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Now, Pay Attention! The Effects of Instruction on Children's Attention

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Abstract

We investigated the effects of instructions to "stay on task" on preschoolers' attention and cognitive performance in the face of either incomprehensible or comprehensible distraction. Three- and 4-year-olds completed problem-solving tasks while a distracting event played continuously in the background, under conditions of (a) no instruction, (b) moderate instruction, or (c) frequent instruction to "stay on task." Under conditions where an incomprehensible distractor was present, *any* amount of instruction reduced looking to the distracting event. Under conditions where a comprehensible distractor was present, however, frequent instruction was the most effective in increasing looking to the task and decreasing looking to the distracting event.

Attention is a complex and multidimensional construct. Researchers have been interested recently in the development of an endogenous, voluntary, top-down-regulated form of attention that emerges late in the first postnatal year and develops rapidly during the second and third years (Colombo, 2001; Colombo & Cheatham, 2007; Courage, Reynolds, Richards, 2006; Ruff & Capozolli, 2003; Ruff & Rothbart, 1996). The ability to hold and maintain attention, especially under conditions where distraction is present, is crucial for learning and problem solving in natural environments (e.g., Choudhury & Gorman, 2000; Frick & Richards, 2001; Kannass & Colombo, 2007; Kirkham, Cruess, & Diamond, 2003; Oakes & Tellinghuisen, 1994). Endogenous attention is often conceptualized in terms of everyday constructs like distractibility, attention span, perseverance, and persistence (Colombo, 2001; Colombo & Cheatham, 2007). The goal of the present study was to investigate whether attention can be influenced by verbal instruction. In particular, we investigated how instruction to stay on task and ignore a distracting event affected young children's attention and task performance.

In infancy and early childhood, endogenous attention is often studied through the use of distractibility and free-play paradigms (e.g., Choi & Anderson, 1991; Hale & Flaugher, 1977; Kannass & Colombo, 2007; Kannass, Oakes, & Shaddy, 2006; Lansink, Mintz, & Richards, 2000; Lansink & Richards, 1997; Oakes & Tellinghuisen, 1994; Ruff & Capozzoli, 2003; Ruff & Lawson, 1990; Turnure, 1970). In these paradigms, there is competition for the child's attentional focus. For example, in the distractibility paradigm, the child is presented with a target task (e.g., playing with a toy, putting together a puzzle, a

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television program), and while the child is attending to the task, a multimodal event (e.g., a children's television program, pictures, computer images) is presented in the periphery, with the intent of distracting the child's attention from the task at hand (e.g., Choi & Anderson, 1991; Oakes & Tellinghuisen, 1994; Ruff & Capozzoli, 2003). Measures of attention and distractibility include the child's maintenance of attention to the task, and the frequency and duration of the child's looking to the distracting event. Relevant to the present project are studies on developmental change and the influence of the context on attention. Research using the distractibility paradigm has shown a developmental progression in children's endogenous attention, when the target task is object-based (in contrast to a television program or movie). For example, resistance to distraction increases between 10 and 42 months (Ruff & Capozzoli, 2003) and from 4 through 8 years of age (Holtz & Lehman, 1995). When dynamic visual stimuli (e.g., children's television programs or movies) are used as the target task and as distractors, however, there were no age differences in distractibility between 6 and 24 months (Richards & Turner, 2001) and 3 and 5 years (Anderson, Choi, & Lorch, 1987). These differences across studies may be due to differences in the nature of the target task; object based tasks may elicit more goal-directed, manipulative, or interactive activity, and developmental differences in distractibility may be more evident here.

Distractibility research has also revealed that features of the distractibility context affect attention, from infancy through adulthood. The characteristics of the distractor (e.g., auditory and visual components, complexity) has been shown to affect distractibility in infants (e.g., Oakes, Tellinghuisen, & Tjebkes, 2000; Tellinghuisen et al., 1999; Ruff & Capozzoli, 2003). In the preschool years and adulthood, the manner in which the distractor is presented affects attention and performance. Specifically, distractors can be characterized as being intermittent (i.e., periodic) or continuous (i.e., constant) in nature. Recent research has shown that intermittent and continuous distraction has differential effects on 3.5- and 4-year-olds' attention and performance (Kannass & Colombo, 2007). The preschoolers received cognitive tasks to complete (e.g., assembling puzzles, matching identical cards, coloring, building with Legos) under conditions of no distraction, intermittent distraction, or continuous distraction. 3.5-year-olds were susceptible to any kind of distraction; task performance and attention were impaired during both intermittent and continuous distraction. Older children were less susceptible to distraction; children's task performance and attention decreased during the continuous distraction condition. These developmental differences are consistent with changes in inhibitory control that have been reported to occur primarily between 3.5 and 4.5 years of age (e.g., Diamond & Taylor, 1996; Gerstadt, Hong, & Diamond, 1994; for a review see Diamond, 2002). Moreover, the preschoolers in the intermittent and continuous distraction conditions exhibited different patterns of attention to the distractor over time; preschoolers habituated to the intermittent distractor but not to the continuous distractor. The decrease in attention to the intermittent distractor is consistent with other infant and early childhood research with intermittent distraction (e.g., Hale & Flaugher, 1977; Oakes et al., 2000; Tellinghuisen & Oakes, 1997).

The study of the development of distractibility has been exclusively conducted under conditions where young children are expected to attend spontaneously; that is, they are given no instruction as to whether they should try to ignore distractions, or to where they might direct their attention. Parents and teachers commonly expect that young children will be able to use prompts to maintain attention, but the topic of when children are capable of incorporating explicit task demands on attentional performance has received little investigation.

We sought to determine when verbal instruction about the task or setting contributes to children's ability to stay on-task or to maintain attentional focus in settings where distraction occurs. Although the research on how instruction affects attention is limited, it is well known that instruction and/or knowledge about the purpose of one's task impacts children's memory. For example, when children as young as 3 to 5 years are instructed to remember or direct their attention to a subset of stimuli, they interact with the stimuli in different manner and recall more than control groups (Baker-Ward, Ornstein, & Holden, 1984; Field & Anderson, 1985; Wellman, Ritter, & Flavell, 1975).

