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Children's and Adults' Processing of Variable Agreement Patterns: Agreement Neutralization in English

Cynthia Lukyanenko and Karen Miller

1. Introduction

Language acquisition and language processing are inextricably linked (e.g., Omaki & Lidz, 2015). At a minimum, infants and children must process their input in order to learn from it, and as researchers, processing is often our window onto children's linguistic knowledge. But many accounts also suggest that key aspects of processing (e.g., prediction) may drive language learning (e.g., Chang, Dell & Bock, 2006; Saffran, 2001; Ramscar, Dye & McCauley, 2013). On these accounts, children build expectations based on incoming linguistic information, and then compare those expectations to their observations. They use mismatches to help them update their system to predict better in the future. On such accounts, the types of cues that drive prediction and the types of predictions they permit govern what this process can be used to learn (for discussion, see Rabagliati, Gambi & Pickering, 2016; Lukyanenko & Fisher, 2016).

Ample evidence shows that adults and children process language incrementally, integrating incoming linguistic material with the preceding context to build a representation of the utterance thus far and to anticipate what might be coming next (see Federmeier, 2007; Rabagliati, Gambi & Pickering, 2016). Studies show that adults and children use many types of cues in processing: They can use syntactic structure to anticipate likely upcoming arguments (Kukona, Fang, Aicher, Chen & Magnuson, 2011; Gambi, Pickering & Rabagliati, 2016), they can use the semantic constraints of content words to predict upcoming referents (e.g., *eat the cake*; Altmann & Kamide, 1999; Mani & Huettig, 2012), and they can use morphological information including grammatical gender, case, and number marking to help them make diffuse predictions about the features of upcoming words (e.g., Lew-Williams & Fernald, 2007; Lukyanenko & Fisher, 2016; Szewczyk & Schriefers, 2013).

Comprehenders rely most heavily on cues that are reliable and readily available (e.g., Beyer & Hudson Kam, 2009; Choi & Trueswell, 2010; MacWhinney, Bates & Kliegl, 1984), but not all cues are reliable. Studies have shown that agreeing verbs facilitate the processing of following subject nouns with matching number features (Deevy, Leonard & Marchman, 2017; Lukya-

* Cynthia Lukyanenko, George Mason University, clukyane@gmu.edu; Karen Miller, Pennsylvania State University, kxm80@psu.edu.

nenko & Fisher, 2016). However, agreement neutralization, a common pattern of sociolinguistic variability¹ in English, shown in (1a), renders the reduced form of the singular copula ('s) an unreliable predictor of an upcoming singular noun (Crawford, 2005). The reduced form may be followed by either a singular or a plural (1), while the full form must be followed by a singular (2).

- | | | |
|--------|-------------------------|-----------------------|
| (1) a. | Here's some examples. | REDUCED 'S + PLURAL |
| b. | Here's an example | REDUCED 'S + SINGULAR |
| (2) a. | *Here is some examples. | FULL IS + PLURAL |
| b. | Here is an example. | FULL IS + SINGULAR |

How do listeners adapt to this variability in their input? It depends on how cues are tracked. If listeners track the reliability of morphemes, they will use the plural in comprehension, but not the singular. If they track finer-grained cues, at the level of the allomorph, they should use the plural and the full-form singular in comprehension, but treat the reduced form of the singular as unreliable.

In the current study, we take advantage of this common variable pattern of verb agreement to explore the grain-size at which adults and children track cues. In what follows, we first review what we know about agreement neutralization, and adults' and children's use of agreement in online processing, and then describe the current study in detail.

