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What's That You're Saying? Children With Better Executive Functioning Produce and Repair Communication More Effectively

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ABSTRACT
Young children often provide ambiguous referential statements. Thus, the ability to identify when miscommunication has occurred and subsequently repair messages is an essential component of communicative development. The present study examined the impact of listener feedback and children's executive functioning in influencing children's ability to repair their messages. Children (ages 4–6 years) completed a referential communication task, in which they described target pictures among an array of similar distractors for a confederate. Stimuli were designed such that children frequently provided ambiguous descriptions. Subsequently, the listener provided the children with feedback (detailed or vague) that they misunderstood the statement. Children also completed executive functioning tasks (working memory, inhibitory control, and cognitive flexibility). Children with larger working memory capacities and better cognitive flexibility provided more effective initial descriptions of the targets. Children with better cognitive flexibility were also more effective at repairing their statements in response to feedback. Although children provided more effective repairs following detailed feedback (vs. vague feedback), this effect did not significantly interact with the cognitive skills of children. However, limited evidence emerged suggesting that cognitive flexibility may be more important when the listener provides vague feedback.

Much to the frustration of parents, children often fail to provide enough information to successfully convey an intended message. Such difficulty means that repairing initially ineffective statements is a relevant skill for young communicators to acquire. The present study investigated the degree to which 4- to 6-year-old children benefit from specific versus vague feedback that miscommunication has occurred for their repair strategies. It also examined whether stronger executive functioning relates to children's ability to repair their statements following feedback from a listener.

Decades of research on referential communication has shown that young children frequently generate ambiguous statements for their listeners (e.g., Glucksberg, Krauss, & Weisberg, 1966; Krauss & Glucksberg, 1969; Lloyd, Mann, & Peers, 1998; Pechmann & Deutsch, 1982). Their management of the task of producing effective referential statements shows a steady but gradual improvement throughout the school-age years (Krauss

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& Glucksberg, 1969; Lloyd et al., 1998; Pechmann & Deutsch, 1982). Young children's difficulty in producing effective statements means that miscommunication during conversational exchanges is a frequent occurrence, and thus, the ability to notice and repair communication breakdowns is critically important for effective communication.

Children demonstrate efforts to repair their statements as early as infancy. For instance, 1-year-old infants use pointing and vocalizations to repair messages that appear to be misunderstood by their listeners (Golinkof, 1986; Liszkowski, Albrecht, Carpenter, & Tomasello, 2008). While young children *attempt* to repair their messages, findings on the effectiveness of such repairs for preschool-aged children are varied. For example, 2-year-olds were found to use pointing to repair their messages following a request for clarification from an experimenter, even when pointing could not be used to uniquely identify a specific object (O'Neill & Topolovec, 2001). In contrast, several studies have shown that preschool-aged children improve their statements following requests for clarification (albeit not completely consistently; Coon, Lipscomb, & Copple, 1982; Deutsch & Pechmann, 1982; Nilsen & Mangal, 2012). For example, when children (aged 3, 6, and 9 years) requested objects from an experimenter and were asked for clarification following an ambiguous message (e.g., "Which ball?"), they were able to effectively repair their message in the majority of trials (Deutsch & Pechmann, 1982).

The type of feedback provided by the listener appears to be important in determining the effectiveness of children's repair strategies. In a study by Coon and colleagues (1982), 5- to 6-year-old children completed a referential communication task in which they were provided with feedback when they produced ambiguous messages. This feedback varied in specificity (e.g., "Tell me whatever I need to know to pick the right one." versus "There were several red ones, and I picked the wrong one. I picked a red circle.") and in whether or not the experimenter showed the child the listener's incorrect object choice (i.e., an object that matched the child's description but was not the target). Children were most effective at repairing their messages (i.e., they were able to provide more descriptors to disambiguate the target from distractors) following specific feedback or when shown the listener's incorrect object choice. Other studies have shown similar effects of feedback type. That is, following vague feedback (e.g., "What?"), preschool-age children tend to use an ineffective strategy of repeating the initially ambiguous statement (Anselmi, Tomasello, & Acunzo, 1986; Wilcox & Webster, 1980). Following specific queries about their statements (Anselmi et al., 1986) or when shown the listener's incorrect object choice (Nilsen & Mangal, 2012), preschoolers tend to modify messages to include additional important elements.

The type of feedback provided to children also has an impact on their subsequent messages. In two studies by Matthews and colleagues (Matthews, Butcher, Lieven, & Tomasello, 2012; Matthews, Lieven, & Tomasello, 2007) children (aged 2–4 years) generated referential statements and were provided with generic (e.g., "Which girl?") or specific (e.g., "Is it the girl dancing or the girl singing?") feedback following ambiguous messages. Children of all ages provided more effective statements on later trials and learned to do so more quickly following specific feedback. Providing children with the opportunity to repair messages appeared to be more effective training than simply having them observe others provide and repair messages (Matthews et al., 2007). Other work similarly has shown that children are able to learn to produce more effective messages when provided with feedback indicating they have been misunderstood (see Abbot-Smith, Nurmsoo, Croll, Ferguson, & Forrester, 2015; Lefebvre-Pinard, Charbonneau, & Feider, 1982; Robinson & Robinson, 1981, 1985; Wardlow & Heyman, 2016).

In addition to extending previous work on listener feedback for children's communicative repairs, the present work examined how children's cognitive skills impact their ability to modify statements. Executive functions, the cognitive skills that control and regulate other lower-level cognitive processes and goal-directed behavior (Alvarez & Emory, 2006), consist of several components (e.g., the ability to hold in mind and mentally manipulate information [working memory], the ability to withhold a dominant response [inhibitory control], and the ability to think flexibly and switch one's way of thinking about a problem [cognitive flexibility]). Such skills are posited to support the use of information about a partner's perspective in guiding communicative behaviors (Nilsen & Fecica, 2011). Indeed, several studies have shown that speakers' working memory and inhibitory control skills are associated with their ability to produce initial statements that are tailored for listeners' needs (Nilsen, Varghese, Xu, & Fecica, 2015; Wardlow, 2013). Executive functioning is also associated with listeners' sensitivity to a speaker's perspective during comprehension. For instance, individuals with stronger working memory and inhibitory control were more likely to attend to the speaker's perspective when interpreting their messages (Brown-Schmidt, 2009; Lin, Keysar, & Epley, 2010; Nilsen & Graham, 2009; Wardlow, 2013).

Although the role of executive functioning in children's repairs has not been examined empirically, there is theoretical reason to see it playing a key role. Volden (2004) proposed that communication repair involves three main steps: "(1) an ability to judge another person's state of knowledge; (2) a comparison of the listener's perceived state of knowledge with the speaker's original utterance and a subsequent determination about what components of the original message were inadequate; and (3) an adjustment to the speaker's utterance that is based on steps 1 and 2." (p. 174) Volden has suggested that Steps 2 and 3 may involve working memory, as a child would be required to hold information in mind about their listener's perspective, the listener's feedback, and their own statement before producing a revised statement. Steps 2 and 3 may involve inhibition and cognitive flexibility as well in that speakers may need to inhibit their own perspective (to take into account that of the listener) and be able to flexibly modify their statement rather than merely repeating the original statement.

