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Speech monitoring and repairs in preschool children's social and private speech

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ABSTRACT

When individuals correct their own speech, it is often assumed they are doing so for the benefit of others' comprehension. As such, most of the research exploring speech repairs, especially among young children, has been conducted with social speech (between two or more people) and little with private speech (speech directed toward the self). In the present study, we explore social and private speech errors and self-repairs from 27 3- and 4-year-old preschoolers who completed a selective attention task and a Lego construction task with and without an involved experimenter. Timing (immediate, delayed) and relevance to task (irrelevant, relevant, action relevant) of self-repairs were compared, and developmental trends were explored. Findings indicated preschoolers made errors and repairs in both private and social speech, though more so in social than private speech. In social speech, there were nearly equal numbers of delayed and immediate repairs suggesting both pre- and post-production monitoring when speaking for a listener. In private speech, there were significantly higher numbers of immediate repairs than delayed repairs suggesting more pre-production monitoring when speaking for the self. Though fewer in number, the presence of delayed self-repairs in private speech indicated some post-production monitoring of private speech. Delayed private speech self-repairs from 4-year-olds were almost exclusively in task-action-relevant speech, while delayed private speech self-repairs from 3-year-olds were mostly in task-relevant speech. Developmental changes in private speech use and awareness of speech during preschool are discussed as possible explanations for these trends. Implications for practice are also provided.

It has been well documented that young children make self-initiated repairs in their conversational speech with others (Caplan, Guthrie, & Komo, 1996; Forrester, 2008; Forrester & Cherington, 2009; Jokinen, 1998; Laakso, 2006; Laakso & Soininen, 2010; LaSalle & Conture, 1995; Levy, 1999; Levy, Tennebaum, & Ornoty, 2003; Prather, Cromwell, & Kenney, 1989; Ridley, Radford, & Mahon, 2002; Rieger, 2003; Salonen & Laakso, 2009; Schegloff, 2000; Tarplee, 1989; Wong, 2000; Wootton, 1994, 2007). These self-initiated repairs, or *self-repairs* (Schegloff, 1979; Schegloff et al., 1977), are often produced spontaneously as a result of perceived non-involvement or need for clarification by a listener (Forrester, 2008) or in response to other-initiated direct requests (whether verbal or non-verbal) for clarity (Laakso & Soininen, 2010). In either case, the use of self-repairs is often associated with or results in errors and other issues in produced speech (Rieger, 2003).

A speech error, broadly defined, consists of deviations from intended speech meanings, disfluencies or breaks in speech production, presentations of the wrong order of words or ideas, use of a linguistically improper word choice or inappropriate syntax, or phonemic slips (Nooteboom & Quené, 2013; Postma, 2000; Postma & Kolk, 1993; Trewartha & Phillips, 2013). Some of these types of speech errors fall under the rubric of grammatical errors (e.g., incorrect word order), while others fall under the rubric of fluency errors (e.g., breaks in speech production). A speech error repair corrects or amends any type of "troubled" speech, including that which results from corrections of misspoken words through word replacement or repetitions, pauses, and fillers (lexical, quasi-lexical, non-lexical) caused by word search (Fox, Hayashi, & Jasperson, 1996; Rieger, 2003; Schegloff et al., 1977). Because repairs can result from unspoken or pre-articulatory speech, observers often do not hear the error or issue with the speech but only the result and evidence of repair (e.g., repetition of a word while searching for an appro-

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priate next word). Such repairs, therefore, imply self monitoring of speech by the user, and studying these self-repairs provides an opportunity to evaluate how and why children monitor their own speech production (Laakso, 2010).

In the present study, we explore self-initiated repairs to evaluate preschool children's speech production monitoring during social (when speaking to someone else) and private (when speaking to the self) speech. Doing so provides important information related to preschoolers' motivation for correcting their speech errors. Nearly all studies exploring young children's self-repairs use social conversational speech, and many authors have concluded that repairs are made for the benefit of the listener. By exploring self-repairs in private speech, when children are not directing their speech toward a listener, we are able to evaluate whether preschoolers make self-repairs when a listener is not present and if so the characteristics (e.g., relevancy to task, speed of correction) associated with self-repairs made for themselves. Results supporting children's use of self-repairs during private speech will provide evidence that making precise statements in private speech is important for children and may suggest that the effectiveness of private speech as a tool for regulation depends on accuracy. Further, such results will provide some evidence that preschoolers are aware of and monitor their private speech production.

In addition to providing data related to understanding children's private speech development and uncovering other reasons and uses of self-repairs for preschool children, the results from the present study will also be applicable for professionals and caregivers. Professionals who develop or use self-talk-based programs and trainings as a means for improving young children's functioning or adjustment (e.g., *Tools of the Mind*; Bodrova & Leong, 2007) can use information about how and why children are motivated to make repairs in their self-talk as an important part of how they can help children use self-talk more effectively. Similarly, caregivers who use conversation as a means of transferring knowledge to children and stimulating cognitive and language development and who wish to encourage children's use of private speech as a means for self-regulation (Berk & Winsler, 1995) can use information about how and why children make social and private speech self-repairs as a means for encouraging more adaptive use of both social and private speech.

The literature reviewed below expands upon reasons why people monitor and repair their speech and describes the role of timing in repairs for understanding the motivation behind repairs. Included in this review are potential hypotheses for how and why children might monitor their private speech differently from their social speech. Nearly all of the self-repair research conducted, and presented below, focuses on social conversational speech. As such, relevant private speech research is also presented as support for potential differences between self-repairs in social and private speech.

1. Reasons for speech monitoring and repair

Many researchers believe speech monitoring is the result of either clarification requests from listeners (i.e., other-initiated monitoring; Bowey & deBhal, 1994; Brinton, Fujiki, Loeb, & Winkler, 1986; Levy, 1999; Levy et al., 2003; Prather et al., 1989) or from personal inspection by the speaker (i.e., self-initiated monitoring; Hartsuiker & Kolk, 2001; Levelt, 1983, 1989; Postma, 2000; Postma & Kolk, 1993). Similarly, repairing speech errors is believed to either occur as a result of the speaker's desire to increase comprehension by the listener (i.e., other-initiated repair; Bowey & deBhal, 1994; Brinton et al., 1986; Levy, 1999; Levy et al., 2003; Prather et al., 1989) or as a result of the speaker's desire (either conscious or unconscious) to use comprehendible, error-free, "good" speech (i.e., self-initiated repair; Nakatani & Hirschberg, 1994; Nooteboom, 1980; Postma, 2000; Van Hest, 1996).

If repairs are made exclusively for comprehension by others (whether self- or other-initiated), then repairs might not be found in self-directed private speech in which the speech is not intended for a listener. If, however, repairs are made for other reasons, such as support for verbal self-regulation (Winsler, 2009), then they should be apparent in private speech and particularly private speech related to regulatory actions. An example might be a speaker talking herself through a task in a self-regulatory way and incorrectly stating something critical to the task. In a case such as this, it might be expected that the misspoken utterance is repaired (e.g., "I need to put the red—blue one here.").

Vygotsky (1987) argued private speech is used by young children as a tool for cognition and is particularly apparent during the preschool years. Private speech has been associated with children's task performance dynamically over time during preschool (Berk, 1986; Fernyhough & Fradley, 2005; see Winsler, 2009 for a review). For example, Winsler, Carlton, and Barry (2000) noted that 3-year-old children use private speech in many different situations and settings, while 4-year-olds use private speech more systematically as a means to achieve task goals. It is possible global changes in children's awareness of their own use of private speech during the preschool years increases the likelihood private speech is used systematically as a tool for self-regulation (Manfra, 2009). Manfra and Winsler (2006) found evidence that children between roughly 4.5 and 6 years were largely aware of their own use of private speech during a problem-solving selective attention task (similar to the one used in the present study), while children between 3 and 4.5 years were largely unaware of their own use of private speech. These researchers suggest development of private speech awareness may contribute to their increased use of private speech as a verbal self-regulatory tool.

