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ATTENTION AND LANGUAGE IN PRESCHOOLERS

by

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in
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ABSTRACT

This study examined the relationship between early-developing attention and a variety of language skills (i.e., general and pragmatic language). A sample of 39 three- and four-year olds was tested on measures of attention (CAPTAP, Visual Search), general language skills (TELD-2), and pragmatic language skills (Story Cohesion and Referential Communication). Parent ratings of their children's attention (CCTI) and pragmatic language skills (PAT) were also collected. Stronger general language skills (as assessed by the TELD-2) were found to be associated with better attentional functions (indexed by children's CAPTAP d-prime scores). In contrast, there was no support for a relationship between attention and pragmatic language skills. It is argued that matching the characteristics of attention and language measures may help to clarify the essential relationships between the various types of attention and language skills.

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DEDICATION

It gives me great pleasure to dedicate this thesis to my parents, Robert and Hannah Cohen, who have provided me with the encouragement and support to pursue my goals. My father's persistence and dedication in his own work and family life have inspired and encouraged me. My mother has always been an excellent role model for me; I continue to aspire to her levels of energy, youthfulness, and attitude of life-long learning.

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INTRODUCTION

This project examines the relationship between attention and a variety of language skills (i.e., general and pragmatic language) in a non-problematic preschool population, with the aim of determining whether attentional skills share an association with general language skills and with pragmatic language skills. One of the major challenges in conducting this research was the lack of standardized measures for the assessment of attention and pragmatic language skills in preschoolers. The aim of the project was to address some of the methodological limitations noted in previous studies, and then to re-examine the relationship between attention and different types of language skills in a sample of non-problematic preschoolers. It was expected that both general language and pragmatic language skills would share a relationship with attentional abilities.

To date, the majority of research on attentional functioning has been conducted with school-aged children rather than preschoolers (Campbell, 1995); however, there is increasing interest in understanding attentional functions in typically developing preschoolers (Corkum, Byrne & Ellsworth; 1995; Levy, 1980). Attention Deficit/Hyperactivity Disorder (AD/HD) is being frequently diagnosed in preschoolers and clinicians have noted that persistent behavior problems are most likely to appear between the ages of three and four (Pisterman, 1988). The incidence of disruptive, aggressive, and recalcitrant behaviors have been shown to peak in children during the preschool years, making it difficult to distinguish normally active children from those with a behavior disorder (Campbell, 1989; Campbell 1995; Campbell, Pierce, March, Ewing, Szumowski, 1994 ; Olson, 1989; Olson & Hoza, 1993; Pisterman, 1988). Furthermore, attentional impairments frequently persist and have negative longstanding implications for children's school and social adjustment (Barkley, 1990).

Attention: Construct Definition

Although no comprehensive models of attention have been elaborated for preschoolers, recent theoretical advances in the study of attention with school-aged children provide some direction for understanding the construct and measurement of attention. Despite the fact that a variety of different models of attention have been proposed (Cooley & Morris, 1990; Douglas, 1983; Mirsky, Anthony, Duncan, Ahearn, & Kellam, 1991; Shelton & Barkley, 1994; Stuss,

Shallice, Alexander, & Picton, 1995), common elements across the models include the view that: (1) attention is a multi-dimensional construct, and (2) sustained attention/persistence of action and selective/focused attention are two of the major components of attention. In order to sample a variety of attentional constructs, tasks that attempt to represent both components of attention have been included in this investigation.

Sustained attention has been generally defined as the maintenance of attention (or task persistence) over time (Douglas, 1983). Sustained attention is required in tasks when relevant events occur at a relatively slow rate over a prolonged period of time (Stuss et al., 1995). The capacity to maintain focus and alertness over time has also been termed vigilance (Davies & Parasuraman, 1981). Typically, computer tasks of sustained attention (or vigilance) require children to monitor over time a series of events for the presence of specific stimuli. Participants are usually required to respond to a critical stimulus and inhibit responding to noncritical or extraneous stimuli, as in the case of continuous performance tasks (e.g., Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956). Sustained attention tasks are considered to tap into factors which facilitate academic success; that is, they are considered analogous to classroom activities that require children to “pay attention” (Cooley & Morris, 1990).

Selective attention (or freedom from distractibility) has been defined as the ability to focus on a critical target stimulus while ignoring concurrent non-target stimuli (Douglas, 1983). Typically, selective attention tasks require children to selectively attend to a target object or sound while ignoring irrelevant information in which the target is embedded. Examples of assessment tools designed to tap selective attention skills include letter/digit cancellation, visual search tasks, speeded classification tasks, perceptual matching (same/different judgment) tasks, central-incident learning tasks, and selective listening tasks (Cooley & Morris, 1990; Mirsky et al., 1991).

The Relationship Between Attention and General Language Skills: Models

Although there is a small but growing body of research supporting an association between attentional deficits and language disorders in children (e.g., Donahue, Cole & Hartas, 1994), the nature of the relationship between attention and language functions is currently unclear. It is

uncertain whether both are attributable to a common antecedent (e.g., a temperamental or neurological characteristic) or whether there is a direct causal link between the two (Beitchman, Hood, Rochon, & Peterson, 1989; N. Cohen, Davine, Horodezky, Lipsett, & Isaacson, 1993; Love & Thompson, 1988; McGee & Share, 1988; Westby & Cutler, 1994). For example, Beitchman and colleagues (1989) have suggested that developmental immaturity antecedes or is coincident with both attentional disorders and language problems. In contrast, Love & Thompson (1988) have suggested that language and attention functions interact with one another; at some point shifts in attention function precede changes in language, while language growth may predispose growth in particular attention function on other occasions. Given the challenges inherent in specifying a model with respect to the relationship between attention and language functions, a number of scientist/practitioners (Barkley, 1990; Donahue et al., 1994; Paul, 1995; Shelton & Barkley, 1994) have argued that attention and language may be so closely associated and intertwined across development that it is not possible to isolate each of their influences on the other in a meaningful way. In the case of children with AD/HD, Shelton and Barkley (1994) have noted that it is unclear whether it is the early problems with attention and inhibition that create a risk for language weakness or whether it is problems with early language development, particularly verbal mediation, that affect the attentional shortcomings in AD/HD children. Rather than attempting to determine whether language causes attention or attention causes language, this study puts aside causal analysis in favor of the study of the relationship of attention to a variety of different language skills in non-problematic preschoolers.

The Relationship Between Attention and General Language Skills: Research Evidence

Evidence for the relationship between general language skills and attention stems largely from research with children with co-occurring attentional deficits and language disorders (Beitchman et al., 1989; Beitchman, Nair, Clegg, Ferguson, & Patel, 1986; N. Cohen et al., 1993; Donahue et al., 1994) (Footnote 1). In addition, one study identified a relationship between attentional skills and language delays in a non-clinic-referred sample of preschoolers described to have language delays (Bowering, Mallay, Ellsworth, & Byrne, 1996). Some further research has examined private speech and its impact on behavior and attention regulation for both typically

developing and AD/HD children (Berk, 1992; Berk, 1994; Diaz, 1992; Vygotsky, 1986). To date, however, there have been no studies examining the relationship between general language skills and attention in non-problematic preschoolers. Evidence from these three areas of research will now be reviewed.

Review of Co-morbid Deficits. Although the link between psychiatric disorders and language problems has been well established (e.g., Baker & Cantwell, 1987), a small but growing body of research has indicated that the prevalence rates of co-morbid attentional and language difficulties may be as high as 50% in children referred to clinics for either attentional or language difficulties (Beitchman et al., 1989; Beitchman et al., 1986; Beitchman, Tuckett, & Bath, 1987; Donahue et al., 1994; Love & Thompson, 1988; McGee, Partridge, Williams, & Silva, 1991). For instance, a five-year follow-up study of children with language impairments (Baker & Cantwell, 1987) indicated that many of the children in the sample had psychiatric problems, and were most commonly diagnosed with attention deficit disorders.

Beitchman and colleagues (1986) found that a group of five-year-old children with speech/language disorders (as assessed by an extensive battery of structured language tasks) were more likely than typically developing children to develop behavioral disturbances, and to be diagnosed with psychiatric disorders such as AD/HD (as indexed by parent and teacher ratings and a psychiatric evaluation). Additional analysis of this sample indicated that those with the lowest language function showed the highest rate of behavioral disturbance (Beitchman et al., 1989). In fact, 59% of the children in the low functioning group received a diagnosis of AD/HD.

Further support for the association between attentional deficits and language impairments stems from research by N. Cohen and her colleagues (1993) with a sample of 4- to 12- year old clinic-referred children with language impairments, as assessed by a comprehensive battery of language tasks including receptive and expressive components of semantics, morphosyntax, phonology and auditory memory. They found that children with language impairments exhibited more symptoms associated with a diagnosis of Attention-Deficit/Hyperactivity Disorder than did children with typically developing language (N. Cohen et al., 1993).

Similarly Love and Thompson (1988) found that in a sample of preschoolers referred for

psychiatric services, three-quarters (56 of 75) of the language-disordered children (assessed with standardized language tasks, such as the Reynell Developmental Language Scales) carried a diagnosis of attention deficit disorder, while two-thirds (56 of 85) of the children with a diagnosis of attention deficit disorder (determined by structured psychiatric interviews) were also diagnosed as language-disordered. Studies by McGee and colleagues (1991) as well as Beitchman and colleagues (1987) also found high incidence of language problems in preschoolers identified as hyperactive.

Although computerized laboratory tasks designed to assess attention have been shown to provide supplementary information to behavior ratings and psychiatric interviews in the diagnosis of AD/HD (Shelton & Barkley, 1990), none of the studies reviewed above included laboratory measures of attentional functions. This investigation includes both parent ratings and laboratory-based measures in order to achieve a comprehensive assessment of children's attentional skills.

Attention-Language Associations in Non-clinical Populations. Few studies have examined the relationship between general language skills and attention in non-clinical preschoolers (Bowering et al., 1996). Bowering and colleagues (1996) compared the behavior of a non-clinical sample of language-delayed preschoolers with a matched control group of normal peers. They coded the children's behavior during a standardized language task and an unstructured free play session for noncompliance, restlessness, covert inattentive behavior (wandering off task), and overt inattentive behavior (interruption of the immediate task with irrelevant verbalizations). They found that language delays were related to attentional problems. Specifically, the non-clinical sample of children with delays in receptive language showed more overt inattentive behaviors (tangential comments), and the non-clinical sample of children with delays in expressive language showed more covert inattention (losing focus particularly during language-laden activities) than their typically developing counterparts. Bowering and colleagues' work (1996) provides some preliminary evidence that language abilities and attentional skills are associated in non-clinical sample of preschoolers with general language delays.

Private Speech Investigations of Typically Developing and AD/HD Children. Theories on children's use of private speech suggest that linguistic skills development may promote behavior regulation and higher cognitive skills, such as attention (Berk, 1992; Berk, 1994; Diaz, 1992; Gillingham & Berk, 1995; Vygotsky, 1986). Private speech is expected to be elicited at the preschool level when tasks are challenging and age appropriate, but overt statements eventually become inaudible, "inner speech," as children mature (Berk, 1992). The emergence of private speech is thought to help children deploy their attention and regulate their behavior (Berk, 1992); however, there has been inconsistent research evidence to support this notion (Berk, 1992; Diaz, 1992). In his review of the research on children's private speech, Diaz (1992) noted that studying private speech empirically has proved especially challenging because it is difficult to elicit consistently; some studies successfully elicited private speech from only half of the sample (Diaz, 1992). Furthermore, there has been inconsistent evidence for the universality of private speech, the developmental progression of the stages of internalization of private speech, and an uncertain role of private speech in improving children's task performance (Berk, 1992; Diaz, 1992).

Inconsistencies also emerge from the research and clinical understanding of AD/HD children's use of private speech (Berk, 1992; Giddan, 1991; Shelton & Barkley, 1994; Westby & Cutler, 1994). Berk (1992) cited evidence that private speech becomes internalized at a delayed rate for children with AD/HD; AD/HD children display private speech over an especially long developmental period and they are delayed in the emergence of inaudible forms of private speech. In contrast, other researchers and clinicians have suggested that AD/HD children are deficient in acquiring average private speech and self-talk skills (Giddan, 1991; Shelton & Barkley, 1994; Westby & Cutler, 1994). Giddan (1991) noted that children with attentional difficulties often lack effective self-talk that would be helpful in controlling and organizing their behavior and planning. Westby and Cutler (1994) also identified AD/HD children's lack of internal language skills as playing a major role in their difficulty initiating and sustaining responses to commands. Due to methodological difficulties in studying private speech and the inconsistent evidence with respect to its nature and pace of development in both typically developing and AD/HD children, the relationship between self-talk and attention was not addressed in these studies.

Evidence of Attention-General Language Associations from a Preliminary Study

In order to address the gap in the literature with respect to the relationship between general language skills and attention in typically developing preschoolers, a preliminary study was conducted (R. Cohen & Steffy, 1996). In our pilot work, a sample of nineteen four- and five-year-olds from a university-based preschool was tested on a measure of cognitive ability (short form of the WPPSI-R), a measure of general language ability (Test of Early Language Development or TELD), a measure of attention (120 trials of Corkum, et al.'s (1995) Continuous Performance Task for Preschoolers or CPTP), and a measure of the ability to delay gratification (delay of gratification task). Behavior rating measures were collected from parents (Child Behavior Checklist) and teachers (Likert-style ratings of children's attention) to substantiate attentional functioning.

The findings of the preliminary study provided modest support for a relationship between general language skills and attention in typically developing preschoolers. Consistent with previous findings that attention deficits and language disorders frequently co-occur for preschool- and school-aged children (Beitchman et al., 1989; Beitchman et al., 1986; Beitchman et al., 1987; Donahue et al., 1994; Love & Thompson, 1988; McGee et al., 1991), higher levels of language ability (as assessed by TELD raw scores) were associated with fewer false alarms (errors of commission), an index of inattention during the laboratory measure of attention (CPTP). In this sample of typically developing preschoolers, stronger language skills were associated with better attention functioning whether or not the contribution of age was statistically controlled (age-corrected language scores and false alarms: $r = -.54$, $p < .05$). In addition, children's TELD raw language scores contributed a marginally significant amount of variance ($p = .06$) to the prediction of false alarms beyond the contribution of cognitive ability, as indexed by full-scale I.Q. estimates.

In contrast to the relationship between false alarms and TELD general language scores, *d-prime*, an index of children's attentiveness that took into account both hit rates and false alarm rates during the CPTP, was not significantly related to TELD scores. Closer examination of the performance errors suggested an unexpected relationship between CPTP misses (errors of omission) and TELD raw language scores. The relationship between misses (a CPTP index of inattention) and TELD raw language scores tended toward significance, but higher numbers of

misses were associated with stronger language scores, thus attenuating the relationship between d-prime and general language scores. As this finding was unanticipated, the hypothesis that fatigue may have had an impact on children's misses was examined. Indeed, many children in the preliminary study had difficulty completing the entire CPTP, and children complained and became resistive to the extent that the task often had to be discontinued. As well, only 50% of the three-year-olds in the Corkum et al. study (1995) were able to manage the full task demands of the CPTP. Using a shorter block of trials (48 trials), the relationships of both false alarms and d-prime scores with general language skills (as assessed by the TELD) showed a trend towards significance. As expected, stronger general language skills were associated with fewer false alarms, and with higher d-prime scores (better attention). In contrast, misses no longer displayed the reverse relationship with general language scores on the shorter and earlier block of trials, indicating that the original misses score (derived from the full test scores) in this preliminary study may have been an artifact of a trial position factor, possibly related to fatigue.

In conclusion, the findings from the preliminary study provided support for the relationship between general language skills and attention in typically developing preschoolers. Two methodological factors, however, limit the conclusions that could be drawn. First, in reviewing the scope of the preliminary study, its small sample size leads one to suspect that the correlations between attention and general language scores might be unstable and require replication. Second, the laboratory assessment of attention (CPTP) requires refinements in order to make it more accessible for preschoolers.

The preliminary study relied on a single measure of language ability (i.e., TELD general language scores), and was therefore not able to address the relationship between attention and other types of language skills, particularly pragmatic language skills. The current study was conducted in order to: a) replicate the relationship between general language skills and attention, b) refine the assessment of attention in preschoolers, and c) to extend the investigation to examine the relationship between attention and other types of language skills (i.e., pragmatic language skills) in non-problematic preschoolers.

The Relationship Between Attention and Pragmatic Language Skills

Although there is no single agreed-upon definition, pragmatics has been generally defined as the study of language use (McTear & Conti-Ramsden, 1992), rather than the semantics or syntax of language (Levinson, 1983; O'Neill, 1996a). Pragmatic language skills have also been defined as how people use language in a social context and how language is used for the purpose of communication (Roth & Spekman, 1984a). An example of a pragmatic skill is the ability to take a listener's pre-existing knowledge state into account and adapt one's communication accordingly (O'Neill, 1996a). Another example of a pragmatic language skill is the ability to introduce referents and maintain connections with linguistic reference devices such as connectives throughout one's story-telling (Peterson & McCabe, 1991a; Peterson, 1993).

Evidence for a relationship between attention and pragmatic language skills stems from theories and research suggesting that attention deficits may co-occur with pragmatic language deficits (Donahue et al., 1994; Giddan, 1991; Humphries, Koltun, Malone, & Roberts, 1994; Westby & Cutler, 1994; Zentall, 1988). Indeed, attention may also be an integral component of some pragmatic language skills (e.g., referential communication and story-telling cohesion) in typically developing children (Berman, 1988; Deutsch & Pechmann, 1982).