Moreover, studies showing that detailed feedback (or showing incorrect object choice) facilitates children's communication repair are consistent with the idea that executive functioning is involved in repair (Anselmi et al., 1986; Coon et al., 1982; Nilsen & Mangal, 2012). That is, specific feedback may reduce the cognitive demands of communication repair (Coon et al., 1982) because, when provided with specific feedback (or shown the listener's incorrect object choice), the child only needs to compare their original message with the referents identified by the listener. In contrast, when provided with vague feedback, the child must compare his or her statement with all the possible referents in the array to determine what was lacking in the original message. Thus, detailed feedback could possibly reduce the amount of information the child needs to hold in working memory. Detailed feedback may also reduce the demands on cognitive flexibility by making more salient which dimensions of the target object the listener is confused about and making the aspects of the object about which a child needs to think flexibly (i.e., that the object is both red and large, etc.) more obvious.

The most direct support for the role of executive functions in repairs comes from Wardlow and Heyman (2016) who found that 5- to 7-year-old children with better working memory improved on their subsequent messages, but only in a context where nonverbal feedback (i.e., the experimenter made a confused face and chose the incorrect object) was provided. However, in this study, children were not given the opportunity to repair their original statements; thus, it remains unclear if executive functioning is involved in the act of repairing ineffective statements per se. The processes involved in repairing one's statement may differ from those involved in the provision of subsequent statements. That is, repairing statements involves responding to a situation in the moment and requires consideration of one's own original message as well as the listener's feedback. In contrast, benefitting from previous feedback to produce better messages reflects learning about what constitutes effective communication and using this information when generating subsequent utterances. Further, Wardlow and Heyman's study did not investigate other executive functions, such as cognitive flexibility and inhibitory control. Moreover, given that different executive skills show different contributions to children's sociocommunicative abilities at different stages (e.g., Huyder, Nilsen, & Bacso, 2017; Im-Bolter, Agostino, & Owens-Jaffray, 2016), it may be that the skills that are important for school-age children (Wardlow & Heyman, 2016) differ from those important for preschoolers (current study).

Addressing a gap in the literature, the present study examined the relationship between executive functioning and late preschool-aged children's ability to repair their messages following feedback indicating that they were misunderstood. In addition, we examined whether the role of executive functioning in repair differed depending on the type of feedback provided. Four- to 6-year-old children completed a referential communication task in which they described pictures to an experimenter. Based on previous work (Lloyd et al., 1998; Nilsen & Mangal, 2012), the stimuli were designed to increase the likelihood that children within this age range would initially provide a description that did not uniquely identify the target (i.e., two descriptors were required for a description to be unambiguous). Following ambiguous statements, the experimenter provided half of the participants with detailed feedback (which identified where the miscommunication occurred) and provided half of the participants with vague feedback (which did not identify where the miscommunication occurred). Following feedback, children had the opportunity to repair their messages. Children also completed tasks assessing their working memory, inhibitory control, and cognitive flexibility.

We anticipated that children who received detailed feedback would provide more descriptors of the target than would those who received vague feedback (e.g., Coon et al., 1982; Nilsen & Mangal, 2012). We expected that children with better executive functioning would provide more descriptors following feedback, although the degree to which each component of executive functioning would be beneficial for children's repairs was unclear. Further, we anticipated that the effect of executive functioning on repairs would be stronger for children who received vague feedback compared to those who received detailed feedback. That is, if detailed feedback reduces the cognitive demands of repair (Coon et al., 1982), it may scaffold the skills of those children with weak executive functioning, thereby creating less difference in the communicative performance of children with weak/strong executive functioning. On the other hand, in the vague feedback condition, children's repairs are not supported in the same fashion, and thus, we would anticipate there would be a more marked role of the children's own executive skills.

Method

Participants and design

Participants were 140 children aged 4 to 6 years old (M_{age} = 5;0; *SD* = 6.6 months; 70 girls) recruited from elementary schools in a midsized Canadian city. Participants were assigned at random to one of two conditions in which varying specificity of feedback (detailed vs. vague) was provided by a confederate following ambiguous messages.

During the communication task, participants completed filler trials (see the Procedure section). These trials required participants to name the target picture without needing any additional descriptors (e.g., "grapes"). Participants who provided an incorrect response (i.e., were unable to correctly identify the target) on three filler trials throughout the communication task were discontinued from the study and not included in analyses (n = 23).[1] Participants' data were also removed from analyses if their vocabulary score was not deemed sufficient to support the task (i.e., *SD* > 3 below the mean on the expressive vocabulary task; n = 1) or there were technical difficulties with video equipment that prohibited coding the data (n = 1). Thus, 25 participants were removed from the analyses in total, leaving 115 participants (M_{age} = 5;1; *SD* = 6.5 months; 57 girls).

The majority of participants in the remaining sample were reported to have spoken English since birth (n = 108). Most participants also spoke primarily English in the home (n = 98), while several participants spoke a wide variety of other languages at home (n = 17), including Punjabi, Japanese, and Russian.

Procedure

Participants were individually administered tasks in a quiet room at their school. Tasks were completed in a set order during one 40-min session (communication task, Red Dog–Blue Dog, Digit Span, Object Classification Task, Picture Naming).

Communication task

An experimenter and an adult confederate tested the children (see Appendix A for task layout). On each trial, the child was provided with a complete card depicting a scene containing several people, animals, or objects (Figure 1). The child and confederate were also both given copies of an incomplete card, which depicted the same scene as the complete card but had one person/animal/object missing. Both the child and confederate were given identical sets of small pictures, which depicted the objects, people, and animals shown on the card as well as some other, unique pictures. Children were told they would be playing a game with the confederate and that the goal of the game was to tell the confederate which of the small pictures she would need to make her incomplete card look like the child's complete picture card.

The communication task consisted of 16 trials (2 practice, 6 test, and 8 filler trials). At the beginning of the task, the experimenter placed a barrier between the confederate and child and explained it would prevent them from seeing each other's cards and pictures. The experimenter also explained that the child and confederate had the same incomplete card and pictures but that the confederate did not have the complete card. The

[1]The majority of participants in the study (77%) identified the correct target on 100% of the filler trials.

