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Exploring the Relationship Between Early Childhood Attentional Control and Language Ability

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by

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ABSTRACT

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Relatively few studies have investigated the relationship between early childhood attentional control and later cognitive outcomes, especially language development. The current study is an investigation of the relationship between the executive functioning (EF) component of attentional control and language ability in the second year of life. More specifically, the predictive nature of two aspects of attentional control, attentional focus and resistance to distraction, was be the primary focus of the proposed study. Although it was expected that children both high in attentional focus and resistance to distraction would have significantly superior language development than infants with lower attentional capacities, analyses indicated associations between the postural deviation component of resistance to distraction and language. Attentional focus was also related to infant language ability. Avenues for future research regarding early childhood attentional control, resistance to distraction, and language ability are discussed.

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CHAPTER 1

INTRODUCTION

In recent years, executive function (EF), higher order cognitive processing, has increasingly become the subject of empirical research in very young children. The general position in the developmental literature has been that EF is comprised of several component abilities. These abilities include attentional control, working memory, and inhibitory control (Carlson, 2005; Huizinga, Dolan & van der Molen, 2006), among others. Importantly, early childhood EF has been identified as a predictor of a host of outcome measures, including those associated with social competence and emotional development (Bierman, Torres, Domitrovich, & Gest, 2004; Diamond, 2010; Hughes, Dunn & White, 1998). Surprisingly, however, relatively few studies have investigated the relationship between early childhood EF and later cognitive outcomes, especially language development.

As defined by Carlson (2005), EF comprises "higher order, self-regulatory, cognitive processes that aid in the monitoring and control of thought and action" (p. 595). Cuevas, Hubble, and Bell (2012) further characterize EF, in its capacity as a collection of component abilities, as a foundational construct that underlies even higher-level goal-directed behaviors. Hence, as a collection of sub-entities, EF can be construed as an entity itself. Attentional control, often regarded as a foundation upon which other EF components develop, can be defined as the degree to which an individual has volitional command over initiating and maintaining attentional resources to relevant and goal-oriented stimuli while necessarily disengaging from competing stimuli (Garon et al., 2008 Rothbart, Ahadi, & Evans, 2000). For example, directing attentional resources to goal-relevant information is an essential first step in performing any goal-directed behaviors. Additionally, attentional control itself, as well as the visual information received through allocating attention, influences the behavior produced (i.e., focusing attention on a particular object may result in the ignoring of other potentially useful visual information; Rueda, Posner & Rothbart, 2004; Ruff & Rothbart, 1996). I argue that attentional control has two similar, yet distinct subcomponents: attentional focus and resistance to distraction. Attentional focus, here derived from the Effortful Control model put forth by Putnam, Gartstein, and Rothbart (2006), includes a child's ability to effectively and efficiently allocate attentional resources to a goal-relevant target. Resistance to distraction refers to the child's ability to maintain the allocation of these attentional resources when environmental disturbances are present.

Welsh, Pennington, and Groisser (1991) suggest that EF component abilities have different developmental trajectories, implying that EF components arise based on psychobiological maturity and differential usage. For example, attentional control may be utilized early on in development, while inhibitory control may not be needed until a later stage in infancy. The rate at which individual components are used may also differ among individuals. Consistent with this line of reasoning, if components of EF are developing at different rates across the lifespan, or are used differentially, it is possible that these components are emerging and/or developing at different points in infancy as well. Better understanding of how individual components of EF develop in early infancy may help to more efficiently and effectively identifying individuals with self-regulatory delays, and perhaps ultimately in identifying children at potential risk for negative cognitive, social, emotional, and physical health sequelae.

In the present paper, I focus specifically on the link between attentional control (i.e., attentional focus and resistance to distraction) and one aspect of cognitive development, namely vocabulary acquisition. Such a research endeavor may allow the identification of specific contributions of attentional control linked with language delay in toddlerhood to be identified prelinguistically, allowing infants to be referred as appropriate for prevention of future language delays. My purpose in the present investigation was to contribute to the limited research examining the relationship between attentional control and language development during infancy.

In the pages that follow, I first review the EF component ability of attentional control as it relates to early cognitive development, specifically language acquisition. I then consider how attentional control reflects both the ability to initiate and maintain focused attention along with the ability to resist environmental distraction; both factors are then discussed as to how they may contribute to early vocabulary acquisition. I conclude with specific hypotheses about the nature of attentional control-vocabulary associations, specifically the relationship between attentional focus and the ability to resist environmental distractions, as they are jointly related to language development.

Attentional Control

Within the developmental literature, the habituation/dishabituation paradigm has served as a popular means through which researchers have investigated infant attentional processes, especially visual attentional processes. In the standard visual habituation paradigm, researchers repeatedly present infants with a visual stimulus. After repeated stimulus presentations, infants tend to show decreases in duration of looks. However, when a new stimulus is presented, infants show more prolonged looks at the novel object. In this paradigm, a decrease in looking time is thought to reflect some form of processing or learning by the infant (Colombo, 1987), suggesting that the infant has encoded salient features of the stimulus.

Although infant looking behaviors in the habituation/dishabituation paradigm are well-known, much less clear is the extent to which individual differences in attentional processing might contribute to those looking behaviors. That is, how is the attentional processing of one fast habituating infant different from another fast habituating infant, and are these differences meaningful? Rate of habituation has often been regarded as a measure of processing speed; however, the attentional processes being used to habituate may differ for different children. To the extent that children may differ from one another in the developmental status of their attentional control systems, habituation rates for children high in attentional control may reflect different underlying attentional processes than habituation rates for children low in attentional control (Dixon & Smith, 2008).

In addition to maximizing attention to focal stimuli, a key component of attentional control is the ability to resist attending to peripheral, or otherwise distracting, stimuli. Infants' abilities to resist environmental distractions has received some empirical attention (Lansink & Richards, 1997; Oakes, Kannass, & Shaddy, 2002; Richards 1989; Tellinghuisen, Oakes, & Tjebkes, 1999); and not surprisingly, it appears that environmental distractions, coupled with young children's abilities to resist attending to them, impact children's performance on attention processing tasks. For example, previous research focused on the impact of distractions on word-learning found that certain types of environmental distractions impeded word learning (Dixon & Sally, 2006). Although attentional control and the ability to resist environmental distractions are both known to impact information processing, the relation between attentional focus and resistance to distractions has not been the subject of empirical investigation. Thus, one reason why distraction may negatively impacted word learning could be that the ability to resist distraction simply reflected poor attentional control (Dixon & Sally, 2006) .

Although executive function components have been investigated individually, within the construct of EF, they are tightly bound to one another. For example, in order to succeed in higher order goal-directed behavior, attention to relevant stimuli must first be established and then maintained, the goal must be maintained in working memory, and goal-irrelevant behavioral responses must be inhibited (Bell, Wolfe, & Adkins, 2007). But it is also true that differences in recruited components based on EF task demands can be seen. For example, when performing a typical A-not-B task (see Bell & Adams, 1999), working memory is recruited in order to maintain the location of the hidden object. However, when the object is moved to the second location, successful performance requires not only working memory to maintain the object location information, but also an inhibition of return to the "A" location for the subsequent B-not-A positioning (Cuevas et al., 2012).