Recent formulations of the nature of deficits experienced by children with AD/HD have highlighted the role that pragmatic language deficits may play in this disorder (Giddan, 1991; Westby and Cutler, 1994). Westby and Cutler (1994) have included difficulties in using communication patterns appropriate to persons and situations in their formulation of the difficulties associated with attentional disorders. Due to their difficulties in role-taking and understanding social situations, children with attentional problems may be at risk for communication problems (Giddan, 1991).

Research explicitly studying the co-morbidity of language and attentional impairments has also highlighted the possibility that pragmatic skills deficits may be one of the linguistic impairments associated with attention deficits (N. Cohen, Barwick, Horodezky, Im, Isaacson, Menna, & Vallance, 1997; Donahue et al., 1994; Humphries et al., 1994; Zentall, 1988). For example, Humphries and colleagues (1994) found that significantly more school-aged boys with attention problems were rated by their teachers as having pragmatic language problems than boys

identified as having learning disabilities or boys achieving in the average range. Although the average incidence of all types of language problems was highest for the boys with attention problems (including receptive and expressive language difficulties), pragmatic language skills were identified as the most problematic communication difficulty for this group of boys. Boys with attention problems had particular difficulties in aspects of maintaining a conversation. Dennis (1991; Dennis & Lovett, 1990) has also documented the link between regulatory deficits (such as attentional impairments) and pragmatic language difficulties (such as story-telling and social discourse) in children with frontal lobe injuries. King & Young (1981) also found evidence of inconsistent application of referential communication skills in school-aged hyperactive boys. Given the possible association between pragmatic deficits and attentional disorders, Donahue and colleagues (1994) emphasized the importance of assessing pragmatic language skills when evaluating attention and language difficulties in children.

Beyond mere associational linkages between attention deficits and pragmatic language deficits in non-problematic children, attention may be an integral component of pragmatic language skills in typically developing children (Berman, 1988; Deutsch & Pechmann, 1982). Indeed, the ability to monitor one's communication during pragmatic language tasks may share particular underlying skills with the ability to monitor one's attention (Berman, 1988; Deutsch & Pechmann, 1982).

Attentional functions may be interwoven with children's ability to manage referential communication tasks in requiring a speaker to sense and take into account the perspective of a listener. In such tasks, children must verbally communicate the salient aspects of an object targeted by an experimenter so that a listener can then unambiguously select that object from a set (Glucksberg & Krauss, 1967; Glucksberg, Krauss, & Higgins, 1975; Glucksberg, Krauss, & Weisberg, 1966; Lloyd, 1994; Roth & Spekman, 1984b). In the standard paradigm, the speaker must communicate verbally, as the task is arranged so that the listener is out of sight of the object being discussed, so that visual feedback (such as pointing) will not be effective. Variability in preschoolers' ability to manage standard referential communication tasks is thought to be associated with linguistic and cognitive factors, but may also include variations in attentional functions (Deutsch & Pechmann, 1982). By the age of 3 or 4 years, children have generally

mastered the necessary vocabulary and syntax for noun-phrases (at least in the English language) to cope adequately with referential communication tasks that employ vocabulary suitable to their age (Deutsch & Pechmann, 1982). Young children's referential communication skills have also been linked to variations in their cognitive functioning, including their ability to take into account the addressee's point of view (Deutsch & Pechmann, 1982).

In addition to linguistic and cognitive skills, attention factors may also play a role in managing referential communication tasks in various ways, including noticing, identifying and selecting appropriate referents to discriminate a particular object or toy from alternatives (e.g. color, size) and then communicating the most informative facts to the listener (Bishop & Adams, 1991; Bruner, 1983; Deutsch & Pechmann, 1982; Lloyd, 1994). Deutsch and Pechmann (1982) note:

Reference is part of an interactive process that takes place between at least two participants. The processes that precede, accompany, and follow the act of referring can influence the outcome of the referential act itself. For example, to direct another person's attention successfully presupposes that his or her attention has already been attracted by an appropriate and effective means. Therefore, attention is a basic precondition for any referential act. (p.163)

It is likely that picking a particular toy out of an array of objects may share some similarities with paying attention to features of a continuous performance task. However, to date no studies have systematically addressed the link between attention and referential communication skills in typically developing preschoolers.

In addition to referential communication skills, story-telling cohesion skills also seem to share features with attentional abilities (Berman, 1988). Typically, analyses of cohesion focuses on the strategies used to introduce referents and maintain connections (e.g., conjunctions) throughout one's story-telling (Footnote 2). Although researchers have repeatedly noted that children up to around the age of five lack the ability to produce sustained, hierarchically organized narratives across different story-elicitation procedures, some of the variations in their performance may be associated with their attentional skills (Berman, 1988). Berman (1988) has suggested that preschoolers do not ordinarily rely on conventional or rule-bound norms for story-telling. Rather,

she argues, “3-year-olds differ from one another erratically, along the dimensions of personal associations, digressions, attitude toward the interviewer, and individual ability or inclination to concentrate on the task at hand” (Berman, 1988, p.491). Individual differences in children’s ability to attend and concentrate on narratives task may be important to the quality of their narrative productions. Despite assertions that young children are limited in their ability to produce narratives, even 3-year-olds have been shown to be able to describe some of the actions in picture-books (Berman, 1988; Berman & Slobin, 1994). Young children’s use of cohesive devices (including conjunctions such as “and”) have been documented (Berman, 1996; Berman & Slobin, 1994). It is possible, therefore, that children’s ability to sustain their attention in repetitive tasks (like continuous performance tasks) and maintain cohesive connections throughout their narratives may share similar underlying skills.

Assessment of Attention: Methodological Concerns and Adaptations for Preschoolers

Attention: Continuous Performance Tasks (CPT)

Computerized continuous performance tasks, which assess children's ability to persist at a repetitive and non-novel activity (e.g., a button press for a particular object), have been used to provide indices of sustained attention (Corkum & Siegel, 1993; Corkum et al., 1995).

Continuous performance or vigilance tasks are a family of measures that share a number of features: the rapid presentation of a long series of stimuli, a relatively low probability (generally around 20%) that a target will appear, the requirement that participants respond whenever a designated target or target sequence (usually presented visually) occurs in the series, and the requirement that participants inhibit responding to non-target/distracter stimuli (Cornblatt & Keilp, 1994; Rosvold et al., 1956). Continuous performance tasks have been found to provide psychometrically sound measures of attention from both adults (Cornblatt et al., 1994) and school-aged children (Barkley, 1990).

Both objective performance indices and associated observations of behavior can be derived from continuous performance tasks. Performance indices include hits (correct button presses), false alarms (errors of commission or incorrect hits) and misses (errors of omission). Although the constructs of impulsivity and inattention have been used to interpret false alarms and

misses (respectively), each of these error measures on their own are problematic, deemed to be impure measures of attentional difficulties (Corkum et al., 1993; Douglas, 1983). In addition, efforts to identify trial-related performance decrements in children with AD/HD have provided inconsistent results (Corkum et al., 1993). Performance impairments (errors) on continuous performance tasks are often present from the outset and continue at a steady (rather than accelerating) pace throughout the task (Cornblatt et al., 1994).

Given the difficulty in interpreting specific types of errors during continuous performance tasks, investigators have used signal detection analysis to combine both hits and false alarm rates into a measure of attentiveness (*d*-prime) (Cornblatt et al., 1994; Davies & Parasuraman, 1981; Macmillan, & Creelman, 1991; McNicol, 1972; Parasuraman & Davies, 1984; Swanson & Cooney, 1989). *D*-prime is generally considered to be a measure of participants' ability to discriminate a target from non-targets, where higher *d*-prime scores indicate better processing capacity and greater attentiveness. Given that *d*-prime takes into account both types of errors (false alarms and misses), it seems to be an appropriate summary score of children's performance on continuous performance tasks, and thus will be focal to the analysis of preschoolers' attentional skills in this study.

In addition to performance indices, associated behavioral observation indices have been derived for continuous performance tasks. Although not typically the primary measure, measures such as out-of-seat behavior, off task activities, and attentional shifts can be helpful adjuncts in the assessment of attention skills (Corkum et al., 1995; Shelton & Barkley, 1994).

In contrast to the oft-attempted assessment of attention in school-aged children, there have been relatively few attempts at measurement of attention in preschoolers. Assessment of attention in preschoolers has been particularly challenging to researchers as preschoolers have been noted for their short attention spans and lack of comfort in testing situations (Campbell, 1989; Pisterman, 1988). Nevertheless, there have been a few continuous performance tasks designed for use with preschoolers (Harper & Ottinger, 1992; Herman, Kirchner, Streissguth, & Little, 1980; Levy, 1980), including the Continuous Performance Task for Preschoolers (CPTP; Corkum et al., 1995), which has successfully identified developmental trends in performance and behavioral indices in young children (R. Cohen & Steffy, 1996; Corkum et al., 1995). The CPTP

was considered appropriate for preschoolers as it (a) used pictures as stimuli (rather than number or letters), (b) included both targets and non-targets presented in a quasi-random fashion, (c) contained a long response window, (d) gathered data from a relatively small number of trials thus reducing total task duration, and (e) provided a training phase to ensure that preschoolers could identify the target reliably before assessing the limits of their attention.

Although the CPTP (Corkum et al., 1995) seemed to be a relatively successful adaptation of continuous performance technologies for preschoolers, the procedure still has limitations. Many children in Corkum's study (1995) and our preliminary study had difficulty completing the entire CPTP, complaining and becoming resistive such that the task often had to be discontinued. As most children in the preliminary study were able to complete only half of the CPTP (Corkum et al., 1995), the analyses for the preliminary study focused on just the first 120 trials of data collection (rather than Corkum et al.'s (1995) proposed 240 trials). These analyses found evidence for a significant relationship between attention and general language skills, and age-associated improvements in performance (R. Cohen & Steffy, 1996). Taken together, these results suggest that it would be appropriate to shorten the CPTP (Corkum et al., 1995) from the original 240 trials (requiring 14 minutes of test time) to 120 trials (requiring approximately 6 minutes of test time). Consequently, an abridged version of Corkum et al.'s (1995) CPTP, the Continuous Performance Task Adapted for Preschoolers (CAPTAP), was designed for this study

Attention: Letter Cancellation and Visual Search Tasks

In addition to computerized assessment tools of attention, letter cancellation and visual search tasks have also been used to assess attentional skills (Cooley and Morris, 1990; Corkum et al., 1995; Mirsky et al., 1991; Welsh, Pennington, Ozonoff, Rouse & McCabe, 1990; Welsh, Pennington, & Groisser, 1991). Such tasks have been considered more "ecologically" valid than some of the computerized measures of attention. These tasks tend to resemble academic paper and pencil tasks and maintain the advantages of objective assessment of attention (Barkley, 1991). Paper and pencil type tasks may also be more easily understood and less intimidating to preschoolers in the younger age range (i.e., 3-year-olds).

Visual search and letter cancellation tasks typically require children to conduct an

organized search of a visual stimulus display (with numerous non-target items) for a target item over successive trials. The main measure derived from visual search and letter cancellation tasks is a search efficiency score (the ratio of response time divided by number of objects correctly identified), thought to reflect an index of selective attention skills (Welsh et al., 1990).

Similar to the literature on continuous performance tasks in preschoolers, few versions of visual search tasks have been adapted for preschoolers. For example, the Visual Search task developed by Welsh and colleagues (1990, 1991) is based on an adult version of the task. A letter cancellation task designed specifically for preschoolers is the Picture Deletion Task for Preschoolers (PDTP) (Corkum et al., 1995). In this task, children are required to identify 15 picture targets (either a shape, a cat or a fish) amongst 45 non-targets with minimal motor demands (i.e., children used a bingo marker to mark their responses). Corkum and her colleagues (1995) evaluated children's performance on this task, scoring time to completion, misses and false alarms. Although the PDTP task successfully identified some developmental trends with respect to the number of errors made by children, it is a very lengthy task, lasting approximately 13 minutes (Corkum et al., 1995). A visual search task, designed to be engaging, and of appropriate length for preschoolers was included in the present study (the Visual Search task).

Assessment of Pragmatic Language Skills: Methodological Concerns and Adaptations for Preschoolers

Currently there are few standardized measures of pragmatic language skills for school-aged or preschool children (Lloyd, 1994; Roth & Spekman, 1984b). Traditional measurement strategies have included language samples collected from the home and clinician-based subjective ratings of children's pragmatic language skills based on interactions with a psychologist or speech-language pathologist (Creaghead, 1984; Paul, 1995). In the current study, two tasks were designed to assess two areas of pragmatic language skills: referential communication skills and story-telling cohesion. Both of these pragmatic language skills are thought to be associated with successful school adjustment (Bishop & Edmundson, 1987; Hemphill, Picardi, & Tager-Flusberg, 1991; Hudson & Shapiro, 1991; Liles, 1993; Lloyd, Boada, & Forns, 1992; Paul & Smith, 1993; Peterson & McCabe, 1991b). For example, the ability to interrelate successive sentences is

considered to be an integral part to almost all comprehensible oral and written texts or discourses, underlying successful communication and literacy acquisition (Gutierrez-Clellen & Heinrichs-Ramos, 1993; Peterson, 1993). Lack of “cohesive adequacy” and the disjointed sentences that ensue are found in children with language disorders (Liles, 1985).

Pragmatic Language Skills: Referential Communication

Few studies have examined referential communication skills in preschoolers (Deutsch & Pechmann, 1982; Pechmann & Deutsch, 1982). In one study (Deutsch and Pechmann, 1982), four age groups (3-, 6-, 9-year-olds and adults) were asked to select from a set of eight toys (and then verbally designate) the object which they liked best as a birthday present for another (imaginary) child. This procedure was repeated four times with different arrays of toys. When the experimenter was able to identify the chosen object from the children's description, he placed it in a “birthday box.” When he was not able to do so, he repeated the description in question form until the child was able to give an unequivocal description. For example, if children asked for the “ball”, the experimenter would question, “Which ball?” until children provided an unambiguous description, such as the “large, green ball”. Objects were placed close together and sufficiently far from the participant so that a nonverbal reference, such as pointing, would not be a usable communication strategy. The researchers found that the initial descriptions of three-year-olds’ object choice were ambiguous 87% of the time. After a standardized questioning phase, many of the children were better able to communicate their choices. However, three-year-olds tended to have longer interchanges with the experimenter, and more questions needed to be asked of them to elicit an adequate description (Deutsch & Pechmann, 1982).

Unfortunately, several procedural features of the paradigm employed by Deutsch & Pechmann (1982) limit the interpretation of preschoolers’ performance on the referential communication task. The level of vocabulary required to perform adequately on the task and the level of abstraction required to comprehend task instructions may have attenuated preschoolers’ performance while the feedback children received with respect to their responses would have had an unsystematic impact on preschoolers’ performance on the task. Consequently, the Deutsch and Pechmann (1982) referential communication task was altered for the purposes of the current

study. Rather than requiring children to provide three to four referents with an older-age level of vocabulary (e.g., “the large blue watering can”), to achieve a correct response children were only required to provide two to three referents with items that were well within their vocabulary (e.g., “the small duck”). In addition, efforts were made to alter the instructions to make them more concrete, engaging, and easily understood by preschoolers. Finally, departing from Deutsch and Pechmann’s (1982) procedure, children were not repeatedly questioned about their responses on all task trials in order to ensure that experimenter feedback did not have an unsystematic impact on children’s performance.

Pragmatic Language Skills: Story-telling Cohesion

In their comprehensive analysis of cohesion, Halliday and Hasan (1976) identified nine different types of cohesion between sentences within text, including ellipsis, reference, lexical collocation, substitution and conjunctions. Among the linguistic structures identified by Halliday & Hasan (1976), some are never used by preschoolers, and some are only rarely used, making it difficult to analyze preschoolers’ narratives for all categories of linguistic cohesion (Berman & Slobin, 1994). Given these considerations, in the current study preschoolers’ narratives were coded on the basis of their use of conjunctions, with a primary focus on the use of “and” in their story-telling. “And” is one of the first connectives to be used by children in their construction of complex sentences; children begin to use this word as early as 2 years of age (Peterson & McCabe, 1988). Furthermore, “and” has been considered a good index of cohesion in text (Peterson & McCabe, 1988). Frequently, “and” tends to serve both semantic and pragmatic functions in text, encoding a wide variety of relationships (e.g., coordinate, temporal, enabling, causal, antithetical and reiterative) (Peterson & McCabe, 1987; Peterson & McCabe, 1988). In addition, “and” functions as a generalized signal of cohesion between sentences and often indicates that the narrator’s conversational turn is not complete and that he has more to say (Berman, 1996; Peterson & McCabe, 1988). Developmental trends have been noted in the use of “and” in children’s text, with “and” tending to be the most common connective up to about three-and-half-years of age; thereafter, the proportion of the use of “and” decreases in favor of other connectives such as “because,” “so,” “but,” and “then” (Berman, 1988; Bloom, Lahey, Hood,

Lifter, & Fiess; Braunwald, 1985; Peterson & McCabe, 1991a). Given the developmental trends noticed in children's use of conjunctions in their narratives, in this study children's use of cohesion in their story-telling was coded and analyzed as one of the primary measures of laboratory-assessed pragmatic language skills.