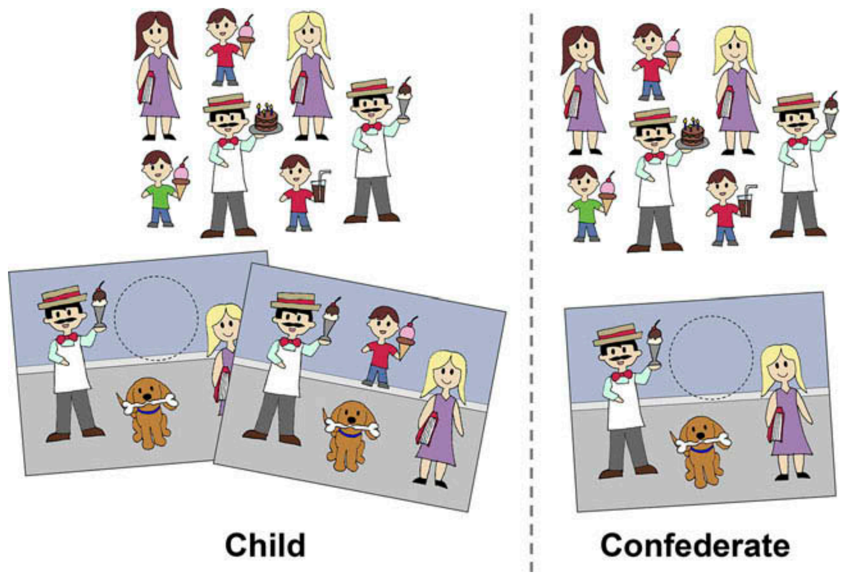

Figure 1. Stimuli used for the communication task. The child was given an incomplete card and a complete card (see left panel) during each trial, whereas the confederate was only given an incomplete card (see right panel). Both the child and confederate were provided with the same pictures (see top of both panels).

experimenter showed the children the confederate's card and pictures on each trial to remind them. Next, the children completed 2 practice trials. For the practice trials, children were asked to tell the confederate which picture she would need to make her incomplete card look the same as the child's complete card. To be successful, the child only needed to provide the target picture's object name (e.g., "shirt") for it to be uniquely identified. During the practice trials, the experimenter also explained the purpose of a light, which was used by the experimenter to indicate whether or not the confederate had chosen the correct target on each trial. When the confederate chose the correct target, the experimenter turned on the light in front of her. When the confederate picked the incorrect target, the experimenter did not turn on the light.

Following the practice trials, children were administered the test and filler trials. The stimuli for test and filler trials were presented in one of four possible orders, which were counterbalanced for the order in which stimuli were presented. On test trials, the pictures from which the child and confederate had to choose contained the target as well as two referential alternatives, which were pictures that depicted the same object as the target but differed on one dimension (e.g., a boy wearing a red shirt holding ice cream, a boy wearing a green shirt holding ice cream, and a boy wearing a red shirt holding a drink), and six pictures of different objects (see Figure 1). Thus, to uniquely identify the correct target for the confederate, the child was required to provide two descriptors of the target (e.g., "the boy in the *red* shirt holding *ice cream*"). Across trials, critical descriptors referred to the target's color (e.g., *red* shirt), to objects on which the target was acting (e.g., holding *ice cream*), or to the target's actions (e.g., the clown *juggling*). If the child successfully provided two descriptors of the target, the experimenter turned on the light and the confederate said, "The light turned on. I picked the right one." If the child failed to provide two correct descriptors, the confederate always chose the wrong picture card and provided the child with feedback indicating that he/she had been misunderstood. The type of feedback varied between participants. They received either *detailed* or *vague* feedback. Detailed feedback was modified depending on the participants' initial response and included a statement of misunderstanding as well as specific information about what was lacking in the child's original statement (e.g., if a child said, "the boy in the red shirt," the feedback was: "I picked the wrong one. There are two boys in red shirts and I don't know which one you mean."). Vague feedback was the same regardless of the participant's initial response and only included a statement of misunderstanding (i.e., "I picked the wrong one. I don't know which one you mean.").

Following feedback, the child was allowed 10 s to repair their message. If the child did not respond or was unable to uniquely identify the target following feedback, the experimenter said, "Actually, let's try another one," and moved on to the next trial. If the child was able to uniquely identify the target following feedback, the experimenter turned on the light and the confederate indicated that she chose the correct card by saying, "The light turned on. I picked the right one."

Filler trials were included to vary the number of descriptors required on each trial and thereby required that participants attend closely to the object options provided. These trials (n = 8) were interspersed among the test trials in a pseudorandom order. On filler trials, the picture cards from which the child and confederate had to choose contained the target and several pictures that were not similar to the target. On the filler trials, the child was only required to say the object name to uniquely identify the target (e.g., "grapes"). When the correct name was provided, the confederate picked up the correct picture, the light was turned on, and a new trial was started. When the child provided the incorrect object name, the experimenter said, "Actually, let's try another one," and moved on to the next trial. No feedback was provided following inadequate responses on filler trials.

Coding. Children's responses were coded by a research assistant blind to the research hypotheses. The responses were coded for the following:

(1) The number of descriptors, referring to those descriptors that disambiguated the target picture from distractor pictures. For example, if a participant said, "the boy in the *red* shirt," his or her response was coded as containing one descriptor. Descriptors that did not disambiguate the target picture were not included (e.g., "the boy with grey shoes" would be coded as no descriptors because all boys in the array of pictures were wearing grey shoes).
(2) New descriptors in the second response, referring to the number of informative descriptors provided in the repair attempt, which were not provided during the first response.
(3) Repetitions, referring to statements in the second response in which the participant repeated their initial response and did not provide any additional information.
(4) Pointing, reflecting the number of times a participant pointed to one of the picture options in front of them or pointed to the target picture on the complete card.

Pointing was considered an ineffective strategy given that the barrier prohibited the confederate from seeing what the participant was pointing toward.

(5) Other communicative responses[2] and behaviors, such as describing the incorrect target and holding up the card above the barrier.

A second research assistant coded the behaviors of 32 randomly chosen participants (25% of the total sample) to ensure reliability in coding. The interrater reliability of the number of descriptors provided in participants' initial descriptions was found to be near-perfect, $ICC(181) = 1.00$, $p < .001$. The interrater reliability of the number of new descriptors provided by participants following feedback was similarly high, $ICC(138) = .97$, $p < .001$. Reliability was also assessed for coding repetitions, $ICC(138) = .61$, $p < .001$, pointing to cards during the first response, $ICC(181) = .81$, $p < .001$, and pointing to cards during the second response, $ICC(138) = .77$, $p < .001$.

Working memory

Following the communication task, children completed the Digit Span subtest from the Wechsler Intelligence Scale for Children–Fourth Edition (Wechsler, 2003) as a measure of verbal working memory. Span tasks have been found to fall on a working memory factor in factor-analytic studies (Fournier-Vicente, Larigauderie, & Gaonac'h, 2008; Pennington, 1997). Participants first completed the Digit Span Forward task wherein the experimenter read a series of digits and then participants were asked to repeat the digits in the same order. Next, participants completed the Digit Span Backward subtest, which required that they repeat the digit string in a backward order. The Digit Span Forward and Digit Span Backward tasks each consisted of eight items, with two trials per item. When a child provided the incorrect response on both trials of an item, the task was discontinued. A total Digit Span score, used in the analyses, was calculated by adding the Digit Span Forward and Digit Span Backward scores. Possible scores ranged from 0 to 32.