It is possible that changes in awareness of private speech will be apparent in private speech repair data. For example, as children become more aware of their private speech, they may also begin to monitor their private speech and subsequently repair their private speech errors when those errors are contrary to achieving their task goals (e.g., saying "blue" when they intend "red"). Such findings might suggest that private speech self-repairs are made for a regulatory benefit. One of the goals of the current study is to explore how younger and older preschool children use self-repairs in their private speech and whether these differences might be associated with differences in the use of private speech during problem-solving tasks and whether these differences might provide some evidence related to the degree to which preschoolers are aware of their own private speech use.

2. Timing of errors and repairs in speech

Both monitoring and repairing have been shown to occur before speech is actually articulated (i.e., the speaker is unable to overtly listen because s/he has not stated anything overtly; Blackmer & Mitton, 1991; Dell & Repka, 1992; Garnsey & Dell, 1984; Kolk & Postma, 1996; Postma & Kolk, 1992a, 1992b; Postma & Noordanus, 1996) and after speech is articulated (i.e., the speaker hears and listens to his/her own overt speech; Berg, 1992; Levelt, 1983, 1989; Nakatani & Hirschberg, 1994; Postma, 2000). Most of the support for repairs occurring prior to speech articulation (i.e., pre-articulatory) has been generated by speech error and repair research with adult samples. Some studies show pre-articulatory repairs by demonstrating that (a) corrections are frequently ready before the articulation of an error (Blackmer & Mitton, 1991), (b) individuals often create errors *without* articulation, such as repeating a tongue-twister with inner speech (Dell & Repka, 1992), (c)

stuttering (a fluency error in speech production) can be produced instead of an overt post-articulatory repair because the speech error or issue is already being "corrected" in some way before it is uttered (Kolk & Postma, 1996; Postma & Kolk, 1993), and (d) slips of the tongue can occur without articulation and/or external feedback (Dell & Repka, 1992; Postma & Kolk, 1992a,b; Postma & Noordanus, 1996). The occurrence of speech repairs both before and after speech articulation has suggested that some speech errors or issues might be repaired without conscious awareness.

In a comprehensive review of speech monitoring models, Postma (2000) raised the question of whether or not conscious awareness is needed to detect and repair speech errors and issues; that is, whether repairing speech errors is explicit and conscious, or implicit and unconscious. Levelt (1989) suggests that self-initiated repairs likely occur with conscious awareness. His view is that the speech monitoring system is a perception-based monitor that screens speech after it is produced, either covertly or overtly. Others (Berg, 1992; Nooteboom, 1980; Postma & Kolk, 1993), however, argue that the speech monitor is a production-based system that detects errors during the conceptual production of speech and thus is not conscious, but rather an automatic check during speech production. Postma (2000) reached the conclusion that research has demonstrated the existence of both conscious and unconscious repairs of speech errors. For example, Postma and Noordanus (1996) asked adult participants to press a button when an error occurred in their speech. The authors found that participants sometimes repaired their speech errors but did not always press the button when a speech error and repair occurred. They concluded that, at least occasionally, speech errors were made and repaired without conscious awareness. Other researchers also support the occurrence of unconscious repairs based on findings suggesting that speakers anticipate errors in their speech prior to articulation (Blackmer & Mitton, 1991; Garnsey & Dell, 1984; Postma & Kolk, 1993).

Repairs are often categorized as conscious if (a) the speech error or issue is corrected in an obvious, slow fashion (e.g., "The dog went – wasn't in the yard.") and (b) the speech contains a pause, repetition, or filler (e.g., "uh") during the editing of an anticipated error or issue, which may not sound like an error or issue to a listener (e.g., "The dog – uh – wasn't in the yard"; Postma, 2000). Unconscious repairs, on the other hand, are often harder to detect and more inference is needed to assess them (Postma, 2000). Characteristics described as indicating self-initiated repairs without conscious awareness include (a) immediate (without any delay) repairs and seamless streams of speech with errors and issues corrected nearly as quickly as they are made (suggesting the speaker anticipates the error or issue and does not need to hear it to repair it; e.g., "The d-cat wasn't in the yard"; Blackmer & Mitton, 1991) and (b) stuttering, or quick repetitions of one or more words (e.g., "The-the-the dog wasn't in the yard"; Postma & Kolk, 1993). Stuttering or repetition of words is believed to occur because the speaker has detected an upcoming speech error or issue covertly via an internal self-monitoring system (Russell, Corley, & Lickley, 2003) and has attempted to repair the error or issue internally. The stutter occurs as a side-effect of the covert repair and the actual speech error or issue is never articulated. Additional examples of immediate and delayed self-repairs in repetition, replacement, and filler categories are presented in Table 1.

The degree to which speech monitoring and repair occur in young children's conscious awareness is a matter of some debate. In the late 1970s, Clark and Anderson (Clark, 1978; Clark & Anderson, 1979) argued that the spontaneous self-repairs by 2-year-olds were possible because children of this age are aware of their speech use. They argued that children need to reflect on and manipulate speech in order to repair it, and therefore young children's ability to repair speech demonstrates their emerging conscious awareness of speech. This conclusion implies a belief that repairs occur in response to conscious monitoring of speech rather than in response to unconscious monitoring of speech. Researchers who have directly explored the need for young children to have consciousness of speech in order to initiate a repair (Cazden, Michaels, & Tabors, 1985; Evans, 1985; Karmiloff-Smith, 1986), however, all tend to agree that conscious awareness of speech errors is not necessary for repairs to be made.

Karmiloff-Smith (1986, 1992) argues that speech monitoring and repairing may be an unconscious metaprocedure (i.e., a mental regulatory task outside the individual's realm of awareness) that detects and fixes linguistic components previously mastered by the speaker. For example, Karmiloff-Smith suggests children utilize metaprocedures to detect incorrect article use after they fully develop an adult-like understanding of articles in speech. She further argues that these unconscious metaprocedures are separate from awareness; that awareness involves the ability of the child to explicitly comment on language, which she suggests develops during the late preschool/early elementary years.

Subsequent studies exploring speech repair data suggest that Karmiloff-Smith's (1992) notion of unconscious metaprocedures might not be completely substantiated. In a study examining the neutral requests (e.g., "what?") in conversations of young children and parents, Levy (1999) concluded that 2- and 3-year-old children are able to recognize and verbalize locations of linguistic errors in their own sentences without necessarily demonstrating an understanding of how to correct the errors. In terms of conversational social speech, this suggests that younger children might in fact be able to use listener requests as a catalyst to reflect on utterances they have just spoken and hone in on the speech error without fully understanding why it is an error or having the know-how or skills to correct the error. This implies, at some level, conscious reflection on speech after articulation is within the realm of young preschoolers. As such, it might be expected that at least some of preschoolers' self-repairs will occur in a fashion consistent with conscious awareness.

3. The present study

The present study addresses several goals related to preschoolers' self-repairs in private and social speech. First, we explore the degree to which preschoolers make repairs in private and social speech. Most previous research exploring repairs with children has focused exclusively on conversational social speech involving obvious listeners (Caplan et al., 1996; Forrester, 2008; Forrester & Cherington, 2009; Jokinen, 1998; Laakso, 2006; Laakso & Soininen, 2010; LaSalle & Conture, 1995; Levy, 1999; Levy et al., 2003; Prather et al., 1989; Ridley et al., 2002; Rieger, 2003; Salonen & Laakso, 2009; Schegloff, 2000; Schegloff et al., 1977; Tarplee, 1989; Wong, 2000; Wootton, 1994, 2007). Examination of speech directed toward the self (i.e., private speech) offers a unique opportunity to learn about speech monitoring and repair when speech is not intended for a listener. Differences between repair practices in social and private speech may illuminate additional reasons for speech repair among preschool children. Second, while much of the research on speech repairs has been conducted with adults and older children, the present study provides additional data about preschool children's speech monitoring and repair.