Little is known, however, about how such external constraints affect the distribution of attention, despite evidence that suggests young children's attention may in fact be susceptible to such influence. For example, when children between 3 and 9 years of age are given restrictive instructions (e.g., instructed to play with one toy, or to not leave their seat), they display less gross motor movement and change toys less often (Routh, Schroeder, & O'Tuama, 1974). In addition, when 5-, 8- and 12-year-olds are given substantial tutoring (1/2 hour of instruction as well as reminders during the task) about meta-attention and ignoring background music, even young children performed better on certain tasks (Kaniel & Aram, 1993). Even infants appear to be influenced by task "instructions." Jankowski, Rose, & Feldman (2001) showed that 5-month-old infants who normally scan small areas of a display can be induced to scan more broadly when a "spotlight" highlighted quadrants of the display; indeed, the spotlight experience facilitated information processing. Therefore, early attention is malleable.

The goal of the current study was to investigate the effects of verbal instruction on attention and performance during the preschool years. This study is important for three reasons. First, it addresses the issue of when, and under what conditions, young children are capable of incorporating explicit task demands on attentional performance; as noted previously, this topic has been largely unexplored. Manipulation of these variables will make important contributions to our basic understanding of attention and have important implications for how parents, teachers, and child-care providers interact with small children. Second, previous distractibility research has not investigated whether the nature of the distractor interacts with the effect of such verbal instruction. An important parameter of the distractor is its comprehensibility; research on television viewing suggests that 3- and 5-year-olds attend more to comprehensible television than to incomprehensible television (i.e., Sesame Street dubbed in a foreign language or with backward speech) (Anderson, Lorch, Field, & Sanders, 1981), and so we might expect that a comprehensible distractor would be far more salient or attractive and thus provide a higher level of distractibility. Moreover, as a secondary goal, we also were interested in how attention may change over the course of the session during incomprehensible and comprehensible distraction. Based on television research showing that young children attend more to comprehensible television and that a comprehensible distractor may be more salient or attractive, children in the different distractibility conditions may exhibit different patterns of attention as the session progressed. For example, if a comprehensible distractor is more salient or more interesting, the total amount of looking may remain high or even increase, in comparison to the total amount of looking to an incomprehensible distractor. However, the comparison of comprehensible and incomprehensible distractors on attention has never been directly conducted. In the present experiment, we studied the effects of both incomprehensible and comprehensible distraction on preschoolers' attention to the task, task performance, and looking to the distractor.

Lastly, this study investigated distractibility during the early preschool period, an important period of development that is marked by developmental change in attention and executive functions. For example, recall the developmental differences in how 3.5- and 4-year-olds resisted intermittent and continuous distraction (Kannass & Colombo, 2007). In addition, important developmental change in other endogenous (i.e., internal, top-down) functions, such as inhibitory control and executive functioning, occurs during the preschool period (Jones, Rothbart, & Posner, 2003; Diamond & Taylor, 1996; Gerstadt et al., 1994). Moreover, as young as 3 to 5 years, young children's behavior appears to be influenced by the presentation of task instruction (e.g., Kaniel & Aram, 1993; Routh et al., 1974; Wellman et al., 1975), and 3- and 4-year-olds appear to recognize that noise inhibits learning (Miller & Zalenski, 1982). Recognizing disruptions as detrimental to performance may lead to adapting one's attentional style to meet situational demands. Thus, the current project seeks to help us understand the development of endogenous attentional control and how young children allocate their attention in the midst of distraction during a period of marked change.

Children worked on four cognitive tasks (Legos, puzzles, matching, coloring), one at a time, while an incomprehensible or comprehensible distractor played continuously in the background. Children were randomly assigned to one of three instruction conditions: No instruction, moderate instruction, frequent instruction.

Method

Participants

Existing databases of families in the metropolitan Chicago and greater Kansas City, Kansas area were used to recruit participants, and data collection took place at two testing sites, first in suburban Kansas City and then second in Chicago. 178 healthy preschoolers from English-speaking families participated in this project. 18 preschoolers did not contribute data in the distractibility task due to participant refusal/shyness (n = 4), maternal interference (n = 1), or experimenter error/technical difficulty (n = 13). Families received a letter describing the study and a follow up phone call, and children received token prizes for participating.

Children from the greater Kansas City, KS area participated in the incomprehensible condition (the language spoken in the distractor was Spanish), and all children were English speakers and were from non-Spanish-speaking homes. There were 42 3-year-olds (21 males) in the Kansas sample, and the average age at testing was 3.30 years (*SD* = .07); there were 42 4-year-olds (20 males) in the Kansas sample, and the average age at testing was 4.36 years (*SD* = .13). The majority of the children were Caucasian, and out of the families who provided demographic information, 78 children were classified as being Caucasian, 4 children were classified as being Hispanic, and 1 child was classified as being American Indian. The average number of years of maternal education was 15.85 (*SD* = 1.81), and the average number of years of paternal education was 15.71 (*SD* = 1.97).

Children from the metropolitan Chicago area participated in the comprehensible condition (the language spoken in the distractor was English), and all children were English speakers. There were 34 3-year-olds (23 males) in the Chicago sample, and the average age at testing was 3.25 years (*SD* = .06); there were 42 4-year-olds (22 males) in the Chicago sample, and the average age at testing was 4.21 years (*SD* = .09). The majority of the children were Caucasian, and out of the families who provided demographic information, 60 children were classified as being Caucasian, 7 children were classified as being Hispanic, 2 children were classified as being African American, and 4 children were classified as being Asian. The average number of years of maternal education was 16.45 (*SD* = 2.12), and the average number of years of paternal education was 16.27 (*SD* = 2.37).