Attentional Control and Language Ability

Of the three components of EF, attentional control has been studied most extensively in relation to cognitive outcomes, especially with respect to preschool readiness (Duncan et al. 2007), early math skills and literacy (Blair & Razza, 2007), and intelligence generally (Ruff, 1988; Ruff, McCarton, Kurtzberg, & Vaughn, 1984). In this regard, individual differences in attentional control in early infancy have been shown to predict individual differences in cognitive outcomes in later infancy. Miller et al. (1977), for example, assessed habituation rates, a component of attentional control, in two-, three-, and four-month-old children, and found that fast habituating children performed significantly better on subsequent cognitive tasks derived from the Uzgiris-Hunt scales of infant cognitive development than their slower habituating counterparts (Miller et al. 1977). Similarly, Ruddy and Bornstein (1982) found that fast habituation was associated with higher scores on the Bayley Scale, a developmental scale measuring motor and cognitive abilities.

However, as noted above, differential habituation rates may reflect different underlying attentional mechanisms. With respect to language development, for example, both Tamis-LeMonda and Bornstein (1989) and Dixon and Smith (2008) found habituation rates at 5 months to predict receptive vocabulary at 13 months. However, this relationship was developmentally sensitive. Although both Tamis-LeMonda and Bornstein (1989) and Dixon and Smith (2008) found that rapid habituation at 5 months predicted large 13-month receptive vocabularies, a similar direct association was not found for 20-month productive vocabulary. Instead, Dixon and Smith (2008) found the relationship between 5-month habituation and 20-month productive vocabulary to be moderated by attentional control. Specifically, Dixon and Smith (2008) reported a null zero-order relationship between 5-month habituation and 20 month productive vocabulary. They found opposite and significant associations between habituation and vocabulary as a function of children's levels of attentional control. For children low in attentional control, rapid habituation predicted large vocabularies; yet for children high in attentional control, rapid habituation predicted small vocabularies. The authors concluded that the attentional processes involved in habituation may vary as a function of the strength of children's attentional control systems. That is, slow habituation in children with high attentional control may reflect volitional attentional processing, whereas slow habituation in children with low attentional control may reflect less well developed central nervous systems.

In relation to infant distractability and word learning, Dixon, Sally, and Clements (2006) demonstrated environmental distraction negatively impacted real-time word learning performance among a sample of 21-month old children. Moreover, children with high attentional control were less affected by environmental distractors when learning novel words than children with low attentional control. Children were presented with a novel word learning task (see Mervis & Bertrand; Figure 1) in which their ability to comprehend novel word/object pairings as well as generalize to similar novel objects was measured. While nearly all children were negatively impacted by the presentation of distraction during word mapping, children who were low in attentional control performed significantly worse on generalization and comprehension word learning phases relative to children who were high in attentional control.

Additional evidence suggesting at attentional control impacts word learning comes from Samuelson and Smith (1998) in their search for a processing account for more advanced word learning outcomes. Children between the ages of 18- and 29-months were assigned to either control or experimental conditions of a novel word learning task (see Akhtar, Carpenter, & Tomassello, 1996). All children were presented with three novel distractor objects, allowed to familiarize themselves with the objects, and informally played alongside the parent and two experimenters (E1 and E2) in attempting to put each novel object down a chute. During this play period novel objects were not labeled in any way, either by the parent or by experimenters. Within the experimental condition, the novel target object (not previously present during the play period) was then taken to a novel location (e.g., table with sparkly tablecloth) with the goal of this being experience with the novel target in a novel area.

After playing with the target at the table, the experimenter took the novel object back to the original play area and placed it, along with the three previously encountered novel objects, into a clear box. The experimenter, without gazing at the novel objects, said “Look I see a gazzer! A gazzer!”, with those in the control condition receiving no label at all. Children’s ability to generalize the novel name to the novel object was measured. The authors used the child’s novel experience during table play as an independent variable, such that children within the experimental condition would have unique attentional experiences with the novel target, relative to children in the control group. Children in the experimental condition were much more likely to pick the novel target object when asked for the gazzer than children in the control group who were just asked “can you find it?”, thus attributing the name novelty to the novelty of the target. The authors concluded that because the target was asked for in the original and more familiar play setting, activating less memory trace, the less familiar object/area attracts the infant’s attention. So, the selection of the target is not only influenced by the child’s ability to remember where in space the object had been encountered, but also by the child’s attentional attraction to novelty.

Although the relationship between attentional processing and language development is not well understood, these studies taken together provide evidence for links between early attentional components of EF and subsequent linguistic outcomes. One possibility is that although attentional resources may be limited in very young children, self-regulatory abilities that derive from EF contribute to language acquisition through children’s effective and volitional shifting and refocusing of attention (Kannass, Colombo & Wyss, 2010).

Despite the obvious expected connections between attentional control and language development, the relationship has not seemed to be a primary focus within developmental research. The connection between the EF component of attentional control and language development has been the subject of a few studies (Dixon & Smith, 2008; Tamis-LeMonda & Bornstein, 1989; Salley, Panneton, & Colombo, 2013); however, there appear to be few formal programs of research aimed at understanding the connection between attentional control and language development.

As stated previously, attentional control can be thought of as a foundational EF ability upon which later EF abilities are built (Cuevas et al., 2012). Engagement of attention and also the ability to make associations between stimuli in the environment (i.e. word-referent mapping) ought to play a significant role in language development early in infancy. Vocabulary acquisition hinges not only on a child's ability to engage attention with an object (e.g., a truck) but also in being able to make an association between that object and a conventional label of the object provided by a social other (e.g., mother says "truck;" Dixon & Smith, 2008). Consistent with this line of reasoning, infants with higher attentional control ought to engage in attentional allocation more effectively, and make more correct associations and word-world mappings than infants low in attentional control.

It stands to reason, then, that individual differences in children's abilities to optimally allocate attention in the service of word-world mappings, especially in the context of environmental distractions, would reflect children's success in the acquisition of novel vocabulary (Dixon et al., 2006; Dixon & Salley, 2007; Oakes et al., 2002). But children's success in establishing these mappings may depend on the unique environmental parameters of the word-learning situation. For example, Dixon and Salley (2007) found that when presented with a novel word learning task, 22-month-old children actually performed better when distracted than when not, suggesting that distraction may actually enhance children's attention when engaging an attractive or novel object. This finding is particularly interesting in that not only is efficient attention allocation necessary in language development, but the ability to focus attention in the presence of environmental distractors may further facilitate language acquisition.

The ability to allocate attention effectively necessitates the shifting and refocusing of attention to competing environmental stimuli, however, shifting attention is a consequence of attentional state which impedes processing of relevant information (Oakes et al., 2002). Attentional state is often categorized as being casual, settled, or focused, which is thought to indicate the amount of attentional resources being allocated to a stimulus (Ruff, Capozzoli, & Saltarelli, 1996). Focused attention is characterized by eye gaze directed at the object, serious facial expression, engaged posture (i.e., orienting the body to the object of interest), limited body movement, and minimal vocal activity (Ruff et al., 1996), enabling maximum attentional resources to be allocated in processing a stimulus. Casual attention can be characterized by looking around at task, or other present, objects, but not actively engaging with stimuli, which settled attention can be conceptualized as a pause in casual attention where additional attentional resources are placed on a particular object/stimuli (e.g., a child engaged in casual attention stops briefly at a particular toy) (Ruff, Capozoli, & Saltarelli, 1996).