1.1 Agreement Neutralization

Agreement neutralization is a pattern of sociolinguistic variability in existential and locative sentences in spoken English, in which a reduced singular form of the copula can precede a plural subject (Crawford, 2005; Meechan & Foley, 1994), shown in (1a). This pattern is common in spoken English, including prestige varieties and formal contexts (e.g., Crawford, 2005), but how often speakers produce neutralization varies (Meechan & Foley, 1994). Neutralization is considered prescriptively wrong, but is neither stigmatized nor strongly associated with a particular social class (Squires, 2013). This means that, though parents often avoid stigmatized forms in speech to young children (e.g., Smith, Durham & Fortune, 2007), neutralization is common in child-directed speech, and that children regularly produce neutralization (Lukyanenko & Miller, 2015): Sarah and Nina's parents (Brown, 1973; Suppes, 1974; MacWhinney, 2000) neutralize agreement at different rates (85% vs. 10%), but both girls frequently produce neutralized forms (Sarah: 92%, Nina: 75%).

Because neutralization is common in spoken English, including speech to children, and occurs almost exclusively with the reduced form of the singular copula, it is an ideal tool for asking how fine-grained listeners' cue-tracking is.

¹ A structure is sociolinguistically variable when more than one form conveying the same meaning is available, and form choice depends probabilistically on linguistic (e.g., phonological context) and extra-linguistic factors (e.g., speaker age, SES; Labov, 1969).

1.2 Using Agreement in Comprehension

From previous studies, we know that both children and adults can use number-marked verbs to anticipate the number of an upcoming referent. For instance, in a visual-world task, Lukyanenko and Fisher (2016) found that 2.5-year-olds, 3-year-olds and adults were quicker to switch from a number-mismatching distractor (e.g., 1 cookie) to the target image (2 apples) when they heard a sentence with an agreeing verb (e.g., *Where are the good apples?*), than when they heard one without (e.g., *Can you find the good apples?*).

Intriguingly, Lukyanenko and Fisher (2016) also found a singular-plural asymmetry: Effects of the agreeing verb were smaller or non-existent for singular-verb trials, especially for children, but strong in plural-verb trials. Listening to the audio recordings suggests that most or all of the verbs in these recordings were full forms. This singular-plural asymmetry therefore provides preliminary support for the possibility that children are tracking reliability at the level of the cell of the morphological paradigm, not at the level of the allomorph. In the current study we follow up on this preliminary evidence.

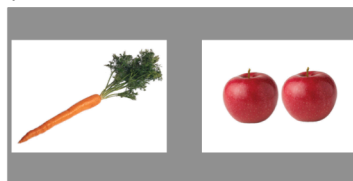
1.3 The Current Study

To determine if adults and children treat the full and reduced forms of the singular copula differently during sentence processing, we designed two versions of a visual-world task based on Lukyanenko and Fisher (2016), one using full forms of the copula (*is*, *are*), and one using reduced forms (*'s*, *'re*). In both versions, participants heard sentences that named familiar items (e.g., carrot), while looking at two images (e.g., 1 carrot, 2 apples; see Figure 1).

Sentences had a plural copula (*are*, *'re*), a singular copula (*is*, *'s*), or no copula (uninformative: *look at*, *can you find*), and these three preceding verb contexts were fully crossed with target noun number (singular, plural). The experimental condition (Figure 1) was compared to a control condition in which the distractor image matched the target in number (e.g., 1 carrot, 1 apple).

If a particular number-marked form of the copula serves as a cue to the number of the following noun, it should facilitate processing in the experimental condition when verb and noun match (*There are the good carrots*), and hinder processing when they do not (*...are the good carrot*). In contrast, if a form of the

Figure 1. Trial structure, Experimental Condition.



Target Noun Number	Singular Verb (reduced full)
	<i>sing.</i> Where' <u>s</u> Where <u>is</u> the good <u>carrot</u> ?
	<i>plur.</i> Where' <u>s</u> Where <u>is</u> the good <u>apples</u> ?
	Plural Verb
	<i>sing.</i> Where' <u>re</u> Where <u>are</u> the good <u>carrot</u> ?
	<i>plur.</i> Where' <u>re</u> Where <u>are</u> the good <u>apples</u> ?
Uninformative	
<i>sing.</i> Can y' Can you find the good <u>carrot</u> ?	
<i>plur.</i> Can y' Can you find the good <u>apples</u> ?	

copula is treated as unreliable, it should pattern with uninformative trials, regardless of the match between verb and noun.