In general, the two cohorts are appropriately comparable. The age at testing is highly similar at both 3 (3.30 and 3.25 years) and 4 (4.36 and 4.21) years of age. The parents had similar years of education. Kansas City, KS (KC) and Chicago (C) are relatively diverse ethnically and racially according to 2000 U.S. Census Bureau reports (White persons, percent: 55.8%

KC, 42% C; Black persons, percent: 30.1% KC, 36.8% C; persons of Hispanic descent, percent: 16.8% KC, 26.0% C; Asian persons, percent: 1.7% KC, 4.3% C; American Indian and Alaska Native persons, percent: .8% KC, .4% C) (U.S. Census Bureau). Children in Chicago may be exposed to more Spanish language and Hispanic culture, given the differences in percentage of persons of Hispanic descent in the census data (16.8% KC, 26.0% C), but because all children in the Chicago cohort were in the comprehensible distractor condition and were all English speaking, this likely did not affect how they understood the comprehensible distractor, which was in English. All children from the Kansas City cohort were in the incomprehensible condition, and importantly, they were English speakers *and* were from non-Spanish-speaking homes, thus assuring that the language of incomprehensible distractor, Spanish, was indeed incomprehensible.

Apparatus

Sessions were recorded using a Panasonic camcorder or camera. The distractors were presented on a 68.58 cm (27-inch) Panasonic video monitor (at the suburban Kansas City site) and a 81.28 (32-inch) LG LCD wide screen television monitor (at the Chicago site) using Panasonic-VCR and DVD players. Similar to Anderson et al. (1987) and Choi and Anderson (1991), the monitor was located to the child's right and was approximately .91m (3 feet) from and at a 90° angle to the child. A video camera and microphone were focused on the child was located approximately 1.83 meters (6 feet) from the child. A mirror was located on the wall behind the child and was positioned to capture the reflection of the distractor and thus be recorded on videotape for coding purposes.

Stimuli

There were two types of stimuli (target tasks and distractors) used in the distractibility task, which was designed to be similar to those used previously with children (e.g., Anderson et al., 1987; Choi & Anderson, 1991; Kannass & Colombo, 2007). The four *target tasks* were Legos™, puzzles, matching, and coloring, and children received task instructions prior to each task (see below). In the Legos™ task, each child received model buildings and the appropriate Legos™ for duplicating the model buildings, one at a time; the child's goal was to replicate the model building. In the puzzles task, each child received wooden puzzles, one at a time; the child's goal was to complete the puzzles. In the matching task, each child received small cards with pictures on them (e.g., boats, flowers, fruit, toys), one set at a time, and some of the cards matched and some did not; the child's goal was to place the matching cards together. In the coloring task, each child received coloring work sheets, one at a time; the child's goal was to color the spaces the appropriate color (i.e., color the space the same color as a dot in the center of each space). Each task was presented for equal duration (3 minutes each), with replacements provided each time a child finished one instance of the task. For example, in the Lego task, when a child completed a building, he received a new model and the appropriate Legos for duplicating it. Thus, the experimenter kept the child occupied with a given task (e.g., building) for three minutes.

There were two distractors, incomprehensible and comprehensible. The *incomprehensible* distractor consisted of continuous presentation of 5-second randomly ordered segments from a children's television show in Spanish. Thus, the distractor presented incomprehensible audio and visual information (i.e., there was no audio or visual story information to follow and the children were from non-Spanish-speaking homes); this distractor was the same as the continuous distractor in Kannass and Colombo (2007), and it was used at the first data collection site, suburban Kansas City. The *comprehensible* distractor was the same children's television show, but in English and played in the normal sequence; this distractor was used at the second data collection site, Chicago.

Procedure

Children were seated at a child-sized table, and the child's parent was seated in the same room, behind and to the child's left, out of the child's sight. Children were randomly assigned to each of the three conditions: Moderate instruction, frequent instruction, or no instruction. In the moderate and frequent instruction condition, children received specific instruction to not look at the distractor/television. In the moderate instruction condition, children were told to not look at the distractor one time per trial, at the start of each trial, and in the frequent instruction condition, children were told to not look at the distractor three times per trial (at the start of each trial, at 60 seconds into the trial, and at 120 seconds into the trial). For example, at the start of trial 1, children in moderate and frequent instruction conditions received their first instruction. At this time the experimenter said, “We are going to play some games with some fun toys!I want you to show me how well you can play. I'm going to give you some toys, and I want you to work really hard at playing with the toys. This tv is going to come on with some silly stuff, but I want you to keep playing with the toys, and don't [experimenter shook her head no] look at the tv. Remember, your job is to play with the toys and don't [experimenter shook her head no] look at the tv.” In both the moderate and frequent instruction condition, all future instruction consisted of the experimenter saying, “Play with the toys, and *don't* [experimenter shook her head no] look at the tv.” Children in the no instruction condition received no special instruction regarding the distractor/television. All children in all conditions received the task directions described in the following section.

Children received each of the 4 tasks (Legos™, puzzles, matching, coloring), and the duration of each task was 3 minutes. Task durations were timed using a hand-held stopwatch. The order of the tasks was counterbalanced across children. The experimenter introduced each task by explaining the task specific directions. For example, in the Legos™ task, she said, “Now it's time for the Lego™ game. See this cool building? This is my building. Can you use these Legos™ [giving the child the appropriate Lego™ pieces] to make your building look just like mine? Your building should look the same as mine. When you are all done with this one, I'll give you some more Legos™ and another building.” Children worked independently on the games, and the experimenter kept her interactions to a minimum. For each task, items were replaced on completion (e.g., when children finished a puzzle, they received another one). After the experimenter presented each toy, she used a remote to start the distractor. At the end of each trial, the experimenter said, “You did a great job playing that game,” stopped the distractor, collected the toys, and then began the next trial.

Measures and Coding

The measures consisted of a task performance score and measures of attention and distractibility (e.g., looking to the task and looking to the distractor).

Task score—After testing, children's performance on each of the tasks was recorded on a scoring sheet. Specifically, the Lego task score was the sum of correctly placed Legos™ (i.e., after testing, the child's buildings were compared to the corresponding models, and the number of correctly placed Legos were calculated) (M = 17.65, SD = 5.89). The puzzle task score was the sum of correctly placed puzzle pieces (i.e., the number of pieces placed in their correct locations) (M = 17.90, SD = 6.08). The matching score was the sum of correct matches (i.e., matches were cards with the same picture) (M = 6.59, SD = 3.96). The coloring score was sum of correctly colored segments (i.e., the number of spaces children colored correctly) (M = 5.94, SD = 4.32). To assess each child's total task performance, a composite score of performance across the tasks (consisting of the total sum across tasks) was calculated, as in Kannass and Colombo (2007). Because we were interested in how instruction to stay on task and ignore the distractor influenced how much work children completed, we used the total amount of work completed, although the differences in completion rates are a limitation.