Importantly, these three states of attention impact how children go about the task of attending to their environment. In particular, when children are presented with multiple stimuli , their manner of attending differs as a function of whether they are in a focused versus casual state of attention. For example, research has demonstrated that children engaged in focused attention have significantly longer distraction latencies (e.g., time from onset of distractor to visual orientation to the distracting stimulus) than children engaged in casual attention (Oakes et al., 2002; Oakes & Ross-Sheehy, 2004; Richards & Turner, 2001). Although success in attending to and processing environmental stimuli depends on children's ability to focus attention on those target stimuli, it would also seem to depend on their ability to resist attending to environmental distractions. On most accounts, allocating attention to target stimuli while resisting attention to irrelevant stimuli are considered two sides of the same coin. A child characterized as high in the ability to engage in focused attention, for example, is usually assumed to be high in the ability to resist attention to irrelevant stimuli, which is a circular argument that does not take into account how those, say, high in attentional focus may also be low in ability to resist outside influences. However, another possibility is that the two abilities are largely associated, but partially dissociable. It is conceivable, for example, that among a group of children high in attentional focusing, are subsets of children who are high versus low in their abilities to resist environmental distractions.

To my knowledge, this partial dissociability hypothesis has not been empirically evaluated. Instead, many researchers have focused on the two abilities, they have conceptualized them as unidimensional. An exception to this unidimensional way of conceptualizing attentional focus and resistances to distraction is evident in the work of Richards and Turner (2001) who investigated distractibility among children 6 months to 2 years of age. Children were presented with a familiar movie for twenty minutes to allow for fixation to be measured. Children were then presented with distractors on a nearby screen (e.g., different familiar movie clip). As is consistent with previous findings children's latency to respond to the distractor was directly related to their length of their target looking behavior before the distraction was presented. That is, children who had longer sustained periods of looking at the target images showed a longer latency to look at the distractor, relative to children who showed shorter sustained attention. Thus, it may be possible to partially dissociate attentional state and resistance to distraction and to test the unique, as well as combined, contribution of these two processes. These results are consistent with the attentional inertia model, which states that engagement of attentional resources increases as looking time increases; for children who look longer at a target stimuli, more attentional resources are allocated to the target, resulting in longer latencies to disengage those attentional resources (Oaks & Ross-Sheehy, 2004; Richards & Turner, 2001).

The ability to resist distractions in the environment, and similarly to maintain focused attention, have been reported as increasing commensurately throughout childhood (Ruff & Capozzoli, 2003). This makes sense, according to the attentional system proposed by Posner and Rothbart (1996), because by the second year of life the higher order executive system has emerged in typically developing children and is being increasingly used for attentional processing. So it is not surprising that as children are better able to control their allocation of attention, they are simultaneously better at resisting distracting environmental stimuli. Importantly, the improvement of both attentional focus and resistance to distraction has clear implications for processing information critical to word-world mappings, in that those children able to resist distraction and remain in a state of focused attention ought to have larger vocabularies than children unable to efficiently allocate attentional resources.

In sum, as noted above, research has demonstrated a link between children's attentional control and language ability. However, the mechanism by which attentional control facilitates word learning is less clear. Two potential directions of effect include: 1) attentional control facilitates focused attention to word-relevant stimuli, thus promoting word-referent mapping and expediting word learning, and 2) attentional control facilitates resistance to distraction, resulting in additional cognitive resources available for information processing. Based on previous investigations of individual differences in EF and their relationship with later cognitive outcomes, the current work highlights differences in attentional control as they relate to vocabulary acquisition as a function of the joint, and unique contributions of focused allocation of attentional and resistance to distraction.

Comprehension Novel Word 1

Familiarization Subphase
Exploration of four known and one novel objects

↓

Test Subphase
(Distraction counterbalanced between Word 1 and Word 2)
Objects from familiarization phase lined up
- Child asked for known object three times
- Child asked for novel object twice
  - Given novel object if not responsive after two attempts
  - Experimenter labels novel object four times

Comprehension Novel Word 2

Familiarization Subphase
Exploration of four known and one novel objects

↓

Test Subphase
(Distraction counterbalanced between Word 1 and Word 2)
Objects from familiarization phase lined up
- Child asked for known object three times
- Child asked for novel object twice
  - Given novel object if not responsive after two attempts
  - Experimenter labels novel object four times

Generalization Word 1

Presented with four known objects, one novel object (taxonomically similar to Word/Object pairing 1 in test subphase) and an unfamiliar object (i.e. turkey baster)

- Asked once for the novel object 1 (Word 1)

Generalization Word 2

Presented with four known objects, one novel object (taxonomically similar object to Word/Object pairing 2), and an unfamiliar object (i.e. door hook)

- Asked once for the novel object 2 (Word 2)

Figure 1. Adapted Mervis and Bertrand (1996) procedure

Current Study

The primary goal of the proposed investigation was to explore the relative contributions of attentional focus and resistance to distraction to children's competence in word-learning. To the extent that these two components make unique and independent contributions to word-learning in the second year, they can be viewed as being largely associated but not wholly associated mechanisms underlying the link between attentional control and children's language development. Based on expectations derived from previous findings, and the arguments provided above, three hypotheses were proposed:

- H1: Because both components reflect an overarching attentional control, attentional focus should be associated with resistance to distraction.
- H2a: Attentional focus and resistance to distraction jointly and uniquely predict language acquisition as measured by real-time word learning.
- H2b: Attentional focus and resistance to distraction jointly and uniquely predict language acquisition as measured by productive maternal-reported productive vocabulary.

CHAPTER 2

METHODS

Participants

Data used for the current investigation were obtained from an archival sample of children who participated in a one-time laboratory visit at East Tennessee State University's Program for the Study of Infancy (PSI). Specifically, 49 typically developing children from a rural community in East Tennessee (n = 26 boys) participated in a one-time laboratory visit lasting approximately 90 minutes (*M* age = 21.6 months, *SD* = .50 months). Names of eligible participants were derived from local newspaper birth announcements. These eligible families were then contacted by mail and phone, during which study details and participation requirements were described. After parents expressed interest, they were mailed a packet of five parental questionnaires which they returned when they visited the laboratory. All parents were consented upon their initial arrival; experimenters verbally went over the informed consent document and answered any questions parents' asked regarding their time in the lab. All of the children who participated came from two-parent households with a median income of $66,000. The average age of the mother at the time of participation was 32 years (*SD* = 5.90); fathers mean age at time of participation was 33.34 years (*SD* = 5.72; only one father participated in the lab visit).

Materials and Tasks

Infants were engaged in behavioral tasks for the duration of their lab visit, with parental engagement limited to particular tasks. Because this project was part of a larger study, not all of the tasks employed in the overarching study are relevant for the present investigation. Behavioral tasks relevant to the present investigation include a self-guided attention task ("Gary the Snail"), two elicited imitation tasks ("Make-a-Rattle" and "Feed-Self"), as well as an adapted Mervis and Bertrand (1994) real-time word learning procedure. Additionally, prior to their lab visit, parents were asked to complete several surveys assessing child behavior and language acquisition. Of these, the Early Childhood Behavior Questionnaire (ECBQ; Putnam et al., 2006) and the MacArthur-Bates Communicative Development Inventory: Words and Sentences Version (CDI-WS; Fenson et al., 1993; Fenson et al., 2007) was used to index attentional control and productive vocabulary, respectively.

