. Rather, what is new is the use of novel nouns and novel objects. The use of novel nouns allowed us to present different kinds of objects in the two arrays, making only one array the correct match on plural trials. The use of different kinds may have increased the differentiation of the two sets, also making the singleton the felicitous choice on the singular trials. Further, by measuring looking times frame-by-frame as pioneered by Fernald, Swingley, and colleagues (Fernald et al., 1998; Swingley et al., 1998, 1999; see also Halberda, 2003a), we were able to discover that it was comprehension of the verb *is/are* and perhaps the quantifier *a/some* that drove selective looking to the correct array.

We used this method to explore the age at which infants understand singular–plural marking in their language as well as the specific cues to number they first learn. Twenty-four-month-olds, but not 20-month-olds, successfully looked longer at the screen that matched the carrier sentence when they were provided with plural information in the verb, the quantifier, and the noun. Analyses of the looking patterns showed that looking patterns diverged from baseline after the child heard *is* or *are,* and that looking at the correct array was maintained during the quantifier (*a* or *some*) and the noun (*blicket* or *blickets*). In two further experiments, 24-month-olds failed when provided with plural marking in noun morphology alone, whereas 36-month-olds succeeded in this condition.

Thus, these experiments provide two descriptive findings. First, with respect to age of mastery, the data suggest that, on average, English-speaking infants learn the semantic force of linguistic singular–plural marking after 20 months of age and before 24 months of age. Second, the data suggest that the semantic distinction between *is* and *are* (or perhaps *is a* and *are some*) is learned before children learn the semantic contrast between *-s* and ∅.

It is possible, of course, that this paradigm underestimates children's knowledge. The use of novel objects and novel labels may engage children in a word learning task and may lead them to process the plural information less than they might if the objects and labels were familiar to them. This particular method requires that the objects–labels be unfamiliar, for reasons sketched in the introduction. That is, if the single object array and the multiple object arrays are all identical objects (e.g., balls), as in all previous studies, then it is correct to scan back and forth between both arrays when asked to look at "the balls." If the arrays have different objects (e.g., a ball and some cups), then complying with the request to look at "a ball" requires knowledge only of the noun, as in the unanalyzed familiar filler trials in this study.

Our confidence in the results of these studies is bolstered by convergent data from a totally different paradigm (Wood, Kouider, & Carey, 2004), in which famil-

iar objects and nouns were used. Toddlers were shown a box into which they could reach through a spandex slit, but could not see into. The experimenter introduced the box, peeked through the slit, and said, "Wow, there are some cars in the box" or "Wow, there is a car in the box," and then handed the box to the child. The dependent measure was the amount of time the child searched for an additional car after having retrieved the first one. The box was always empty at this point. Twenty-four-month-olds, but not 20-month-olds, searched longer for an additional car in the plural linguistic context ("are some cars") than in the singular linguistic context ("is a car"). In addition, just as in this study, 24-month-olds failed when cued with noun morphology alone.

The data from the box search paradigm thus converge with those from this preferential looking paradigm on both descriptive points: that toddlers learning English work out the semantic force of the singular–plural distinction between 20 and 24 months of age, and 24-month-olds fail if provided with nominal morphological cues to plurality alone. The extension of these findings to the box search paradigm is important beyond the convergent data. The nouns in the box search paradigm were familiar, "car versus cars," in contrast to the novel nouns of this study, so success would not be hampered by the processing demands of encoding unfamiliar nouns or novel objects. In addition, the contrast in set sizes (one vs. two) was vastly different from that in this paradigm (one vs. eight). These convergent data suggest that infants take sets both within and outside the range of parallel individuation (up to three) to fall under the scope of plural morphology.

There are two possible interpretations, not mutually exclusive, of the findings that in both of these paradigms 24-month-olds succeed with the contrast "are some Ns/is a N" and fail with the contrast "the Ns/the N." First, as we have suggested, children may simply learn the semantic force of linguistic marking on *are/is* or *a/some* earlier than nominal plural making. Both production and comprehension data from older children are consistent with the conclusion that plurality marking on the verb *is/are* is understood before nominal plural morphology (Fraser et al., 1963). Alternatively, it may be that multiple, redundant markings help performance by providing cumulative evidence for choosing the correct array.

There are, of course, many other cues to plurality in English other than those we probed here. Clark and Nikitina (2004) reported a toddler who used "2" as a generalized plural marker, a finding confirmed by studies of toddlers learning to count. When asked to give the experimenter "2 apples," English-learning toddlers often incorrectly grab a handful of apples, whereas they correctly proceed with a single one when asked for "1 apple" (Wynn, 1990, 1992). Similarly, when asked to say "what's on this card," for cards containing 1, 2, 3, 4, 5, 6, 7, or 8 apples, children who can only reliably give 1 apple in Wynn's give a number task often say "2 apples" or "2 apple" or "2" for all sets with more than a single apple on it (LeCorre & Carey, 2005). These children are called "one-knowers" in

the literature on learning the cardinal meaning of numerals. For present purposes what is important is evidence that numerals larger than 1 seem to mark plurality. Thus, early in the toddler years, English-speaking toddlers establish mappings between many different linguistic contrasts (*is/are, a/some, one/two, one/three,* and -∅/-s), on the one hand, and the semantic distinction between sets containing a single individual and those containing more than one individual, on the other. It is entirely reasonable that redundant marking with several of these cues would help the young toddler establish the singularity or plurality of the referent of a noun phrase.

An interesting open question is whether children learning languages with a richer determiner system (such as French or Spanish) might mark the semantic distinction linguistically earlier than do English-speaking children. Cross-linguistic studies using the same paradigms reported here and in Wood et al. (2004) would be of interest and are underway in our laboratories.

Finally, let us return to the striking failures of infants to draw on a distinction between individuals and sets of multiple individuals in the nonlinguistic tasks developed by Feigenson and Carey (2005). When provided with a choice between four crackers placed into a container one at a time and a single cracker, infants between 10 and 12 months choose randomly, even though they succeed if the choice is three versus two (Feigenson, Carey, & Hauser, 2002). Shown four objects placed into a box into which they can reach but not see, even infants as old as 20 months of age are satisfied when they have retrieved just one, even though they search more vigorously if they had originally seen three placed into the box and have retrieved just one (Barner et al., 2005; Feigenson & Carey, 2005). All the infants would have to do to solve these tasks is represent 4 as plural, but they fail to do so in these tasks, at least up to 20 months of age. These data reveal that English-speaking toddlers come to mark the singular–plural distinction in language between 20 and 24 months of age.

This rough correlation is consistent with two very different interpretations. On the one hand, some cognitive developmental process independent of language learning may make a summary representation of sets as such more salient to children just before their second birthday, and this cognitive developmental change is what allows children to work out the semantics of the singular–plural marking in their language. Alternatively, it is possible that it is only on learning language that toddlers come to draw the distinction between individuals and sets of individuals. On either hypothesis, one should see within-child consistency in this age range on the nonlinguistic tasks, on the one hand, and tasks that tap verbal comprehension of the distinction, such as this preferential looking task. If learning the semantic force of linguistic expressions for the singular–plural distinct makes the distinction between sets and individuals explicit, or more salient, then children learning classifier languages such as Chinese or Japanese (which

do not mark singular–plural on nouns or verbs) should solve the nonlinguistic tasks later than English learners. Experiments testing these hypotheses are currently underway in our laboratories.

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