Third, we include an exploration of the timing of speech repairs, immediate versus delayed, which provides information about the degree to which preschoolers monitor and repair their speech in an unconscious, automatic fashion (immediate repairs) and a conscious, effortful fashion (delayed repairs). Finally, utterances with speech repairs are compared based on how relevant the utterances are (irrelevant, relevant, action-relevant) to the task children

Table 1
Self-repair categories.

Repair Type	Speed	Timing of Monitoring and Repair	Definition	Examples
Repetitions	Immediate (no fillers)	Pre-Articulatory Monitoring Pre-Articulatory Repair	A repetition of a word or phrase of speech with no break in speech.	"...need the re-red one..."
	Delayed (with or without fillers)	Post-Articulatory Monitoring Pre-Articulatory Repair	A repetition of a word or phrase of speech with a noticeable pause/break in speech lasting over a full second with or without fillers.	"...this goes–this goes..." "...where–eh–where is it?"
Replacements	Immediate (no fillers)	Pre-Articulatory Monitoring Post-Articulatory Repair	An amended word or phrase with no break in speech.	"...the bl-red one..."
	Delayed (with or without fillers)	Post-Articulatory Monitoring Post-Articulatory Repair	An amended word or phrase with a one second or more pause/break in speech with or without fillers.	"...need one–two small ones for here..." "...I have to get–um–have to put it here."
Fillers (without repetitions or replacements)	Delayed	Post-Articulatory Monitoring Pre-Articulatory Repair	A pause/break in speech with fillers with no repetition or replacement of words.	"...this one–eh–is next..."

Note. Categories of Repair Type and associated definitions were adapted from Schegloff et al. (1977) and Fox et al. (1996). Categories of Timing of Monitoring and Repair were adapted from Postma (2000).

Table 2
Descriptive statistics for all child-level variables.

Demographic and Task Variables	Range	*M* or%	*SD*
Gender (Male = 1)	–	55.6%	–
Race (White = 1)	–	74.1%	–
Age (in months)	37.17–60.40	48.86	6.63
Task Performance	0–100	64.93	26.79
Speech Use Variables			
Total utterances	0–87	15.59	18.46
Proportion of speech errors to total utterances	0–1	0.088	0.189
Proportion of fluency errors/self-repairs to total utterances	0–1	0.058	0.142
Proportion of grammatical errors to total utterances	0–1	0.031	0.111
Proportion of repetitions to total utterances	0–1	0.041	0.110
Proportion of replacements to total utterances	0–0.5	0.011	0.053
Proportion of fillers only to total utterances	0–0.5	0.006	0.044

complete. By doing so, we are able to evaluate the proportion of utterances with repairs that are more or less relevant to the task in social and private speech.

4. Method

4.1. Participants

Twenty-seven 3- and 4-year-old children from a university-affiliated and accredited laboratory preschool participated in this study. Data from these children were collected as part of a larger, two-wave, longitudinal study (*reference withheld*). As shown in Table 2, participants consisted of 56% males and had a mean age of 48.86 months (*SD* = 6.63; range: 37.17–60.40). The majority of children (74%) were identified as White, 15% of the children were identified as African American, and 11% were identified as Asian American. Families of the participants represented a wide range of socioeconomic status (SES; Hollingshead index Range = 31–66; *M* = 52.52; *SD* = 10.38) as a result of the preschool director's efforts to stratify its enrollment into three equal thirds: (a) children of university faculty/staff, (b) children of university students, and (c) children of community members.

Fourteen children (57% male) were in a '3-year-old' classroom and had a mean age of 43.61 months (*SD* = 4.05; range: 37.17–48.50) at the beginning of the school year. Thirteen children (54% male) were in a "4-year-old" classroom and had a mean age of 54.51 months (*SD* = 3.27; range: 48.96–60.40) at the beginning of the school year. The average paternal age was 36.46 years (*SD* = 6.06), and the average maternal age was 32.59 years (*SD* = 5.79). Fathers' years of education ranged from 12 to 21 years (*M* = 17.21, *SD* = 2.96). Mothers' years of education also ranged from 12 to 21 years (*M* = 16.58, *SD* = 2.27). Independent *t*-tests indicated that parent age, parent education level, and family SES did not vary significantly by classroom/age group. Chi-square analysis revealed no differences in child race/ethnicity by classroom/age group.

All 27 children completed at least one task during at least one of the two data collection sessions. For 17 of 27 (63%), we have complete data for both tasks at both sessions (seven 3-year-olds, 10 4-year-olds). Of the remaining 10 participants, three (two 3-year-olds, one 4-year-old) were unavailable to participate during the second data collection session as a result of withdrawal from the childcare center. Finally, we did not have data for all tasks for seven participants (five 3-year-olds, two 4-year-olds) due to technical difficulties with the recording equipment or lack of interest by the participant to complete a task.

4.2. Procedures

During two separate data collection sessions, participants completed two developmentally-appropriate, problem-solving tasks known to elicit private speech among preschoolers. The first session took place near the begin of the school year (during September and October), and the second session took place approximately 6 months later (during March and April). Both tasks were completed during both sessions and in the same fixed order. The selective attention task was completed first, and the Lego construction task was completed second. The instructions and procedures during both sessions were identical. Data were collected at two time points

during the school year to explore consistency and stability of speech use in the larger study, which was supported (*reference withheld*). In the present study, speech errors and self-repairs in both social and private speech were explored using data from both time points. Differences in numbers of speech errors and self-repairs between the first and second data collection sessions were considered in preliminary and child-level analyses. Data from these two time points were combined for utterance-level analyses.

Each task was completed during two separate meetings within one week to reduce the chances of participant fatigue. The two problem-solving tasks (selective attention and Lego construction) were selected as a means of providing an opportunity to observe children's speech use while they worked on goal-directed tasks. Previous research (Berk & Spuhl, 1995; Winsler, 1998; Winsler, De León, Wallace, Carlton, & Willson-Quayle, 2003) has demonstrated that most preschoolers use speech while completing these tasks.

Both task were completed by children in a separate, large room of the preschool. A male experimenter was present in the room with the children at all times. A video camera was set up in the corner of the room about 12 ft away from children to record the sessions and a high-quality omni-directional table microphone was used as the audio input to generate high-quality speech recordings. The experimenter sat next to the participants at a table while providing instructions and completing a portion of the tasks with them. After providing instructions and working with them for part of the task, the experimenter moved his chair over to the side end of the table, turned it away from the children such that he was not looking at them, and engaged in his own "paperwork" while they completed the tasks by themselves. This positioning of the experimenter is typical of studies exploring private speech in young children.

4.3. Tasks

4.3.1. Selective attention task

The selective-attention (SA) task (Winsler, Diaz, & Montero, 1997) required children to identify one of two characteristics (either shape or color) that two stimulus pictures (depicting both a shape and a color) had in common and then to select a third answer picture (depicting a shape or a color, but not both) that shared the common characteristic. The two stimulus pictures were glued to the left side and center of a $4'' \times 12''$ card that was sectioned into three $4''$ portions. The right side of the card had a piece of Velcro glued to it such that children could attach a $4'' \times 4''$ card containing the answer picture. The experimenter first introduced the task, assisted children with the first two example items (repeatedly if needed), and asked children to finish the remaining 12 items individually before moving his seat. Utterances made by children during the remainder of the task were not responded to by the experimenter unless the children made explicit repeated attempts to engage the experimenter. These attempts were greeted with a gentle reminder to continue working on the task by themselves (e.g., "Please try to finish the rest of these by yourself. You can do those by yourself."). At no point were participants given prompts from the experimenter to use speech.