Behavioral Tasks

Gary the snail. The Gary the Snail task was originally designed to index joint attention as described in Salley and Dixon (2007). For the present investigation, however, the task was re-purposed and re-conceptualized as an index of attentional control. Below, details about the task are provided, followed by a description of how the measure of attentional focus was derived. During the task, infants were shown an attractive, wind-up, "Gary the Snail" toy, which the experimenter demonstrated to the child. After being wound up, Gary the Snail crawled slowly across the surface of the experimental table. After the demonstration, the toy was placed in a clear plastic container, and secured with a lid designed to resist children's opening efforts. The experimenter then exited the room for two minutes after giving the instructions "I will be back in a minute. You can play while I am gone." During this time, the child was able to play with the container, but unable to access the toy inside. Parents were encouraged at the beginning of the session not to open the container even if the child prompted them to do so.

Measures of interest from the Gary the snail task. The Gary the Snail Task served as one source of attentional focus measured in the present study. Children's attentional state during the Gary the Snail task was sampled every five seconds and categorized as either casual or focused in nature (Ruff et al., 1996). A third category, “off-task,” was used to classify all behavioral samples that are neither casual nor focused; these children were engaging in activities unrelated to task component or demands (i.e., walking around the room, throwing toys). Upon the experimenter leaving the room, coders scored attentional state for the duration of the task. *Casual attention* was defined as looking at Gary the snail but not engaging with the container housing the toy. This absence of focused engagement was scored when eye gaze is resting minimally, or without interest, on the target object within the container and/or “looking while rapidly moving the toys in some stereotyped way” (Ruff & Capozzoli, 2003, p. 879). *Focused attention* was defined as “concentrated attention that involve[s] an intent facial expression, minimal extraneous bodily activity, a posture that enclose[s] the object of interest and [brings it] closer to the eyes, [involving] either no talking or soft talking clearly directed to the self” (Ruff & Capozzoli, 2003, p.879). Coders scored the approximately two minute intervals in which the child interacts with Gary the Snail, indicating either casual or focused attention (or “off-task) for every five second behavioral sample. From these measures, two overall proportion measures were derived: 1) proportion of samples reflecting casual attention, and 2) proportion of samples reflecting focused attention. On this task, inter-rater reliability was calculated using 10% of the sample, and coders were trained to 80% agreement prior to scoring children’s attentional behavior. Inter-rater reliability was assessed upon the completion of scoring to ensure continued reliability, with 10% of the sample coded. This 80% cut-off score for inter-rater reliability was used as a standard for all behavioral tasks within the current study.

<u>Elicited imitation.</u> During their visit, children were also presented with two elicited imitations tasks, which for present purposes are labeled the “Make-a-Rattle” and “Feed-Self” tasks. Each task was used to derive measures of both attentional focus and resistance to

distraction. Children were distracted in one, but not both of the tasks, as they were counterbalanced. The distracted imitation condition for each child was used. Below, each task is described in detail, including how a distraction condition was implemented, followed by a description of how attentional focus and resistance to distraction was derived.

In the make-a-rattle task, children were asked to imitate the construction of a rattle using two nesting cups and a small block. First, children were given one minute to become familiar with the three objects. After this phase, the experimenter performed and narrated the demonstration of making a rattle: “Watch what I can do. I’m going to put the block in the cup. I’m going to cover it up. Shake it. Look, I made a rattle. Can you make a rattle?” The experimenter demonstrated making the rattle by placing the block in the smaller of the two cups and inverting and nesting the larger cup on top and shaking the finished product to produce a rattle-like noise. Children were then presented with the rattle props and given a two minute time frame to imitate the demonstrated sequence.

The second imitation task, feed-self, used five objects: a bowl, a spoon, a small empty cereal box, a small empty milk carton, and a napkin. As with make-a-rattle, children were given one minute to familiarize themselves with the objects and then watched the experimenter demonstrate and narrate a pretend episode of eating breakfast: “Watch what I can do. I’m so hungry I’m going to eat breakfast. I’m going to pour in the cereal. I’m going to pour in the milk. I’m going to stir it all up. Mmm, good cereal (bring spoon to mouth). Mmm, good cereal (bring spoon to mouth). All done, gotta wipe my mouth (bring napkin to mouth). Can you eat breakfast like I did?”

Both imitation tasks were presented to children in counterbalanced order. In addition, each task was presented under either a nondistraction or a distraction condition, such that if one task was presented in the nondistraction condition (e.g., Make-a-Rattle), the other was presented in the distraction condition (e.g., Feed-Self). The form of distraction employed in the elicited imitation tasks involved simultaneously playing audio and/or video tracks of the Sesame Street DVD, *Elmo's World: Head to Toe with Elmo*. The four possible conditions of distraction versus nondistraction included: 1) Nondistraction: no distraction was presented, 2) Auditory-verbal distraction: imitation task was performed during an audio-only distraction, 3) Visual distraction: imitations task was performed during a visual-only distraction, 4) Auditory-verbal + visual: imitation task was performed in the presence of simultaneous auditory and visual distraction.

Measures of interest from imitation tasks. The imitation tasks served as the source for two measures of interest: attentional focus and resistance to distraction. Attentional focus was scored identically to that of the Gary the snail task; upon demonstrating inter-relater reliability, coders examined both the familiarization period and the imitation periods, indicating the frequency of casual or focused attention, or time spent off-task, using the same definitional description of casual and focused attention outlined above (Ruff & Capozzoli, 2003). Again, from coded data, two overall task proportion measures were derived: 1) proportion of samples categorized as casual attention, and 2) proportion of samples categorized as focused attention; with attentional state being sampled every five seconds for the duration of the task. The time period of interest for measuring attentional focus in both imitation tasks was from the onset of object presentation during the familiarization period to the experimenter's initial movements and/or verbal command to remove the toys (e.g., experimenter moves hands towards objects for removal; verbal command of "Would you like to play with some more toys?").

A child's ability to resist distraction was scored as a function of their behavioral responses in each of the distraction conditions described above. Specifically, response to distractor onset and postural deviation were scored. *Response to distractor onset* was indicated as either looking 1) toward task relevant objects (i.e., nesting cups and block during the "Make-a-Rattle" task, and breakfast props during feed-self task), or 2) away from task relevant objects; target of look was measured three seconds before and after the onset of the distractor. *Postural deviation* was scored on a four-point scale at two different time points: 3 seconds before and after the onset of the distractor. A score of 1l indicate that the child was completely posturally oriented toward task objects (i.e., body posture is centered toward the target object; head, shoulders, and torso facing front). A score of 2 was given to children who were moderately posturally oriented toward task objects (i.e., defined as shoulder and torso alignment toward task objects). A score of 3 was given if the child was mildly posturally oriented toward task objects (i.e., defined as torso alignment toward task objects). Finally, a score of 4 was given if the child was completely posturally oriented away from task objects (i.e., defined as head, shoulder, and torso alignment toward the distractor). As with the Gary the Snail task, coders were trained to 80% reliability on 10% of the sample prior to scoring each variable. The recorded period of interest for measuring resistance to distraction was from onset of familiarization period to initiation of removal.