In particular, if participants track the reliability of agreement at the level of allomorph, they should treat full-form *is* as a reliable cue. It should facilitate processing of following singulars and hinder processing of following plurals. If participants track the reliability of agreement at the level of the cell of the morphological paradigm, both *is* and *'s* should be treated as unreliable. Key questions include whether (a) the full- and reduced-forms of the copula will pattern together, and (b) whether children and adults will show the same patterns.

2. Study 1: Adults

In the first study we examined adults' processing of the full and reduced forms of the copula. Using primarily the full-form copula, Lukyanenko and Fisher (2016) found a singular-plural asymmetry for both adults and children. Adults had a numerically similar informative advantage in plural and in singular verb trials, but planned comparisons showed that the advantage was less reliable in the singular trials. This leaves the predictions for the current study unclear: Perhaps the difference in statistical reliability is meaningful, and we will find no effect of preceding singular verbs even in the full-form, or perhaps the numerical pattern is more meaningful, and we will find that full-form singulars are treated as reliable cues to noun number by adults.

2.1 Methods

2.1.1 Participants

112 adults participated, 56 in the full-copula version of the study (18-45 years, $M = 30.5$, 52 women) and 56 in the reduced-copula version (18-46 years, $M = 31.5$, 51 women). Half of the participants in each group were assigned to the experimental condition and half to the control. All were native speakers of American English and recruited from the area around State College, Pennsylvania. An additional 10 adults were excluded for inattentiveness or poor calibration resulting in substantial data loss ($n = 3$; see section 2.1.4), experimenter error resulting in no datafile being saved ($n = 2$), experimenter error resulting in an incorrect trial being played ($n = 4$), or for child interference ($n = 1$).

2.1.2 Stimuli

Stimuli were sentences naming one of eight familiar objects, accompanied by photographs (see Figure 1). The set of sentences fully crossed the three preceding verb contexts (singular, plural, uninformative) with noun number (singular, plural). To avoid potential issues of naturalness resulting from recording ungrammatical sentences (e.g., *there are the good carrot*), only sentences with matching agreement patterns were recorded. All stimulus sentences were created by splicing together a frame (e.g., *Where's the, Look at the*) and target noun

(e.g., *good carrot, pretty babies*). Full- and reduced-copula sentences differed only in the frame; the target noun was from the same recording in both versions.

Photographs appeared in yoked pairs (carrot-apple, doggy-baby, kitty-turtle, bike-truck). In the experimental condition, the pictures always differed in number (e.g., 1 carrot, 2 apples). In the control condition, the distractor image matched the target image in number (e.g., 1 carrot, 1 apple). Because of the lack of number contrast, in the control condition, a number-marked copula should not direct participants' attention to one image over the other.

Participants each saw 16 singular verb, 16 plural verb, and 16 uninformative trials, evenly split between singular and plural target nouns, for a total of 48 test trials. Trial order was pseudo-randomized such that target noun number, target side and plural side never repeated more than twice, preceding verb context never repeated more than once, and picture pair never repeated. Half the participants saw trials in the selected order, and half saw the reverse. The left-right position of the target image was counterbalanced with item, target number and trial-type.

2.1.3 Procedure

Participants sat approximately 2.5 feet from a 24-inch monitor in a quiet lab space. Gaze was tracked using an Eyelink 1000+ eye-tracker (SR Research) operating in remote mode. Participants wore a small target sticker on their forehead or cheek to permit remote tracking, and completed a 9-point calibration before the study. Participants were not given an explicit task during the study.

On each trial, two pictures appeared, aligned with the left and right edges of the screen. The pictures were visible for 6.5 s. Recorded sentences were aligned so that the onset of the determiner occurred 3 s after the pictures appeared. Trials were separated by a central point that participants had to fixate to continue. Every 8 trials, a single silly illustration appeared (e.g., a boy riding a pig).