Inhibitory control

The Red Dog–Blue Dog task was used to assess inhibitory control. This Stroop-like task (modified from Beveridge, Jarrold, & Pettit, 2002; Stroop, 1935) has been used in previous studies on a sample of 4- to 5-year-olds (Nilsen & Graham, 2009) and on a sample of 6- and 8-year-olds (Beveridge et al., 2002). Stroop tasks have been found to load onto factors of inhibition in factor-analytic studies (Miyake et al., 2000).

Participants were shown a card depicting a red dog, which they were told was named "Blue," and a card depicting a blue dog, which they were told was named "Red." Children first completed two practice trials and were given corrective feedback if they provided the wrong name. Next, they were shown 28 cards depicting red and blue dogs, one at a time, at a consistent rate of approximately 1 card per second. They were asked to say each dog's name out loud as the cards were presented. To be accurate, participants were required to inhibit their natural response of saying the color of the dog. Participants received a total

[2]Other coded behaviors included whether or not participants referred to the spatial location of the target object, whether they provided irrelevant or incorrect descriptors, and whether they described an incorrect target. These behaviors were not included in subsequent analyses as they occurred infrequently (i.e., less than 6% of trials).

score ranging from 0 to 28, which reflected the number of cards they correctly named. Higher scores reflected stronger inhibitory control.

Cognitive flexibility

Participants completed the Object Classification Task for Children (Smidts, Jacobs, & Anderson, 2004) as a measure of cognitive flexibility. Children completed a practice trial to help them become familiar with how they should sort the test objects. During the practice trial, they were provided with four toys including two sets of identical toys (i.e., two plastic ducks and two plastic turtles) and were asked to group the toys that were the same. If a child did not do it correctly, they were provided with corrective feedback. They were then provided with six test objects, which could be sorted based on size, color, or function: a small yellow plane, small red plane, large red plane, large red car, large yellow car, and small yellow car. Participants were asked to sort these toys into two groups. If they were unable to do so, two toys were removed and the task proceeded with four objects. Next, the experimenter asked what was the same about the toys in each group. Children were then asked to sort the toys again in a different way. This procedure was then repeated a third time.

Participants received 3 points for each correct sorting and received an additional point for correctly labeling their sorting criteria. If children were unable to sort the objects in all three possible ways, the experimenter grouped the toys in the fashions that were missed and asked what was the same about the toys in each group. Children received 2 points for correctly labeling the sorting criteria for each sort. If children were unable to correctly name the sorting criteria using this procedure, the experimenter then asked them to group the objects based on the criteria they had missed. Participants received 1 point for each correct sorting per instruction provided by the experimenter. Possible scores on this task ranged from 0 to 12.

Expressive vocabulary

Expressive vocabulary was assessed using the Picture Naming task from the Wechsler Preschool and Primary Scale of Intelligence–Third Edition (Wechsler, 2002). Participants were shown a series of 30 pictures from a booklet and were asked to name them. Difficulty increased with each subsequent item. When children provided an incorrect response on 5 consecutive items, the task was discontinued. Children's raw scores, which had a possible range of 0 to 30, were used for analyses.

Results

Preliminary analyses

As mentioned previously, one participant's data was removed from analyses as his expressive vocabulary score was a statistical outlier. Outliers for expressive vocabulary were handled in this way because children without adequately developed expressive vocabulary would be expected to have difficulty completing the communication task generally. Outliers for other variables were Winsorized to be within 3 standard deviations of the mean (as per Tabachnick & Fidell, 2007; Red Dog–Blue Dog task [n = 4]). See Table 1 for demographic information on participants and for comparisons of

Table 1. Demographic information for participants and *p* value of statistical tests comparing each variable across groups.

		Feedback Type		
	Overall *M (SD)*	Detailed *M (SD)*	Vague *M (SD)*	*p* value of comparison across groups
Age	5.07 (0.54)	5.08 (0.52)	5.06 (0.57)	.86
Expressive vocabulary	21.95 (3.40)	22.32 (2.99)	21.56 (3.77)	.24
	n	*n*	*n*	
Number of participants	115	59	56	.85
Number of girls	57	26	31	.23
Number of bilingual children	29	13	16	.42

demographic information across groups. There were no significant differences across groups in age, expressive vocabulary, number of participants, gender, or number of bilingual participants.

Executive functioning tasks

Children's mean performance on the executive functioning tasks was as follows: Digit Span, M = 8.05, SD = 3.08; Red Dog–Blue Dog, M = 22.31, SD = 5.82; and Object Classification Task, M = 8.10, SD = 2.15. Correlations between measures of executive functioning, age, and expressive vocabulary are shown in Appendix B. While data for the Digit Span subtest and Object Classification Task were normally distributed, inspection of the data revealed a negatively skewed distribution for the Red Dog–Blue Dog task[3] (40% of participants had a score of 26 or higher, with the maximum possible score being 28).

Initial responses

Although the main focus of the study was to examine repairs, children's initial responses were first examined. As intended, on the majority of trials, participants failed to provide enough information within their initial responses to uniquely identify the target picture for the confederate. More specifically, the mean number of descriptors provided in the first response (M = 0.72, SD = 0.57) was substantially lower than the number of descriptors required to uniquely identify the target (two descriptors). Participants were able to uniquely identify the target for the confederate during their first response on 21% of trials.

Participants' initial descriptions of the target improved across trials (first trial, M = 0.46, SD = 0.70; second trial, M = 0.58, SD = 0.77; third trial, M = 0.85, SD = 0.76; fourth trial, M = 0.90, SD = 0.81; fifth trial, M = 0.82, SD = 0.85; sixth trial, M = 0.83, SD = 0.77), $F(5, 530) = 9.63$, $p < .001$, $\eta_p^2 = .08$. On average, across trials, participants in the detailed condition were not found to initially provide significantly more descriptors (M = 0.77, SD = 0.60) compared with those in the vague condition (M = 0.68, SD = 0.53), p = .34 (see Table 2), and there was no interaction between test trial and feedback type (p = .77). However, participants in the vague condition (M = 0.15, SD = 0.24) pointed to the target card more often than did

[3]When data for the Red Dog–Blue Dog task was transformed using either a log or square root transformation, results remained consistent with those reported.

Table 2. Mean number (*SD*) of behaviors during initial responses and following differential feedback from the listener.

Behavior	Feedback Type: Detailed *M (SD)*	Feedback Type: Vague *M (SD)*
Initial response behavior		
Number of descriptors	0.77 (0.60)	0.68 (0.53)
Number of points to target	0.06 (0.13)	0.15 (0.24)
Repair behavior		
Number of new descriptors	0.67 (0.50)	0.44 (0.44)
Number of points to target	0.11 (0.20)	0.12 (0.23)
Number of repetitions	0.10 (0.18)	0.24 (0.30)
Number of trials with no response	0.17 (0.32)	0.27 (0.38)

participants in the detailed condition (M = 0.06, SD = 0.13), $t(113) = 2.69$, $p = .008$, $d = 0.52$. The frequency of other behaviors, such as holding up the target card to show the confederate, did not differ across feedback conditions (*ps* > .48).