<u>Mervis and Bertrand (1994) procedure.</u> Finally, an adapted version of the Mervis and Bertrand procedure (1994), described below, was used to provide an estimate of children's abilities to acquire new vocabulary in real time. Below I first describe the structure of the Mervis and Bertrand (1994) procedure in the context of how it was adapted for present purposes, and then I describe how vocabulary acquisition scores were derived.

The adapted version of the word learning task created by Mervis and Bertrand (1994), which assesses a child's ability to fast-map words onto novel objects, was used primarily to index children's abilities to learn novel word-object pairings. Consistent with Mervis and Bertrand's original paradigm, the procedure employed in the present study included first a comprehension and then a generalization phase (see Figure 1). Success in either phase indicated the extent that a child had learned a novel word (comprehension phase) and could extend it to a new exemplar (generalization phase). However, word comprehension and generalization were tested in both a nondistraction and a sudden onset distraction condition. The phases and conditions are described in more detail below. Across the entire session, children were asked to learn four different words.

Children's initial understanding of each of four specific novel word-referent mappings was tested during each of four comprehension phases. However, each comprehension phase itself consisted of two phases, a familiarization subphase and a test subphase. During the familiarization subphase for each novel word, children were shown and allowed to explore one novel and four known objects for a period of one minute. Each set of objects (one novel and four known), comprised the props used to teach an individual word. Following this familiarization subphase, the test subphase began. Here, the objects for the specific word being learned were lined up in a row and children were asked for a) the name of a known object (e.g., apple), and then b) the name of the novel object for the specific word-learning episode (e.g. with "noop" as the name of the novel object). When asking for the novel object, the child was always asked "Can you find the [novel label]." If the child failed after two attempts at retrieval, the novel object was handed to the child so he could again become familiarized with the object. Novel objects were labeled in this way a total of four trials before a new set of one novel and four known objects replaced the first set.

Word-referent mappings were taught two at a time, such that Word 1 and Word 2 were taught as a unit early in the experimental session, while Word 3 and Word 4 were taught as a unit later in the experimental session. However, for both units, children were exposed to the two comprehension phases for both words in the pair, before being exposed to the two generalization phases for the same words. For example, the Word 1 (or Word 3) comprehension phase immediately preceded the Word 2 (or Word 4) comprehension phase.

Although two different novel words were taught in each word pair, the procedures were otherwise identical. For Words 1 and 2, for example, two novel words (e.g., “tuz” and “noop”) were applied to two novel objects. Here, the first novel object, a toothbrush holder, might have been labeled as a “tuz” among an array of known objects (i.e., truck, cup, banana, and bird); while the second novel object, a pastry blend, might have labeled as a “noop,” again, among a different array of known objects (i.e., fork, plane, arm, brush, and dog). However, immediately following the comprehension phase involving the first set of novel/known items, items from the second novel/known array were presented for familiarization. Only after completing the familiarization and comprehension for both Word 1 and Word 2 (or both Words 3 & 4) did experimenters move on to the generalization phase for each word.

After completing the comprehension phase for the second word in each word-learning pair, children were exposed to the generalization phase for the first word in the pair. At this point, children were again presented with the four known objects from the comprehension phase of each word, but alongside the known objects were *two* novel objects. One of the novel objects was taxonomically similar to the previously presented novel object, but was a different token. The second novel object served as a foil, and so was not taxonomically similar to the novel object. A more specific example of this array can be found in Dixon et al. (2006). After lining up the now 6 items, children were asked “Where is the ‘noop’?” “Can you find the ‘noop’?” The child was only asked for the novel object once during generalization. Children’s word comprehension score was calculated by summing the number of times the child selected the new token of the novel object. Likewise, generalization was scored by the number of times the child selected the taxonomically similar novel object during the comprehension phase of Word 1 and Word 2 (see Figure 1 for a visual representation of word learning task steps).

Children were provided opportunities to learn words in real-time under both nondistraction and distraction conditions. The two conditions were administered in exactly the same way, the only exception being that during each of the comprehension trials in the conditions, one of two salient sudden onset distractors were presented: 1) a mechanical toy monkey was suddenly animated (e.g., moving from side to side and banging two cymbals together) upon onset of the comprehension test subphase, or 2) a new female “stranger” entered the room and either greeted the child and began to read *Goodnight Moon* or simply stood at the end of the experimenter table and smiled at the child.

<u>Measures of interest from the Mervis and Bertrand procedure.</u> The Mervis and Bertrand (1994) procedure served as the source for two measures of interest: resistance to distraction, and word-learning ability. Consistent with the scoring of resistance to distraction during the elicited-imitation tasks, response to distractor onset, postural deviation, and child looks to the distractor was scored as a function of the ability to resist distraction within the adapted Mervis and Bertrand (1994) procedure. More specifically, these variables were measured during the sudden onset distractor conditions of the word-learning task (see Figure 1). Coded information was used as an index of resistance to distraction during the distracted word-learning presentations. As

before, coders were trained to 80% agreement on 10% of the sample prior to scoring each of the attention and resistance to distraction variables derived from this task.

Finally, word-learning ability within the task was previously measured using a five-point Likert scale (see Dixon et al., 2006). Coder judgments regarding degree of word-learning was used to index children's acquisition of vocabulary, as object selection was not always clear (e.g., a child might touch one object before picking up and selecting another object). Thus, identical five-point rating scales were used to score word comprehension as well as generalization for each of the four words. Ratings for word comprehension and generalization were as follows: 1) child did not respond to experimenter or picked up objects seemingly at random with no presentation to the experimenter, 2) child chose incorrect object, 3) child responded to experimenter with incorrect object; afterwards, child responded with correct object, 4) child showed signs of comprehension but was distracted before correct object was chosen (i.e. child reached for correct object and brushed had against another object which is subsequently chosen), and 5) child responded to experimenter with correct object, demonstrating comprehension/generalization. Each child's performance was averaged across both word-learning trials within the two sudden onset distraction conditions and baseline conditions.

Maternal Report Measures

Early Childhood Behavior Questionnaire. The Early Childhood Behavior Questionnaire (ECBQ; Putnam et al., 2006; Putnam et al., 2007), described below, was used for two purposes. First, the subdimension of attentional focus provided a maternal report measure of a child's ability sustain orientation of attention to objects in their environment. Secondly, items consistent with aspects of resistance to distraction were combined to reflect a maternal report of their child's ability to resist distraction. Below, the ECBQ is described, followed by a description of the attentional focus and resistance to distraction measures obtained through aggregating relevant ECBQ items.

The ECBQ is a parent report survey consisting of 201 items inquiring about the child's daily activities. These items can be broken down into a 3-factor structure: Surgency, Negative Affectivity, and Effortful Control. The factor of primary interest to the current study is that of effortful control, which is comprised of six subdimensions: Attentional Focusing, Attentional Shifting, Low-Intensity Pleasure, Inhibitory Control, Cuddliness, and Perceptual Sensitivity. In completing the ECBQ, parents are asked to indicate on a scale of 1 ("never") to 7 ("always") whether specific child behaviors may have occurred in the previous two weeks. Putnam et al. reported that all of the ECBQ subdimensions demonstrated internal consistency in their standardization sample. For present purposes, they reported Chronbach's alphas in the range of .81 to .86 for their effortful control measure. The attentional focus subdimension of effortful control is comprised of 12 items regarding a child's ability to sustain orientation of attention to objects. Example items from the attentional focus subdimension include: "When engaged in play with his/her favorite toy, how often did your child play for 5 minutes or less?", "When engaged in an activity requiring attention, such as building with blocks, how often did your child stay involved for 10 minutes or more?", and "When playing alone, how often did your child have trouble focusing on a task without guidance?" After applying reverse scoring procedures to appropriate items, attentional focusing subdimension items are then summed to yield a combined score. This combined score indexes mother-reported child performance in the area of attentional focus.