Attention coding—We used the duration of looking to the task as an indicator of how long children hold or sustain their attention to a stimulus. Previous research on attention in a distractibility context has used duration of looking, duration of play episodes, and duration of focused attention as indicators of how children maintain their attention to a task in the midst of competition for attentional focus (Choi & Anderson 1991; Kannass & Colombo, 2007; Schmidt et al, 2008), and previous research on attention during free play has shown that typically developing children maintain their attention for longer durations than do children with attentional problems (DeWolfe, Byrne, & Bawden, 2000; Roberts, 1990). Coders (who were unaware of the hypotheses of the research) watched the session and recorded duration of looking to the task (i.e., the duration of looking at the task materials, e.g., puzzles, coloring, etc.) using the program Habit (Cohen, Atkinson, & Chaput, 2004). Coders pressed a key on a MacIntosh computer and held the button as long as the child looked at the task. An individual look was defined being one second or longer in duration. Looks to the toy that were separated by a very short look away (i.e., less than 1 second in duration) were combined. Reliability for each behavior was assessed by correlating the duration of each individual look as recorded by the two coders. At each age, for each task, two coders recorded the behavior for at least 25% of the sample coded for that measure. The average interobserver reliability was .99 for duration of individual looks (mean difference = .77 s). From this record of coding, it was possible to calculate the mean duration for looks to the toy and the total amount of looking.

Looking to the distractor/TV—We used the duration of looking to the distractor/TV as an indicator of how long children attended to the distractor, consistent with previous research (e.g., Kannass & Colombo, 2007; Schmidt et al., 2008). Coders also recorded the amount of looking to the distractor/TV by pressing a key on the computer. An individual look to the distractor/TV was defined being one second or longer in duration. Looks that were separated by a very short look away (i.e., less than 1 second in duration) were combined. The mean durations for looks and total duration of looking to the television were calculated. Reliability for at least 25% of the sample was good, $r = .99$ (mean difference = .36 s). From this record, we calculated the mean duration for looks to the distractor/TV and the total amount of looking to the distractor/TV.

Results

We had three goals in our analyses. First, we examined the effects of distractor comprehensibility, age, and the different amounts of instruction on three measures: Task performance, the average length of looks to the tasks, and the average length of looks to the distractor. We conducted separate ANOVAs on each measure, with between-subject factors of Distractor (2: Incomprehensible, vs. Comprehensible), Age (2: 3 vs. 4 years) and Instruction (3: No Instruction, Moderate Instruction, and High Instruction).

Second, we were interested in how the total amount of looking to the task and the total amount of looking to the distractor may change over the course of the session as a function of distractor comprehensibility. To do so, we divided the session into two blocks (i.e., we divided the session in half); Block 1 consisted of behavioral responding in trials one and two (the first half of the session), and Block 2 consisted of behavioral responding in trials three and four (the second half of the session). Previous distractibility research has shown that the duration of the distractor (constant or periodic distraction, i.e., the amount of competition for attentional focus) affects how preschoolers attend to it over time; preschoolers habituated to periodic distraction but not to constant distraction (Kannass & Colombo, 2007). In addition, children attend longer to comprehensible television than to incomprehensible television (Anderson et al., 1981). We expected that a comprehensible distractor may be more salient or attractive and expected that children would exhibit contrasting patterns of attention to comprehensible and incomprehensible distractors across the session (Block 1 to Block 2). We reasoned that if a comprehensible distractor is more salient or more interesting, the total amount of looking may remain high or even increase, in comparison to the total amount of looking to an incomprehensible distractor.

Third, we examined the relations between task performance and measures of attention. Previous research has shown relations between children's task performance and measure of attention (Kannass & Colombo, 2007).[1]

The Effects of Distractor Comprehensibility, Age, and Instruction

Task Performance—The analysis examining the effects of distractor comprehensibility, age, and amount of instruction on task performance revealed a main effect of Distractor, $F(1, 148) = 55.68$, $p < .01$, $\eta_p^2 = .27$, and a main effect of Age, $F(1, 148) = 69.44$, $p < .01$, $\eta_p^2 = .32$. Overall, children had lower task scores when the distractor was comprehensible ($M = 40.05$, $SE = 1.43$) than when it was incomprehensible ($M = 54.70$, $SE = 1.35$). Four-year-olds ($M = 55.56$, $SE = 1.35$) had higher task scores than did 3-year-olds ($M = 39.19$, $SE = 1.43$). A marginal Instruction × Age interaction, $F(2, 148) = 2.77$, $p = .07$, $\eta_p^2 = .04$, was attributable to 4-year-olds in the frequent-instruction condition tending to have the highest performance scores.

To explore whether the effects of distraction language and type of instruction were the same for each task, we conducted a mixed-model ANOVA with Task (4: Puzzles, Coloring, Legos, Matching) as the within-subjects factor and Distractor (2: Incomprehensible, vs. Comprehensible), Age (2: 3 vs. 4 years) and Instruction (3: No Instruction, Moderate Instruction, and High Instruction) as the between subjects factors. We first standardized the sores by computing a z score for each child's performance in each task and entered the z scores into the analysis. The results were generally consistent with the analysis of the overall raw task scores. There was a main effect of Distractor, $F(1, 148) = 55.94$, $p < .01$, $\eta_p^2 = .27$, a main effect of Age, $F(1, 148) = 67.24$, $p < .01$, $\eta_p^2 = .31$, and a marginal Instruction × Age interaction, $F(2, 148) = 2.50$, $p = .09$, $\eta_p^2 = .03$. Children had lower task scores when the distractor was comprehensible, and 4-year-olds had higher task scores. There was no main effect of Task, $F(3, 146) = .01$, *ns*. There was a Task × Age interaction, $F(3, 146) = 6.49$, $p < .01$. We then examined age differences and set alpha to $p = .0125$ to control for family-wise error. 4-year-olds had higher scores for the puzzle task, $t(158) = 5.34$, $p < .01$, the Lego task, $t(158) = 6.92$, $p < .01$, and the matching task, $t(158) = 6.48$, $p < .01$, but not the coloring task, $t(158) = 2.02$, $p = .04$. There were no other main effects or interactions. In summary, the effects of distraction language and type of instruction were the same across tasks.