Narratives have been elicited from children in a number of different ways, including asking children to tell personal or fictional stories, requesting that children re-tell a story first told by the experimenter, and using props such as movies or picture-books to assist with story-telling (Berman & Slobin, 1994). Although each of these methods have been effectively used to elicit narratives from children, some are also problematic. For example, personal narratives tend to be a rich source of information (Peterson, 1993), but it is difficult to elicit these narratives in a standardized manner and the productions of children can vary tremendously, making it difficult to analyze the data in a systematic way (Berman & Slobin, 1994). Asking children to make up fictional stories can be problematic as it requires the creation and mental representation of a number of characters and actions, cognitive skills which are not fully developed for preschoolers. Retelling a story first told by the experimenter is problematic in that the story is structured by the experimenter rather than the children and this procedure may also tap children's memory skills rather narrative abilities (Berman & Slobin, 1994). Using movies to elicit narratives has been successful with school-aged children (Gutierrez-Clellen & Heinrichs-Ramos, 1993); however, showing a film to children and then asking them to re-tell the story may also tap into children's memory of the details of the film, rather than their narrative skills (Berman & Slobin, 1994).

To rule out these problems, children in this study were asked to preview a picture story-book (Frog Goes to Dinner), and then to tell the story to a naive listener while they reviewed the same pictures. Previewing the picture sequence has been shown to facilitate preschoolers' production of cohesive narratives (Shapiro & Hudson, 1991), and eliciting narratives via a picture story-book can be done in a systematic and consistent way for all children. As well, picture story-books are especially appropriate for use with preschoolers as they show a sequence of actions so that a coherent story can be told without the need to gain additional information from printed text. Using a picture story-book as a prop during story-re-telling also has the advantage of not confounding narrative ability with memory skills (Berman & Slobin, 1994).

Multi-modal Assessment

Reports from various sources and laboratory measures are often found to provide discrepant information about school-aged children's attentional, learning and language difficulties (Biederman, Faraone, Milberger, & Doyle, 1993; R. Cohen & Steffy, 1995; Shelton & Barkley, 1994). Given the challenges in assessing attention and pragmatic language skills, some researchers (Barkley, Fischer, Newby, & Breen, 1988; Shelton & Barkley, 1994; Taylor, 1988) have suggested that a multi-modal approach (i.e., convergent information from a variety of sources) to assessment is preferable to reliance on single tests or a single report from parents or teachers. By including behavior ratings, laboratory measures and observational techniques, researchers and clinicians can hope to gain a convergent picture of children's skill level (Shelton & Barkely, 1994). In order to achieve a comprehensive assessment of children's skills levels, the current project assessed attentional skills using laboratory-based measures, behavioral observations and parent ratings. In addition, pragmatic language skills were assessed via both parent ratings and laboratory-based measures. One of the goals of the study was to examine the cross-domain relationships between parent ratings and laboratory-based measures of two domains of skills for non-problematic preschoolers (i.e., attention and pragmatic language skills).

Project Goals

The goal of the current study was to examine the relationship between attention and different types of language skills (i.e., general language and pragmatic language skills) in a large sample of non-problematic preschoolers, and thus test the relationship between general language skills and attention found in the preliminary study. In the current work, efforts were made to adapt all instruments (attention and pragmatic language skills tasks) so that they would be appropriate for preschoolers. Finally, a younger sample of preschoolers were studied (i.e., 3- and 4-year olds as opposed to 4- and 5-year olds in the preliminary study and 3-, 4-, and 5-year olds in the Cokum et al. (1995) research) in order to extend the study of the relationship between attention and language skills into a younger age range.

In the current study, a sample of preschool children was tested individually on laboratory

tasks of attention (CAPTAP and Visual Search), general language skills (TELD-2), and pragmatic language skills (Referential Communication and Story-telling Cohesion). Parent ratings of attention and pragmatic language skills were also collected.

Predictions of the Study

- (1) An association between general language skills and attention skills was expected. That is, based on previous findings (R. Cohen & Steffy, 1996), it was expected that TELD-2 language scores and d-prime scores would be related beyond the contributions of age and gender.
- (2) Pragmatic language skills (laboratory-assessed and parent ratings) and attention scores were expected to be related beyond the contribution of age and gender.
- (3) Evidence for cross-domain associations between laboratory-assessed and parent ratings of attention and pragmatic language skills was assessed in a sample of non-problematic preschoolers. Specifically, the relationship between laboratory-assessed and parent ratings of attention, laboratory-assessed and parent ratings of referential communication skills, and laboratory-assessed and parent ratings of children's story-telling cohesion skills were examined. Given the inconsistent findings in the literature regarding the amount of agreement between the different domains, no specific predictions were made about these relationships.

METHOD

Participants

Fifty-three preschool-aged children participated in the study. All children spoke English, but six children had exposure to a language other than English (ranging from one hour per week to several hours every day of the week), including French, Portuguese, Spanish, East Indian, German and Swiss. Children were largely from middle to upper class families and were recruited through the University of Waterloo Center for Child Studies, a research laboratory at the University of Waterloo. Because of invalid data, the scores obtained from eleven children were not included in the analyses, reducing the sample to 42 children (20 boys and 22 girls; mean age 47 months, range: 41 to 54 months). Within this group of eleven children, seven children refused to complete one of the five main experimental tasks (ages: four 3-year-olds and three 4-year-olds; gender: three girls and four boys), one child had a history of major speech delay (a 4-year-old boy), and one child's family compromised the testing situation (a 3-year-old boy).

Overview of Procedure

Each child was tested individually. Prior to beginning the study, steps were taken to ensure that children were comfortable in the testing situation. First, children were shown a room adjacent to the testing room, where either one or both of their parents watched while they participated in the experiment. Then, parents accompanied children and the experimenter into the testing room, where children had a chance to play with toys and get comfortable in the testing room. Once children seemed relaxed, parents left the testing room and the study began. Children were tested individually, while parents observed the testing through a one-way-mirror in the adjacent room.

Five measures were administered to children in a counter-balanced order, resulting in ten different orders (each task was presented in every position via a reverse Latin square), and each order was presented to one boy and one girl within the two age groups (i.e., 3- and 4-year-olds). Children were administered one measure of general language skills (Test of Early Language Development- 2nd edition), two measures of attentional ability (Continuous Performance Test Adapted for Preschoolers and Visual Search task) and two measures of pragmatic language skills

(Referential Communication task and Story-telling task). Upon completion of the children's portion of the experiment, parents were asked to complete two questionnaires about their children's typical language and behavior at home (Colorado Child Temperament Inventory and an abridged version of the Pragmatics Aptitude Test for Young Children). After parents completed these questionnaires, the experimenter further discussed the purpose of the study with the parents and answered parents' questions about the study.

Overview of all Assessment Tools and Measures Used

General Language Skills: Assessment

Test of Early Language Development - 2nd edition

Children's general language skills were assessed with the Test of Early Language Development- 2nd edition (TELD-2). This is a test of receptive and expressive language, semantics, and syntax skills, designed for children from 3-7 years of age. It has been used as both a clinical and research instrument (e.g., Jenkins & Astington, 1996; Paul, 1995; Plante & Vance, 1994), and has well developed norms (Hresko, Reid & Hammill, 1991). For example, children were asked: "Who is in your family?" (an expressive language item), "Show me the picture of the word I say - hat" (a receptive language item), "Show me the child who is first in line" (a semantics item), and "This is a shoe. These are — (children are shown a picture of shoes)" (a syntax item).

TELD-2: Measures

In order to examine the relationship between language and attention performances particular to our sample, the main measure of general language skills was children's raw scores on the TELD-2 (number of correct responses on the TELD-2). Language quotients, percentile ranks, and language ages were also available from the TELD-2, but were not the focus of the analyses described below. In order to investigate whether significant relationships between variables (e.g., attention scores and TELD-2 raw language scores) were associated with age, children's raw language scores were also age-corrected by partialling age out of the raw score.

To assess inattention during the structured language task, children's off-task behavior during the first 5 minutes of the TELD-2 was also coded from the videotapes (Bowering et al.,

1996). Time Looking at Toys was defined as the amount of time (in seconds) children spent looking away from the TELD-2 test materials (head turns of at least 45 degrees) at a basket of toys situated to the right of children and on the floor of the testing room. Frequency of Leaving Seat was defined as the number of times children left their seat during the TELD-2. Off-task Talk was defined as the number of instances of non-task related talk (e.g., personal stories).

Attention: Assessment

Children's attentional skills were assessed using three measures: a Continuous Performance Test Adapted for Preschoolers (CAPTAP), a Visual Search task, and the Colorado Child Temperament Inventory (Buss & Plomin, 1984).

1. Continuous Performance Test Adapted for Preschoolers (CAPTAP)

The CAPTAP is a computerized continuous performance task in which children were required to quickly identify a target stimulus (presented individually within a series of non-target stimuli) by depressing a button key.

Stimuli/Equipment

Children were seated at a table in front of a 15 inch SVGA color computer monitor which was positioned at a distance of approximately 0.70 m. and at children's eye-level. A button-box was also presented to the children. Six stimuli, ranging in height from 7 to 11 cm., were presented individually to the children on the computer screen (one target and five non-target images). All of the images were circular, controlling for any variance that might have been accounted for by very different target and non-target configurations. The target stimulus was a cat and the non-target stimuli were a turtle, a baby's face, a balloon, a tennis racquet, and a watch. The stimuli were presented individually in a random order, with the constraint that each of the stimuli occurred once every six trials. Each stimulus was presented for 750 ms, with an inter-trial interval of 1350 ms. The accuracy of responses (correct/incorrect identifications) occurring during the stimulus presentation or subsequent inter-trial interval was recorded. The original CPTP (Corkum et al., 1995) was altered in order to make the task more interesting for children,

by including a constant background color (blue) for the computer screen and a quiet computer beep for all button presses. The CAPTAP lasted approximately six minutes.

Procedure

Task introduction - Children were seated at the computer and asked to identify (by naming) each of the six pictures presented individually on the computer screen. The experimenter said, "I am going to ask you to look at the computer screen and tell me what each picture is. What is this?" The experimenter then gave feedback to children about their answers (e.g., "Right! That's a cat").

Familiarization trials - Children were provided with instructions, positive feedback for correct button presses, and a repeat of the instructions for incorrect button presses or misses during the familiarization period, which consisted of 60 trials (lasting approximately 2 minutes). Children were instructed to quickly identify (by depressing the button) a target stimulus (a cat) which was presented individually in a random order on the computer screen within a series including the target stimulus and the five non-target stimuli. The experimenter said to the children:

Your job in this game (name of child) is to press this button here (the experimenter showed children the large button) every time you see the cat (i.e., the target stimulus). Every time the cat comes on the screen, your job is to press this button as fast as you can (the experimenter demonstrated a button press). OK, press when you see the cat. When you see the other pictures do not press the button; if you do that will be a mistake. Press the button only for the cat.

For correct hits children were told, "Good job! That's right. That's when you press the button." For errors, children received further instructions, "Oops! Don't press the button for the (name of the non-target stimulus). Remember only press the button when you see the cat. Keep watching for the cat". Throughout the familiarization trials, the experimenter looked at the computer, and, modeling an intent gaze, hoped to encourage children to focus on the computer.

Experimental trials - Data collection consisted of 120 experimental trials (lasting approximately 4 minutes) or until children were no longer willing to continue with the task. After the familiarization trials were completed, the experimenter commented, "Wow. You are doing a great job so far! You are part way through now. I just have to do some writing over here. You keep working to get all those cats!" During the experimental trials, the experimenter sat at the back of the room pretending to work. This encouraged children to focus their attention on the task and to minimize interference in the task, as children's off-task talk was easily ignored by the experimenter.

CAPTAP: Measures

Although many changes had been made to make the CAPTAP accessible to preschoolers, some children were still unable to complete the entire task. The task was discontinued when children made a comment indicating that they would no longer continue the game, or broke away from the CAPTAP to play with toys in another area of the room. Although eight children (out of 42) terminated their work before the full set of 120 trials was completed, all 42 children managed to complete at least 48 experimental trials of the CAPTAP (lasting approximately 1 minute and 30 seconds). Thus, data analyses for all children ($n = 42$) focused on 48 experimental trials of the CAPTAP (comprising 8 target stimuli).

The performance measures derived from the 48 CAPTAP experimental trials included hits (number of correct target identifications), misses (number of failures to correctly identify targets), and false alarms (number of incorrect identifications of non-targets as targets). The main index of children's attentional abilities was children's perceptual sensitivity or d -prime, an index which reflected children's ability to discriminate targets from non-targets. D -prime was calculated by subtracting children's standardized false alarm rate (number of false alarms divided by 40) from their standardized Hit Rate (number of hits divided by 8), thereby taking into account both types of errors made by children during the CAPTAP. Higher d -prime scores were thought to indicate greater attentiveness.

Children's non-verbal, off-task behavior was also coded from the videos of the children during the first 48 experimental trials of the CAPTAP. Looking away from the computer monitor

was defined as head turns of at least 45 degrees away from the computer screen in the vertical or horizontal planes. Two measures of behavioral indices thought to reflect poor sustained attention were coded from the videos: Frequency of Looking Away and Total Time Looking Away.

2. Visual Search task

In the Visual Search task, children were required to find a target picture of a toy (either with one match or more than one match) that was embedded within a picture depicting a large number of toys and objects.

Stimuli

Three large, colorful pictures (ranging in size from 9 x 11 to 11 x 18), each depicting a number of objects and toys, were used in this task (Appendix A). These pictures were taken from a school-aged children's book (Wick & Marzollo, 1993: I Spy Mystery: A Book of Picture Riddles). The picture used for the familiarization trials was the least complex, as it only contained 25 familiar objects (e.g., a tree, a tea kettle, a crown). The two pictures (the "toys" picture and the "jewelry" picture) used for the experimental trials were more complex, as they included smaller, more difficult to find objects embedded in approximately 100 objects. Targets varied in the number of instances in the toys picture; five provided only one match (a dog, a car, a bushel of apples, a star and a whistle), one had two matches (a roller-blade), and one target object had eight matches (a multi-colored bowling-pin). Additional non-target objects in the picture (e.g., uni-colored rather than multi-colored bowling pins) were also embedded within the picture, making false alarms or incorrect identifications possible. There was also one target object (a butterfly) for which there was no match in the toys picture. The match for this impossible target object was easily identified in the jewelry picture. A picture of each target object was reproduced to size on a 3 x 5 cue card, and presented individually to the children.

Procedure

Familiarization trials- The familiarization trials were included to accustom children to search for and point to target objects, and to distinguish between the times when there was only

one and more than one match for a target object. Children were first shown the familiarization picture. They were then presented with a 3 x 5 cue card (placed in front of them on the table) with a picture of a target object from the familiarization picture and asked to find the target object which was embedded among the objects of the familiarization picture. When there was only one match for the target object, children were instructed, "Point to the toy that looks like this (experimenter pointed to the target object on the cue card)." When there was more than one match for the target object, children were told, "This time there are more than one of these (experimenter pointed to the target object on the cue card). Point to all of the toys that look like this." In order to ensure that children understood when there was more than one match for a target object, they were encouraged to search for the other target object matches if they only pointed to one of the target objects. At no time during the task were children required to name the target objects. Rather, children were required to point to the target object(s) on the pictures. The same order of target objects was presented to all children, as follows: a pumpkin, a tea kettle, a crown, a pig, a tree, a girl skipping, a can of plums, and a black-bird.

Experimental trials - With the exception of a few modifications detailed below, the toys picture was shown along with the same instructions used for the familiarization trials. For the experimental trials, the same order of target objects was presented to all children, as follows: a dog (one match), a car (one match), a bushel of apples (one match), a roller-blade (two matches), a star (one match), a whistle (one match), a multi-colored bowling-pin (eight matches), and a butterfly (no match). For two of the more challenging target objects with only one match each (i.e., the bushel of apples and the star), children were provided with a location hint, "It is somewhere up/down here" (the experimenter pointed to the area where the target object was located). In addition, although children were typically able to identify more than one match for the target objects with multiple matches (i.e., the roller-blade and the multi-colored bowling pin), no further prompts were provided by the experimenter if they did not identify all of a target object's matches. The last target object presented (the butterfly) had no match within the toys picture. Children were asked to locate the matchless target object as in the other experimental trials, and then given a maximum of 30 seconds to search for the target object in the toys picture.

After 30 seconds, the toys picture was removed and replaced with the jewelry picture in which the butterfly was easily identified, ensuring that children would end the task on a positive note. When presenting the jewelry picture, the experimenter commented, "Oops I goofed. I gave you the wrong picture before. I am sorry. No wonder you could not find the butterfly. See if you can find it in this picture here."

Visual Search: Measures

From the videotapes of the Visual Search task, both the number of correct identifications (accurate identifications of a target object or hits) and the number of incorrect identifications of non-target objects (false alarms) were recorded for children's responses during the experimental trials. Latency (time in seconds) to locate each target object (hits) was also recorded. Three main measures were assessed during the experimental trials of the Visual Search task:

(1) Single Target Search was defined as the mean reaction time (seconds) for the six target objects to be located in the toys picture. This measure included the five target objects with only one match (the dog, the car, the bushel of apples, the star, and the whistle) and the one target object with two matches (the roller-blade). Longer Single Target Search times were thought to be indicative of less efficient search strategies and weaker attentional skills. In this study, scores for the Single Target Search measure ranged from 2 seconds to 15 seconds (mean score: 8.44 seconds).

(2) Multiple Target Search was defined as the number of correct matches of multi-colored bowling-pins (hits) identified less the number of incorrect objects (false alarms) identified in the toys picture. Higher Multiple Target Search scores were thought to be indicative of better attentional skills. The maximum score for this measure was eight correctly identified multi-colored bowling-pins.

(3) A Search Persistence index was derived from the amount of time children persisted in searching for the matchless target object in the toys picture (the butterfly) before looking away from the picture. Children's first look away from the toys picture (with a maximum of 30 seconds) was coded based on the videotapes of their behavior during the task. Higher Search Persistence scores were thought to indicate greater persistence and sustained attention skills. The

maximum score possible for this measure was thirty seconds.