Impact of executive functions on children's initial responses

Correlations between children's executive functioning skills and their performance on the communication task (collapsed across conditions) are shown in Table 3. The relations between each of the three components of executive functions and children's initial descriptions of target pictures were assessed using hierarchical regression. As the executive functioning tasks were correlated, three separate regressions were conducted for each of the three executive functioning components to ensure that the shared variance between these measures did not impact the findings. However, further hierarchical regression analyses, which included all three measures of executive functioning simultaneously, were also conducted. These analyses were conducted to determine the extent to which various components of executive functioning *uniquely* contribute to children's effectiveness on the communication task beyond other components of executive functioning. The dependent variable for each regression was the average number of descriptors provided in participants' initial responses across trials. To control for age and expressive vocabulary, these variables were entered into each regression as a first step. These variables alone predicted 17% of the variance in the average number of descriptors provided across trials, and both significantly predicted the number of descriptors provided (age, β = .21, p = .02; expressive vocabulary, β = .28, p = .003). This model was statistically significant, $F(2, 108) = 10.81$, $p < .001$.

Table 3. Bivariate and partial correlations (95% confidence interval [CI]) between executive functioning measures and communication measures pooled across the vague and detailed conditions (n = 109).

	Number of descriptors (initial response)		Number of new descriptors (repairs)	
	r [95% CI]	$r_{partial}$ [95% CI]	r [95% CI]	$r_{partial}$ [95% CI]
Age	.32** [.15, .47]	—	.22* [.06, .42]	—
Expressive vocabulary	.36** [.15, .55]	—	.30** [.11, .47]	—
Digit span	.39** [.23, .54]	.27** [.06, .43]	.21* [.03, .42]	.10 [−.09, .28]
Red Dog/Blue Dog	.13 [−.07, .35]	.07 [−.13, .28]	.04 [−.15, .23]	−.03 [−.20, .15]
Object Classification Task	.33** [.17, .48]	.21* [.03, .38]	.33** [.15, .46]	.21* [.03, .39]

Note. Table includes partial correlations controlling for age and expressive vocabulary. 95% CIs were calculated in the Statistical Package for the Social Sciences using bootstrapping with 5,000 samples.
* p < .05. ** p < .01.

Initially, the interactions between each component of executive functioning and feedback condition were assessed using multiple regression (as a subsequent step after age and expressive vocabulary were entered in a first step and each executive functioning component as a second step). However, as no statistically significant interactions were found between working memory (β = .03, p = .78), inhibitory control (β = .23, p = .37), or cognitive flexibility (β = .18, p = .16) and feedback type, interaction terms were not included in subsequent analyses. As a further examination of the impact of condition, correlations between measures of executive functioning and children's initial statements in each condition were computed and compared (see Table 4). Fisher's z test revealed no significant differences in the magnitude of correlations across conditions (ps > .33).

Working memory

When working memory was entered into the regression as the second step, a 6% increase in the variance of descriptors provided was explained by the model. This change in R^2 was significant, $\Delta F(1, 107) = 7.68$, p = .007. Together, age, expressive vocabulary, and working memory accounted for 22% of the variance in descriptors provided. The model was statistically significant, $F(3, 107) = 10.21$, $p < .001$. When examining the regression weights of the predictors, working memory (β = .26, p = .007) and expressive vocabulary (β = .19, p = .049) were significant predictors, while age (β = .17, p = .08) was no longer a significant predictor.

Inhibitory control

When inhibitory control was entered into the second step of the regression, an additional 3% in the variance of descriptors provided was explained by the model. This change in R^2 was not statistically significant (p = .50). Age, expressive vocabulary, and inhibitory control together predicted 17% of the variance in the number of descriptors provided. The overall model was statistically significant, $F(3, 106) = 7.39$, $p < .001$. When examining the regression weights of the predictor variables, age (β = .22, p = .02) and expressive vocabulary (β = .27, p = .005) were significant predictors of children's initial descriptors provided, but inhibitory control was not (β = .061, p = .50).

Cognitive flexibility

When cognitive flexibility was entered into the second step of the regression, an additional 4% in the variance of descriptors provided was explained by the model. This change in R^2 was statistically significant, $\Delta F(1, 107) = 4.83$, p = .03. Together, cognitive flexibility, age, and expressive vocabulary accounted for 20% of the variance in descriptors provided. The overall model was statistically significant, $F(3, 107) = 9.08$, $p < .001$. When examining the regression weights of the predictor variables, cognitive flexibility (β = .20, p = .03) and expressive vocabulary (β = .23, p = .005) were significant predictors of children's initial descriptors provided, but age was not (β = .17, p = .07).

All components

As noted, further regression analyses were also conducted and included all three components of executive functioning simultaneously. The overall model was statistically significant, $F(5, 109) = 7.18$, $p < .001$, and together, age, expressive vocabulary, working memory,

Table 4. Bivariate and partial correlations (95% confidence interval [CI]) between executive functioning measures and communication measures separated by feedback condition (n = 109).

	Number of descriptors (initial response)				Number of new descriptors (repairs)			
	Detailed		Vague		Detailed		Vague	
	r [95% CI]	$r_{partial}$ [95% CI]	r [95% CI]	$r_{partial}$ [95% CI]	r [95% CI]	$r_{partial}$ [95% CI]	r [95% CI]	$r_{partial}$ [95% CI]
Age	.25 [−.04, .45]	—	.40** [.23, .62]	—	.11 [−.18, .39]	—	.34** [.18, .56]	—
Expressive vocabulary	.25 [−.02, .50]	—	.46** [.13, .73]	—	.03 [−.24, .29]	—	.51** [.31, .68]	—
Digit span	.42** [.20, .61].	.35* [.11, .54]	.38** [.14, .59]	.27 [−.10, .54]	.13 [−.15, .43]	.16 [−.14, .42]	.34** [.11, .58].	.22 [−.06, .50]
Red Dog/Blue Dog	.18 [−.08, .45].	.16 [−.13, .46]	.07 [−.23, .44]	−.05 [−.30, .26]	−.10 [−.33, .11]	−.12 [−.36, .09]	.23 [−.03, .50].	.16 [−.11, .41]
Object Classification Task	.41** [.18, .60]	.36** [.11, .56]	.24 [−.01, .48]	.03 [−.24, .27]	.17 [−.05, .43]	.22 [−.06, .44]	.47** [.28, .66]	.35* [.07, .59]

Note. Table includes partial correlations controlling for age and expressive vocabulary; 95% CIs were calculated in the Statistical Package for the Social Sciences using bootstrapping with 5,000 samples.
$^*p < .05$. $^{**}p < .01$.

inhibitory control, and cognitive flexibility accounted for 26% of the variance in descriptors provided. When examining the regression weights of the predictor variables, cognitive flexibility (β = .19, p = .04) and working memory (β = .25, p = .01) were significant predictors of children's initial descriptors provided, but age (β = .14, p = .13), expressive vocabulary (β = .14, p = .14), and inhibitory control (β = −.01, p = .91) were not. Thus, consistent with the previously presented analyses, only working memory and cognitive flexibility were significant predictors of children's initial statements. Cognitive flexibility and working memory appear to account for a similar amount of variance in children's initial statements, and both uniquely predict variance in children's initial statements.