4.3.2. Lego construction task

The second problem-solving task was a Lego construction (LC) task (Berk & Spuhl, 1995; Winsler et al., 2003). For this task, children attempted to reproduce a Lego structure according to an accessible 27-piece three-dimensional model of a robot. Like the SA task, the experimenter first worked with children on the task before asking them to work on the task by themselves. For the LC task, the experimenter worked with the children to complete the entire Lego model once together and then asked the children to complete the entire Lego model again on their own while he distanced himself from them in the same manner as he had done in the SA task. As such, more social interaction occurred during the LC task than the SA task. At no point were participants given prompts from the experimenter to use speech.

4.4. Coded variables

4.4.1. Speech utterances

Speech utterances were transcribed from video-taped sessions of participants completing the problem-solving tasks at both time points. A speech utterance was defined as a complete sentence, independent clause, conversational turn, or segment of speech separated from another segment by at least three seconds (Winsler et al., 2003). Speech transcripts were created by trained graduate students using standard, although slightly simplified/modified, CHILDES transcription procedures (Macwhinney, 2000), which utilizes codes and symbols to mark speech utterances involving pauses, time elapsed, incomplete words, repetitions, recasts, and physical actions.

Speech utterances were categorized as social or private speech as part of the larger study. For the present study, all utterances (social and private speech) were coded for speech errors and self-repairs. Then, speech errors and self-repairs were further coded for type, speed, and content. The processes for coding speech utterances and evaluating reliability are described below. Coding for social and private speech was completed by one set of two independent coders, and coding for speech errors and self-repairs was completed by a second set of two independent coders. For all reliability coding, discrepancies between coders were discussed and resolved by the pair who agreed upon a final category. The agreed upon categories were used for analyses.

4.4.2. Private and social speech

Each utterance produced by children was first identified as being either private or social speech. Private speech utterances were defined as speech utterances not explicitly directed toward or intended for another person. As is typical for private speech research, speech intentionally directed toward another person (denoted by a glance, conversational turn, direct answer to an adult's question, touch, or use of a pronoun or name) was coded as social speech. Speech utterances that did not reach any of these criteria were coded as private speech (Winsler, Ferynhough, McClaren, & Way, 2005). Inter-rater reliability for the social and private speech distinction was assessed by two independent raters who coded utterances from a random subset of 15 transcripts and was found to be high, Kappa = 0.87.

4.4.3. Speech errors and self-repairs

Each utterance was categorized as having either no error, an error of fluency, or a grammatical error. If an utterance contained more than one error (regardless of the type of error), each error was to be coded separately. Among the speech utterances produced by participants, none were identified by coders as having multiple errors. As such, utterances were identified as either having or not having an error.

Fluency errors were defined as having any type of break in speech production that disrupted the flow of the utterance. This included word or phrase repetitions, word or phrase replacements (re-wording or amending an utterance), use of lexical, quasi-lexical, and non-lexical fillers (such as "eh" or "um"), or pauses. Grammatical errors consisted of utterances with inappropriate word order structures or subject-verb disagreements. Two independent raters coded speech error type (fluency, grammatical) for 10 transcripts that included 187 utterances and reached good reliability, Kappa = 0.81. Based on the reliability coding for the distinction between social and private speech, it was determined that 10 transcripts (rather than 15 transcripts) would be sufficient for reliably

demonstrating category distinctions between coders. Therefore, 10 transcripts were coded for this and subsequent reliability analyses. All reliability coding using 10 transcripts yielded data that reliably demonstrated distinctions between coded categories.

Grammatical errors were then coded as having been corrected or not corrected. Because there were no occurrences of corrected grammatical errors in the sub-set of transcripts, two independent coders examined all transcripts for corrected grammatical errors. Both coders determined that none of the grammatical errors had been corrected (100% agreement).

Fluency speech errors were categorized into type of self-repair and speed of self-repair. A complete description of these categories, including definitions, examples, and associations with timing of monitoring and repairing, is presented in Table 1. Self-repair types included word or phrase repetitions (with or without fillers between the repeated word), word or phrase replacements (with or without fillers between the initial and changed words), and other fillers (not categorized as repetitions or replacements). Two independent raters reliably categorized 270 utterances from 10 transcripts into these categories (including "no self-repair"), Kappa = 0.87.

Speech utterances were also categorized as immediate or delayed based on the speed of self-repairs. Delayed repairs included those with a pause in speech production of one or more seconds between the initial word and subsequent word (whether a repetition or replacement of the initial word) and those with a filler between the initial and subsequent word. Immediate repairs included those with quick repetitions or replacements (<1 s) and no fillers. Two independent raters reliably categorized 270 utterances from the same 10 transcripts used for self-repair type reliability into immediate, delayed, or no self-repair categories, Kappa = 0.85.

For each of the speech error and self-repair categories, three variables were created and used for analyses. The first was the frequency of occurrence in relation to total errors or self-repairs across all participants. The second was the proportion of occurrence to total utterances used by each participant. Total speech utterances were associated with number of speech errors and self-repairs overall ($r = 0.88$, $p < 0.001$) and in both social ($r = 0.82$, $p < 0.001$) and private speech ($r = 0.85$, $p < 0.001$). Because of these high correlations, proportions of errors and self-repairs to total speech utterances were used to control for general talkativeness in analyses (e.g., more talkative children have more opportunities for making errors and self-repairs). The third was a dichotomous indicator (yes, no) for each participant capturing whether or not s/he made a given error or self-repair at least one time.

4.4.4. Content of speech

All speech errors and self-repairs were categorized into one of three speech content categories based on the relevancy of the utterance to the task. *Task-irrelevant* speech consisted of speech utterances that had content unrelated to the task (e.g., "I want to color some more."). *Task-relevant* speech consisted of verbalizations that were related to the task in general, but not related to the particular motor actions needed at that moment to complete the task (e.g., "I like this game."). *Task-action-relevant* speech consisted of utterances that were directly related to the motoric action needed to complete a task item (e.g., "The yellow flower goes here."). Two independent coders reliably distinguished between these categories using a sample of 10 transcripts, Kappa = 0.84.

4.4.5. Task performance

Task performance for both tasks was calculated globally at the child-level as the percent correct and therefore could range from 0 to 100. For the SA task, performance was simply the number of correctly answered items divided by the total number of items (12). For the LC task, performance was calculated using the same method as Berk and Spuhl (1995). Points were based on three indicators for each Lego block placed: (a) correct color; (b) correct shape; and (c) correct location. Therefore, points allocated for each of the 27 Lego blocks in the model could range from 0 (color, shape, and location incorrect) to 3 (color, shape, and location correct). Total points possible for the LC task was 81 (three times the number of pieces). Performance was the total points earned divided by the total points possible (81). Mean, standard deviation, and range of performance scores are presented in Table 2.

5. Results

Results are organized into three sections: (a) preliminary analyses describing the overall nature of speech errors and repairs produced by participants; (b) child-level analyses exploring individual differences in speech use, errors and repairs, and task performance; and (c) utterance-level analyses exploring the characteristics of utterances containing self-repairs.

5.1. Preliminary analyses

Overall, there were 2120 utterances coded from 26 of the 27 participants. One participant (4.86-year-old) did not use any speech while completing the tasks. On average, participants used approximately 15.82 utterances ($SD = 18.49$; range: 1–87) per task per time point. For the SA task at Time 1, children used 17.53 utterances on average ($SD = 20.08$; range: 1–83); for the SA task at Time 2, children used 9.17 utterances on average ($SD = 15.79$; range: 1–73); for the LC task at Time 1, children used 13.14 utterances on average ($SD = 16.67$; range: 1–79); and for the LC task at Time 2, children used 20.64 utterances on average ($SD = 19.11$; range: 1–87). These differences were explored further in the child-level analyses section that follows.

More utterances were categorized as private speech ($N = 1173$; 55.3% of total utterances) than social speech ($N = 947$; 44.7% of total utterances), $\chi^2\,(1, N = 2120) = 24.09$, $p < 0.001$. Of the 26 participants who used speech, all (100%) used at least one social speech utterance, and 24 (92.3%) used at least one private speech utterance. On average, private speech utterances contained fewer words ($M = 4.98$ words; $SD = 2.27$; range: 1–11) compared to social speech utterances ($M = 7.72$ words; $SD = 7.72$; range: 2–17), $B = -2.87$, $SE = 0.58$, $t = -4.96$, $p < 0.001$.