3. Colorado Child Temperament Inventory

Materials

The Colorado Child Temperament Inventory (CCTI; Buss & Plomin, 1984; Plomin & Rowe, 1977; Rowe & Plomin, 1977), an assessment tool designed to assess four areas of children's temperament (i.e., attention-span/persistence, emotionality, activity level, and soothability), was completed by participating children's parents. This questionnaire has been used in previous research with typically developing preschoolers (Coplan, Rubin, Fox, Calkins & Stewart, 1994; Rubin, Coplan, Fox, & Calkins, 1995). The CCTI consists of thirty items, rated on a 5 point likert scale (from "Not at all/Strongly disagree" to "A lot/Strongly agree"). A copy of the CCTI can be found in Appendix B.

CCTI: Measure

The measure of interest to this research was the summed score of the parent ratings on the 5 items tapping attention-span and persistence (the attention span/persistence index):

- (1) Child persists at a task until successful
- (2) Child gives up easily when difficulties are encountered (reverse coded)
- (3) Child goes from toy to toy quickly (reverse coded)
- (4) With a difficult toy, child gives up easily (reverse coded)
- (5) Child plays with a single toy for long periods of time.

The maximum score for this measure was 25, where higher scores on the attention/persistence index were thought to be indicative of stronger attention and persistence skills.

Pragmatic Language Skills: Assessment

Children's pragmatic language skills were assessed using three measures: a Referential Communication task, a Story-telling task, and an abridged version of the Pragmatics Aptitude Test for Young Children (O'Neill & Baron-Cohen, 1996).

1. Referential Communication task

In the Referential Communication task, children were required to provide unambiguous verbal descriptions of a toy that would enable the experimenter to choose that toy from among an array of four toys which differed on either two or three attributes (i.e., type, size, color).

Stimuli

In total, the experimental and feedback trials consisted of six arrays of four toys. Each array of four toys consisted of objects that would be easily named by preschoolers (e.g., duck, cow, ball). On two of the experimental trials, and both of the feedback trials, the toys differed with respect to only two attributes (e.g., type: cow or duck, and size: big or small). On the other two experimental trials, the toys differed with respect to three attributes (e.g., type: cow or duck, size: big or small, and color: red or blue). The order of presentation of the toys in the arrays for the experimental trials were as follows: (1) small duck, large duck, large cow, small cow, (2) large car, small pig, small car, large pig, (3) small red ball, large red ball, small blue ball, large blue ball, and (4) large blue block, small red block, small blue block, large red block. Within each array, the above-listed order was fixed for the presentation of the toys from left to right. During the experimental trials, the order with which the arrays were presented was counter-balanced. The two toy arrays for the feedback trials were: (1) big frog, small frog, small bear, large bear, and (2) small bird, large dog, large bird, small dog. The two feedback trials always followed the four experimental trials and were counter-balanced. For each experimental and feedback trial, the toys were placed approximately 1m away from the children and within each array (approximately 30 cm. long) the toys were placed close together, so that a verbal (rather than a pointing) response would be required in order to communicate clearly which toy the children had chosen. A puppet of Ernie (Sesame Street) and a plastic bucket were also used in this task.

Procedure

Control trials - Control trials were included to ensure that all children had the necessary vocabulary to complete the task. Children's knowledge of "red" and "blue" was pre-tested during the warm-up play period, when children were inconspicuously asked to name the colors red and

blue on an object in the room. All children were able to name the colors accurately. In addition, if during the experimental and feedback trials children had not used the terms “big” or “small” (or, as some children used, “mommy”/“baby” distinction) to differentiate any of the objects in size, the experimenter showed children a picture of identical triangles that differed only in size, and asked, “How is this one different from this one?” It was necessary to administer this second control question to only two children. Children were not taught the terms big and small prior to the Referential Communication task, as it might have confounded their performance by highlighting the salient words for effective communication in the task.

Experimental trials - A plastic bucket was placed on the table in front of the children. Holding the Ernie puppet, the experimenter told children, “Ernie needs your help to put his toys in his bucket. Your job in this game is to tell Ernie which toy to put in his bucket. You tell Ernie which toy to put in his bucket. If you help him get them all in, he’s going to make sure you get a sticker. Tell Ernie which toy to put in his bucket.” Then, on each successive trial, the experimenter (with the Ernie puppet) asked the children, “Which toy should I put in my bucket?” If children did not respond initially, the experimenter repeated the same instructions. The instructions were identical for the four experimental trials. Children were not provided with any feedback about their responses during the experimental trials. On each trial, the experimenter placed a toy in the plastic bucket. In order to avoid providing children feedback about the accuracy of their communication during the task, even if children’s responses were ambiguous, the experimenter chose a toy to place in the bucket. For example, if a child’s response was “the car,” then the experimenter chose either the large or small car, trying to make sure (by following the child’s eye gaze or pointing response) that the one chosen was the toy that the child intended. Only one child indicated that the experimenter had chosen the wrong toy from an array of one experimental trial.

Feedback trials - After the four experimental trials, two additional trials were included in which the toys differed with respect to only two attributes (type and size). These two trials were similar to the first four in every way, except that children were provided with feedback if their

responses were ambiguous (i.e., if they did not clearly identify one toy). If children's responses were ambiguous, the experimenter asked, "Which (name of the item)?" to assess whether children were able to modify their communication appropriately. For example, if children responded with "the dog," the experimenter would then ask, "Which dog?", as a big and little dog were included in the trial. The experimenter asked this question only once. Even if children's responses remained ambiguous after the feedback question, the experimenter placed a toy in the bucket. As in the experimental trials, the experimenter attempted to choose the toy that was intended by children by following either their eye gaze or pointing response.

Referential Communication: Measures

The main measure (Referential Communication) derived from the task was the number of unambiguous descriptions on the four experimental trials as an index of children's recognition of appropriate referents (e.g., big vs. small and blue vs. red) and ability to communicate them effectively. Children received a score out of a maximum of four on the Referential Communication measure. A Feedback measure was also derived based on the number of unambiguous descriptions children provided on the two feedback trials. Children received a score out of a maximum of two on the Feedback measure, which was thought to be an index of children's referential communication skills when additional structure was provided.

2. Story-telling task

In the Story-telling task, children were first required to look through a picture-story book, Frog Goes to Dinner, and then tell the story to a puppet who had no previous knowledge of the story.

Stimuli

A 17-page abridged version of Mercer Mayer's Frog Goes to Dinner (1979), a story about the adventures of a frog who goes to dinner with a family at a fancy restaurant and causes mischief, was used in this study. Frog Goes to Dinner is a picture story-book that can be understood and recounted from the pictures alone, with no text accompanying the pictures. In order to maintain preschoolers' interest in the story, the book was abridged in a manner that

maintained the story-line (Footnote 3). Twelve pages of the original book were copied, laminated and bound. Seven of the pictures were single frames, and five of the pictures were double frames. Although the pictures in the book were black and white, the main character of the story, the frog, was colored in green in order to ensure that children were aware of the frog's location in each picture and were not failing to comment on the main character because they could not locate him. A detailed description and pictures from Frog Goes to Dinner can be found in Appendix C and Appendix D, respectively.

Procedure

Familiarization trial- In the Story-telling task, children were shown the story book, Frog Goes to Dinner. The experimenter introduced the task to children by saying, "Let's look at a book together (the experimenter displayed the book)." Opening the book to the first page, the experimenter explained, "This book tells a story about a boy (the experimenter pointed to the boy) who went to a fancy restaurant with his family and his pet frog (the experimenter pointed to the frog). Some funny things happen when they get to the restaurant. Let's see what happened when they got to that restaurant (the experimenter turned to the second page). Now, what's happening in this picture?" For each (single or double frame) picture, the experimenter prompted children by saying, "Now what's happening in this picture?" or "What's happening in this picture here?" If children did not give a response to a picture, the experimenter waited, and then provided the same prompt again. If children still did not respond, the experimenter went on to the next picture. No other prompts or questions were provided to the children during their story-telling in this task.

Experimental trial- After children viewed the entire book, the experimenter took the book away, and based on their preference, a Big Bird or Ernie doll was introduced. The experimenter then explained to the children, "This is a brand new book for Big Bird (Ernie). He has never, ever seen the book that you just looked through. He would really like it if you could tell him what's going on in the book that you just looked at. Would you like him to sit on your lap or on the table over here (the experimenter pointed to the corner of the table, next to the child)? OK, you tell him what's going on in the pictures." Big Bird (Ernie) was then placed so that he could "see"

the pictures as children told the story. Once children began telling the story, no further prompts were provided by the experimenter. Children were encouraged to turn the book pages on their own. If children were reluctant to tell the story to Big Bird (Ernie), further encouragement was provided. Three children who refused to tell the story initially agreed to tell the story at the end of the experiment. According to parent reports, none of the children had any previous exposure to the book Frog Goes to Dinner.

Story Cohesion: Measure

Based on previous work examining the development of children's narrative skills between the ages of three and five, children's use of cohesion in their story-telling was coded (Berman, 1996; Berman & Slobin, 1994; Halliday & Hasan, 1976; Peterson, 1993; Peterson & McCabe, 1988). To this end, the video transcripts of children's stories told to Big Bird (Ernie) were coded for children's use of different conjunctions (including "and", "and then", "then", "but", "because", and "so"), which were considered to be an index of children's Story Cohesion skills (Peterson & McCabe, 1988). Children were given a score ranging from 0 to 2 depending on the level of sophistication of their use of conjunctions. Children received a score of 0 if they did not use any conjunctions in their story. Children received a score of 1 if they used "and" to introduce a picture (e.g., "And he jumped into the dinner") as well as if they used "and" to list or chain objects together (e.g., "He was with his frog and his dog"). Children received a score of 2 if they used conjunctions in any of the following more sophisticated ways: (1) "then" to introduce a picture (e.g., "Then they left the restaurant"), (2) "and then" to introduce a picture (e.g., "And then the boy screamed at the waiter"), (3) "and" to chain two events together (e.g., "The waiter took the frog and the boy screamed to him"), and (4) "so", "but", or "because" to indicate relationships (e.g., "He can't blow because the frog's in the trumpet"). The number of times that children used a particular conjunction was not tabulated. Rather, scores for the level of sophistication of conjunction use were awarded on the basis of the presence of one or more conjunctions that displayed cohesion within the categories described above. Consequently, it was not necessary to transform children's scores with regard to the proportion of statements they made. Samples of children's narratives of Frog Goes to Dinner can be found in Appendix E.

3. Pragmatics Aptitude Test for Young Children (Abridged version)

Materials

Two sections from the Pragmatics Aptitude Test for Young Children (O'Neill & Baron-Cohen, 1996), a parent-report questionnaire currently under development to assess children's pragmatic language skills, were used in the present study. The Pragmatics Aptitude Test for Young Children (PAT) (O'Neill & Baron-Cohen, 1996) is being developed to provide a standardized and reliable psychometric measure of children's pragmatic language skills using a parent report method.

The two sections of the PAT used in the present study were designed to assess children's ability to adapt conversation to other people (Adaptive Communication), and children's ability to tell stories (Story-telling Skills). Assessments of these two sections in a pilot study of approximately 180 children between ages 18 to 48 months suggested that both sections have good internal consistency; reliability was estimated as .93 for Adaptive Communication and .79 for Story-telling Skills (D.K. O'Neill, personal communication, April 15, 1998). Significant developmental trends were also identified for both of these sections of the PAT, suggesting that better Adaptive Communication and Story-telling Skills were associated with increases in age (D.K. O'Neill, personal communication, April 15, 1998). Parent ratings of children's Adaptive Communication and Story-telling Skills were included in the study in order to bolster the laboratory assessment of Referential Communication and Story Cohesion. As well, the laboratory assessment of Referential Communication and Story Cohesion skills provided an assessment of the validity of the parent ratings of children's Adaptive Communication and Story-telling Skills.

The Adaptive Communication section consisted of 14 different scenarios (70 statements), requiring parents to indicate whether a certain statement was true of their child's ability to adapt their conversation to other people. A sample item from the Adaptive Communication section asked parents to envision their child's attempt to tell their parent about an event that the parent did not know about. In the typical format of the questionnaire, parents were required to provide a yes/no response to each of the following statements, indicating whether their child would:

- (1) introduce a topic 'out of the blue'
- (2) refer to 'he', 'she', 'it', without explaining who or what they are

- (3) mention people or events that the parent doesn't know about without introduction
- (4) talk about the event in a way that the parent needs to do some prompting in order to understand
- (5) talk about the event at length in a way that the parent is able to understand, without prompting, what happened and who was involved

The Story-telling Skills section required parents to indicate whether a certain statement was true of their child's story-telling skills. This section consisted of only four items as follows:

- (1) he/she introduces people and things clearly
- (2) he/she can link the events in the story in a way that makes sense
- (3) he/she warns you that he or she is changing the topic by saying something beforehand such as 'well', 'now', 'see', or 'right'
- (4) he/she has begun to use some words for time such as 'today', 'yesterday', 'tomorrow'

Although the two sections of the PAT that parents completed corresponded to the laboratory measures of pragmatic language skills, the specific questions and scenarios that were presented to parents were different with respect to surface features from the types of tasks that children completed in the laboratory.

PAT: Measures

Both sections of the PAT were scored by assigning "yes" responses with scores of one and "no" responses with scores of zero. Because there were a number of "filler" items included in the Adaptive Communication section, and children were only credited for their sophisticated use of language, the maximum score for the Adaptive Communication section was forty-nine. The maximum score for the Story-telling Skills section was four. Higher scores in both sections indicated more advanced pragmatic language skills.

RESULTS

This study was conducted to investigate the degree to which language measures (ranging from traditional, structured tasks to pragmatic language tasks) may be related to aspects of attentional behavior. In addition, a multi-modal assessment strategy was adopted in order to examine cross-domain associations between laboratory-assessed and parent ratings of their children's attention and pragmatic language skills.

Preliminary Data Analyses

To prepare the data for analysis, outliers, defined as participants with TELD-2 language quotient scores or CAPTAP errors falling at least two standard deviations away from the mean, were identified and removed from the analyses. Children were identified as such outliers for the following reasons. One child was identified as having an exceptionally high number of false alarms on the CAPTAP, suggesting that she may not have fully understood the CAPTAP task requirements (3-year-old girl). One child was identified as having an exceptionally low TELD-2 language quotient score relative to the sample (3-year-old girl). One child had a high number of CAPTAP false alarms and a low TELD-2 language quotient score relative to this sample (4-year-old boy). Thus, the final sample consisted of thirty-nine children (19 boys and 20 girls; mean age 47 months, range: 41 to 54 months). All of the analyses focused on the 39 children in the final sample with the exception of the analyses involving the parent ratings of their children's Adaptive Communication. The parents of two children (one 3-year-old girl and one 4-year-old boy) did not complete the Adaptive Communication section of the PAT, so analyses of parent ratings of their children's Adaptive Communication included 37 children only. As indicated in Table 1, the 39 children in the sample had strong general language abilities relative to the general population, as indexed by TELD-2 percentile rank and language quotient norms.

Table 1

Means, Standard Deviations, Minimum and Maximum for
General Language Skills as Measured by the TELD-2 (N = 39)

<u>TELD-2 Language scores</u>	<u>Mean</u>	<u>SD</u>	<u>Minimum</u>	<u>Maximum</u>
Raw score	49.56	5.53	34	58
Percentile rank	93.70	8.46	61	99
Language quotient	127.28	8.45	104	135

Coding of Videotapes: Reliability Analyses

Reliability results are reported for the several measures that required subjective judgments. All of the data was coded independently by the primary investigator and an undergraduate research assistant who was blind to the hypotheses of the study, with the exception of behavior during the CAPTAP. For the two categories of off-task CAPTAP behavior, a random sample of 30 percent or 12 videotapes was coded by the research assistant and the primary investigator. As indicated in Table 2, reliabilities for all of the coding ratings for the various measures were high.

In addition, all of the children's narratives from the Story-telling task were transcribed from the videotapes by the primary investigator, who coded Story Cohesion from the transcripts. In order to ensure that the narratives were coded as independently as possible, an undergraduate research assistant coded Story Cohesion directly from the videotapes rather than the transcribed stories. Cohen's kappa for Story Cohesion ratings was .87. Subsequently, all disagreements were resolved via discussion.

Table 2

Inter-Rater Reliability of Coded Measures

<u>Measures</u>	<u>Indices</u>	<u>Inter-Rater Reliability</u>
TELD-2 Behavior	Time Looking at Toys	.75
	Frequency of Leaving Seat	.95
	Off-task Talk	.96
CAPTAP Behavior	Frequency of Looking Away	.89
	Total Time Looking Away	.99
Visual Search Indices	Single Target Search	.99
	Search Persistence	.95

The Relationship Between TELD-2 General Language Skills and D-prime Scores

The first major question addressed by the study was whether general language skills, as assessed by the TELD-2, and attention skills, reflected in children's d-prime scores (based on 48 trials of the CAPTAP), were related. Based on the findings from the preliminary study suggesting that general language skills (as measured by the TELD) and attention (indexed by performance on the CPTP) were related, it was expected that general language skills and attention would be related in a slightly younger sample of preschoolers, once methodological concerns were addressed. Pearson Product-Moment correlations were computed in order to address this question. In the present study, general language skills, as assessed by the TELD-2, and d-prime were found to be significantly related ($r = .52, p < .01$), and a similar result was obtained when this relationship was age-corrected ($r = .35, p < .05$) (Footnote 4). Although this relationship was slightly weaker once age was partialled out of the relationship, indicating that age did account for some portion of the relationship between general language skills (TELD-2 raw scores) and attention (d-prime scores), both the age-corrected and non-age-corrected results lent support to the language-attention findings from the preliminary study (Footnote 5). In addition, with both age and gender held constant, TELD-2 general language scores continued to account for a

significant amount of variance in d-prime scores (Appendix F).