Length of Looks to Task—Next, we examined the effects of distractor comprehensibility, age, and the different amounts of instruction on the average length of individual looks to the task (see Tables 1 and 2). This analysis yielded significant main effects for Distractor, $F(1, 148) = 46.84$, $p < .01$, $\eta_p^2 = .24$, Age, $F(1, 148) = 10.70$, $p < .01$,

[1]We had no theoretically driven hypotheses for gender differences, and preliminary analyses revealed no main effects of gender. In these preliminary analyses, there were a small number of gender interactions (e.g., 3 and 4-way interactions), but they are difficult to interpret and are not meaningful given the small number of children in each individual cell; for example, at 3 years of age, there are 4 females in the no instruction and moderate instruction conditions and 3 females in the frequent instruction condition for the comprehensible distractor. Thus, gender was not included in the final analyses.

$\eta_p^2 = .07$, and Instruction, $F(2, 148) = 4.34$, $p < .05$, $\eta_p^2 = .06$, and a significant Distractor × Instruction interaction, $F(2, 148) = 4.40$, $p < .05$, $\eta_p^2 = .06$. However, these main effects and interactions were all qualified by a significant three-way Distractor×Age × Instruction interaction, $F(2, 148) = 3.16$, $p < .05$, $\eta_p^2 = .04$. We decomposed this interaction by conducting Instruction ×Age ANOVAs for each of the two Distractor groups.

The analysis for the Incomprehensible Distractor group yielded a main effect of Age, $F(1, 78) = 10.49$, $p < .01$, $\eta_p^2 = .12$, that was qualified by an Age × Instruction interaction, $F(2, 78) = 3.14$, $p < .05$, $\eta_p^2 = .08$ (see Table 1 for individual cell means). There were no differences in looking to the task as a function of instruction condition at 3 years of age, $F(2, 41) = .83$, *ns*, but at 4 years of age, looking to the task tended to vary across conditions, $F(2, 41) = 3.11$, $p = .056$, $\eta_p^2 = .14$. Least Squares Difference (LSD) post hoc analyses revealed that children in the moderate instruction group had significantly longer looks to the task than did children in the frequent instruction condition ($p < .05$) and marginally longer looks to the task than did children in the no instruction condition ($p = .10$). Thus, when the distractor was incomprehensible, moderate amounts of instruction facilitated looking to the task; high levels of instruction proved to be as ineffective as no instruction at all.

The analysis for the Comprehensible Distractor group revealed only a significant main effect of Instruction, $F(2, 70) = 6.95$, $p < .01$, $\eta_p^2 = .17$ (see Table 2 for individual cell means). LSD post hoc analyses revealed that children in the frequent instruction condition had significantly longer looks to the task than did children in the moderate and no instruction conditions ($p \le .01$); there was no difference in looking to the task between the no instruction and moderate instruction conditions. Thus, in contrast to the incomprehensible distractor group, where moderate instruction was most effective in reducing distractibility, frequent instruction was the most effective in facilitating attention to the task here.

Length of Looks to Distractors—Next, we examined the effects of distractor comprehensibility, age, and the different amounts of instruction on the average length of individual looks to the distractor/television (see Tables 1 and 2). This analysis yielded main effects for Distractor, $F(1, 148) = 53.45$, $p < .01$, $\eta_p^2 = .26$, Age, $F(1, 148) = 8.44$, $p < .01$, $\eta_p^2 = .05$, and Instruction, $F(2, 148) = 8.12$, $p < .01$, $\eta_p^2 = .10$. These main effects were qualified by significant Distractor × Age, $F(1, 148) = 5.01$, $p < .05$, $\eta_p^2 = .03$, and Distractor × Condition, $F(2, 148) = 3.32$, $p < .05$, $\eta_p^2 = .04$, interactions.

To decompose the Distractor × Age interaction, we conducted independent samples t-tests comparing the average length of individual looks to the distractor/television for 3- and 4-year-olds in each of the two Distractor groups. The analysis for the Incomprehensible Distractor group revealed no age differences, $t(82) = 1.15$, *ns*; 3- ($M = 3.62$, $SE = .49$) and 4-year-olds ($M = 2.86$, $SE = .45$) exhibited looks to the distractor that were similar in length. In contrast, the analysis for the Comprehensible Distractor group revealed an age difference, $t(74) = 2.43$, $p < .02$. Three-year-olds ($M = 14.79$, $SE = 2.09$) exhibited significantly longer looks to the comprehensible distractor than did 4-year-olds ($M = 8.84$, $SE = 1.41$).

To decompose the Distractor × Condition, we conducted one-way ANOVAs using Instruction as the between subjects factor for each Distractor group. The analysis for the Incomprehensible group was significant, $F(2, 81) = 8.99$, $p < .01$, $\eta_p^2 = .18$. LSD post hoc analyses revealed that children in the no instruction condition ($M = 5.05$, $SE = .53$) had significantly longer looks to the distractor/TV than did children in the moderate ($M = 2.13$, $SE = .53$) ($p < .01$) or frequent ($M = 2.53$, $SE = .53$) ($p < .01$) instruction conditions; there was no difference in looking to the distractor between the moderate and frequent conditions. Thus, both moderate and frequent amounts of instruction reduced distractibility in both age groups. In contrast, the analysis for the Comprehensible Distractor group revealed a different pattern, $F(2, 73) = 4.32$, $p < .05$, $\eta_p^2 = .11$. LSD post hoc analyses on the Instruction effect showed that frequent instruction ($M = 6.52$, $SE = 2.14$) significantly reduced the length of looking to the distractor/TV in comparison to moderate ($M = 12.52$, $SE = 2.10$, $p < .05$) or no ($M = 14.99$, $SE = 2.02$, $p < .01$) instruction; there was no difference in looking to the distractor between the moderate and no instruction conditions. Again, frequent instruction was the most effective in reducing attention to the comprehensible distractor.