2.1.4 Data Processing and Measure

Trials that included more than 50% trackloss or away looks (i.e., looking to neither of the pictures nor the location of the central point), or for which no data were collected (e.g., the study was ended early) were excluded. When this resulted in the removal of more than half the trials in one or more cells of the design (i.e., singular verb/plural noun, singular verb/singular noun, plural verb/plural noun, plural verb/singular noun, uninformative/plural noun, uninformative/singular noun), the participant was excluded. This process resulted in the exclusion of 3 adults (see section 2.1.1). For the remaining adults, it resulted in the exclusion of 334 of 5376 possible trials (6%).

In remaining trials, we measured the proportion of time participants spent looking at the target image during a 1-s window anchored at noun onset². At this

² Data were processed using R 3.3.3 (R Core Group, 2017), and eyetrackingR (Dink & Ferguson, 2015).

point in the sentence, participants have heard the preceding verb context and are processing the noun, which may or may not match that verb in number³. If the verb serves as a useful cue to participants, it should facilitate processing when the noun matches in number and hinder processing when the noun mismatches.

2.2 Results

Figure 2 shows the proportion of the 1-s noun window adults spent looking at the target, out of time they spent looking to either image. Panels are split by form (reduced/full) and condition (experimental/control).

Grouping on the x-axis indicates target noun number (plural, singular). Points and error bars show group means and standard error, and the “violins” show the distribution of participant means. Violins shaded in dark gray are plural verb trials

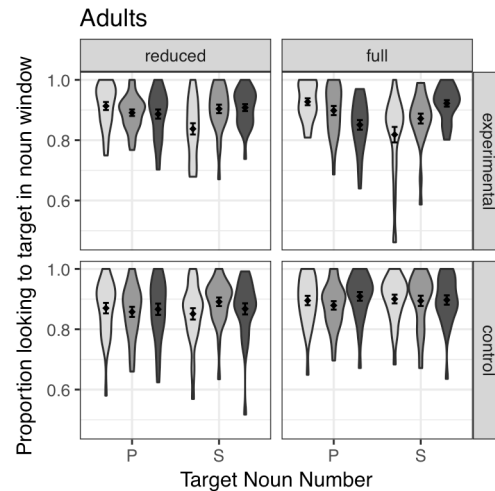
(*there’re, there are*), mid gray are uninformative trials (*look at*), and light gray are singular verb trials (*there’s, there is*).

Notice the three-tiered pattern in the full-form experimental condition on the upper right: for both plural and singular target nouns, a preceding verb with the same number marking facilitates processing and increases looks to the target image, while a preceding verb with the opposite marking hinders processing. In contrast, reduced-form experimental condition in the upper left panel shows a two-tier pattern: While the plural verb helps or hinders according to its match with noun number, singular ‘s patterns with the uninformative sentences. This suggests that adults treat the full-form singular as a reliable cue to noun number, but not the reduced singular, and therefore that they are tracking the reliability of the allophones separately.

2.2.1 Analysis

To further explore these patterns, we conducted a mixed effects regression analysis (*lme4* version 1.1-14, Bates, Mächler, Bolker & Walker, 2015) for each

Figure 2. Adults’ proportion looking to target in the noun window.



³ We also examined the early, dynamic measures used by Lukyanenko and Fisher (2016): reaction time from the determiner and pre-noun shift proportion. In this study, those measures were noisy and showed no systematic patterns. We return to this in section 4.

version of the study (full- vs. reduced-form). Analyses included the between-participants predictor *condition* (control/experimental), and the within-participants predictors *noun number* (singular/plural) and *verb number* (plural/singular/uninformative). All predictors were entered into the model using mean-centered, Helmert-coded contrasts (calculated using *psycholing*, Fraundorf, 2017), with the first-listed element as the negative level. Because verb number had three levels, Helmert coding created two orthogonal contrasts, one comparing trials with plural verbs to trials with singular and uninformative verbs (“verb plural”) and one comparing trials with singular verbs to uninformative trials (“verb singular”).

The random effects structure of the models was determined using a forward best path algorithm (Barr, Levy, Scheepers & Tily, 2013, $\alpha = .2$). No random slopes met the inclusion criterion for either model. Models included only the random intercepts for participant and target noun.