In order to ensure that the significant relationship between general language skills (TELD-2) and attention (d-prime scores) was not inflated due to the exclusion of the children who did not complete a sufficient amount of the CAPTAP to be included in the analyses, scores of three children who completed fewer than 48 trials of the CAPTAP were pro-rated for the full 48 trials and the relationship between general language skills (TELD-2), and attention (d-prime scores) was re-examined (Footnote6). The three children who completed fewer than 48 trials of the CAPTAP were assigned a pro-rated number of CAPTAP errors (both misses and false alarms) based on their performance on the first 24 trials. That is, they were assigned the average number of errors (misses and false alarms) for the second 24 trials of children who displayed similar performance on the first 24 trials. D-prime scores were then calculated for each of the three children who were not included in the initial set of analyses. The results from the missing data correction indicated that TELD-2 raw scores were significantly related to d-prime scores ($r = .55, p < .01$), and a similar result was obtained when scores were age-corrected ($r = .33, p < .05$). These results suggested that the relationship between general TELD-2 language skills and d-prime scores was not due to the exclusion of children who did not complete 48 trials of the CAPTAP from the sample.

In order to ensure that the significant relationship between general language skills, as assessed by the TELD-2, and attention (d-prime scores) was not inflated as a result of limiting the analyses to a 48 trial short-form of the CAPTAP, the scores of eight children (out of 39 total) who did not complete the entire CAPTAP (120 trials) were also pro-rated, and the relationship between general language skills (TELD-2 scores) and attention (d-prime scores) was re-computed (Footnote 7). The children's overall CAPTAP scores were pro-rated on the basis of errors (misses and false alarms) they made on the parts of the task that they did complete. That is, they were assigned scores for the later, uncompleted portions of the CAPTAP based on the average score of children who demonstrated a similar performance on earlier sections of the CAPTAP. D-prime scores were then re-calculated for each child based on the full 120 trials of the CAPTAP. Similar to the results for the 48 trial sample, the results again indicated that TELD-2 raw scores were significantly related to d-prime scores ($r = .57, p < .01$), and a similar result was obtained

for the age-corrected relationship ($r = .33, p < .05$). These results suggested that the relationship between general language skills (TELD-2) and attention (d-prime scores) was not due to limiting the analyses to a smaller portion of CAPTAP trials than the first study, which employed 120 trials of the CPTP.

The Relationship Between General Language Skills (TELD-2) and Pragmatic Language Skills

As indicated in Table 3, there was only a modest relationship between general language skills (as assessed by the TELD-2) and the laboratory and parent ratings of pragmatic language skills. Although better TELD-2 general language scores were associated with better Story-telling Skills, overall the very modest relationship suggests that these two areas of language development may be relatively independent of one another and warrant separate examination with respect to the relationship of each type of language to attention skills.

Table 3

Correlations Between TELD-2 General Language Scores and Pragmatic Language Measures

	<u>TELD-2 Raw Language Scores</u>	
	Age-Corrected	Non-Age-Corrected
<u>Pragmatic Language Measures</u>		
Referential Communication	.14	.16
Story Cohesion	.23	.26
Adaptive Communication (parent ratings)	.13	.24
Story-telling Skills (parent ratings)	.37 *	.21

* $p < .05$

The Relationship Between Pragmatic Language Skills and D-prime Scores

As described above, general language skills (TELD-2 raw scores) were found to be

significantly related to attentional abilities (d-prime scores), replicating the results from the first study. However, the question of whether pragmatic language skills were related to d-prime scores remained to be addressed in the second study. The questions that were examined in the next analyses included (a) whether laboratory-assessed and parent ratings of pragmatic language skills were positively related to attentional abilities (d-prime scores), and (b) whether pragmatic language skills (indexed by laboratory performance and parent ratings) predicted attention (d-prime scores), beyond the contributions of general language skills (TELD-2 raw scores), gender and age.

The Relationship Between Laboratory-Assessed Pragmatic Language Skills and Attention (d-prime scores)

In order to examine whether laboratory-assessed pragmatic language skills (Referential Communication and Story Cohesion) were related to attentional skills (d-prime scores), correlations between children's laboratory-assessed pragmatic language skills (Referential Communication and Story Cohesion) and their d-prime scores were computed. As indicated in Table 4, neither Referential Communication nor Story Cohesion skills were significantly related to d-prime scores (Footnote 8). Furthermore, neither Referential Communication nor Story Cohesion predicted d-prime scores beyond the contributions of age and gender (Appendix G).

Table 4

Correlations Between Pragmatic Language Skills and Attention (D-prime)

<u>Laboratory Measures of Pragmatic Language Skills</u>				
<u>Age-corrected scores</u>			<u>Non-age-corrected scores</u>	
<u>Attention</u>	<u>Referential</u>	<u>Story Cohesion</u>	<u>Referential</u>	<u>Story Cohesion</u>
	<u>Communication</u>		<u>Communication</u>	
<u>D-prime</u>	.15	.05	.19	.11

To rule out the possibility of a suppression effect, regression equations were calculated to determine whether laboratory-assessed pragmatic language skills (Referential Communication and Story Cohesion) contributed unique variance in the prediction of d-prime scores beyond the contributions of general language skills (TELD-2 raw scores), age and gender. In two subsequent regression analyses (one for each type of laboratory-assessed pragmatic language skills), background factors were controlled by forcing both age and gender into the equation on the first step. On the second step, TELD-2 raw language scores were entered. On a final third step, laboratory-assessed pragmatic language skills (Referential Communication or Story Cohesion) were entered to determine whether children's pragmatic language skills predicted children's attentional abilities (d-prime scores). As described above, age and gender as well as TELD-2 raw scores significantly predicted changes in d-prime scores. However, the addition of children's laboratory-assessed pragmatic language skills (either Referential Communication or Story Cohesion) did not significantly predict attention (d-prime scores) beyond the contributions of TELD-2 language scores, gender and age (Appendix H).

To further examine the lack of significant relationship of laboratory-assessed pragmatic language skills and d-prime scores, measurement issues were explored. In order to ensure that the relationship between laboratory-assessed pragmatic language skills (Referential Communication and Story Cohesion) and d-prime scores was not attenuated due to low reliability of each measure, a correction for attenuation was calculated. The internal-consistency reliability for children's d-prime scores was $r_{xx} = .79$. The internal-consistency reliability for children's performance on the Referential Communication task was $r_{xx} = .73$. Unfortunately, it was not possible to calculate internal-consistency reliability for children's performance on the Story-telling task, so, for the attenuation analysis, it was assumed that the reliability was perfect ($r_{xx} = 1.00$). Calculation of the correction for attenuation indicated that the correlation between the age-corrected laboratory-assessed Referential Communication skills and d-prime scores ($r = .14$), as well as the correlation between age-corrected laboratory measure of children's Story Cohesion and d-prime scores ($r = -.07$) continued to be negligible. Thus, the correction for attenuation results suggested that the lack of significant relationship between laboratory-assessed pragmatic language skills (Referential Communication and Story Cohesion) with d-prime scores was

probably not due to problems in reliability of measurement.

Examination of the frequency distributions of both Referential Communication and Story Cohesion skills suggested that children's performance on these tasks was not normally distributed. Although the full range of scores were represented for both tasks, children's Referential Communication scores tended towards the lower end of the distribution (Mean score = 1.4, Mode = 0, with a maximum possible score of 4) (Footnote 9), while their Story Cohesion scores tended towards the upper end of the distribution (Mean score = 1.4, Mode = 2, with a maximum score of 2). The modest variability in children's performance on the laboratory-assessed pragmatic language tasks would have reduced the likelihood of detecting a relationship between pragmatic language skills and d-prime scores. In order to attempt to reduce the skew in the data, children were categorized into groups based on their performance on the pragmatic language tasks and compared (via *t*-tests) on their d-prime scores. No significant difference in children's d-prime scores were found when comparing children with low performances (scores below 2) with those with good performances (scores of 2 and better) on the Referential Communication task. In addition, no significant difference in children's d-prime scores were found when comparing children with low performances (scores below 2) and those with good performance (scores of 2) on Story Cohesion skills. Thus, efforts to reduce the impact of the skew of the laboratory-assessed pragmatic language skills did not detect a relationship between pragmatic language skills and attention (d-prime scores). The lack of variability in the Referential Communication and Story Cohesion scores may have made it difficult to detect a relationship between laboratory-assessed pragmatic language skills and attention (d-prime scores).

The Relationship Between Laboratory Measures of Pragmatic Language Skills and Parent Ratings of Pragmatic Language Skills

In order to ensure that the non-significant relationship between laboratory-assessed pragmatic language skills and d-prime scores was not due to invalid laboratory measures, providing a poor assessment of Referential Communication and Story Cohesion skills, the cross-domain relationships of pragmatic language skills were examined. In addition, given that the PAT (O'Neill & Baron-Cohen, 1996) was a newly developed measure of parent ratings of their

children's pragmatic language skills, there was also the opportunity to examine whether there was support for the parent ratings, as demonstrated by the relationship between the laboratory and parent ratings of the same pragmatic language skills. Specifically, were parent ratings of children's Adaptive Communication associated with children's laboratory performance on the Referential Communication task? Likewise, were parent ratings of children's Story-telling Skills related to the laboratory assessment of their Story Cohesion skills? In order to address these questions, Pearson Product-Moment correlations were computed between the parent ratings and children's performance on the laboratory measures of pragmatic language skills.

As can be seen in Table 5, irrespective of whether scores were age-corrected, laboratory-assessed Referential Communication skills were significantly related to parent ratings of children's Adaptive Communication, as were laboratory-assessed children's Story Cohesion skills and parent ratings of their children's Story-telling Skills. These findings also provided an informal validation of parent ratings of children's pragmatic language skills.

Table 5

Correlations Between the Laboratory and Parent Ratings of Pragmatic Language Skills

	<u>Laboratory Measures of Pragmatic Language Skills</u>			
	Age-corrected scores		Non-Age-corrected scores	
<u>Parent Ratings of Pragmatic Language Skills</u>	<u>Referential Communication</u>	<u>Story Cohesion</u>	<u>Referential Communication</u>	<u>Story Cohesion</u>
Adaptive Communication	.38 *	-.04	.40 *	-.01
Story-telling skills	.15	.39 *	.13	.36 *

Note. N=37 for parent ratings of Adaptive Communication only

* $p < .05$

As noted previously in Table 3, general language skills, as assessed by the TELD-2, were also found to be significantly related to the parent ratings of Story-telling Skills ($r = .37, p < .05$;

when the scores were age-corrected). In order to rule out the possibility that the relationship between laboratory-assessed Story Cohesion and parent ratings of children's Story-telling Skills was due to the variables' shared association with TELD-2 language scores, both TELD-2 scores and age were partialled out of Story Cohesion scores and parent ratings of Story-telling Skills, and then the parent rating-laboratory test association was re-examined. Once TELD-2 scores and age were partialled out, the relationship between laboratory-assessed Story Cohesion and parent ratings of Story-telling Skills remained significant ($r = .33, p < .05$), indicating that general language skills, as assessed by the TELD-2, and age did not account for the relationship between laboratory-assessed Story Cohesion and parent ratings of Story-telling Skills.

The significant relationships between laboratory-assessed and parent ratings of pragmatic language skills lent support to the validity of parent-report measures of pragmatic language, as assessed by the PAT measures. Although the Referential Communication task was based on traditions of assessing adaptive communication (Deutsch & Pechmann, 1982), the findings seemed to indicate that performance on the present study's version of the Referential Communication task provided a reasonable assessment of children's adaptive communication skills, reported by parents observing the children's language in the natural environment. The findings also lent further support to the tradition of assessing cohesion via narrative tasks (Berman & Slobin, 1994; Peterson & McCabe, 1988), insofar as the Story Cohesion index provided a reasonable assessment of children's story-telling cohesion skills, reported by parents observing the children's language in the natural environment. The moderate but significant relationship between parent-ratings and laboratory-assessed measures of pragmatic language skills seemed to suggest that the lack of relationship between d-prime scores and laboratory-assessed pragmatic language skills was probably not due to poor laboratory assessment of these skills.

The Relationship Between Parent Ratings of Pragmatic Language Skills and D-prime Scores

Although the laboratory measures of pragmatic language skills (Referential Communication and Story Cohesion) were not found to be significantly related to d-prime scores, the question of whether the parent ratings of their children's pragmatic language skills (PAT measures) would be related to children's attentional abilities (d-prime scores) remained to be

addressed. In addition, even though the relationships between the laboratory and parent ratings of pragmatic language skills were significant, the percent of variance accounted for was modest (approximately 15%), suggesting that the parent ratings of their children's pragmatic language skills may be independently associated with d-prime scores. Questions that were examined included (a) whether parent ratings of their children's pragmatic language skills (Adaptive Communication and Story-telling Skills) were related to children's d-prime scores, and (b) whether parent ratings of pragmatic language skills (Adaptive Communication and Story-telling Skills) predicted d-prime scores beyond the contributions of general language ability (TELD-2 raw scores), age, and gender.

As indicated in Table 6, parent ratings of their children's Adaptive Communication were significantly related to children's d-prime scores, such that higher ratings of Adaptive Communication were associated with higher ratings of attentiveness (d-prime scores). However, once scores were age-corrected, parent ratings of children's Adaptive Communication and d-prime scores were no longer significantly related. These results suggested that developmental factors were playing a role in the relationship between parent ratings of pragmatic language skills (Adaptive Communication) and d-prime scores.

Table 6

Correlations Between Parent Ratings of Pragmatic Language Skills and Attention (D-prime)

	<u>Parent Ratings of Pragmatic Language Skills</u>			
	<u>Age-corrected scores</u>		<u>Non-age-corrected scores</u>	
<u>Attention</u>	<u>Adaptive</u>	<u>Story-telling</u>	<u>Adaptive</u>	<u>Story-telling</u>
	<u>Communication</u>	<u>Skills</u>	<u>Communication</u>	<u>Skills</u>
D-prime	.26 *	.12	.32 **	.05

N=37 for parent ratings of children's Adaptive Communication only

* $p = .11$, ** $p < .05$

In order to more fully examine whether parent ratings of pragmatic language skills (Adaptive Communication and Story-telling Skills) predicted d-prime scores beyond the contributions of TELD-2 language scores, age and gender, two regression equations were calculated (one for each type of parent rating). In this analysis, background factors were controlled for by forcing both age and gender into the equation on the first step. On the second step, TELD-2 raw language scores were entered. On the final step, parent ratings of pragmatic language skills (Adaptive Communication or Story-telling Skills) were entered into the equation to determine whether parent ratings of pragmatic language skills contributed unique variance in the prediction of children's d-prime scores. The results indicated that neither of the parent ratings of pragmatic language skills (Adaptive Communication or Story-telling Skills) predicted attention beyond the contributions of age, gender and TELD-2 raw language scores (Appendix I).

The Relationship Between Other Indices of Attention and TELD-2 Language Scores

Although d-prime scores (CAPTAP) have been central to the assessment of attention in this study, the relationship between other aspects of attention assessed in this study and language (both general and pragmatic language skills) was also examined. Pearson Product Moment correlations were computed between language skills (general and pragmatic language skills) and diverse indices of attention other than d-prime scores (behavior during the CAPTAP, Visual Search indices, and parent ratings of attention).

The Relationship Between Off-Task Behavior and TELD-2 General Language Scores

Given that indices of behavior during a continuous performance task, such as head turns away from the screen, have been used elsewhere to reflect inattention to the task (Corkum et al., 1995), the relationship between behavior during the CAPTAP and TELD-2 language scores was investigated in this study. When scores were not age-corrected, both Frequency of Looking Away ($r = -.43$, $p < .01$) and Total Time Looking Away ($r = -.51$, $p < .01$) were significantly related to TELD-2 raw language scores. Higher general language scores, as assessed by the TELD-2, were associated with less time spent off task and less frequent looking away from the computer screen during the CAPTAP. However, these findings were attenuated (though

remaining in the same direction) once age was partialled out of this correlation (Frequency of Looking Away: $r = -.25$, $p = .12$; Total Time Looking Away: $r = -.28$, $p = .08$). In contrast to the significant relationship between d-prime scores and general language scores, the relationship between behavior during the CAPTAP and children's TELD-2 language scores seemed to be substantially dependent on the variables' association with age (developmental factors).

Behavioral observations during a structured language task have been used elsewhere to reflect inattention (e.g., Bowering et al., 1996). However, due to lack of variability in children's TELD-2 off-task behavior (Time Looking at Toys, Frequency of Leaving Seat, and Off-task Talk), it was not possible to examine the relationship between inattentive behavior during the TELD-2 and TELD-2 general language scores.

The Relationship Between Visual Search Indices and TELD-2 General Language Scores

In an effort to investigate whether indices from an "ecologically valid" task of attention (Visual Search task) were related to TELD-2 language scores, Single Target Search, Multiple Target Search, and Search Persistence were correlated with TELD-2 raw language scores. The results indicated that Multiple Target Search was significantly related to TELD-2 language scores ($r = .49$, $p < .01$), although when scores were age-corrected this relationship was only marginally significant ($r = .30$, $p = .06$). Consistent with the relationship between d-prime scores and TELD-2 language scores, more accurate identification of complex items within a visual array (hits less false alarms) was associated with better general language skills, as assessed by the TELD-2. Neither Single Target Search (age-corrected: $r = -.10$, $p > .10$; non-age-corrected: $r = -.21$, $p > .10$) nor Search Persistence (age-corrected: $r = .13$, $p > .10$; non-age-corrected: $r = .18$, $p > .10$) were significantly related to TELD-2 raw language scores.