Changes in Attention to the Task and Distractor over the Course of the Session

Total looking to the task—To investigate changes in behavior over the course of the session, we examined changes in total looking to the task between Block 1 (trials one and two) and Block 2 (trials three and four). An ANOVA was conducted on total looking time to the task with Block (2: 1 vs 2) as the within subjects factor and Distractor (2: Incomprehensible vs. Comprehensible), Age (2: 3 vs. 4 years), and Instruction (3: No Instruction, Moderate Instruction, and High Instruction) as the between subjects factors. The analysis revealed main effects for Distractor, $F(1, 148) = 121.23$, $p < .01$, $\eta_p^2 = .45$, Instruction, $F(2, 148) = 6.23$, $p < .01$, $\eta_p^2 = .08$, and Age, $F(1, 148) = 7.38$, $p < .01$, $\eta_p^2 = .05$. These main effects were qualified by a Distractor × Instruction interaction, $F(2, 148) = 4.83$, $p < .01$, $\eta_p^2 = .06$ and a Block × Distractor interaction, $F(1, 148) = 5.06$, $p < .05$, $\eta_p^2 = .03$; there was also a marginal Block × Distractor × Instruction × Age interaction, $F(2, 148) = 2.65$, $p = .07$, $\eta_p^2 = .03$. In order to provide a single follow-up to the Distractor × Instruction and Block × Distractor interactions, we conducted Block × Instruction ANOVAs for each of the two Distractor groups.

The analysis for the Incomprehensible Distractor group revealed only a significant main effect of Block, $F(1, 81) = 7.63$, $p < .01$, $\eta_p^2 = .09$; children exhibited an increase in total looking to the task between blocks 1 ($M = 262.32$, $SE = 4.89$) and 2 ($M = 276.28$, $SE = 4.65$). The analysis for the Comprehensible Distractor group showed that children exhibited a similar amount of looking to the task in blocks 1 ($M = 179.14$, $SE = 8.22$) and 2 ($M = 174.25$, $SE = 9.31$), $F(1, 73) = .47$, *ns*, but they exhibited different patterns of looking to the task across conditions, $F(2, 73) = 6.62$, $p < .01$, $\eta_p^2 = .15$. LSD post hoc analyses revealed that children in the frequent instruction condition ($M = 216.77$, $SE = 14.26$) exhibited longer looking to the task than did children in the moderate ($M = 166.03$, $SE = 13.97$, $p = .01$) or no instruction ($M = 147.30$, $SE = 13.44$, $p < .01$) conditions.

Total looking to the distractor/television—We were also interested in how attention to the distractor may change from the first half of the session (Block 1) to the second half of the session (Block 2). Recall that children look longer at comprehensible television than incomprehensible television (Anderson et al., 1981). We predicted that a comprehensible distractor may be more salient or attractive and expected that children would exhibit different patterns of attention to comprehensible and incomprehensible distractors across the session (Block 1 to Block 2). To investigate the influence of distractor comprehensibility on the total duration of looking to the distractor/television over the course of the session, a Block × Distractor × Age × Instruction ANOVA was conducted on total looking time to the distractor. The analysis revealed four main effects, Block, $F(1, 148) = 4.53$, $p < .05$, $\eta_p^2 = .03$, Distractor, $F(1, 148) = 87.32$, $p < .01$, $\eta_p^2 = .37$, Instruction, $F(2, 148) = 7.07$, $p < .01$, $\eta_p^2 = .09$, and Age, $F(1, 148) = 9.33$, $p < .01$, $\eta_p^2 = .09$. These main effects were qualified by three interactions, Block × Distractor, $F(1, 148) = 12.11$, $p < .01$, $\eta_p^2 = .08$, Distractor × Instruction, $F(2, 148) = 3.18$, $p < .05$, $\eta_p^2 = .04$, and Distractor × Age, $F(1, 148) = 6.53$, $p < .05$, $\eta_p^2 = .04$. In order to provide a single follow-up to the Block × Distractor, Distractor × Instruction, and Distractor × Age interactions, we conducted Block × Instruction × Age ANOVAs for each of the two Distractor groups.

The analysis for the Incomprehensible Distractor group revealed only a main effect of Block, $F(1, 78) = 3.98$, $p = .05$, $\eta_p^2 = .05$, due to children looking less to the incomprehensible distractor in block 2 (*M* = 17.18, *SE* = 3.82) than in block 1 (*M* = 22.62, *SE* = 4.09). The analysis for the Comprehensible Distractor group revealed a main effect of Block, $F(1, 70) = 8.07$, $p < .01$, $\eta_p^2 = .10$, but in the opposite direction. Here, children looked more to the distractor over the course of the session; children looked longer at the comprehensible distractor during block 2 (*M* = 124.83, *SE* = 11.13) than during block 1 (*M* = 102.25, *SE* = 9.87). The analysis also revealed a main effect of Instruction, $F(2, 70) = 5.20$, $p < .01$, $\eta_p^2 = .13$, due to children in the frequent instruction condition (*M* = 73.55, *SE* = 17.28) looking significantly less at the distractor/television than did children in the no instruction (*M* = 150.17, *SE* = 16.33) condition and marginally less than did children in the moderate instruction condition (*M* = 116.89, *SE* = 16.99). The main effect of Age, $F(1, 70) = 8.33$, $p < .01$, $\eta_p^2 = .11$ was due to 4-year-olds (*M* = 85.42, *SE* = 13.04) looking less at the distractor/television than did 3-year-olds (*M* = 141.65, *SE* = 14.48).