The second measure of interest from the ECBQ is that of resistance to distraction. Resistance to distraction was derived from an aggregate of 7 items from the ECBQ, presumed to reflect dimensions of a child's ability to resist distraction. Consistent with the scoring described earlier, parents were asked to rate how often their child exhibited the 201 listed behaviors within the past two weeks. Likert scale scores ranged from 1 to 7, with 1 indicating "never" and 7 indicating "always". Example resistance to distraction items include: "After having been interrupted, how often did your child return to a previous activity?" (for a detailed list of all included items, see Table 1). For many items, it was necessary to use a reverse scoring process, where 1 indicates high resistance to distraction and 7 indicates low resistance to distraction. For example, the item "During everyday activities, how often did your child notice low-pitched noises such as the air-conditioner, heater, or refrigerator running or starting up??" was reverse coded so that parental indication of 1 (never), would indicate a more advanced ability to resist distraction than a score of 6 (almost always). Items included in the resistance to distraction aggregate were summed to yield a mother reported score of children's ability to resist environmental distraction during daily activities.

Table 1.
Resistance to Distraction

Item	*Description*
R6	During everyday activities, how often did your child startle at loud noises (such as a fire engine siren)?
R35	During everyday activities, how often did your child notice low-pitched noises such as the air-conditioner, heater, or refrigerator running or starting up?
R38	While at home, how often did your child show fear at a loud sound (blender, vacuum cleaner, etc.)?
60	After having been interrupted, how often did your child return to a pervious activity?
R61	After having been interrupted, how often did your child have difficulty returning to the previous activity?
R126	When playing alone, how often did your child become easily distracted?
157	When interrupted during a favorite TV show, how often did your child immediately return to watching the TV program?

R indicates items that will be reverse scored (1= high resistance to distraction, 7= low resistance to distraction)

MacArthur-Bates Communicative Development Inventory: Words and Sentences Version. As a portion of the larger study, parents were asked to complete the CDI-WS (CDI; Fenson et al., 1993; Fenson et al., 2007) before their scheduled laboratory visit. For the purposes of this study, the CDI-WS served to index maternal-reported productive vocabulary. Below, a brief description of the CDI-WS components as well as the variable of interest is provided.

The CDI-WS is broken down into five sections that assess productive vocabulary (i.e., words the child is able to say), use of words representing removal or displacement (i.e., does the child talk about past events or past experiences), use of complex nouns and verbs (e.g., "children," "brought"), complex word forms (e.g., does the child say "foots" or "feets"), word combinations (e.g., kitty sleep), length of sentences produced, and complexity of sentences. The reliability and validity of this measure is well documented (Fenson, 1993; Fenson et al., 2007). To index language productivity, eight measures were derived from the CDI: nouns, predicates, closed-class words, morphology, irregular words, word endings, word combination, and word complexity.

Summary of Measures

To summarize the variables of interest described above, the current study derived three measures of attentional focus, three measures of resistance to distraction, and two measures of word-learning competence. More specifically, the proportion of five-second measurements spent in casual and focused attention were collected during three behavioral tasks, while the effortful control subdimension of Attention Focusing were derived from mother reported attentional abilities on the ECBQ. All within task measures of attentional focus were converted into comparable z-scores and then summed to achieve an overarching composite score of attentional focus.

The second variable of interest, resistance to distraction, was examined in both the elicited imitation tasks as well as the real-time word learning procedure, as both provide conditions under which the child is exposed to environmental distractors; mother reported resistance to distraction was evaluated based on the 7 reflective ECBQ items. Measures of resistance to distraction within task conditions were also converted into z-scores and then summed to produce a composite score of resistance to distraction. Lastly, word-learning competence was measured behaviorally (i.e., real-world word learning procedure), as well as through maternal report (i.e., CDI-WS).

CHAPTER 3

RESULTS

Descriptive Statistics

Attentional Focus

Means and standard deviations for the attentional focus proportion scores are presented in Table 2. Most notable was that the kinds of attention paid varied across the three tasks. During the Gary the Snail task, for example, children spent over half of their time engaged in attentional states categorized as “off-task” (*M* = .567, *SD* = .227), whereas casual attention was engaged in the least (*M* = .064, *SD* = .078). On the imitation tasks, in contrast, children were more often engaged in focused attention (Feed-Self *M* = .775, *SD* = .228; Make-a-Rattle *M* = .643, *SD* = .218), with casual attention being the attentional state engaged in for the lowest proportion of time (Feed-Self *M* = .042, *SD* = .076; Make-a-Rattle *M* = .058, *SD* = .085).

Table 2
Mean Performance on Attentional Focus Measures

Measure	**Mean**	**SD**	**Min**	**Max**	**N**
Gary the Snail					
Proportion of time spent in focused attention	.369	.194	.040	.875	44
Proportion of time spent in casual attention	.064	.078	.000	.357	44
Proportion of time spent off-task	.567	.227	.125	.960	44
Feed-Self					
Proportion of time spent in focused attention	.755	.228	.000	1.000	44
Proportion of time spent in casual attention	.042	.076	.000	.367	44
Proportion of time spent off-task	.202	.200	.000	1.000	44
Make-a-Rattle					
Proportion of time spent in focused attention	.643	.218	.111	1.000	44
Proportion of time spent in casual attention	.058	.085	.000	.367	44
Proportion of time spent off task	.300	.205	.000	.889	44
Attentional Focus (ECBQ)	3.930	1.020	1.420	5.670	49

Resistance to Distraction

Means and standard deviations for the resistance to distraction measures are presented in Table 3. A first step was to validate the Resistance to Distraction subscale of the Early Childhood Behavior Questionnaire. Unfortunately, Cronbach's alpha analysis revealed very low internal scale consistency. To address this issue, item-to-total correlations were calculated, and items were dropped in a step-wise fashion until an alpha of at least .70 was derived. The final subscale consisted of 6 of the original thirteen items (see Table 1), to achieve $\alpha = 075$.

For the remaining measures, before versus after difference scores were calculated by subtracting the pre-distraction onset score from the post-distraction onset score. Descriptives of these scores can be seen in Table 3. For the imitation task, because children were randomly assigned to be distracted either during Make-a-Rattle or Feed-Self, difference scores were only calculated for the task on which they were distracted. To evaluate the overall coherence of the three kinds of resistance to distraction measures, correlations between each of the measures were also conducted. As can be seen in Table 5, the three resistance to distraction measures were generally not intercorrelated, with the exception that the overall difference score for response to distractor was positively and significantly related to the overall difference score for postural deviation. This latter relationship was likely an artifact of the fact that both measures included a head turning component. Recall that the response to the distractor measure was based on looking behavior, while the postural deviation measure included orientation of the head.

Means and standard deviations for both the real-time word learning and the CDI vocabulary measures are presented in Table 4.