The Relationship Between Parent Ratings of Attention (CCTI) and TELD-2 General Language Scores

In order to examine whether parent ratings of their children's attention and persistence were related to TELD-2 language scores, the CCTI index of attention and persistence was correlated with TELD-2 raw language scores. When scores were not age-corrected, parent

ratings of attention and persistence were significantly related to TELD-2 raw language scores ($r = .34, p < .05$), such that stronger parent-rated attention skills were associated with better language scores on the TELD-2. In contrast to the more consistent relationship between d-prime scores and TELD-2 language scores, parent ratings of attention and persistence were no longer significantly related to TELD-2 language scores once age was partialled out of the relationship ($r = .24, p = .15$), although the relationship remained in the expected direction.

The Relationship Between Factor Structure of Measures of Attention and TELD-2 General Language Scores

In order to more fully examine whether the collective indices of attention were associated with TELD-2 language scores, the laboratory indices and parent ratings of their children's attentional abilities were factor analyzed via a principal component analysis with an orthogonal rotation, and the major factors were then correlated with TELD-2 language scores (Footnote 10). A factor analysis allows for the opportunity to capitalize on the multiple indicators of children's attentional skills and to identify possible underlying structures in the laboratory indices (zero-order correlations are presented in Appendices J and K). As shown in Table 7, two main factors were derived from the indices of attention (eigenvalues greater than 1). The first factor comprised d-prime scores from the CAPTAP, associated behavior during the CAPTAP, persistence during the Visual Search task and parent ratings of their children's attention and persistence, suggesting that the factor was reflecting elements of Sustained Attention. Notably, the Sustained Attention factor spans two laboratory measures, behavioral indices, as well as parent ratings of their children's attentional abilities, suggesting that the factor is not likely an artifact of method variance. The second factor comprised aspects of children's search efficiency (indices of both speed and accuracy of search) on a task thought to measure selective attention, and thus was named the Selective Attention factor. On the basis of these two factors, factor scores were derived for each subject. Each variable was unit-weighted (i.e., standard scores) and entered on one factor only, the one on which it loaded most highly. Notably, the two resulting composites shared a modest correlation ($r = .21, p = .21$), suggesting that they were tapping into relatively independent constructs.

Table 7

Factor Loadings of Measures of Attention (Rotated factor matrix)

<u>Attention Measures</u>	<u>Factors</u>	
	<u>Sustained Attention</u>	<u>Selective Attention</u>
D-prime	.74	.04
Frequency of Looking Away	-.72	-.13
Time Spent Looking Away	-.89	-.02
Search Persistence	.70	.06
Parent ratings of attention	.47	.26
Single Target Search	.04	-.87
Multiple Target Search	.20	.66
Percent Variance	39.0	16.8

As displayed in Table 8, both factors were significantly related to TELD-2 language scores when scores were not age-corrected. In contrast, when scores were age-corrected, only the Sustained Attention factor was significantly related to TELD-2 language scores, suggesting that age might have been playing a role in the association between the Selective Attention factor and TELD-2 language scores. These results suggest that the sustained or persistence elements of attention are more related to general language skills, as assessed by the TELD-2.

Table 8

Correlations Between Attention Factor Scores and TELD-2 General Language Scores

Factor	Age-corrected	Non-age-corrected
	<u>TELD-2 Language Scores</u>	<u>TELD-2 Language Scores</u>
Sustained Attention	.33 *	.55 **
Selective Attention	.24	.44 **

* $p < .05$, ** $p < .01$

The Relationship Between Other Indices of Attention and Pragmatic Language Skills

Although there was no evidence in these data for a relationship between d-prime scores and pragmatic language skills (laboratory and parent ratings), it was possible to explore whether aspects of attention other than d-prime scores were related to performance on the Referential Communication task, Story Cohesion skills, and parent ratings of pragmatic language skills. Similar to the d-prime findings, none of the age-corrected or non-age-corrected relationships between the other indices of attention (behavior during the CAPTAP, Visual Search indices, parent ratings of attention, or factor scores) and all indices of pragmatic language skills were significant. Furthermore, neither the Sustained nor the Selective Attention factors derived from the attention measures were related to any of the measures of pragmatic language skills (laboratory or parent ratings). That aspects of attention other than d-prime scores were also unrelated to pragmatic language skills suggested that attention, as assessed in the current study, was not related to pragmatic language skills.

The Relationship Between Parent Ratings of Attention and Laboratory-Assessed Attentional Skills

The final hypothesis of the study focused on whether the parent ratings of children's attentional skills were associated with children's performance on the laboratory tasks of attention. In order to address the question of whether there was evidence for cross-domain associations

between laboratory-assessed and parent ratings of attentional skills, Pearson Product-moment correlations were calculated between parent ratings of attention (CCTI attention/persistence index) and the laboratory indices of attention (d-prime, CAPTAP performance, CAPTAP behavior, Visual Search indices). As indicated in Table 9, parent ratings of attention (CCTI index of attention/persistence) were significantly related to indices of performance on the CAPTAP and behavior assessed during the CAPTAP. In particular, higher parent ratings of attention were associated with higher levels of attentiveness on the CAPTAP, fewer performance errors on the CAPTAP, and less frequent off task behavior during the CAPTAP. However, once scores were age-corrected, none of the laboratory variables remained significantly related to the parent ratings of attention (CCTI). Nevertheless, all of the associations were in the same direction, displaying trends in the expected direction. These findings lent limited support to the cross-domain relationships between parent ratings and laboratory-assessed attentional skills, as developmental factors were playing an important role in these associations. However, given the modest correlations between parent ratings of their children's attention and laboratory-assessed attention skills, it seems as though parent and laboratory assessments of attentional skills may be contributing different information to an understanding of children's attentional profiles.

Table 9

Correlations Between Parent Ratings of Attention and Laboratory Measures of Attention

<u>Lab measures of attention</u>	<u>Parent Ratings of Attention/Persistence</u>	
	<u>Age-corrected</u>	<u>Non-age-corrected</u>
D-prime	.21	.30 *
Misses	-.11	-.19
False Alarms	-.28 *	-.38 **
Frequency of Looking Away	-.28 *	-.35 **
Total Time Looking Away	-.18	-.29 *
Single Target Search	-.17	-.22
Multiple Target Search	-.15	-.01
Search Persistence	.18	.21

* $p < .10$, ** $p < .05$

DISCUSSION

This project was undertaken to examine the relationship between early-developing attentional skills and language skills, two factors associated with school adjustment. In particular, the relationship between diverse measures of attention and both general language and pragmatic language skills was investigated in non-problematic preschoolers. Previous research findings had demonstrated an association between general language impairments and attentional deficits in children (Beitchman et al., 1989; Beitchman et al., 1986; N. Cohen et al., 1993; Donahue et al., 1994; Love & Thompson, 1988), and a relationship between general language skills (as assessed by a structured language task, the TELD) and attention (as assessed by a continuous performance task) in a small sample of non-problematic preschoolers (R. Cohen & Steffy, 1996). Based on these findings, it was predicted that general language skills (as assessed by the TELD-2) and attention (as indexed by d-prime scores) would be significantly related in a sample of non-problematic preschoolers.

In contrast to the structural aspects of language captured in assessments of general language (receptive, expressive, semantics and syntactic skills), pragmatic language skills are thought to reflect the rules governing communication in social contexts (Roth & Spekman, 1984a). Although not as consistently documented as the relationship between general language impairments and attentional challenges, pragmatic language skills deficits may also be associated with attentional challenges in children (Donahue et al., 1994; Giddan, 1991; Humphries et al., 1994; Westby & Cutler, 1994). Furthermore, attention may be an integral component of some pragmatic language skills (e.g., referential communication and story-telling cohesion) in typically developing children (Berman, 1988; Deutsch & Pechmann, 1982). For example, in order to communicate effectively in referential communications, children need to notice, identify and select appropriate referents (e.g., color, size) and then communicate the most informative facts (Bishop & Adams, 1991; Lloyd, 1994). Likewise, in order to use conjunctions to maintain cohesive connections in their story-telling, children need to maintain their focus on the actions depicted in the story and sustain their attention throughout a narration (Berman, 1988). In this study, it was expected that Referential Communication and Story Cohesion indices of pragmatic language skills would be significantly related to attention (as indexed by d-prime scores).

A third focus of the study involved examining the cross-domain relationships with respect to parent ratings of children's functioning in both attention and pragmatic language domains and children's performance on laboratory tasks of these skills (Biederman et al., 1993; R. Cohen & Steffy, 1995; Shelton & Barkley, 1990; Taylor, 1988). Comprehensive assessments of both parent ratings and laboratory indices of attention and pragmatic language skills were collected in this study. Insofar as the measurement of pragmatic language skills is a less well developed area than is general language skills, collecting information from these two domains also afforded the opportunity to examine the validity of the pragmatic language tasks employed in this work.

Are General Language Skills and Attention Related in Non-problematic Preschoolers?

The findings of the study confirmed a relationship between general language skills and attention, discovered in the preliminary study. That is, stronger general language skills, as assessed by the TELD-2, were associated with better attentional functions, as indexed by d-prime scores. The results of this study were also consistent with other research that had previously identified an association between language impairments and attentional deficits in samples of both school-aged and preschool children (Beitchman et al., 1989; Beitchman et al., 1986; Beitchman et al., 1987; N. Cohen et al., 1993; Donahue et al., 1994; Love & Thompson, 1988). Although the relationship between TELD-2 language abilities and d-prime scores of the CAPTAP proved replicable despite variations in the measures and experimental format, the other individual indices of attention (behavior during the CAPTAP, Visual Search and parent ratings) were only modestly related to general language skills, and those relationships seemed to be underwritten by a "third variable" association with age. Of the two factors identified by a factor analysis of the attention measures (described in detail below), Sustained Attention was more closely associated with general language skills (as assessed by the TELD-2) than was Selective Attention.

Are Pragmatic Language Skills and Attention Related in Non-problematic Preschoolers?

In this study, general language skills (TELD-2 raw scores) and pragmatic language skills were not correlated. In considering the hypothesized association between pragmatic language skills and attention, neither of the laboratory measures of pragmatic language skills (Referential

Communication, Story Cohesion) nor the parent ratings of their children's Story-telling Skills, were associated with any of the indices of attention. Although parent ratings of their children's ability to adapt their conversation to others were related to the CAPTAP d-prime measure of attention, the relationship was no longer significant once the contributions of background variables (i.e., gender and age) and general language skills (as assessed by the TELD-2) were statistically controlled, suggesting that the relationship between Adaptive Communication and attention may be partially attributable to the measures' shared relationship with background measures and general language skills. Taken together, these findings suggest that, in contrast to the relationship between general language skills and attention, the relationship between pragmatic language skills and attention ranged from modest to negligible in this study.

The relationship between laboratory-assessed and parent ratings of pragmatic language skills was examined in order to investigate the possibility that the lack of significant relationship between pragmatic language skills and attention was due to measurement problems. Furthermore, given that there are few standardized measures available of pragmatic language skills for school-aged or preschool children (Lloyd, 1994; Roth & Spekman, 1984b), examination of the cross-domain relationships also afforded the opportunity to assess the validity of the pragmatic language skills measures. A significant, albeit modest, relationship was obtained between laboratory-assessed pragmatic language skills and parent ratings of pragmatic language skills in this study. This finding provided evidence for the validity of both types of measures of pragmatic language skills, and suggested that the lack of relationship between pragmatic language skills and attention was probably not due to problems in measurement, except possibly for insufficient variability in children's scores on laboratory measures of pragmatic language skills.

Although there was evidence for the validity of the pragmatic language skills measures, there may not have been sufficient variability in the Referential Communication scores to demonstrate a relationship between Referential Communication and attention, as indexed by d-prime scores. The Referential Communication task proved to be very challenging for the preschoolers in the sample. The full range of possible scores was represented in the sample, yet most children's performance on the Referential Communication task was relatively poor. Although the Referential Communication task used in this study addressed a number of

methodological problems identified in previous designs of the tasks (e.g., fewer attributes required for a correct response, knowledge of the necessary vocabulary, and concrete instructions), most three- and four-year-olds in this sample were not able to successfully complete the task, thus constricting the range of scores and lowering the size of relationship between Referential Communication and other variables. Insofar as other research has indicated that toddlers as young as two-years-old are able to take into account the knowledge state of their communication partner when communicating with them (O'Neill, 1996b), it may be that the Referential Communication task designed for this study could be improved to reflect more variability in young preschoolers' abilities. Consistent with this notion, most children were able to provide unambiguous responses on the feedback trials of the Referential Communication task, thus showing a better quality response when additional structure was provided by the experimenter. Future studies will need to address whether referential communication skills are related to attention when referential communication skills are assessed in ways that better reflect the variability in young children's skill level.

For the purposes of this study, attempts were made to quantitatively examine small but meaningful variations in preschoolers' narratives (e.g., children's use of conjunctions) in relationship to attention in order to determine whether pragmatic language skills (Story Cohesion) and attention were significantly related in a narrow age range of preschoolers (41 to 54 months). This approach is in direct contrast to the approach characteristic of Slobin and Berman's (1994) studies in which qualitative and descriptive analyses are conducted on such variables (e.g., children's use of conjunctions) using children whose ages extend across a relatively large age range (3-, 5-, and 7-year-olds). One of the challenges in examining shifts in the ability to cohesively tie together a story within such a narrow age-range of children was identifying an area where there was meaningful variability in preschoolers' performance (Story Cohesion skills). Although there was a lot of variability in the narratives produced by the children in this study (e.g., story length, use of mental state terms), there still may not have been sufficient variability in the Story Cohesion scores to identify a relationship with attentional abilities.

Task Structure and Cognitive Demands: Match or Mismatch?

The association between general language skills and attention in this study seemed to be strongest and limited to the types of language and attention assessed by the TELD-2 and CAPTAP respectively. The data suggests that attentional skills are not related to different types of language functions in a general way. Rather, there may be relationships between specific language skills and particular attention functions that depend on the ways in which language and attention are assessed.

Analysis of the task demands of the TELD-2 and the CAPTAP suggest that both of these tasks are structured, task-driven activities, similar to what might be required of children in school-based seat work tasks. That is, both tasks require children to attend to and persistently work at relatively simple, dull, and uncomplicated requirements while they inhibit other activity. Although both tasks are taxing for children, they seem to require relatively little cognitive effort. The TELD-2 typically requires either some indication of receptive understanding or one-word responses with little expressive elaboration (Paul, 1995). For example, in one item purported to reflect children's expressive language skills, children are asked, "What is the name of your favorite story?" (Hresko et al., 1991). In addition, although there was variability in children's performance on the TELD-2, many of the children in the sample displayed very high performances on the TELD-2, suggesting that it was not very cognitively demanding for them. Similarly, the CAPTAP requires children to provide a simple, repetitive response by pressing a button to signal the presence of a target stimulus. Although effort is required to maintain focus on the computer to detect the presence of the target, the task demands are relatively uncomplicated. (Footnote 11).

The strength of the measured relationship between language and attention may depend on the extent to which the level of task difficulty and other task characteristics are matched. Attentional tests vary widely in their cognitive demands, and such tasks can be altered via instructions or presentation style to shift the level of cognitive effort required to successfully complete the task. Cooley and Morris' (1990) analysis of diverse attention measures suggests that such tasks vary particularly in the amount that children are required to focus intently on presented stimuli and to inhibit other behavior. Using their approach to analyzing task demands, it seems that the TELD-2 and CAPTAP are similar on these dimensions. One can speculate that a

significant relationship between other types of language and attention tasks would emerge if both tests were operationalized by difficult or cognitively effortful task features. For example, future research matching a more cognitively effortful general language task (e.g., complex grammar or expressive language tasks) with a cognitively effortful attention task (e.g., complex divided attention tasks, “stop and go” tasks) might also yield a significant relationship between general language skills and attention.

Similar to the variability found in attentional tasks, pragmatic language tasks also vary in terms of their level of sophistication and cognitive effort required (Roth & Spekman, 1984b). In this study there may have been a mis-match between the level of difficulty of the assessment of pragmatic language and attention skills, which might partly account for the failure to find a significant relationship between pragmatic language and attention skills. Pragmatic language skills, as assessed in this study (Referential Communication and Story Cohesion), made fairly sophisticated language use demands of preschoolers. In contrast to the relatively uncomplicated demands for one word or unelaborated expressive responses required of children in the TELD-2, the pragmatic language test procedures required children to monitor their communication while taking into account the perspective of a listener and maintain cohesive connections throughout their story-telling. Both referential communication skills and story cohesion skills continue to develop through school-age.

Therefore, attempts to match the assessment of attention and pragmatic language skills, so that both tasks tap into more sophisticated, cognitively effortful activities, may aid in demonstrating the relationship between pragmatic language skills and attention. Notably, studies demonstrating a relationship between attentional impairments and deficits in pragmatic language skills in school-aged children may assess pragmatic language skills differently than in this study. For example, in one study of school-aged boys with attentional problems, pragmatic language skills were assessed via teacher ratings of complex pragmatic skills such as topic initiation and conversation maintenance (Humphries et al., 1994), two areas that differ from the assessment of referential communication and story cohesion in this study.

Although it would be difficult to design measures of attention that require preschool children to invest high levels of cognitive effort, in order to assess whether general language skills

and attentional functioning are associated after technical features of the assessment (e.g., difficulty level) are controlled, future attempts titrating different levels of task difficulty will be needed.