2.2.2 Full-Form

For the full-form version of the stimuli, this analysis supported the visible three-tier pattern. It revealed reliable interactions of noun number and verb plural ($b = -0.065$, $se = 0.015$, $t = -4.31$, $\chi^2(1) = 18.49$, $p < .001$), noun number and verb singular ($b = 0.038$, $se = 0.017$, $t = 2.18$, $\chi^2(1) = 4.77$, $p = .03$), and crucially the reliable three-way interactions of condition, noun number and verb plural ($b = -0.136$, $se = 0.03$, $t = -4.53$, $\chi^2(1) = 20.41$, $p < .0001$), and of condition, noun number and verb singular ($b = 0.119$, $se = 0.035$, $t = 3.42$, $\chi^2(1) = 11.69$, $p = .0006$). No other main effects or interactions reached significance (verb singular $b = -0.011$, $t = -1.27$, $\chi^2(1) = 1.62$, $p = .20$; all other $\chi^2(1) < 1.2$).

Planned comparisons revealed that the interaction of noun number and verb plural and of noun number and verb singular were reliable in the experimental (plural; $b = -0.132$, $se = 0.02$, $t = -6.25$, $\chi^2(1) = 38.77$, $p < .0001$; singular: $b = 0.096$, $se = 0.02$, $t = 3.95$, $\chi^2(1) = 15.57$, $p < .0001$) but not in the control condition (both $\chi^2(1) < 1$, $p > .35$). This indicates that adults use the full-form singular as a cue to upcoming noun number.

2.2.3 Reduced Form

For the reduced-form version of the study, the analysis revealed a reliable main effect of verb plural ($b = 0.017$, $se = 0.008$, $t = 2.25$, $\chi^2(1) = 5.07$, $p = .024$), a reliable interaction of noun number and verb plural ($b = -0.065$, $se = 0.015$, $t = -4.22$, $\chi^2(1) = 17.75$, $p < .0001$), and crucially a marginal interaction of condition, noun number and verb plural ($b = -0.057$, $se = 0.031$, $t = -1.84$, $\chi^2(1) = 3.39$, $p = .066$). No other main effects or interactions were reliable (condition $b = 0.024$, $t = 1.53$, $\chi^2(1) = 2.28$, $p = .13$, all other $\chi^2(1) < 1$).

Planned comparisons revealed that the interaction of noun number and verb plural was reliable in the experimental condition ($b = -0.09$, $se = 0.02$, $t = -4.28$, $\chi^2(1) = 18.27$, $p < .0001$) and, oddly, marginal in the control condition ($b = -$

0.04, $se = 0.02$, $t = -1.69$, $\chi^2(1) = 2.86$, $p = .09$). In contrast, the interaction of noun number and verb singular was not reliable in either the experimental or the control condition (both $\chi^2(1) < 1.5$, $p > .2$). The marginal significance of the overall interaction of condition, noun number and verb plural and visual inspection suggest that the interaction of noun number and verb plural is much smaller in the control condition than in the experimental condition. We consider the control condition further in the General Discussion (section 4).

Overall, these patterns indicate that adults do not use the reduced singular form of the copula as a cue in processing, but they do use the reduced plural.

2.3 Discussion

In Study 1, we found that adults use both the full and the reduced forms of the plural copula, but only the full form of the singular copula as cues in online processing. Having heard a plural verb, processing a plural noun was easier, as indicated by increased looks to the target image in the experimental condition for both forms. Hearing a singular verb, in contrast, only facilitated processing of a singular noun in the full-form version of the study.

The fact that adults treat the full and reduced forms of the singular differently indicates that they are (a) sensitive to the presence of agreement neutralization in their input, and adjust to it by (b) tracking the reliability of each allomorph separately. For adults at least, the grain-size for tracking cues is quite small.