The proportion of private speech utterances (and social speech, which is the inverse of private speech here) to total utterances decreased between Time 1 ($N = 636$; 57.6% of 1104 utterances at Time 1) and Time 2 ($N = 537$; 52.9% of 1016 utterances at Time 2), χ^2 (1, $N = 2120$) = 4.84, $p = 0.029$. Similarly, the proportion of private speech utterances to total utterances was higher for the SA task ($N = 504$; 59.9% of 842 utterances used in the SA task) compared to the LC task ($N = 669$; 52.3% of 1278 utterances used in the LC task), $\chi^2\,(1, N = 2120) = 11.58$, $p < 0.001$. These differences were explored further in the child-level analyses section that follows.

5.2. Child-level analyses

5.2.1. Total utterances

Analyses were conducted to explore the impact of child-level task and demographic factors on total utterances spoken. Descriptive statistics for variables considered in this analysis are presented in Table 2. A mixed-effects model was use for this analyses to control for individual child variation in the random effects model while exploring the influence of gender (male, female), race/ethnicity (White, other), age (in months), speech type (private, social), time (1, 2), and task (SA, LC) on total utterances spoken. In addition to main effects, two-way interactions among the independent variables were also explored.

Table 3
Number and percent of children who made at least one occurrence by category of speech error and self-repair.

	Social Speech	Private Speech	All Speech
Children who used speech ($n = 26$)			
Any error	21 (81%)	18 (69%)	24 (92%)
Grammatical error	12 (46%)	11 (42%)	18 (69%)
Fluency error/self-repair	20 (77%)	15 (58%)	23 (88%)
Children who made at least one fluency error/self-repair ($n = 23$)			
Immediate	13 (57%)	13 (57%)	18 (78%)
Delayed	17 (74%)	9 (39%)	19 (83%)
Irrelevant	8 (35%)	3 (13%)	10 (43%)
Relevant (in general)	13 (57%)	9 (39%)	17 (74%)
Action relevant	7 (30%)	11 (48%)	15 (65%)
Repetitions	17 (74%)	15 (65%)	23 (100%)
Replacements	9 (39%)	4 (17%)	11 (48%)
Other fillers	7 (30%)	4 (17%)	8 (35%)

Results revealed gender differences and a time-by-task interaction for total utterances. Males were found to use more speech utterances than females, $B = 10.10$, $SE = 3.71$, $t = 2.72$, $p = 0.015$, and speech utterances decreased on the SA task from Time 1 to Time 2 and increased on the LC task from Time 1 to Time 2, $B = 16.03$, $SE = 5.98$, $t = 2.68$, $p = 0.008$.

5.2.2. Speech errors and self-repairs

This section is divided into two sub-sections: (a) number of children who showed at least one occurrence of the different categories of speech errors and self-repairs; and (b) proportion of speech errors and self-repairs to total utterances.

5.2.2.1. At least one occurrence. Children who made at least one occurrence of the various categories of speech errors and self-repairs are presented in Table 3. As shown in the top portion of the table, making speech errors and self-repairs was fairly widespread across children and not the result of only a few children. For each of the speech error and self-repair categories presented in Table 3, continuous age (in months) associations using point-biserial correlations were explored for those who made at least one occurrence and those who did not make at least one occurrence. Results revealed significant findings for private speech word replacements, social speech other fillers, and all speech other fillers. For all three, at least one occurrence was positively associated with age: children who used at least one other filler (in either social or private speech) were older ($M = 52.88$ months; $SD = 4.42$) than those who did not use other fillers ($M = 45.46$ months; $SD = 6.04$), $r_{pb}(21) = 0.56$, $p = 0.006$; children who used at least one social speech other filler were older ($M = 53.56$ months; $SD = 4.28$) than those who did not make any ($M = 45.62$ months; $SD = 5.87$), $r_{pb}(21) = 0.57$, $p = 0.004$; and children who made at least one private speech word replacement were older ($M = 53.80$ months; $SD = 5.45$) than those who did not make any ($M = 46.83$ months; $SD = 6.16$), $r_{pb}(21) = 0.42$, $p = 0.049$.

5.2.2.2. Proportion of speech errors and self-repairs to total speech utterances. Analyses were also conducted to explore the potential influence of child-level task and demographic factors on speech errors and self-repairs. Descriptive statistics for variables considered in these analyses are presented in Table 2. The goal was to determine if speech errors and repairs produced by participants varied between person. High variation based on child and task factors could imply that subsequent utterance-level analyses are biased and should be limited in generalization. Low variation, which is what we found, implies limited bias and more confidence in generalizing the utterance-level findings.

Mixed-effects models were utilized to control for child variation in the random effects model while exploring the impact of within-child (speech type, time, task) and between-child (gender, race/ethnicity, age) factors in the fixed-effects model. Based on the within-child design with three independent factors (each with two levels), excluding missing data resulting from some children not completing every task and/or time point or not using both social and private speech, participants contributed a total of 134 data points to these analyses. A separate model was conducted for each of the following dependent variables: proportion of all speech errors in total speech utterances, proportion of fluency errors/self-repairs in total speech utterances, proportion of grammatical errors in total speech utterances, proportion of word replacement self-repairs in total speech utterances, proportion of repetition self-repairs in total speech utterances, and proportion of other filler self-repairs in total speech utterances. The following independent variables were included in the fixed-effects model: gender (male, female), race/ethnicity (White, other), age (in months), speech type (private, social), time (1, 2), task (LC, SA), and task performance. In addition to main effects, two-way interactions among independent variables were explored for all dependent variables.

None of the models yielded significant associations between child and task factors and proportions of speech errors and self-repairs. These non-significant findings indicate speech utterances produced by participants had limited between-person variation in speech errors and repairs. This suggests that between-utterance variation in speech content, type of repair, and speech of repair explored in the utterance-level analyses section below is not biased based on these measured between-person factors.

5.2.3. Task performance

Task performance was also explored using mixed-effects modeling in the same fashion as described previously. Descriptive statistics for the variables considered in this analysis are presented in Table 2. The only notable difference in this model involved use of task performance as a dependent rather than independent variable. Results yielded two significant factors: task type and age. Performance was higher for the SA task compared to the LC task, $B = 20.78$, $SE = 4.68$, $t = 4.44$, $p < 0.001$, and performance was positively associated with age (in months), $B = 2.23$, $SE = 0.47$, $t = 4.76$, $p < 0.001$. Task performance was not significantly associated with any of the proportion of speech errors or self-repairs variables. Given that our task performance measure is a global child-level measure, we cannot evaluate whether self-repair of individual utterances may have impacted the concomitant or immediately subsequent actions of the children.

5.3. Utterance-level analyses of speech errors and self-repairs

In this section, we explore the nature of self-repaired utterances produced in social and private speech. The number of utterances in each of the categories considered in this section are presented in Tables 4 and 5 Age group based on classroom (3-year-old, 4-year-old) was considered in this section and differences between utterances produced by children in the 3-year-old classroom compared to the 4-year-old classroom will be described where applicable. As demonstrated in the child-level analyses section, child and task factors played little role in the production of speech errors and self-repairs.

5.3.1. Overview of speech errors and self-repairs

Among the 2120 speech utterances analyzed, 162 (8%) contained a speech error of some type. There were significantly more errors of fluency ($N = 120$; 74%) compared to errors of grammar ($N = 42$; 26%), $\chi^2(1, N = 162) = 37.56$, $p < 0.001$. As shown in Table 4, speech errors among all children occurred significantly more in social speech

Table 4
Number (and percent) of speech utterances by speech categories for social speech, private speech, and all speech.