How are Parent Ratings and Laboratory Measures of Attention Related?

Consistent with the literature on school-aged children with a variety of disorders (Biederman et al., 1993; R. Cohen & Steffy, 1995; Shelton & Barkley, 1994; Taylor, 1988), parent ratings of attention were not closely associated with laboratory-assessed attentional skills in non-problematic preschoolers. In this study, the cross-domain relationships were weak and associated with age. Nevertheless, there were some indications that parent ratings overlapped with laboratory-assessed attentional skills. Given the challenges associated with assessing attentional functioning in preschoolers and the low level of convergence of the measures of laboratory-assessed and parent ratings of attention in this study, it seems prudent to include aspects of both domains of attention in assessments of preschoolers' attentional abilities. Assessments of children based separately on parent ratings of children's attentional skills and on children's laboratory measure performance may each shed light on only part of children's attentional profiles. Notably, cross-validating laboratory measures of attention designed for preschoolers will be particularly challenging given that laboratory and parent ratings of attention may be tapping into somewhat different aspects of attention.

Previous research into attention factors has discriminated among qualitatively different attentional functions (Cooley & Morris, 1990; Douglas, 1983; Mirsky et al., 1991; Shelton & Barkley, 1994; Stuss et al., 1995), especially sustained and selective variants (Douglas, 1983). The factor analysis of the measures of attention in this study provided support for including elements of both sustained and selective attention in assessments of children's attentional skills. As in the research into school-aged children's attentional functions (e.g., Cooley & Morris, 1990), sustained and selective attention appeared to be relatively independent attentional functions within this sample of non-problematic preschoolers. The data suggest that, at least with respect to these two elements of attention, preschoolers' attentional skills separate in a manner similar to school-aged children's attentional functions (Cooley & Morris, 1990; Douglas, 1983). That the factor analysis includes several laboratory measures, several "in lab" behavioral indices, and parent

ratings of attention further provides compelling evidence that separable aspects of attentional functions in preschoolers can be clarified. However, given the preliminary and exploratory nature of these analyses, future research focused on further elaborating a model of the components of attention in preschoolers is required.

Alternative Explanations for the Findings and Study Limitations

Two possible “third factor variables” (i.e., age and I.Q.) that might account for the association between attention and language skills need to be ruled out. In the present study, the association between general language skills and attention was examined with and without statistical controls for age. The relationship between general language skills, as assessed by the TELD-2 and attention, as indexed by d-prime scores, did not seem to shift systematically within the confines of the range of ages studied (41 to 54 months), ruling out the possibility that the relationship between general language skills and attention was attributable to the variables’ shared association with age in this study. Despite the fact that the age range studied was relatively narrow, the shift from 3- to 4-years of age has been noted as a time of significant development in such domains as theory of mind and self-regulation (e.g., Jenkins & Astington, 1996; Kopp, 1982). Although the current study was not designed to examine developmental trends in language and attention skills in preschoolers, by sampling from such a narrow age range the variability necessary to identify the relationship between attention and pragmatic language skills may have been limited.

Although I.Q. was not assessed in the present study, results from the preliminary study provided evidence that estimates of full-scale I.Q. were not related to TELD or attention scores, insofar as general language predicted attentional errors (false alarms) beyond the contribution of I.Q. estimates. Further evidence that children’s I.Q. does not account for the relationship between general language and attention has been found in previous research (Corkum & Siegel, 1993) suggesting that I.Q. is inconsistently related to performance on attentional tasks.

Given the challenges inherent in assessing attention skills in preschoolers, it was deemed necessary to assess whether test instrumentation may have influenced the results. Although continuous performance tasks have been used in previous research with preschoolers (e.g.,

Corkum et al., 1995), in this study the CAPTAP was significantly abridged, making it difficult to assess performance decrements over time that might be associated with a long work period. In contrast to Corkum and colleagues' (1995) CPTP which consisted of 240 trials (lasting approximately 14 minutes), the CAPTAP was designed to be only 120 trials (lasting approximately 6 minutes) and due to some children's difficulty completing the entire CAPTAP, the task was further abridged to 48 trials (lasting approximately 4 minutes) for the purposes of data analysis in this study. Efforts to pro-rate the scores of children who did not complete the entire CAPTAP suggested that the relationship between general language and attention skills remained strong regardless of the length of the attentional task. Thus, the relationship between general language skills and attention does not seem to be due to shortening the CAPTAP.

One notable limitation of the current study included the restricted range of language abilities represented in the sample of preschoolers. As reflected in their TELD-2 language quotient scores, children in this study had a superior level of language ability as compared to children in the general population. In order to ensure the generalizability of the findings, the relationship between general language skills and attention would require replication in a more representative group of preschoolers. Insofar as the detection of a significant relationship between general language skills and attention within a sample of children with superior language abilities offers a conservative test for the relationship, an even stronger relationship between general language and attention skills would likely be identified in a more evenly distributed sample. It is unclear, however, whether the fact that children had superior language abilities had an impact on the ability to detect a relationship pragmatic language skills and attention in this study.

Future Directions

Although this project provided evidence for the relationship between general language skills and attention, it also raised a number of research questions that would need to be addressed in further studies on the relationship between language and attention in preschoolers. Systematic validation of attention and pragmatic language skills measures for preschoolers would be an important first step in future studies on the relationship between language and attention.

Following the development of measures for preschoolers, the relationship between different types of attention and language, ranging from simple and repetitive to more sophisticated and cognitively effortful activities, could be assessed. Once a clearer model of the relationship between different types of attention and language skills is developed, longitudinal and experimental studies could be carried out to test causal models that stem from that work.

In addition to studies focusing on typically developing children, research with impaired populations would allow the opportunity to examine any dissociations in language and attentional abilities displayed by children with single deficits (language impairments or attention impairments) and double deficits (both language and attention impairments). Finally, given that attentional skills have been considered within the domain of frontal lobe or executive functioning skills (Mirsky et al., 1991; Welsh et al., 1991), the inter-relationships of language, attention and other executive functions could also be assessed.

Clinical Implications

A number of different models have been considered to account for the high level of co-morbidity of children's attention deficits and language disorders. Contrasting models include those that suggest a causal link between attention and language difficulties and those that propose a common antecedent between the two (N. Cohen et al., 1993; Love & Thompson, 1988; McGee & Share, 1988; Westby & Cutler, 1994). Although there is insufficient support for any one particular model over another, the appropriate focus of treatment for children with co-occurring difficulties would depend on the model endorsed. For example, McGee & Share (1988) have proposed that children's learning difficulties precede their attentional deficits, and that learning difficulties ought to be the primary focus of intervention. In contrast, if one assumes a common antecedent for both disorders (e.g., a temperamental or neurological characteristic), it would be sensible to target that third variable along with efforts to deal with associated attention and language difficulties. Although the current study did not address the etiological origins and the nature of the causal relationship between language and attention, the findings of this study clarify that attention and language functions are moderately related very early on in development. The finding is consistent with those of several studies (Beitchman et al., 1987; Love & Thompson,

1988) that have identified significant relationships between attention and language problems in clinic-referred preschoolers.

In the absence of clearly established causal paths, one can see that attempts to treat children at risk by singularly targeting either attention or language problems may be short-sighted. Given the frequency with which difficulties in attentional functioning are associated with language impairments, one can speculate that, until more detailed models are elaborated, educational and remedial treatment goals may need to encompass both domains. Indeed, cognitive-behavioral interventions aimed at improving children's attentional focus often make intensive language demands on children (Kendall & Braswell, 1985; Westby & Cutler, 1994). Furthermore, speech-language pathologists recognize that to be maximally effective, attentional and self-control strategies may need to be integrated within the context of language-based interventions (Giddan, 1991; Paul, 1995).

FOOTNOTES

1. Since language difficulties identified in young children have been associated with the development of learning disabilities in school-aged children (Paul, 1995; Whitehurst & Fischel, 1994), the relationship between attention difficulties and both language or learning difficulties will be reviewed.
2. Measures adopted to study use of cohesion in story-telling are distinct from story-telling coherence, which refers to the inclusion of relevant structures (e.g. story beginning and ending, character descriptions) to form a coherent narrative (Shapiro & Hudson, 1991).
3. Five pages were removed from Frog Goes to Dinner. These included the first two pages of the book that depicted the boy preparing for an outing, and three pages depicting the frog jumping into a man's wine glass at the restaurant. Abridging the story did not alter the main story-line, as there were no breaks in the logic of Frog Goes to Dinner.
4. Given that the sub-components of the TELD-2 (i.e., receptive, expressive, semantics and syntactic skills) are highly inter-related in the test's construction (Hresko, Reid, & Hammill, 1991), it was not possible to distinguish between the relationship of the various sub-components of the TELD-2 with attention in this study. In order to address the relationship between different aspects of general language skills and attention, it would be necessary to assess receptive, expressive, semantics and syntactic skills via independent tests.
5. In addition to d-prime scores, signal detection theory has also considered beta, an index of participants' response bias with respect to the degree of certainty required in order to generate a response independent of participants' ability to discriminate targets from non-targets. Higher beta scores are thought to indicate a more conservative response strategy, whereas lower beta scores indicate a more impulsive response strategy (Davies & Parasuraman, 1981; McNicol, 1972). Beta scores are thought to be independent of d-prime scores, such that variability in d-prime scores is not thought to be due to individual differences in participants' response criteria (Macmillan & Creelman, 1991; Sekuler & Blake, 1990). Indeed, in this study, beta scores were not significantly correlated with d-prime scores. Furthermore, beta scores were also not correlated with TELD-2 general language suggesting that response style or impulsivity was not associated with general language skills in this study.

6. The three children who completed less than 48 trials of the CAPTAP were excluded from the main sample of 39 children. As such, these three children are not included in any of the other analyses reported here.
7. T-tests (for unequal samples) indicated that the eight children who did not complete the full 120 trials of the CAPTAP did not differ significantly from the children who completed the full 120 trials with respect to their TELD-2 raw language scores or 48 trial sample d-prime scores.
8. Children's beta scores were not correlated with any of the indices of pragmatic language, suggesting that response style or impulsivity was not associated with pragmatic language skills in this study.
9. Although children performed poorly on the Referential Communication task, examination of their scores on the two feedback trials of the task suggested that, with the additional structures afforded by those trials, most children were able to display good performance. Specifically, 29 children provided unambiguous responses for both feedback trials, 7 children provided unambiguous responses for one of the feedback trials, and only 3 children provided unambiguous responses for none of the feedback trials.
10. Although the sample size in this study is small, the minimum number of 5 cases per variable entered into the factor analysis has been met (Tabachnik & Fidell, 1989). Nevertheless, the factor analysis reported here is exploratory and would require replication with a larger sample in order to confirm the factor structure of the attention measures.
11. Analyses of the associations between children's inattentive behavior during the CAPTAP and the TELD-2 might have assisted in supporting these speculations. Unfortunately, due to the lack of variability in children's off-task behavior during the TELD-2 (Time Looking at Toys, Frequency of Leaving Seat, and Off-task Talk), these correlations could not be calculated.

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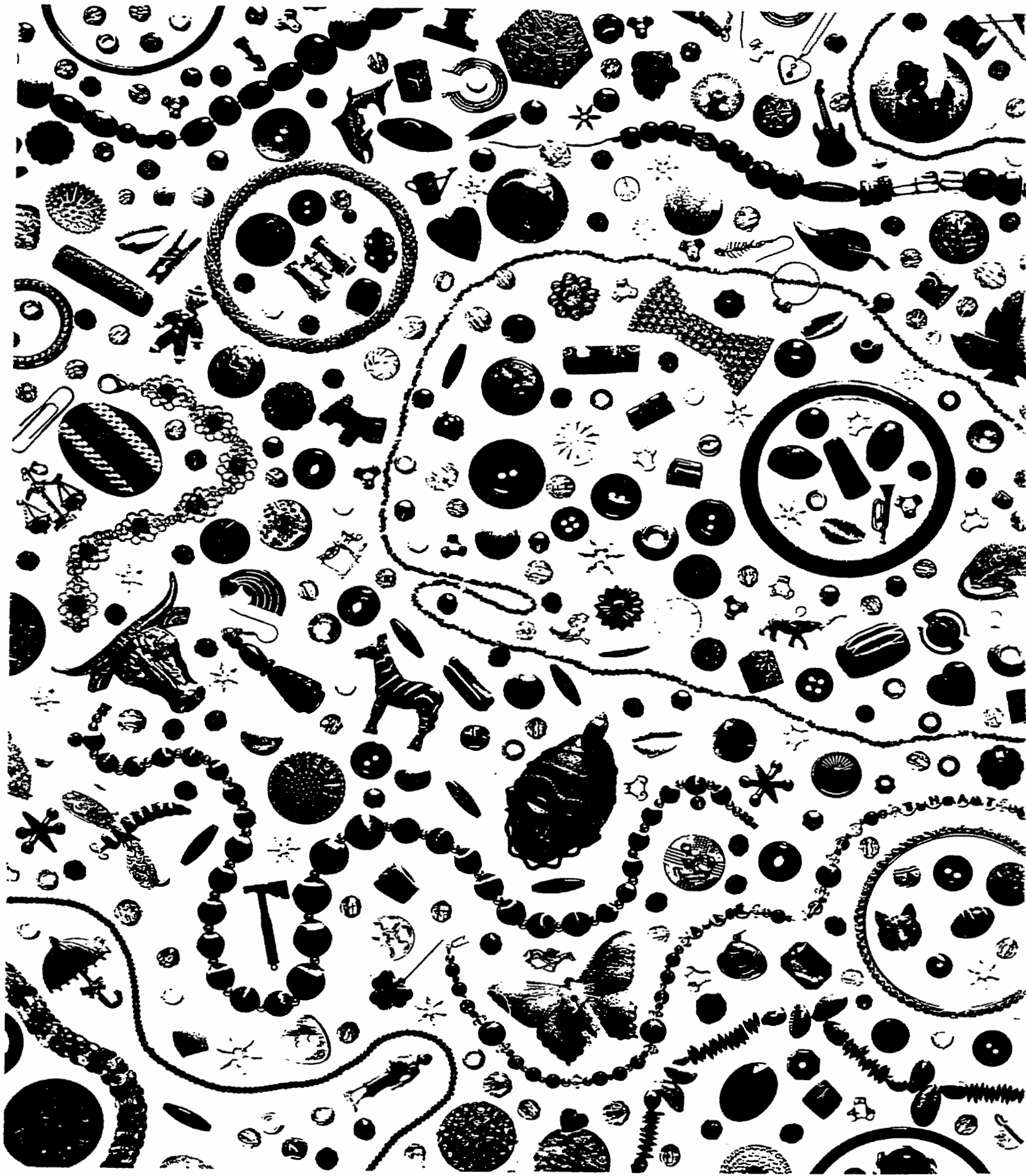
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Appendix B

Colorado Child Temperament Inventory

name of child (please print)

Please answer the items on these pages about the behavior of your child by *circling* one of the numbers following each item. We know that no item will apply to the child in every situation, but try to consider his/her usual or general behavior. Please answer all questions-- there are no right or wrong answers.

	How much is your child like that?				
	<i>Not at All</i>				<i>A Lot</i>
	(Strongly <i>DISAGREE</i>)				(Strongly <i>AGREE</i>)
1. Child persists at a task until successful.	1	2	3	4	5
2. Child gives up easily when difficulties are encountered.	1	2	3	4	5
3. Child tends to be shy.	1	2	3	4	5
4. Child cries easily.	1	2	3	4	5
5. When upset by an unexpected situation, child quickly calms down.	1	2	3	4	5
6. Child goes from toy to toy quickly.	1	2	3	4	5
7. Child likes to be with people.	1	2	3	4	5
8. Child is always on the go.	1	2	3	4	5
9. Whenever child starts crying, he/she can be easily distracted.	1	2	3	4	5
10. Child prefers playing with others than alone.	1	2	3	4	5
11. Child tends to be somewhat emotional.	1	2	3	4	5
12. When child moves about, he/she usually moves slowly.	1	2	3	4	5
13. If talked to, child stops crying.	1	2	3	4	5
14. Child makes friends easily.	1	2	3	4	5
15. Child is off and running as soon as he/she wakes up in the morning.	1	2	3	4	5

How much is your
child like that?

	<i>Not at All</i> (Strongly <i>DISAGREE</i>)			<i>A Lot</i> (Strongly <i>AGREE</i>)	
16. Child finds people more stimulating than anything else.	1	2	3	4	5
17. Child often fusses and cries.	1	2	3	4	5
18. With a difficult toy, child gives up easily.	1	2	3	4	5
19. Child is very sociable.	1	2	3	4	5
20. Child is very energetic.	1	2	3	4	5
21. Child takes a long time to warm up to strangers.	1	2	3	4	5
22. Child plays with a single toy for long periods of time.	1	2	3	4	5
23. Child gets upset easily.	1	2	3	4	5
24. Child is something of a loner.	1	2	3	4	5
25. Child prefers quiet, inactive games to more active ones.	1	2	3	4	5
26. When alone, child feels isolated.	1	2	3	4	5
27. Child tolerates frustration well.	1	2	3	4	5
28. Child reacts intensely when upset.	1	2	3	4	5
29. Child stops fussing whenever someone talks to him/her or picks him/her up.	1	2	3	4	5
30. Child is very friendly with strangers.	1	2	3	4	5

**Thank you for your
participation!**

Appendix C

Summary of Frog Goes to Dinner

The summary of the Frog Goes to Dinner story is as follows: A frog is hiding in a little boy's pocket as his family is entering a fancy restaurant (page 1). The frog jumps into a restaurant-musician's saxophone while the family examines their menus (page 2). The musician has difficulty playing his instrument and then turns the saxophone upside down to have a look inside of it (pages 3 and 4). The frog falls onto the musician's face and then the musician loses his balance and falls into another musician's drum (pages 5 and 6). The musicians are left wondering what happened, while the frog jumps into a salad platter carried by a waiter (page 7). The salad, in which the frog is hiding, is served to a woman patron. The frog jumps out of the salad as the woman takes her first taste of her meal (pages 8 and 9). The woman is startled as the frog jumps from the salad, and then she complains to the waiter (pages 10 and 11). The boy notices that the waiter is throwing the frog out of the restaurant (page 12). The boy retrieves the frog from the waiter and the family leaves the restaurant (pages 13 and 14). The upset family drives home with the frog (page 15). The father sends the boy to his room with his frog (page 16). The boy and his frog are laughing in the bedroom (page 17).