3. Study 2: 3- to 6-year-olds

Study 2 explores the same questions with young children: At what grain-size are preschoolers tracking cue reliability? Previous findings suggest that preschoolers may track reliability at the level of the morphological cell rather than the allomorph. Toddlers' and preschoolers' acquisition of several third-person singular morphemes is correlated, suggesting that they are being acquired as part of a morphological paradigm, rather than as fully independent entities (Rispoli, Hadley & Holt, 2012; Rispoli, 2016). The strong singular-plural asymmetry Lukyanenko and Fisher (2016) observed in children also suggests that, unlike adults, they may not be able to use the full-form singular copula as a cue in online processing. Here we test this question directly.

Study 2 was identical to Study 1 with two exceptions: the age of the participants, and the fact that children filled a small bookmark with stickers as they progressed through the experiment. These differences are outlined below.

3.1 Methods

3.1.1 Participants

95 3- to 6-year-old children participated, 48 in the full-copula version of the study (3;1-6;0, $M = 4;2$, 26 girls) and 47 in the reduced-copula version (3;0-5;9, $M = 4;4$, 24 girls). Half of the participants in each group were assigned to the

experimental condition and half to the control condition. Children were native speakers of American English, and were recruited from the area around State College, Pennsylvania. Most had parents who were included in Study 1.

An additional 16 children were excluded for refusing to complete calibration ($n = 4$), or inattentiveness or poor calibration resulting in substantial data loss ($n = 11$; see section 3.1.2), or for unplugging the eye-tracker before sufficient data had been collected ($n = 1$).

3.1.2 Stimuli, Procedure and Measure

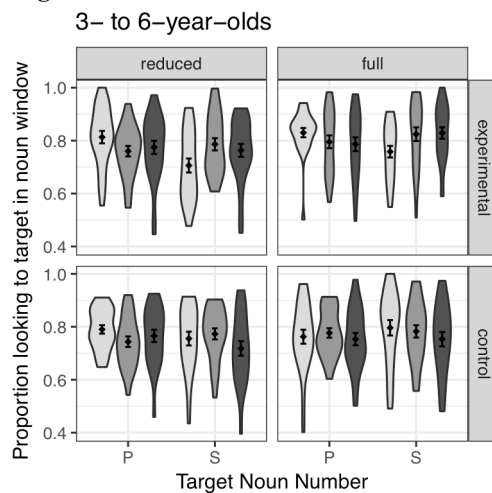
Stimuli, procedures and measures were the same for children as for adults (see 2.1.2-2.1.4), with one exception. Every 8 test trials, when the single silly picture appeared, children got a brief break and added a sticker to a bookmark. At the end of the study they filled the last space on their bookmark with the eye-tracking target sticker from their forehead. This helped keep children engaged.

As in Study 1, trials with no data or with $>50\%$ trackloss or away looks were excluded. When this resulted in the exclusion of more than half of the trials in a given cell of the design for a participant, that participant was excluded. This resulted in the exclusion of 11 children (see section 3.1.1). For the remaining children, it resulted in the exclusion of 809 of 4560 possible trials (18%).

3.2 Results

Figure 3 shows the proportion of the 1-s noun window that the children spent looking at the target image, split and formatted as for adults. Children showed the same two-tier pattern in the reduced trials that adults did: Plural verbs provide an advantage for following plural nouns and a disadvantage for following singular nouns, but singular verbs pattern with the uninformative trials. For children, the pattern in the full-form version of the study also appears to be two-tiered, in contrast to the adults' three-tiered pattern. Thus, it appears that children do not use *is* or *'s* as a cue in processing, and therefore that they are probably tracking cue reliability at the level of the cell of the morphological paradigm.

Figure 3. Children's proportion looking to target in the noun window.



3.2.1 Analysis

To explore these patterns we conducted analyses parallel to those for adults. For each version of the study (full- vs. reduced-form) we ran a mixed effects regression analysis with *condition* as a between participants predictor, and *noun number* and *verb number* as within-participants predictors. All contrasts were mean-centered and Helmert-coded. For the reduced-form analysis, no random slopes met the forward best-path inclusion criterion. For the full-form version the random slope of noun number by participant met the inclusion criterion, but caused convergence issues in the model comparison procedure used to get p-values. Inspection of the full models with and without this random slope suggested that it made little difference for the fixed effects and their interactions, either in the estimates or t-values. Therefore, as for the adults, both models included only the random intercepts by participant and target noun.