Table 3
Mean Performance on Resistance to Distraction Measures

Measure	Mean	SD	Min	Max	N
Difference Scores (after minus before distraction onset)					
Imitation Task (Make-a-Rattle or Feed-Self)					
Response to distractor	.472	.609	-1.00	1.00	36
Postural deviation	.444	.652	-1.00	1.00	36
RTWL Social Distraction					
Response to distractor	.541	.374	-.50	1.00	38
Postural deviation	.500	.403	-.50	1.00	38
RTWL Mechanical Distraction					
Response to distractor	.667	.350	.00	1.00	39
Postural deviation	.587	.521	-1.00	1.00	39
Across Task Difference Scores					
Overall response to distractor	1.53	1.05	-1.00	3.00	34
Overall postural deviation	1.50	.952	-1.00	3.00	33
Resistance to Distraction (ECBQ)	4.17	1.22	0.57	6.00	49

RTWL = Real time word learning

Table 4
Mean Performance on Language Measures

Measure	Mean	SD	Min	Max	N
Mervis and Bertrand: Real Time Word Learning					
Comprehension Performance	17.98	6.24	6.00	34.00	46
Generalization Performance	22.63	6.82	8.00	38.00	46
CDI-WS					
Nouns	140.85	99.18	4.00	317.00	47
Predicate	42.51	42.78	0.00	154.00	47
Closed-class	10.31	11.43	0.00	48.00	47
Morphology	2.65	2.41	0.00	8.00	46
Irregular	3.83	4.95	0.00	20.00	47
Word Endings	1.96	4.38	0.00	20.00	47
Combining Words	1.26	.727	0.00	2.00	43
Complexity	27.85	23.84	0.00	74.00	47

Table 5
Correlations Among Resistance to Distraction Measures

	RD (ECBQ)	RD Overall	PD Overall
RD (ECBQ)	--	-.151	-.117
RD Overall		--	.803**
PD Overall			--

* $p < 0.05$
RD = Response to distractor (difference score)
PD = Postural Deviation (difference score)

Inferential Statistics

The next set of analyses represents tests of the hypotheses I outlined in the introduction. For the first hypothesis (H1), with one exception, outcomes were contrary to expectations such that measures of attentional focus and resistance to distraction were not significantly associated with one another. Pearson product-moment correlations were conducted to assess this relationship and are presented in Table 6. Neither the proportion of time children spent in any of the attentional states, nor maternal reports of attentional focus, were consistently related to children's abilities to resist the distractions. The one exception was that attentional focusing was significantly correlated with overall postural deviation during distraction conditions (r = -.42, p = 0.007), indicating that postural deviation may provide a unique measure of children's' attentional abilities within comparable tasks.

Table 6
Correlations Among Attentional Focus and Resistance to Distraction Measures

	Resistance to Distraction		
Attentional Control	Resistance to Distraction (ECBQ)	RD Overall	PD Overall
GS Focused	-.183	.050	-.045
GS Casual	.098	.126	.089
GS Off-task	.105	-.088	.004
MR Focused	.060	-.155	-.036
MR Casual	-.333	.007	.127
MR Off-task	.037	.162	-.015
FS Focused	.043	.081	-.012
FS Casual	-.113	-.040	.097
FS Off-task	-.005	-.073	-.020
Attentional Focus (ECBQ)	-.231	-.208	-.420**

** p < 0.01
GS = Gary the Snail
MR = Make-a-Rattle
FS = Feed-Self
RD = Response to distractor (difference score)
PD = Postural deviation (difference score)

Pearson product-moment correlations were also conducted to investigate Hypothesis 2, in which it was expected that attentional focus and resistance to distraction would both be associated with language outcomes. These analyses (see Tables 7 and 8, respectively) revealed many significant relationships between attentional focus and language, but not between resistance to distraction and language.

With respect to the links between attentional focus and language, the lion's share of the associations were found on the Gary the Snail task. Here, the amount of time spent in focused attention during Gary the Snail was positively associated with number of nouns (r = .33, p = 0.036) and predicates (r = .35, p = 0.029) produced, as well as word combinations (r = .40, p = 0.015) and language complexity (r = .44, p = 0.005). Interestingly, the proportion of time spent in casual attention was not associated with nouns and predicates produced, but was positively associated with the number of closed-class words (r = .41, p = 0.009) produced, the number of irregular words produced (r = .40, p = 0.032)**,** and the diversity of word endings used (r = .37, p = 0.020).

In contrast, time spent in attentional states labeled as "off-task," on the Gary the Snail task, was significantly and negatively associated with the production of nouns (r = -.38, p = 0.016), predicates (r = -.35, p = 0.026), closed-class words (r = -.37, p = 0.036), word combination (r = -.37, p = 0.029), and complex language (r = -.48, p = 0.002). The Gary the Snail task was unique in producing these associations, as the proportion of times spent in attentional states during the imitation tasks were not associated with language outcomes. This unique role of attention during Gary the Snail may be related to differences in task requirements and guidance of attention. Attention during Gary the Snail can be characterized as eliciting self-guided measures of attentional focus, while the structure of the imitation tasks is such that children are asked to focus their attention on learning a sequence in real time. Finally, the maternal report measure of Attentional Focus was also significantly and positively associated with nouns (r = .39, p = 0.008), predicates (r = .34, p = 0.021), as well as closed-class (r = .34, p = 0.018) language production.

Although there was no significant relationship between the overall resistance to distraction measures and language ability, there were sporadic associations between some of the pre and post resistance to distraction measures and language. During the social distraction condition of RTWL, for example, postural deviation before distractor onset was significantly related to generalization in the RTWL task (r = .48, p = 0.005), as well as the CDI measures of predicates (r = .36, p = 0.036), closed-class (r = .37, p = 0.034), morphology (r = .37, p = 0.030; r = .37, p = 0.030) and word endings (r = .35, p = 0.038; r = .34, p = 0.038).

To test Hypothesis 2, I had initially planned to conduct regressions analyses to determine the extent that measures of resistance to distraction accounted for variation in children's language over and above measures of attentional focus. However, the fact that the resistance to distraction measures were not associated with language measures rendered these analyses moot. Thus, the proposed regression analyses were not conducted.

Table 7

Correlations Among Attentional Focus and Language Measures

	Language Outcomes									
	CDI-WS								**RTWL**	
Attentional Control	Nouns	Predicates	Closed-class	Morph	Irregular	Word Endings	Combine	Complex	Comp	Gen
GS Focused	.333*	.345*	.268	.370	.206	.053	.401*	.436**	.251	.065
GS Casual	.271	.169	.408**	.194	.339*	.366*	.047	.296	.175	.016
GS Off-task	-.377*	-.352*	-.369*	-.382*	-.291	-.170	-.365*	-.475**	-.277	-.060
MR Focused	-.099	-.037	.061	-.106	-.003	.082	-.198	-.212	.056	.149
MR Casual	-.079	-.072	-.044	-.082	-.131	-.047	-.064	.050	.006	-.204
MR Off-task	.137	.068	-.047	.144	.055	-.069	.233	.206	-.062	-.072
FS Focused	.059	.051	-.018	-.053	-.025	.088	-.020	-.007	-.026	.232
FS Casual	.222	.246	.311	.086	.209	-.022	.116	.267	.142	-.020
FS Off-task	-.176	-.180	-.126	.026	-.069	-.096	-.039	-.115	-.030	-.265
Attentional Focus (ECBQ)	.385**	.336*	.344*	.365*	.342*	.304*	.210	.386**	.116	.124