	All Children			3-Year-Olds			4-Year-Olds		
	Social Speech	Private Speech	χ^2	Social Speech	Private Speech	χ^2	Social Speech	Private Speech	χ^2
Total Utterances	947 (45%)	1173 (55%)	24.09****	504 (44%)	629 (56%)	13.79****	443 (45%)	544 (55%)	10.34***
Total Errors	97 (60%)	65 (40%)	6.32**	39 (50%)	39 (50%)	0.00	58 (69%)	26 (31%)	12.19****
Grammatical Errors	27 (64%)	15 (36%)	3.43*	15 (54%)	13 (46%)	0.14	12 (86%)	2 (14%)	7.14***
Grammatical Corrections	0	0	–	0	0	–	0	0	–
Fluency Errors/Self-Repairs	70 (58%)	50 (42%)	3.33*	24 (48%)	26 (52%)	0.08	46 (66%)	24 (34%)	6.91***
Type of Fluency Errors/Self-Repairs									
Repetitions	46 (53%)	41 (47%)	0.29	14 (37%)	24 (63%)	2.63	32 (65%)	17 (35%)	4.59**
Replacements	15 (75%)	5 (25%)	5.00**	9 (90%)	1 (10%)	6.40*	6 (60%)	4 (40%)	0.40
Fillers Only (Delayed only)	9 (69%)	4 (31%)	1.92	1 (50%)	1 (50%)	0.00	8 (73%)	3 (27%)	2.27
Timing of Fluency Errors/Self-Repairs									
Immediate	31 (48%)	33 (52%)	0.06	9 (32%)	19 (68%)	3.57*	22 (61%)	14 (39%)	1.78
Delayed	39 (70%)	17 (30%)	8.64***	15 (68%)	7 (32%)	2.91*	24 (71%)	10 (29%)	5.77**
Speech Content of Fluency Errors/Self-Repairs									
Irrelevant	20 (80%)	5 (20%)	9.00***	6 (75%)	2 (25%)	2.00	14 (82%)	3 (18%)	7.12***
Relevant	28 (61%)	18 (39%)	2.17	16 (52%)	15 (48%)	0.03	12 (80%)	3 (20%)	5.40**
Action Relevant	22 (45%)	27 (55%)	0.51	2 (18%)	9 (82%)	4.46**	20 (53%)	18 (47%)	0.11

Note: All%s presented directly next to number of occurrences are proportion of speech type utterances (social or private) to the total number of utterances for the given row within the given grouping of children. As such, these%s sum to 100%. All χ^2s presented in the table are based on 1 degree of freedom.

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.
**** $p < 0.001$.

(60%) than private speech (40%). This indicates that while just over 10% of all social speech utterances contained an error, only 5.5% of all private speech utterances contained an error.

Among 3-year-olds only, no differences in number of social and private speech errors were seen for total errors, grammatical errors, or fluency errors. However, among 4-year-olds only, utterances with errors were significantly more likely to occur in social speech compared to private speech (true for total errors, grammatical errors, and fluency errors). Table 4 contains the numbers for each of these comparisons and the results from the statistical tests.

Finally, utterances with grammatical errors (regardless of being social or private) were never corrected by any of the participants, and therefore, were not analyzed further.

5.3.2. Self-repairs

Self-repairs were explored for differences in repair type (repetitions, replacements, other fillers), timing of repairs (immediate, delayed), and speech content of repairs (task irrelevant, task relevant, task action relevant). All analyses in this section were based on utterances that contained self-repairs ($N = 120$).

5.3.2.1. Repair type. For social and private speech combined, most self-repairs were repetitions ($N = 87$; 73%), with few word replacements ($N = 20$; 17%) and other fillers with no replacements or repetitions ($N = 13$; 11%), $\chi^2(2, N = 120) = 83.45$, $p < 0.001$. As shown in Table 4, repetitions and other fillers were equally as likely to occur in private speech and social speech among all children, while word replacements were significantly more common in social speech (75%) compared to private speech (25%). When examined by age group, the same pattern of findings was true for 3-year-olds, but not 4-year-olds. Repetitions from 4-year-olds occurred more often in social speech (65%) compared to private speech, while word replacements and other fillers were similar in frequency for social speech and private speech.

5.3.2.2. Timing of repairs. For all speech combined and all children, no significant differences emerged between the number of delayed ($N = 56$; 47%) and immediate self-repairs ($N = 64$; 53%), χ^2 $(1, N = 120) = 0.53$, *ns*. Similarly, social speech self-repairs were also just as likely to be immediate ($N = 31$; 44%) and delayed ($N = 39$; 56%), χ^2 $(1, N = 70) = 0.91$, *ns*. However, private speech self-repairs tended to be immediate repairs ($N = 33$; 66%) compared to delayed repairs ($N = 17$; 34%), χ^2 $(1, N = 50) = 5.12$, $p = 0.024$. These timing patterns were also true for the self-repair sub-group of repetitions only and the self-repair sub-group of word replacements only (the self-repair sub-group of other fillers only, by definition, were only in the delayed category and therefore immediate and delayed could not be compared).

For 3-year-olds, self-repairs from all speech occurred similarly in an immediate fashion ($N = 28$; 56%) as in a delayed fashion ($N = 22$; 44%) overall, χ^2 $(1, N = 50) = 0.72$, *ns*. While this pattern held true for social speech, it did not for private speech. Social speech self-repair frequency from 3-year-olds was not statistically different between delayed repairs ($N = 15$; 63%) and immediate repairs ($N = 9$; 38%), χ^2 $(1, N = 24) = 1.50$, *ns*. Private speech self-repairs from 3-year-olds occurred more often in an immediate fashion ($N = 19$; 73%) compared to a delayed fashion ($N = 7$; 27%), χ^2 $(1, N = 26) = 5.54$, $p = 0.019$. For 4-year-olds, self-repairs from all speech occurred similarly in an immediate fashion ($N = 36$; 51%) as in a delayed fashion ($N = 34$; 49%), χ^2 $(1, N = 70) = 0.06$, *ns*. This pattern was also found for social speech self-repairs (22 immediate, 48%; 24 delayed, 52%; χ^2 $[1, N = 46] = 0.09$, *ns*) and private speech self-repairs (14 immediate, 58%; 10 delayed, 42%; χ^2 $[1, N = 24] = 0.67$, *ns*).

5.3.2.3. Speech content of repairs. As shown in Table 5, self-repairs for all speech combined differed significantly by speech content. Most self-repairs were task action relevant (41%) and task relevant (38%) with fewer task irrelevant (21%). This was not true for social speech. No significant difference in frequency emerged among task-irrelevant, task-relevant, and task-action-relevant social speech self-repairs. Significant differences did emerge for private speech, such that private speech repairs were more likely to be task action relevant (54%) compared to task relevant (36%) and task irrelevant (10%).

Next, immediate ($N = 64$) and delayed ($N = 56$) self-repairs were examined separately for differences in speech content. As shown in Table 5, immediate self-repair frequency did not differ significantly

Table 5
Number (and percent) of speech utterances with self-repairs by speech type, speech category, and speed category.