3.2.2 Full-Form

For children this analysis revealed a reliable main effect of condition ($b = 0.036$, $se = 0.017$, $t = 2.13$, $\chi^2(1) = 4.34$, $p = .04$), and crucially a reliable interaction of condition, noun number and verb plural ($b = -0.136$, $se = 0.05$, $t = -2.64$, $\chi^2(1) = 6.96$, $p = .008$), but not an interaction of condition, noun number and verb singular ($b = 0.02$, $se = 0.059$, $t = 0.34$, $\chi^2(1) = 0.12$, $p = .73$). The interactions of noun number and verb plural ($b = -0.04$, $se = 0.026$, $t = -1.6$, $\chi^2(1) = 2.56$, $p = .11$) and of noun number and verb singular ($b = -0.002$, $se = 0.029$, $t = -0.07$, $\chi^2(1) = 0.005$, $p = .94$) were also non-significant. No other main effects or interactions were reliable (all $\chi^2(1) < 1$)

Planned comparisons revealed that the interaction of noun number and verb plural was reliable in the experimental condition ($b = -0.11$, $se = 0.036$, $t = -3.00$, $\chi^2(1) = 8.95$, $p = .003$), but not in the control condition ($\chi^2(1) = 0.57$, $p = .45$). The interaction of noun number and verb singular was not statistically reliable in either condition (both $\chi^2(1) < 1$, $p > .7$). This suggests that though children use the full-form plural copula in comprehension, they do not use the full singular.

3.2.3 Reduced-Form

For children, analysis of the reduced-form version of the study revealed a marginal main effect of noun number ($b = 0.023$, $se = 0.013$, $t = 1.81$, $\chi^2(1) = 3.26$, $p = .071$), and reliable interactions of noun number and verb plural ($b = -0.072$, $se = 0.027$, $t = -2.71$, $\chi^2(1) = 7.33$, $p = .007$) and of noun number and verb singular ($b = -0.062$, $se = 0.031$, $t = -2.02$, $\chi^2(1) = 4.07$, $p = .044$). Neither of the three-way interactions with condition reached significance (verb plural: $b = -0.061$, $se = 0.053$, $t = -1.14$, $\chi^2(1) = 1.30$, $p = .25$, verb singular: $b = 0.051$, $se = 0.061$, $t = 0.83$, $\chi^2(1) = 0.69$, $p = .41$), nor did any other main effects or interactions (all $\chi^2(1) < 1.7$).

Planned comparisons revealed that the interaction of noun number and verb plural was reliable in the experimental condition ($b = -0.10$, $t = -2.73$, $\chi^2(1) =$

7.44, $p = .006$), but not in the control condition ($\chi^2(1) = 0.76$, $p = .38$). In contrast, the interaction of noun number and verb singular was reliable in the control condition ($b = -0.088$, $t = -2.00$, $\chi^2(1) = 3.98$, $p = .046$), but not in the experimental condition ($\chi^2(1) = 1.15$, $p = .28$). Despite this effect in the wrong direction in the control condition, recall that the overall interaction of condition, noun number and verb singular was not significant ($p = .41$). We return to the control in the General Discussion (section 4).

3.3. Discussion

In contrast to the adults in Study 1, the 3- to 6-year-olds in Study 2 did not treat the singular as a reliable cue in comprehension, regardless of whether it appeared in its full or reduced form. This suggests that children are tracking the reliability of verb agreement at the level of the morpheme, not the allomorph.

4. General Discussion

In two studies, we compared participants' use of full- and reduced-forms of the English copula as a cue in comprehension. Both adults and children treated plural forms as cues to the number of the following noun: they drove increased looking to following plural targets and decreased looking to singular targets. Adults and children differed in their treatment of singular forms. Children treated singular forms of the copula as unreliable cues: they patterned with uninformative trials. Adults, in contrast, treated the reduced form 's, as unreliable, but the full-form singular *is* as a reliable cue to a following singular noun.