Responses following feedback

After receiving feedback, participants provided, on average, less than one new descriptor on each trial (M = 0.57, SD = 0.48). On trials where the participant did not uniquely identify the target during the first trial and thus feedback was provided, participants were able to uniquely identify the target with their second response on 22% of trials. Children partially repaired their messages on 21% of trials, meaning they provided some new information following feedback but not enough to uniquely identify the target. Participants provided no response after receiving feedback on 27% of trials and used ineffective repair strategies such as repetition or pointing on 30% of trials.

The omnibus Feedback × Trial analysis of variance (ANOVA) revealed no effect of trial, $F(5, 235) = 1.73$, $p = .13$, $\eta_p^2 = .04$, or an interaction between feedback type and trial, $F(5, 235) = 0.71$, $p = .62$, $\eta_p^2 = .02$. However, as the omnibus ANOVA only included participants who provided repair statements for *all* trials (i.e., if a child unambiguously identified the target initially on any trial, their data for all trials were not included), the comparison between conditions was assessed through t tests, with the average number of new descriptors provided across trials and feedback as the dependent variable. Participants who received detailed feedback (M = 0.68, SD = 0.50) provided significantly more new descriptors following feedback than did participants in the vague condition (M = 0.44, SD = 0.44), $t(113) = 2.70$, $p = .008$, $d = 0.54$ (see Table 2). Participants provided with detailed feedback were also less likely (M = 0.10, SD = 0.18) than those provided with vague feedback (M = 0.24, SD = 0.30) to repeat their initial response following feedback, $t(113) = 3.01$, $p = .003$, $d = 0.57$. The frequency of other behaviors in response to feedback did not differ across feedback conditions (ps > .10).

Impact of executive functions on children's repairs

Correlations between children's executive functioning skills and repairs (collapsed across condition) are shown in Table 3. The relations between each of the three components of executive functions and children's descriptions of target pictures following feedback were assessed using hierarchical regression. Separate regressions were conducted for each of the three executive functioning components. Regression analyses were also conducted that included all three components of executive functioning simultaneously to examine the unique contributions of each component. The dependent variable for each regression was the average number of new descriptors of the target picture provided across trials. To control for participants' age and expressive vocabulary, these variables were entered into each regression as a first step. Age and expressive vocabulary alone predicted 11% of the variance in the average number of new descriptors provided across trials, and together, they were statistically significant, $F(2, 108) = 6.43$, $p = .002$. When individual predictors were examined, expressive vocabulary ($\beta = .25$, $p = .01$) predicted the number of new descriptors provided, while age did not (age, $\beta = .14$, $p = .14$).

The interactions between each component of executive functioning and feedback condition were also assessed using multiple regression. These analyses were conducted using the same procedure discussed previously, with the exception that the dependent variable was the number of new descriptors provided during the second response. No statistically significant interactions were found between working memory ($\beta = -.15$, $p = .24$), inhibitory control ($\beta = -.45$, $p = .08$), or cognitive flexibility ($\beta = -.15$, $p = .23$) and feedback type.

However, to further explore potential impacts of condition, correlations between measures of executive functioning and children's repairs in each condition were computed and compared (Table 4). Fisher's *z* tests revealed a significant difference across conditions in the correlation between expressive vocabulary and repairs ($Z = 2.78$, $p < .001$), where children's expressive vocabulary was more strongly associated with their repairs in the vague condition than in the detailed condition. While Fisher's *z* tests revealed no significant differences in the strength of the correlations between executive functioning and repairs in the different conditions, some comparisons approached statistical significance. For instance, the correlation coefficients between children's cognitive flexibility and inhibitory control and their repairs were slightly higher in the vague condition than in the detailed condition ($Z = 1.74$, $p = .08$, and $Z = 1.71$, $p = .09$, respectively).[4] While these comparisons were not statistically significant, they were consistent with predictions and provide hints for future investigations. As the interaction terms were not statistically significant, subsequent analyses were conducted collapsed across condition.

Working memory

When working memory was entered into the regression as the second step, a 1% increase in the variance of the number of new descriptors provided was explained by the model. This change in R^2 was not significant ($p = .35$). Together, age, expressive vocabulary, and working memory accounted for 11% of the variance in descriptors provided. The model was statistically significant, $F(3, 107) = 4.50$, $p = .005$. When examining the regression weights of the predictors, expressive vocabulary ($\beta = .22$, $p = .04$) was a significant predictor of descriptors provided, while age ($\beta = .13$, $p = .20$) and working memory ($\beta = .10$, $p = .35$) were not significant predictors.

[4]To further explore these findings, separate regressions predicting repairs including age, expressive vocabulary, working memory, cognitive flexibility, and inhibitory control for the vague ($n = 55$) and detailed ($n = 57$) conditions were run. Working memory and inhibitory control were not significant predictors of children's repairs. Consistent with predictions, cognitive flexibility was found to be a significant predictor of repairs in the vague condition ($\beta = .06$, $p = .02$) but not the detailed condition ($\beta = .05$, $p = .15$). However, it is important to note that there was no significant interaction between cognitive flexibility and feedback type in predicting children's repairs—thus, we caution against strong conclusions based on this finding.

Inhibitory control

When inhibitory control was entered into the second step of the regression, no additional variance in the number of new descriptors provided was explained by the model. The overall model remained statistically significant, $F(3, 106) = 4.37$, $p < .001$. Expressive vocabulary (β = .24, $p = .02$) significantly predicted children's initial descriptors provided, but age (β = .16, $p = .11$) and inhibitory control did not (β = –.024, $p = .80$).

Cognitive flexibility

When cognitive flexibility was entered into the second step of the regression, an additional 4% of the variance in the number of new descriptors provided was explained by the model, with a statistically significant change in R^2, $\Delta F(1, 107) = 4.85$, $p = .03$. The overall model was statistically significant, $F(3, 107) = 6.06$, $p = .001$, with cognitive flexibility (β = .21, $p = .03$) significantly predicting children's new descriptors provided, but not age (β = .10, $p = .30$) or expressive vocabulary (β = .19, $p = .05$).[5]

All components

Further regression analyses were also conducted that included all three components of executive functioning simultaneously. The overall model was statistically significant, $F(5, 109) = 3.94$, $p = .003$. Together, working memory, inhibitory control, cognitive flexibility, age, and expressive vocabulary accounted for 16% of the variance in new descriptors provided. When examining the regression weights of the predictor variables, cognitive flexibility (β = .22, $p = .03$) was a significant predictor of children's repairs, but age (β = .11, $p = .30$), expressive vocabulary (β = .16, $p = .13$), working memory (β = .10, $p = .35$), and inhibitory control (β = –.06, $p = .50$) were not. Thus, consistent with the previously presented analyses, only cognitive flexibility was a significant predictor of children's repairs. Notably, cognitive flexibility appears to contribute to unique variance even when controlling for other components of executive functioning.