	Social Speech				Private Speech				All Speech			
	Irrelevant	Relevant	Action Relevant	χ^2	Irrelevant	Relevant	Action Relevant	χ^2	Irrelevant	Relevant	Action Relevant	χ^2
Immediate	8 (26%)	14 (45%)	9 (29%)	2.00	5 (15%)	14 (42%)	14 (42%)	4.91*	13 (20%)	28 (44%)	23 (36%)	5.47*
Repetitions	6 (26%)	11 (48%)	6 (26%)	2.17	5 (17%)	14 (47%)	11 (37%)	4.20	11 (21%)	25 (47%)	17 (32%)	5.59*
Replacements	2 (25%)	3 (38%)	3 (38%)	0.25	0 (0%)	0 (0%)	3 (100%)	–	2 (18%)	3 (27%)	6 (55%)	2.36
Delayed	12 (31%)	14 (36%)	13 (33%)	0.15	0 (0%)	4 (24%)	13 (76%)	4.77[a,**]	12 (21%)	18 (32%)	26 (46%)	5.29*
Repetitions	8 (35%)	8 (35%)	7 (30%)	0.09	0 (0%)	4 (36%)	7 (64%)	0.82[a]	8 (24%)	12 (35%)	14 (41%)	1.65
Replacements	0 (0%)	4 (57%)	3 (43%)	0.14[a]	0 (0%)	0 (0%)	2 (100%)	–	0 (0%)	4 (44%)	5 (56%)	0.11[a]
Fillers only	4 (44%)	2 (22%)	3 (34%)	0.67	0 (0%)	0 (0%)	4 (100%)	–	4 (31%)	2 (15%)	7 (54%)	2.92
Overall	20 (29%)	28 (40%)	22 (31%)	1.49	5 (10%)	18 (36%)	27 (54%)	14.68****	25 (21%)	46 (38%)	49 (41%)	8.55**

Note: Percents are row-based for speech categories (irrelevant, relevant, action relevant) within speech type (social speech, private speech, all speech). Sub-category values for the type of self-repair (repetitions, replacements, fillers) represent the distribution of self-repairs contained within the primary category value for a given column. All reported chi-squares, excepted where otherwise noted, are based on 2 degree of freedom.
[a]These comparisons were based on only 1 degree of freedom because one of the values was equal to zero.
*$p < 0.10$.
**$p < 0.05$.
***$p < 0.01$.
****$p < 0.001$.

by speech content for all speech combined, for social speech only, nor for private speech only. Delayed self-repairs also did not differ by speech type for all speech combined and for social speech only. However, for private speech, delayed self-repairs were mostly task action relevant (76%), with few task-relevant (24%), and no task-irrelevant delayed self-repairs.

Finally, utterance content in social and private speech was examined by age group. The content of self-repair utterances from 3-year-olds was more often task-relevant ($N = 31$; 62%) compared to task-action-relevant ($N = 11$; 22%) and task-irrelevant ($N = 8$; 16%), χ^2 (2, $N = 50$) = 18.76, $p < 0.001$. This pattern was also similar within social speech, χ^2 (2, $N = 24$) = 13.00, $p = 0.002$ and private speech, χ^2 (2, $N = 26$) = 9.77, $p = 0.008$. Numbers for each of these are in the bottom, middle column of Table 4.

Unlike the pattern seen with 3-year-olds, the content of self-repair utterances from 4-year-olds was more often task-action-relevant ($N = 38$; 54%) compared to task-relevant ($N = 15$; 21%) and task-irrelevant ($N = 17$; 24%), χ^2 (2, $N = 70$) = 13.91, $p < 0.001$. This pattern was less pronounced and non-significant for social speech, χ^2 (2, $N = 46$) = 2.26, *ns*, but more pronounced and significant for private speech, χ^2 (2, $N = 24$) = 18.75, $p < 0.001$. Numbers for each of these are in the bottom, right column of Table 4.

6. Discussion

The primary goal of this study was to assess preschool children's speech errors and self-repairs during social and private speech. The social and private speech utterances of 3- and 4-year-old children were collected and coded for speech errors and self-repairs while children completed two problem-solving tasks at two time points during the school year. One of the unique features of the present study is the exploration of speech self-repairs in both conversational, social speech–the focus of most of studies exploring self-repairs–and self-directed, private speech. Use of both speech types allowed for comparisons between self-repairs made in speech intended for a listener (conversational, social speech) and speech not intended for a listener (self-directed, private speech). In doing so, we were able to provide additional data about preschool-aged children's speech monitoring and repair practices and explore non-listener explanations for why children produce self-repairs.

Results indicate that about 8% of preschoolers' utterances made during problem-solving tasks contain speech errors and self-repairs. Results also indicate that preschool children make more errors and repairs in their social speech (10%) compared to private speech (5.5%) and make more fluency errors (in both social and private speech) compared to grammatical errors while completing problem-solving tasks. Though social speech errors occurred at a higher rate, the fact that children did make and repair errors in their private speech is noteworthy. At a minimum, it seems reasonable to concluded that preschool children are not only monitoring their speech for the sake of a listener. It seems they also monitor their speech for themselves.

While grammatical errors occurred in both social and private speech, none were corrected by any of the participants. Fluency errors similarly occurred in both private and social speech. Interestingly, more self repair of fluency errors occurred in social speech (7.4% of all social speech utterances contained a self-repair) compared to private speech (4.3% of all private speech utterances contained a self-repair). The rate of social speech self-repairs is consistent with other research exploring young children's speech errors and self-repairs in conversation, which tends to be between nine and 11% (Rieger, 2003). Thus, it seems self-repairs in private speech occur at a lower rate than self-repairs in social speech. These findings suggest preschool children may have more difficulty speaking clearly when a listener is present than they do when speaking to themselves. It is possible that more errors and repairs are made in social speech because social situations create increased demands on children resulting in more errors than less social situations. Social situations may cause children to contemplate the role of the listener in addition their own roles. By doing so, children likely have fewer cognitive resources available for monitoring speech production when there is an intended listener compared to when there is no intended listener. It might also be possible that young children monitor their speech differently when using social speech compared to private speech, resulting in more social speech errors.

The findings reveal a similar number of social speech self-repairs coded as immediate and delayed, but more private speech self-repairs coded as immediate (compared to delayed). The latter finding was particularly pronounced among utterances produced by 3-year-olds (the difference was not significant among utterances produced by 4-year-olds). This suggests that younger preschoolers may be more likely to monitor their private speech in a pre-articulatory, automatic fashion prior to verbally expressing their thoughts, as opposed to a post-articulatory, deliberate fashion. Their social speech, on the other hand, seems to be equally monitored in a pre-articulatory and post-articulatory fashion. These differences in the way children monitor their social and private speech may help explain why more speech errors were noted in social speech compared to private speech. Evidence of post-articulatory monitoring of social speech is possibly the result of the presence of a listener. Children may have noted expressions or gestures made by the listener that caused them to believe they needed to amend or change their speech in some way to improve the communication between them and the listener (Forrester, 2008).

The content of utterances with self-repairs also provides information about what preschool children might pay attention to in their social and private speech. Most of the self-repairs produced by children in the 3-year-old classroom were categorized as generally task-relevant speech but not related to particular immediate actions, regardless of whether the speech was social or private. Unlike the self-repairs produced by children in the 3-year-old classroom, the classification of self-repairs produced by children in the 4-year-old classroom based on speech relevancy categories varied between social and private speech. Social speech self-repairs produced by children in the 4-year-old classroom did not differ by relevance category, but, importantly, private speech self-repairs produced by children in the 4-year-old classroom were categorized mostly as task-action-relevant.

At a broad level, the differences noted here are consistent with typical patterns of private and social speech noted by researchers. More task-relevant utterances, compared to task irrelevant utterances, tend to be produced in private speech compared to social speech (e.g., Winsler et al., 2003). Therefore, it might be expected that more utterances relevant to the task would occur in private speech. Nonetheless, it is still interesting that private speech self-repairs differed in the degree to which they were action relevant for those produced by 3-year-olds compared to those produced by 4-year-olds. This difference adds additional evidence for a shift in how private speech is used among 3- and 4-year-olds (Winsler, Carlton et al., 2000; Winsler, Diaz, Atencio, McCarthy, & Adams Chabay, 2000), with 4-year-olds using it more for task-action-relevant regulation and 3-year-olds using it more for general narration of on-task behavior. It is also possible–though not testable with the current data–this indicates more than just a shift in how private speech is used; it is possible this represents a shift in the aspects of private speech being monitored by preschoolers–from more general language (3-year-olds) to language specific to regulation (4-year-olds). What is clear from the data is that self-repairs, like other aspects of speech, seem to be different in the private speech produced by 4-year-olds compared to 3-year-olds.