Relations Between Measures of Attention and Task Performance

Last, we examined the relations between measures of attention and task performance. For the Incomprehensible Distractor, task scores were correlated with more total looking to the task, $r(84) = .37$, $p < .01$, and less total looking to the distractor/TV, $r(84) = -.37$, $p < .01$. Similarly, for the Comprehensible Distractor, children who had higher task sores had more total looking to the task, $r(76) = .71$, $p < .01$, and less total looking to the distractor/TV, $r(76) = -.79$, $p < .01$. Thus, in both cases, less distractibility was related to higher cognitive performance; it is worth noting that the correlations are strikingly higher when the distractor was comprehensible. Indeed, we applied Fisher's z′ Transformation and Comparison between Independent Correlations, a test for the significant difference between two independent correlations (Cohen & Cohen, 1983) to test for significance here. The differences between the sets of correlations for the Comprehensible and Incomprehensible Distractor conditions were in fact significant. For looking to the task and performance correlations, this test yielded $z' = 3.04$, $p < .01$, and for the looking to the distractor and performance correlations this test yielded $z' = 4.24$, $p < .01$. Thus, the correlations between attention and performance in the comprehensible distractor groups were significantly stronger than those in the incomprehensible distractor. Of course, given the distinct cohorts participating in the two conditions, the difference observed in the magnitude of the correlations must be interpreted with caution.

Discussion

There are several key findings in the current project. First, the comprehensible and incomprehensible distractors influenced children's performance differently. In the comprehensible distractor context, attention to the distractor increased and looking to the task remained stable. In contrast, when the distractor was incomprehensible, attention to the distractor decreased and looking to the task increased over time.

In addition, task instructions had distinct impacts on children's attention in the two comprehensibility contexts. When the distractor was comprehensible, frequent instruction was the most effective in increasing attention to the task (both the average look length and the total amount of looking to the task) and decreasing attention to the distractor (again, both the average look length and the total amount of looking to the distractor). Also, 4-year-olds showed better resistance to comprehensible distraction (as indicated by shorter average looks to the distractor) than did 3-year-olds. When the distractor was incomprehensible, there was no influence of instruction on looking to the task at 3 years of age, but at 4 years of age, moderate instruction was the most effective. Also, any amount of instruction reduced the average length of looking to the incomprehensible distractor at both ages.

Last, the relations between task performance and the attention measures (looking to the task, looking to the distractor) were stronger in the context of comprehensible distraction. The current project contributes to our understanding of attention and distractibility in four important ways, as presented in the following sections.

First, the results show that at as young as three years of age, children are able to use explicit task instruction to guide their attention allocation. For example, both 3- and 4-year-olds decreased their attention to the distractor/TV when instructed to do so. For 3-year-olds who received instruction, their average length of looking to the distractor decreased by more than half (2.63 and 2.40 s in comparison to 5.84 s) to the incomprehensible distractor and by up to about 68%, with frequent instruction, (7.48 s in comparison to 22.91 s) to the comprehensible distractor. In the context of comprehensible distraction, both 3- and 4-year-olds were able to use the instruction to help sustain their attention to the task. At 3 years of age, the average length of looking to the task increased dramatically from 9.70 s with no instruction to 16.23 s with frequent instruction; similarly, the total amount of looking to the task increases from 139.40 s with no instruction to 179.59 s with frequent instruction at 3 years of age. Therefore, the present results suggest that in certain contexts, children as young as 3 years of age can use instruction to increase their attention to the task and decrease their attention to a distracting event.

It is interesting to note that while the study revealed some developmental change, there were relatively few age interactions. For example, 3-year-olds had lower performance scores in general and were less attentive to the task (e.g., shorter average look lengths and less total looking to the task). There was evidence, however, that preschoolers' attention to the distractor varies as a function of age and the comprehensibility of the distracting event. Three-year-olds were more susceptible to comprehensible distraction; when they could understand the distractor, they showed longer average look lengths and more total looking to the distractor/television. When the distractor was incomprehensible, 3-year-olds were just as resistant as 4-year-olds. This developmental change in resistance to distraction may be related to increases in inhibitory control, with some marked change occurring between 3.5 and 4.5 years of age (e.g., Diamond, 2002; Diamond & Taylor, 1996; Gerstadt et al., 1994).

Second, it appears that the effectiveness of the amount of instruction to preschoolers varies with the nature of environmental distraction. We found that *any* amount of instruction was effective in reducing children's average length of individual looks to the incomprehensible distraction, while only frequent instruction was effective in increasing attention to the task and reducing children's attention to the comprehensible distractor. Thus, when the distractor conveys comprehensible information, children needed more frequent reminders to stay on task and ignore the distracting event. These results add to a collection of research that shows that providing children with instruction and/or knowledge about the task facilitates their responding (Baker-Ward et al., 1984; Field & Anderson, 1985; Wellman et al., 1975). These results have important implications for parents, teachers, and care providers. Adults need to consider the kind of distracting event that is competing for a child's attention and scaffold their directions accordingly.

Third, the present study is the first to investigate how comprehensible and incomprehensible distractors affected children's attention and task performance. The results showed that the comprehensible distractor was more detrimental to task performance, looking to the task, and looking to the distractor. Moreover, children who worked in the midst of the incomprehensible distractor increased their looking to the task and decreased their looking to the distractor over the course of the session; in other words, they became more attentive to the task and increased their resistance to the distractor. Children who worked in the midst of the comprehensible distractor showed an opposite pattern; they became less attentive to the task and more distracted over the course of the session. Thus, young children are better able to resist incomprehensible distraction and maintain attention to the target task.

Moreover, given these differences, we suggest that the comprehensible distractor context may have been more challenging and that the differences in performance and attentional responding cannot be explained by the cohort differences alone. As discussed earlier (see the participants section for further details), the two cohorts were appropriately comparable in many ways, such as their age at testing, years of parent education, and, most importantly, their ability or inability to understand the comprehensible or incomprehensible distractor. Specifically, all children in the Chicago cohort were in the comprehensible distractor condition and were all English speaking; thus, the comprehensible distractor was in their native language and understandable to them. All children from the Kansas City cohort were in the incomprehensible condition, and importantly, they were English speakers and were from non-Spanish-speaking homes, thus assuring that the language of incomprehensible distractor, Spanish, was indeed incomprehensible. Thus, the present results are consistent with research on children's viewing of comprehensible and incomprehensible television. Specifically, Anderson et al. (1981) found that 2-, 3.5-, and 5-year-olds looked less at incomprehensible (e.g., foreign language dubbing, backwards dialogue) than comprehensible versions of Sesame Street, suggesting that children's ability to understand the content is a strong determinant of their television viewing. Therefore, the present results suggest that whether or not children understand a distracting event affects the degree to which it impedes their attention, task performance, and ability to resist the distraction.