2



3



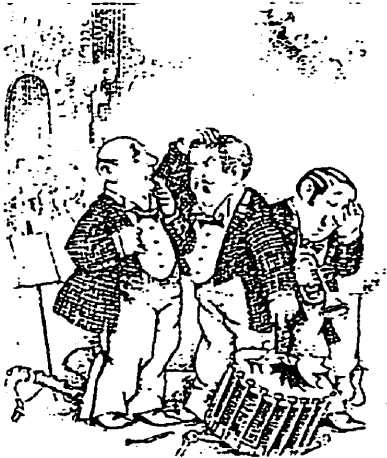
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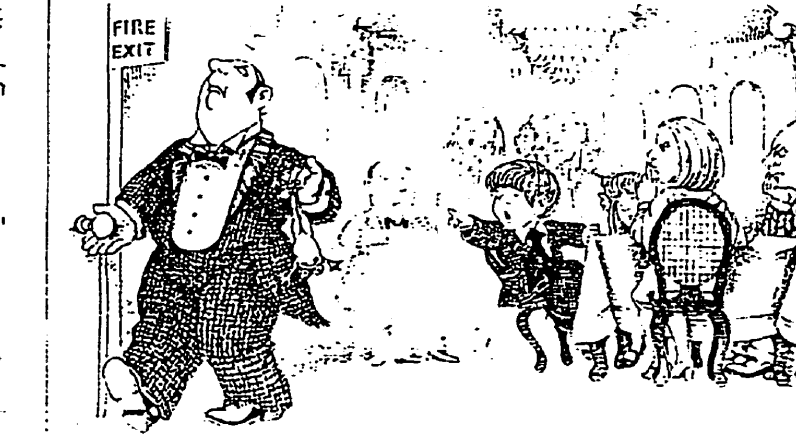
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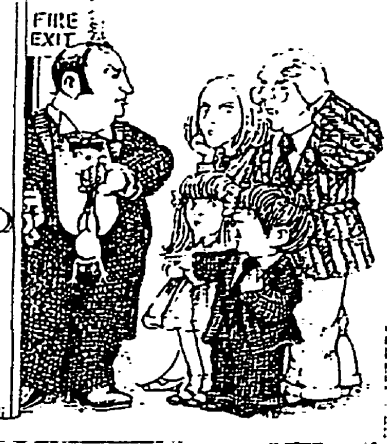
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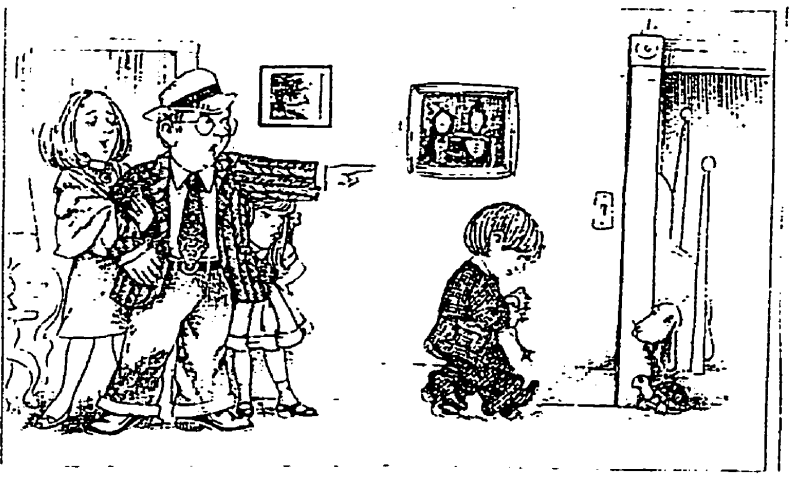
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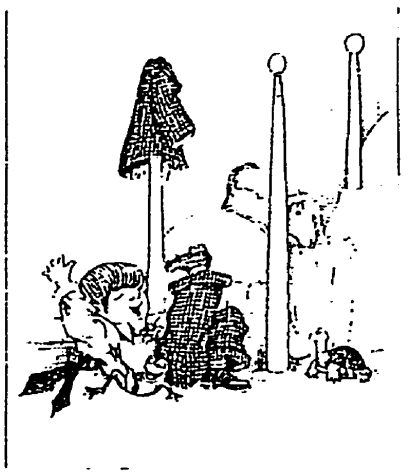
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17

Appendix E

Samples of Children's Narratives for Frog Goes to Dinner

NB Bracketed comments refer to children's gestures. Page numbers are also included in brackets.

Age: 3 years, 7 months

Gender: Female

There's a frog (pointing to the frog) (P1)

He jumps in there (pointing to the saxophone) (P2)

The frog is in there (pointing to the saxophone) (P3)

Trying to figure out what's the matter (P4)

He jumped on his face (pointing to the frog on the musician's face) (P5)

And there (P6)

Then he jumped out of there (pointing to the drum) into the glass (pointing to the glass) (P7)

Then he jumped into there (pointing to the salad) (P8)

And he (pointing to the frog) ate so much of the salad (P9)

And he jumped out (pointing to the frog) (P10)

And she's mad (pointing to the lady), trying to talk it all over (P11)

And there he is (pointing to the waiter), trying to put him in the garbage (P12)

But then, "That's mine" (pointing to the boy) (P13)

There he (pointing to the boy) is holding it (P14)

There he is..the mom, she's mad (pointing to the sister), she's mad (pointing to the mother), she's mad (pointing to the dad) (P15)

She's happy (pointing to the mother), she's mad (pointing to the sister), he's mad (pointing to the dad), she's mad (pointing to the sister), she's happy (pointing to the mother), they are both sad (pointing to sister and dad) (P16)

And there they are playing in the room (P17)

Age: 4 years, 4 months

Gender: Male

They're going to a restaurant (P1)

They're playing music (P2)

He can't blow (P3)

He doesn't even see the frog (P4)

They're all on the drum (P6)

And he gets on the head (P5)

And he's going on the food (P7)

He's in the food, eating (P8)

He comes back out (P9)

He tips the glass over and the food (P10)

And they're all angry (P11)
 And he throws him back outside (P12)
 And he gets him back (P13/14)
 They're all angry in the car (P15)
 He's putting him in the room (P16)
 And there he is (P17)

Age: 4 years, 1 month
Gender: Female

Jumping (P2)
 (turns page) (P3/P4)
 Jumping on his head (P5)
 Jumping in supper (P7)
 Eating (P8/P9)
 Jumping (P10/P11)
 Holding (P12)
 Holding (P13/P14)
 In the car (P15)
 Holding (P16)
 In bed (P17)

Age: 3 years, 9 months
Gender: Male

There's going to be all sorts of funny things in this book, guys (P1)
 Look at that (pointing to the family at the table). That's funny (pointing to the band) (P2)
 Exp: You tell them what's happening. Turn the pages when you are ready.
 Ch: The frog's jumping into the band (P2)
 And he can't even get a note out of it (pointing to the instrument) (P3)
 And he's dumping it over (P4)
 Now this guy's laughing (pointing to band member),
 And he's... "oooh", and the frog's jumping out (P5)
 Then he's saying, "hooray" (pointing to one musician). He's saying, "No, stop it" (pointing to the other musician) (P6)
 And he's laughing, he's laughing, he's laughing (pointing to one band member while repeating himself) And the frog jumped on there (pointing to the dinner plate) (P7)
 And he had ??? (P8)
 And she found the frog inside (P9)
 Now she's saying, "Aah, a frog!" (P10)
 And now she's saying to him (pointing to the waiter), "You brang me a bad supper/summer (?) frog" (P11)
 [I need to put this egg together - the boy is playing with an egg while telling the story and then in

the next phrase says egg rather than frog]

He's taking the egg to the, he's taking the egg to jail, and he's saying, "No" (pointing to the boy) (P12)

And he's saying, "That's my pet" (P13)

Now he's happy that he got his frog back (P14)

They're sad cause it's night time (P15)

Now they're saying, "Go to bed" (P16)

And he's going upstairs and playing instead (P17)

Age: 4 years, 4 months

Gender: Female

The frog's in his, the pocket (pointing to the frog) (P1)

And he jumps out of his pocket (pointing to the frog) (P2)

And he goes in there (pointing to the saxophone) (P3)

And he can't blow (pointing to the band member and saxophone) (P4)

Then he jumps out onto his face (pointing to the band member and frog) (P5)

And he crawls through his armpit (pointing to the frog) (P6)

And he goes and jumps into the food (pointing to the frog, salad plate) (P7)

And they're eating it (P8)

And she's eating it and she yells (giggling) (P9)

And then she jumps, the frog jumps out of the food (P10)

And they're yelling and screaming at each other (P11)

And they're taking away the frog (P12)

The boy said, "Give me my frog back" (P13)

And then he had his frog (P14)

And the way home. He had his frog on the way home (P15)

And then he took his frog to bed (P16)

And they had fun together (P17)

Appendix F

Multiple Regression Analysis Predicting D-Prime from Age, Gender and TELD-2 General Language Skills

Multiple Regression Analyses Predicting D-prime from Age, Gender and TELD-2 General Language Skills (N=39)

	Predictor	Cumulative R ²	Increase R ²	F-test	p	Beta*
<u>Step 1</u>	Age	.20	.20	4.54	.02	0.18
	Gender					0.05
<u>Step 2</u>	Language (TELD-2 raw score)	.28	.08	4.65	.007	0.39 *

Note. * beta weights at the final step, when all other variables have been entered into the regression equations, are presented

* p = .05

Appendix G

Multiple Regression Analyses Predicting D-Prime from Age, Gender, and Laboratory-Assessed Pragmatic Language Skills

Multiple Regression Analyses Predicting D-prime from Age, Gender, and Referential Communication (N=39)

	Predictor	Cumulative R ²	Increase R ²	F-test	p	Beta ^a
<u>Step 1</u>	Age	.20	.20	4.54	.02	0.42 *
	Gender					0.17
<u>Step 2</u>	Referential Communication	.23	.03	3.50	.03	0.18

Note. ^a beta weights at the final step, when all other variables have been entered into the regression equations, are presented

* p < .001

Multiple Regression Analyses Predicting D-prime from Age, Gender, and Story Cohesion (N=39)

	Predictor	Cumulative R ²	Increase R ²	F-test	p	Beta ^a
<u>Step 1</u>	Age	.20	.20	4.54	.02	0.44 *
	Gender					0.12
<u>Step 2</u>	Story Cohesion	.20	.001	2.99	.04	0.05

Note. ^a beta weights at the final step, when all other variables have been entered into the regression equations, are presented

* p < .001

Appendix H

Multiple Regression Analyses Predicting D-prime from Age, Gender, General Language Skills and Laboratory-Assessed Pragmatic Language Skills

Multiple Regression Analyses Predicting D-prime from Age, Gender, TELD-2 General Language Skills, and Referential Communication (N=39)

	Predictor	Cumulative R ²	Increase R ²	F-test	p	Beta ^a
<u>Step 1</u>	Age	.20	.20	4.54	.02	0.17
	Gender					0.08
<u>Step 2</u>	TELD-2 raw score	.28	.08	4.65	.01	0.37 *
<u>Step 3</u>	Referential Communication	.29	.01	3.52	.02	0.10

Note. ^a beta weights at the final step, when all other variables have been entered into the regression equations, are presented

* p = .07

Multiple Regression Analyses Predicting D-prime from Age, Gender, TELD-2 General Language Skills, and Story Cohesion (N=39)

	Predictor	Cumulative R ²	Increase R ²	F-test	p	Beta ^a
<u>Step 1</u>	Age	.20	.20	4.54	.02	0.18
	Gender					0.04
<u>Step 2</u>	TELD-2 raw score	.28	.08	4.65	.01	0.40 *
<u>Step 3</u>	Story Cohesion	.29	.0008	3.4	.02	-0.03

Note. ^a beta weights at the final step, when all other variables have been entered into the regression equations, are presented

* p < .05

Appendix I

Multiple Regression Analyses Predicting D-prime from Age, Gender, General Language Skills and Parent Ratings of Pragmatic Language Skills

Multiple Regression Analyses Predicting D-prime from Age, Gender, TELD-2 General Language Skills, and Parent Ratings of Children's Adaptive Communication (N=37)

	Predictor	Cumulative R ²	Increase R ²	F-test	p	Beta*
<u>Step 1</u>	Age	.19	.19	3.94	.03	0.08
	Gender					0.06
<u>Step 2</u>	TELD-2 raw score	.32	.13	5.21	.01	0.45 *
<u>Step 3</u>	Adaptive Communication	.36	.04	4.47	.01	0.20

Note. * beta weights at the final step, when all other variables have been entered into the regression equations, are presented

* p < .05

Multiple Regression Analyses Predicting D-prime from Age, Gender, TELD-2 General Language Skills, and Parent Ratings of Children's Story-telling Skills (N=39)

	Predictor	Cumulative R ²	Increase R ²	F-test	p	Beta*
<u>Step 1</u>	Age	.20	.20	4.54	.02	0.17
	Gender					0.05
<u>Step 2</u>	TELD-2 raw score	.28	.08	4.65	.01	0.40 *
<u>Step 3</u>	Story-telling skills	.29	.0002	3.39	.02	-0.01

Note. * beta weights at the final step, when all other variables have been entered into the regression equations, are presented

* p = .07

Appendix J

Master Correlation Table for Age-corrected Scores

	<u>D-prime</u>	<u>FLA</u>	<u>TLA</u>	<u>Single</u>	<u>Multi</u>	<u>Persist</u>	<u>CCTI</u>	<u>TELD-2</u>	<u>Cohesion</u>	<u>RC</u>	<u>Telling</u>	<u>Adaptive</u>
<u>D-prime</u>	1											
<u>FLA</u>	-.26	1										
<u>TLA</u>	-.52 **	.41 **	1									
<u>Single</u>	.00	-.09	.04	1								
<u>Multi</u>	.06	-.08	-.09	-.18	1							
<u>Persist</u>	.29	-.32 *	-.67 **	.13	-.07	1						
<u>CCTI</u>	.21	-.28	-.18	-.15	-.17	.18	1					
<u>TELD-2</u>	.35 *	-.25	-.28	-.10	.30	.13	.24	1				
<u>Cohesion</u>	.05	.06	.05	.06	-.22	-.13	.24	.23	1			
<u>RC</u>	.15	.30	.03	.10	.20	-.16	-.14	.14	.19	1		
<u>Telling</u>	.12	-.29	-.12	.06	-.03	.12	.25	.37 *	.39 *	.15	1	
<u>Adaptive</u>	.26	.09	.005	.00	.05	-.10	-.11	.13	-.04	.38 *	.08	1

* p < .05, ** p < .01

FLA = Frequency of Looking Away during the CAPTAP, TLA = Total Time Spent Looking Away during the CAPTAP, Single = Single Target Search, Multi = Multiple Target Search, Persist = Search Persistence, CCTI = parent ratings of attention/persistence, TELD-2 = TELD-2 raw language scores, Cohesion = Story-telling Cohesion, RC = Referential Communication skills, Telling = Parent ratings of Story-telling Skills, Adaptive = Parent ratings of Adaptive Communication

Appendix K

Master Correlation Table for Non-Age-corrected Scores

<u>D-prime</u>	<u>FLA</u>	<u>TLA</u>	<u>Single</u>	<u>Multi</u>	<u>Persist</u>	<u>CCTI</u>	<u>TELD-2</u>	<u>Cohesion</u>	<u>RC</u>	<u>Telling</u>	<u>Adaptive</u>
1											
<u>FLA</u>	1										
<u>TLA</u>	.53 **	1									
<u>Single</u>	.19	-.19	1								
<u>Multi</u>	-.03	.03	-.25	1							
<u>Persist</u>	.31 *	-.33 *	.16	-.08	1						
<u>CCTI</u>	.30	-.35 *	-.01	-.22	.21	1					
<u>TELD-2</u>	.52 **	-.43 **	-.21	.49 **	.18	.34 *	1				
<u>Cohesion</u>	.11	.00	-.04	-.26	-.10	.27	.26	1			
<u>RC</u>	.19	.23	-.04	.16	-.13	-.11	.16	.20	1		
<u>Telling</u>	.05	-.21	-.04	.00	.10	.20	.21	.36 *	.13	1	
<u>Adaptive</u>	.32 *	-.01	-.11	.10	-.10	-.04	.24	.00	.40 *	.06	1

* p < .05, ** p < .01

FLA = Frequency of Looking Away during the CAPTAP, TLA = Total Time Spent Looking Away during the CAPTAP, Single = Single Target Search, Multi = Multiple Target Search, Persist = Search Persistence, CCTI = parent ratings of attention/persistence, TELD-2 = TELD-2 raw language scores, Cohesion = Story-telling Cohesion, RC = Referential Communication skills, Telling = Parent ratings of Story-telling Skills, Adaptive = Parent ratings of Adaptive Communication