Further, one significant trend for speech content emerged among private speech when self-repairs occurred in a delayed fashion. Nearly all of the delayed private speech self-repairs (which comprised a minority one-third of all private speech self-repairs) occurred during task-action-relevant speech. None of the delayed private speech self-repairs were coded as task irrelevant and very few were coded as generally task relevant. Because utterances from 4-year-olds were found to be mostly task-action-relevant, it might be argued that more delayed private speech self-repairs were coded as task-action-relevant simply because more of these utterances were produced by 4-year-olds. A look at these data indicates that 3- and 4-year-olds produced similar amounts of delayed private speech self-repairs (41% and 59% of the total delayed private speech, respectively), suggesting that the difference is not simply associated with number of delayed private speech self-repairs produced by each age group. However, a closer inspection indicates the distribution of delayed private speech self-repairs by speech categories is not similar for 3- and 4-year-olds. Almost all of the delayed private speech self-repair utterances produced by 4-year-olds were categorized as task-action-relevant (90%), while those produced by 3-year-olds were categorized similarly as task-action-relevant (57%) and task-relevant (43%).

A method for determining whether the differences noted among delayed private speech self-repairs were simply the byproduct of overall private speech differences as previously suggested (e.g., 4-year-olds use more task-action-relevant speech in general, therefore produce more task-action-relevant private speech self-repairs) or whether they are unique to this type of speech (e.g., 4-year-olds use disproportionately more task-action-relevant private speech self-repairs) would be to compare the type of speech produced by 4-year-olds repaired in a delayed fashion with the type repaired in an immediate fashion. If self-repairs reflect overall private speech use, the content of private speech repairs should be similar for those repaired in either a delayed or immediate fashion. If self-repairs do not reflect overall private speech use, the content of private speech repairs should be different for those repaired in a delayed and immediate fashion. What we found was that the private speech self-repairs produced by 4-year-olds in an immediate fashion consisted of 64% task-action-relevant utterances, 21% task-irrelevant utterances, and 14% general task-relevant utterances. When this distribution of immediate private speech self-repairs produced by 4-year-olds is compared to the distribution of delayed private speech self-repairs produced by 4-year-olds, clear differences emerge: almost all of the delayed private speech self-repairs are task-action-relevant (90%) while less than two thirds of the immediate private speech self-repairs are task-action-relevant (64%). This suggests that something is different about why 4-year-olds repair private speech in a delayed fashion compared to an immediate fashion. One suggestion might be that this difference is the result of multiple methods of speech monitoring available to 4-year-olds.

For example, it may be that preschool children monitor all of their private speech at an automatic level prior to articulation. This would explain why patterns in immediate private speech self-repairs seem to follow typical private speech patterns. However, after private speech is articulated, older preschool children may note discrepancies between the speech they used (e.g., "I need the red one") and the actions they made based on non-verbal cognitive systems (e.g., reaching for a blue one) or the subsequent sensory information they gather from the task (e.g., visual information indicating the blue one is correct). Correcting such discrepancies would result in delayed self-repairs (e.g., ". . .uh–blue one"). Since visual sensory information gathered from the task and actions based on non-verbal cognitive systems are both likely to be highly task-action-relevant, it is not surprising there is an over-representation of task-action-relevant delayed utterances in private speech self-repairs produced by 4-year-olds. If children's goals for using private speech are to help them regulate task-directed behavior and be more successful on the task (Winsler et al., 1997), then it is not surprising that older preschool children find it important and possibly beneficial to repair incongruencies between their thoughts about the actions needed and the words they overtly say.

Such an interpretation also suggests some level of awareness of private speech production by 4-year-olds. In order for 4-year-olds to use sensory input from the task, compare it to their private speech, and make a delayed self-repair, they need to be aware that they are using private speech and aware of the content in

their private speech, and then compare that to the information they are gathering from the task itself. Such an interpretation does not preclude younger children from having awareness of their private speech – they also use delayed private speech self-repairs – but with no data to differentiate their delayed private speech self-repairs from their immediate private speech self-repairs, it is impossible to speculate that they do. Research exploring preschool children's awareness of their private speech (Manfra & Winsler, 2006) suggests that 3-year-old children are not likely aware of their private speech use, while most 4-year-old children are aware of their private speech use. These findings are consistent with the present notion that differences in how 4-year-olds repair their private speech compared to 3-year-olds might reflect increased awareness and conscious monitoring of private speech.

Like most studies exploring components of naturally produced private speech of young children in a controlled environment, this study has limitations resulting from individual variation in the number of speech utterances produced by children under these conditions, which has the potential to limit generalization of the findings. As such, several steps were taken to decrease the potential for biased findings. First, like many researchers exploring speech variation using similar designs, we explored the data at the utterance level. Fortunately, we had a very high rate of contribution to our speech corpora as all but one child produced speech during the tasks, indicating that nearly all of the children contributed to the utterances analyzed. Second, we systematically explored child and task factors in a series of child-level analyses and found very little between-person variation in utterances, errors, and self-repairs based on these characteristics suggesting that our utterance-level analyses were appropriate and unbiased. Comparisons of task factors that may have influenced the findings similarly did not yield much evidence of bias. Performance on the selective attention task was higher than performance on the Lego construction task, but this was consistent across children suggesting that it is more likely the result of the Lego construction task being more involved and having a more intricate performance coding scheme than bias. As might be expected given that the same task difficulty was used for all children, task performance was higher for older preschoolers compared to younger preschoolers, but no other child factor differentiated performance with age groups. Finally, the only Time 1 to Time 2 change uncovered was that total utterances decreased on the SA task and increased on the LC task, but there was no evidence of developmental changes in speech errors or self-repairs, which were the focus of the utterance-level analyses, between Time 1 and Time 2.

Overall, the results of this study suggest that it is useful to examine children's private speech for errors and repairs and that young children do appear to attend to and monitor their private speech as well as their social speech. Additionally, this study provides some evidence that studying repair data in private speech can help researchers uncover more about the development of private speech and differences in the ways in which 3- and 4-year-olds use and monitor their private speech. For instance, it is possible that younger preschool children are not aware they can actively monitor and repair the content of their private speech post-articulation based on other information gathered while completing the task. Such a difference in use and understanding of private speech might be a reason younger preschool children are less able to use their private speech effectively as a tool for self-regulation. While we did not find a broad association between proportion of utterances with self-repairs and child task performance, it is still possible that self-repairs do make or reflect a difference in performance at a microgenetic level. Though these differences may not be seen in our global task performance measures (likely due to the overall low percent of self-repairs in general), it is nonetheless important for future research to explore these differences at an item or within-item level. If researchers reveal associations between repairs and actions leading to more accurate responding at a small (item, within-item) level, this would provide valuable information for training programs designed to increase the effectiveness of children's private speech use while working on goal-directed tasks. Such research will also benefit by including other factors such as language experience or speech internalization, which might help explain when, how, and why children repair private speech errors.

Finally, we believe the findings from this study can help inform the practices of caregivers and professionals working with preschool children. Recognizing that it may be important for children to repair their own private speech, caregivers and professionals might find ways to model speech repair behavior and encourage children to engage in more systematic monitoring of their own speech particularly for consistency with their intended plan or goal. Disconnection between private speech and task behavior has been observed in studies of children with problems of self-regulation, such as children at risk for or diagnosed with ADHD (Winsler, 1998; Winsler, Diaz et al., 2000). It is possible that such children may have difficulty monitoring and repairing their private speech. Exploration of this possibility in future research can add to the understanding of how private speech relates to task behavior. Similarly, caregivers and professionals may also find it useful to listen to children's private speech for self-repairs when trying to develop an understanding of how and why children are using private speech. It is likely that the amount and type of self-repairs children use may provide insight into the extent to which private speech is being used effectively for self-regulation. For example, a child who makes no self-repairs despite clear inconsistencies between goals and actions may not benefit as much from their private speech as a child who makes many self-repairs to correct for incongruent statements between his/her goals and actions.

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