Discussion

Repairing one's message following miscommunication is an important aspect of communication. Indeed, without such a skill, a listener would be left mistaken or unclear about the actual communicative intent. The present findings illustrate the degree to which this skill is impacted by the type of the feedback provided by the listener, as well as the executive skills of the speaker.

While the main focus of the study was on children's repair strategies, the results also provide insight into the skills required for initial attempts to communicate one's

[5]As the number of new descriptors that can possibly be added is dependent on how many descriptors were provided during children's initial responses, data were also analyzed separately for trials where children provided no descriptors in their initial response. Data were examined in the same manner that was described in previous sections, with the exception that the dependent variable for each regression was the average number of new descriptors of the target picture provided across trials *when no descriptors were provided during the initial response*. Results were consistent with previous analyses, which suggests that the previous finding where working memory did not relate to children's repairs was likely not attributable to a restricted range in the number of descriptors provided in the second response.

referential intention. Consistent with previous work on children in this age range, the vast majority of participants provided ambiguous statements initially (e.g., Glucksberg et al., 1966; Krauss & Glucksberg, 1969; Lloyd et al., 1998; Pechmann & Deutsch, 1982). Children's initial referential statements also improved across trials (i.e., more relevant information was included on subsequent trials), which provides additional evidence that children may learn to provide more effective statements following feedback indicating that they have been misunderstood (as in Abbot-Smith et al., 2015; Lefebvre-Pinard et al., 1982; Matthews et al., 2007, 2012; Robinson & Robinson, 1981, 1985; Wardlow & Heyman, 2016).

The present work highlights the importance of executive functioning for young children's production of referential statements. Specifically, children with stronger working memory and cognitive flexibility skills provided more effective initial descriptions of target pictures (even when controlling for age and verbal skills, though, notably, with a small effect size; Cohen, 1969). Working memory may have aided children in producing effective messages in a number of possible ways. First, individuals with larger working memory capacities may be better able to hold features of the target object in mind and compare these features to the surrounding distractors (as suggested by Wardlow, 2013). Second, children with larger working memory capacities may be better able to incorporate and remember the responses from the listener to produce more effective subsequent referential statements across trials (as in Wardlow & Heyman, 2016). The present finding that 4- to 6-year-olds' working memory aids their ability to produce effective messages extends similar findings from research on 9- to 12-year-olds (Nilsen et al., 2015) and adults (Wardlow, 2013). Thus, although it may be the case that in some domains of communication, executive functioning has a varying role depending on the developmental stage (e.g., Best, Miller, & Jones, 2009; Gillis & Nilsen, 2014; Hughes & Ensor, 2007; Senn, Espy, & Kaufmann, 2004), it appears that working memory plays a continued role from preschool age to adulthood.

Representing a novel finding, children with better cognitive flexibility were also found to produce more effective referential statements (however, note that this effect was also small in magnitude; Cohen, 1969). Work by Gillis and Nilsen (2014) revealed that children with stronger cognitive flexibility were better able to detect when a speaker made an ambiguous statement. Thus, it may be that children with stronger cognitive flexibility are better able to notice the various dimensions of an object (e.g., notice that the boy in red is also a boy who is holding ice cream), and they can use this information to describe an object that captures the various features. Consistent with previous work examining children's production of statements (e.g., Nilsen & Graham, 2009; Nilsen et al., 2015), inhibitory control was not found to relate to children's effectiveness as speakers.

Turning to the main focus of the present study, while the majority of children attempted to provide a repair, they were relatively ineffective at completely repairing their messages in response to feedback. Children who provided ambiguous messages during their initial attempt were able to uniquely identify the target for the listener following feedback on only 22% of trials. The effectiveness of children's repairs in the present study was somewhat less than reported elsewhere. For example, in Deutsch and Pechmann's (1982) study, even children in the youngest age group (3-year-olds) were able to successfully repair their messages following feedback on 89% of trials. However, methodological differences likely account for these differences. In Deutsch and

Pechmann's study, feedback consisted of questions (e.g., "Which ball?"), whereas in the present study, feedback consisted of statements (e.g., "I don't know which one you mean."). As a result, participants were less directed in the present study.

Feedback type was found to influence children's repair strategy, as has been shown in previous studies (Anselmi et al., 1986; Coon et al., 1982; Nilsen & Mangal, 2012; Wilcox & Webster, 1980). Children who received detailed feedback following an ambiguous message provided more new descriptors of the target picture following feedback than did the children who received vague feedback. Replicating previous work, children who received vague feedback were also more likely to repeat their original messages (Anselmi et al., 1986; Nilsen & Mangal, 2012; Wilcox & Webster, 1980). Children may resort to this latter strategy when they are unsure about which specific component of their statement the listener misunderstood or when they feel the listener did not hear them.

In the past, researchers have hypothesized that executive functioning facilitates children's communication repair (Volden, 2004). In the present study, when children's age and verbal skills were controlled, cognitive flexibility emerged as the only significant predictor of children's ability to repair their statements. Cognitive flexibility also remained a significant predictor even when other components of executive functioning such as working memory and inhibitory control were controlled, thereby highlighting the unique role of cognitive flexibility in children's repairs. Cognitive flexibility may enhance repair by aiding children in detecting communicative ambiguity (as per Gillis & Nilsen, 2014) and allowing them to see objects' dimensions more flexibly (e.g., in Figure 1, the target is not only a boy in red, but it is also a boy holding ice cream). The ability to see an object flexibly could allow children to appreciate what additional information is important to provide to repair ambiguity.

We did not find that working memory was associated with children's ability to repair their messages once age and verbal skills were controlled. Instead, working memory appears to play a role in children's production of initial responses and not their repairs. This finding may be explained by the fact that children are required to hold a greater amount of information in mind when producing initial statements, as they would need to compare the full set of objects in the array. During repairs, children would need to compare a smaller number of objects as in most cases, they would have provided an initial response that partially identifies the correct target. Thus, while a certain level of working memory capacity would almost certainly be required for effective communication repair, it is possible that additional working memory capacity beyond this level does not further contribute to children's ability to repair messages. Consistent with previous work failing to show a relationship between inhibitory control and the production of referential statements, there was no significant relationship between children's inhibitory control skills and repairs. It may be that the role of inhibitory control is more relevant for children's interpretation of referential statements as opposed to production/repair (e.g., Nilsen & Graham, 2009) or that the negatively skewed distribution of the inhibitory control task scores masked any potential associations.