Finally, children's task performance was directly related to their ability to sustain attention on task. Looking to the task was positively related to task performance; looking to the distractor was negatively related to task performance. This is entirely consistent with previous research which has shown similar relations between task performance and measures of looking to the task and looking to the distractor (Higgins & Turnure, 1984; Kannass & Colombo, 2007; Turnure, 1971). Interestingly, when children are in a more challenging attentional setting (e.g., comprehensible distraction), the association between attention and performance is significantly stronger. The association is likely to be stronger under comprehensible distraction because there is more variability in children's responding here. In other words, attention is a better predictor of performance under conditions where distractors are more challenging. Other work has shown that task performance was positively correlated with looking to the task, but only when a distractor was present, and negatively correlated with looking at a continuous distractor (Kannass & Colombo, 2007).

The idea that the relations between attention and performance are stronger in a challenging attention context and the effects of distraction on attention and performance are intriguing. Moreover, they have important implications for the issue of how noise and distraction affect young children. Indeed, there are conflicting perspectives on how distraction affects attention. For example, some have suggested that the presence of distraction may actually facilitate attention and performance (Ruff & Capozzoli, 2003; Ruff & Rothbart, 1996). Specifically, Ruff and Rothbart (1996) proposed that as distractors arouse children, the intensity of their attention and/or efficiency in performance may increase. In other words, the presence of distraction may increase concentration or effortful control over attention. Research has shown that when 10-month-old infants are playing with a toy in the midst of an intermittent distractor (slides with a tones), they exhibit longer mean durations of concentration than do infants who played without distraction (Ruff, Capozolli, & Saltarelli, 1996). Research on the effects of background television, likely a more salient or effective distractor than those just described, suggests a different impact of distraction (see also Anderson & Pempek, 2005; Geist & Gibson, 2000). For example, 12-, 24-, and 36-month-olds exhibited shorter play episodes and less concentration when they played with toys while an adult game show played in the background, in comparison to toddlers who played without background television (Schmidt et al., 2008). In addition, preschool children who watched cartoons first and then participated in various tasks (e.g., looking at books, painting, playing with Play-Doh) spent less time on-task than did children who first watched an educational program or children in a control group (Geist & Gibson, 2000). The present results suggest that while both comprehensible and incomprehensible distraction are detrimental, comprehensible distraction may be more disruptive, and young children may need more direction to stay on task in this context.

An important direction for future work is what kinds of deliberate behaviors might young children use to maintain their attention. Anecdotally, in the present study, children sometimes used their hands to “block” the television from their field of vision or used self talk (e.g., whispered “do not look” to themselves). Research has shown that at 3 and 4 years of age, children appear to have a rudimentary understanding that noise is detrimental, although their ability to use this information to guide their own attentional behavior is unknown. Interestingly, Miller and Zalenski (1982) found that 3- and 4-year-olds exhibit some understanding that noise and interest level affect learning. For example, when presented with a miniature room that contained “noisy” (e.g., electric mixer, television) and quiet (e.g., lamp, stove) objects and asked to remove an item that would help a pretend child learn or listen, a greater number of preschoolers removed a noisy object. When presented with the choice between a noisy room versus a quiet room and an interested (i.e., interested in the task) pretend child versus an uninterested pretend child and asked which situation would be a better place for the pretend child to listen, more preschoolers selected the quiet and interested situations. However when interest level and noise were pitted against one another, children thought that interest level was more important than was noise. Further work is needed to understand how children may be able to use their understanding of noise to adapt their behavior in the context of distraction. Indeed, although preschool aged children often do not exhibit traditional or conventional strategic behaviors, they frequently do exhibit deliberate behaviors that enhance their responding. For example, memory research has revealed that toddlers and preschoolers show deliberate “remembering” behaviors during a hiding task (e.g., pointing to toys, talking about them) when asked to remember, but not conventional mnemonic strategies to recall information (DeLoache, Cassidy, & Brown, 1985; Wellman, Ritter, & Flavell, 1975).

In closing, the present work makes important contributions to our understanding of how attention is influence by verbal instruction and the effects of distractor comprehensibility on attention and task performance. Moreover, this research has implications for the kinds of environments that are conducive to young children's learning and attentional capabilities and the kind of support adults may provide to facilitate their attention.

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Table 1

Incomprehensible Distractor, Means and Standard Error for the Performance Scores and the Attention Measures Across Instruction Conditions at Each Age

	No Instruction		Moderate Instruction		Frequent Instruction	
Measure and Age	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Performance Scores						
3 years	47.57	2.84	48.14	2.84	45.07	2.84
4 years	63.50	2.84	61.21	2.84	62.71	2.84
Toy Average Look Length						
3 years	16.70	1.75	16.78	1.75	19.48	1.75
4 years	21.54	1.75	25.69	1.75	19.62	1.75
TV Average Look Length						
3 years	5.84	.75	2.63	.75	2.40	.75
4 years	4.27	.75	1.63	.75	2.67	.75

Table 2

Comprehensible Distractor, Means and Standard Error for the Performance Scores and the Attention Measures Across Instruction Conditions at Each Age

Measure and Age	No Instruction		Moderate Instruction		Frequent Instruction	
	Mean	SE	Mean	SE	Mean	SE
Performance Scores						
3 years	27.81	4.20	33.14	4.30	30.67	2.64
4 years	43.36	3.61	46.59	3.82	57.01	3.81
Toy Average Look Length						
3 years	9.70	2.17	10.21	2.19	16.63	2.37
4 years	8.98	1.84	13.60	1.95	19.56	1.95
TV Average Look Length						
3 years	22.91	2.90	15.50	2.97	7.48	3.20
4 years	10.96	2.49	9.75	2.64	4.19	2.63