These results replicate Lukyanenko and Fisher's (2016) finding that children and adults use agreement in online processing, and extend them by showing that adults treat full and reduced forms of the singular copula differently, but children do not. This suggests that both adults and children are sensitive to the presence of neutralization in their input: They know that the singular copula is a less reliable predictor of following noun number than the plural copula *is*. Furthermore, it suggests that adults track cue reliability at a finer-grain size than children do. Adults have correctly identified the full-form singular *is* as a reliable indicator of a following singular noun, but the reduced-form 's as unreliable. In contrast, children appear to be tracking reliability at the level of the morpheme: They treat reduced- and full-form singulars similarly.

Previous studies have sometimes explained singular-plural asymmetries in comprehension as the result of the singular being unmarked for number, or being inherently less informative, since plural sets always include singletons (Eberhard, 1997; Lukyanenko & Fisher, 2016). The fact that adults use the full form singular in this task suggests that, at the very least, neither of these is absolute: a singular agreeing verb can act as a cue in comprehension.

Children's performance aligns well with previous findings on non-agreeing *don't* (Miller, 2012; Miller, 2013). In these studies, children whose input includes non-agreeing *don't* go through a phase during which their production of

agreeing forms of *do/does* and *don't/doesn't* pattern together, before they sort out the appropriate variable context, and begin to produce non-agreeing forms only in the context of negation. Similarly, in the current study, children are treating two forms similarly, when only one actually exhibits variation in the input.

4.1 Issues with the Mismatch Trials

The current findings differ from Lukyanenko and Fisher (2016) in their timing. We examined the same early measures (see footnote 3), in these data, but they did not reveal consistent patterns. The most likely explanation for this is the presence of the mismatch trials. The fact that we found effects of verb-form on processing means that the mismatch trials did not cause participants to give up on using verb agreement as a cue altogether, but it may well have slowed them down and shifted the weight of the processing from prediction to integration.

The control condition also showed some surprising, unpredicted interactions in the current study: noun number by verb singular in the reduced-form version of the study for children, and noun number by verb plural in the reduced-form version for adults. It is unclear precisely where these patterns came from, but it is possible that this too had to do with the mismatches, which became obvious much earlier in the control condition than in the experimental condition.

The target image always matched the number of the target noun, and therefore sometimes mismatched the number of the preceding verb (e.g., *There are the good carrot*; target image: 1 carrot). In control trials, the distractor image matched the target in number (e.g., 1 apple). This meant that whether the verb and noun would match was apparent as soon as the verb was heard. In the experimental condition, a match or mismatch could not be identified until noun onset.

4.2 Future Directions

To help address the two concerns raised above, we plan to run a version without mismatch trials. We also intend to explore the effects of age and of differences in experience. Are children whose parents produce little neutralization more likely to treat the singular copula as a reliable cue? Are children whose parents produce a lot of neutralization more likely to have picked up on the relevance of the allomorph to cue reliability? Comparing the performance of children who hear large or small amounts of neutralization will help clarify how different aspects of input variability result in the observed patterns of processing. We collected small samples of parent speech during a search-and-find task as part of this study, and are in the process of transcribing it for analysis.

4.3 Conclusions

In the current study, we showed that children and adults are sensitive to the patterns of variability in their input, correctly treating singulars as unreliable, but that adults are tracking that variability at a finer grain than children are. These

results provide further evidence that children and adults predict syntactic features such as number in online comprehension, and also indicate that children are tracking cues at the morphological level, rather than at the level of the allophone ('s, is) or surface form (/s/, /z/, /əz/, /ɪz/).

This is an intriguing example of how sociolinguistic variability can provide a tool with which to explore the mechanisms and development of language processing. Instead of abstracting away from input variability, as is common in language acquisition research, we can use it to explore children's knowledge.

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