The present work explored whether there was a differential role of executive functioning depending on the type of feedback provided to a child. The hypothesis that children's executive functioning skills would be more relevant to successful repairs in a context where the feedback is vague as opposed to detailed (drawing from Coon et al.'s [1982] premise that cognitive demands are reduced by way of detailed feedback) received limited support from the current data. There was not a significant interaction between children's executive functioning and feedback conditions. However, providing some hints for directions of future studies, there were marginally significant differences in correlations with cognitive flexibility across conditions. Consistent with hypotheses, cognitive flexibility was slightly more strongly associated with children's ability to repair their messages in the vague condition compared with the detailed condition (and significantly predicted children's performance in the vague but not detailed condition when regressions were conducted separately; see footnote 4). Thus, it appears that detailed feedback may have slightly reduced the demands on executive functioning. It is possible that more detailed feedback could help children to narrow in on which features need to be described to uniquely identify the target, thereby reducing the demands on cognitive flexibility during the repair process. Future work should further explore this possible effect with a larger sample size, as our sample may have lacked the necessary power to detect such an effect.

Identifying the skills involved in late preschool-aged children's communication repair has applied implications. For instance, children who are more likely to have communicative difficulties can be identified and cognitive skills can be targeted for intervention. Related to this latter point, because executive functioning was found to play a role in children's effectiveness as speakers, improving children's executive functioning skills may aid their communication skills as well. Previous work has shown that working memory training may be effective for children (Bergman-Nutley et al., 2011; Thorell, Lindqvist, Bergman-Nutley, Bohlin, & Klingberg, 2009; see Melby-Lervåg & Hulme, 2013, for a review). However, only one study to our knowledge has demonstrated the efficacy of cognitive flexibility training (Preiss, Shatil, Cermáková, Cimermanová, & Ram, 2013). It would be of interest for future research to investigate whether executive functioning training generalizes to children's communicative skills, though at this point, training programs do not seem to transfer widely to other areas of functioning (Simons et al., 2016). The present findings also inform interventions targeting children's production of statements directly and provide evidence that giving children specific feedback and the opportunity to repair their messages may improve their effectiveness as speakers (e.g., Matthews et al., 2007, 2012).

Although this research has shed light on the cognitive skills involved in children's communication repair, it is not without limitations. Due to time constraints, only one task was used to measure each component of executive functioning, which prevented the use of latent variable analyses. Further, using only one measure of executive functioning per component makes it difficult to rule out the possibility that task demands associated with the measure account for relations with the communication task as opposed to the construct of executive functioning per se. Further, due to time limitations, children's general intelligence was not assessed. Thus, the extent to which children's executive functioning uniquely related to their communication skills independent of intelligence could not be assessed. However, verbal skills were assessed and controlled for in all analyses, with this skill (i.e., verbal skills) showing a strong correlation with children's intellectual ability (e.g., Childers, Durham, & Wilson, 1994).

As noted previously, our study may have also lacked the necessary power to detect an interaction between children's cognitive skills and feedback type with their repairs. As such, future work should further investigate the cognitive demands associated with repair following different types of feedback using a larger sample size. Along these lines, it is also important to note that a large amount of variance in children's communication skills was not explained by the reported models, which suggests that there are likely other contributing factors. One possible contributing factor is children's theory of mind (as proposed by Volden, 2004). In the present study, children would need a basic level of theory of mind to understand which objects the listener can and cannot see. However, given that this basic understanding of the visual perspectives develops around age 2 years (Moll & Tomasello, 2006), it was anticipated that children in the present study would not have had difficulty with this aspect of the task (although children with impairments in theory of mind may have difficulty with communication repair generally). Another factor that may have contributed to children's performance is their understanding of social pragmatics. Children with a stronger understanding of social pragmatics and those who were not reticent to correct the confederate's incorrect object choices may have been more likely to repair their messages following feedback.

These findings elucidate the role of working memory and cognitive flexibility in late preschool-aged children's ability to produce effective referential statements as well as the role of cognitive flexibility in their ability to repair their messages. In addition, the findings highlight the benefit of specific feedback for facilitating communicative repairs. More generally, the findings shed light on factors that may facilitate communication repair, an important process through which children learn to become effective speakers.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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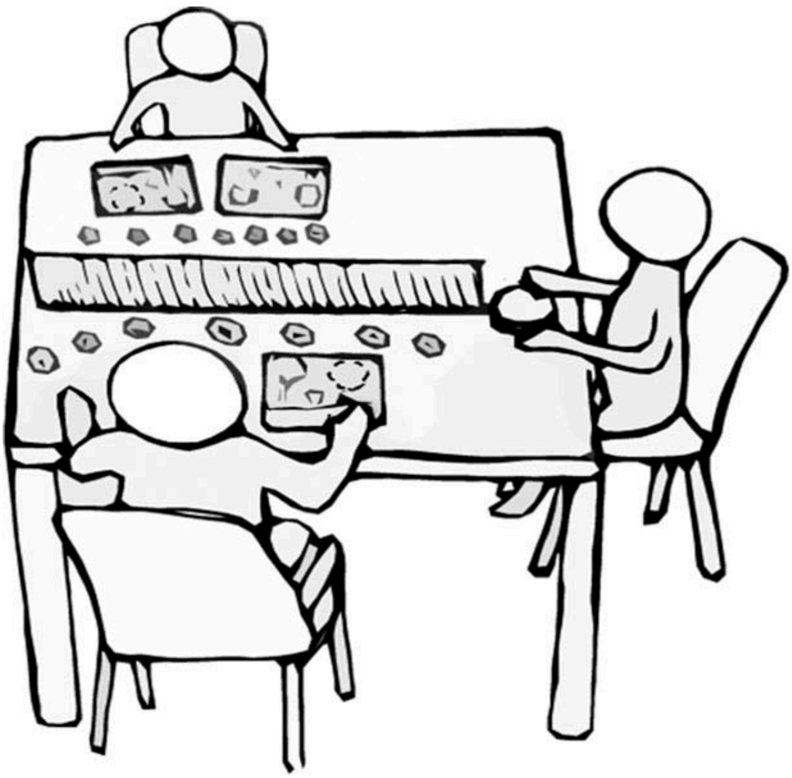
Appendix A

Layout for the communication task.



Appendix B. Bivariate and partial correlations (95% confidence interval [CI]) between executive-functioning measures and communication measures separated by feedback condition (n = 109).

	Expressive Vocabulary	Digit Span	Red Dog–Blue Dog		Object Classification Task	
	r [95% CI]	r [95% CI]	r [95% CI]	$r_{partial}$ [95% CI]	r [95% CI]	$r_{partial}$ [95% CI]
Age	.35** [.17, .52]	.30** [.11, .46]	.13 [–.06, .35]	—	.29** [.12, .44]	—
Expressive vocabulary		.41** [.17, .63]	.15 [–.04, .36]	—	.32** [.15, .48]	—
Digit span			.28** [.11, .47]	.24* [.06, .43]	.23* [.04, .40]	.08 [–.11, .26]
Red Dog/Blue Dog					.14 [–.04, .35]	.09 [–.10, .29]

Note. Table includes partial correlations controlling for age and expressive vocabulary; 95% CIs were calculated in the Statistical Package for the Social Sciences using bootstrapping with 5,000 samples.
*p < .05. **p < .01.