* $p < 0.05$
** $p < 0.01$
GS = Gary the Snail
MR = Make-a-Rattle
FS = Feed-Self
Gen = Generalization
Comp = Comprehension
Morph = Morphology

Table 8

Correlations Among Between-Task Resistance to Distraction Raw Scores and Language Measures

	CDI-WS								RTWL	
Resistance to Distraction	Nouns	Predicates	Closed - class	Morph	Irregular	Word Endings	Combine	Complex	Gen	Comp
Imitation Task										
RD Before	.082	.159	.067	.205	.175	.239	.119	.141	-.238	.037
RD After	-.254	-.107	-.067	-.268	-.110	-.128	-.186	-.160	.117	.082
PD Before	.005	.056	.009	.126	.095	.198	.095	.173	-.166	.080
PD After	-.265	-.188	-.124	-.236	-.167	-.145	-.171	-.060	.130	.062
RTWL Social Distraction										
RD 1 Before	.263	.310	.272	.115	.196	.115	-.050	.094	.470**	.257
RD 1 After	-.049	.012	-.053	-.089	.076	.019	-.118	.053	.056	-.215
RD 2 Before	.118	.157	.184	.373*	.266	.352*	.080	.230	-.214	.027
RD 2 After	.120	.132	.124	.157	.174	.112	.101	.168	.174	.125
PD 1 Before	.336	.360*	.365*	.107	.262	.094	.013	.168	.483**	.266
PD 1 After	-.049	.012	-.053	-.089	.076	.019	-.118	.053	.056	-.215
PD 2 Before	.118	.157	.184	.373*	.266	.352*	.080	.230	-.299	-.021
PD 2 After	.120	.132	.124	.157	.174	.112	.101	.168	.174	.125
RTWL Mechanical Distraction										
RD 1 Before	-.400*	-.314	-.227	-.232	-.221	-.034	-.266	-.243	-.100	-.224
RD 1 After	-.172	-.209	.000	.056	-.025	-.022	.053	.084	-.225	-.277
RD 2 Before	-.108	-.153	-.163	-.043	-1.78	-.175	-.142	-.133	-.106	.140
RD 2 After	-.036	-.050	.030	.026	.076	.043	.076	.190	-.082	-.135
PD 1 Before	-.305	-.287	-.205	-.159	-.220	-.058	-.141	-.120	-.045	-.198
PD 1 After	-.270	-.237	-.087	-.157	-.128	-.083	-.023	-.116	-.176	-.271
PD 2 Before	-.223	-.216	-.224	-.151	-.222	-.199	-.242	-.213	-.046	.071
PD 2 After	-.267	-.215	-.136	-.161	-.108	-.070	-.201	.015	-.101	-.129

RD = Response to distraction
PD = Postural Deviation
Gen = Generalization
Comp = Comprehension.
Morph = Morphology

CHAPTER 4

DISCUSSION

The overarching goal of this study was to explore the relationships between attentional control and language ability in the second year. Of special interest was whether attentional control could profitably be viewed as reflecting the cooperative contributions of two subcomponents, namely attentional focusing and resistance to distraction. Due to the lack of previous investigation into the potential dissociability of attentional focus and resistance to distraction within the construct of attentional control, behavioral and maternal report measures were used in an attempt to parse out any meaningful dissociations as they related to word learning. Because previous research has shown strong relationships between attentional processing and language ability early on in infancy, I expected that individual differences in attentional focusing and resistance to distraction would uniquely and differentially predict language outcomes.

Within the current study, there were three specific hypotheses. However, with a few exceptions, results were generally not in the expected direction. It was first predicted (H1) that there would be a significant association between attentional focus and resistance to distraction measures, reflecting an overall attentional control component. This prediction was partially supported, as maternal report of attentional focus and overall behavioral postural deviation were significantly related to one another. But this was only a single association out of many potential others. Still, this single association opens up the possibility of a novel avenue of investigation into relationships between posture and attentional processing during word learning. It may be that children who are more posturally oriented toward task objects are also more likely to engage in focused attention due to stimuli being more centrally located in the infant's visual field, with distractors being located in the periphery. Extending this to a word learning situation, children who tend to posturally orient toward objects consistent with word-world mapping may be more likely to attend to these objects simply due to their position, relative to peripheral events or objects. While this finding should be interpreted with caution, future researchers should attempt to replicate these findings not only with word learning tasks, but with learning more generally. Additionally, as future researchers continue to explore the construct of resistance to distraction, they would do well to clearly distinguish it from potentially closely related constructs such as behavioral inhibition and inhibitory control. My characterization of this distinction would be that while inhibitory control is the ability to inhibit a dominant response when a rule or correct response is known and using a previous experience or schema in order to override this dominant response to achieve a goal, while resistance to distraction should be conceptualized as the ability to maintain attentional focus while in the presence of a distractor. In the instance of a child being resistant to distraction, the rule is not known beforehand (e.g., the child does not know the consequences of shifting attention to a distractor until performance is impacted). Attending or not attending to the distraction is a response to additional stimuli in the environment and either withstanding or conceding to its influence, which then in turn influences the achievement of an attentional goal.

It was also hypothesized (H2a) that both attentional focus and resistance to distraction would uniquely account for variance in real time word learning (RTWL). Although this prediction was not wholly supported, as measures of attentional focus were not associated with RTWL performance, certain measures of postural deviation were again linked to language outcomes in the RTWL social distraction conditions. As before, although this result must be cautiously interpreted, overall postural orientation during attention tasks seems to impact word learning experiences and should be the focus of future research endeavors. I return at greater length to the potential role that postural deviation may play in children's word learning within the section on Dynamic Systems Theory (DST).

Lastly, it was predicted (H2b) that attentional focus and resistance to distraction would uniquely predict additional variance in maternal reported language ability (CDI-WS). Analyses revealed that both maternal reported attentional focus and behavioral attentional focus in the Gary the Snail task were associated with language outcomes on the CDI-WS. Most notably, the type of attention children engaged in during Gary the Snail was related to specific and dramatically different language measures. First, the proportion of time that children spent in focused attention was associated with what are typically considered to be open-class language measures (e.g., nouns, predicates). Open-class words hold some semantic information (Caramazza & Zurif, 1976); these language categories are one in which new members are continuously added. For example, as we learn language, we are constantly adding new nouns to our repertoire as we come into contact with new word-world mappings. This can also be said for predicates, word combinations, and language complexity. On the other hand, the proportion of time children spent in casual attention was associated with closed-class language measures which can be described as grammatical in nature (Caramazza & Zurif, 1976). Unlike open-class language, close-class categories are rarely, if ever, added to after initial learning. For example, irregular words (e.g., bring/brought) do not change over time, and new forms of these words are not generated. Similarly, closed-class words and word endings are considered part of this relatively static closed-class category, both of which were associated with infant casual attention. While these differential associations were not predicted, future research investigating attentional control and language ability should consider these open- and closed-class breakdowns as they relate to children's differences in attentional processing.

Curiously, this finding did not extend to the imitation task conditions. This task effect may be reflective of the attentional task demands unique to the two kinds of situations. In conditions where children are required to self-direct attention toward the exploration of task-relevant stimuli, the proportion of time spent in focused, versus other-focused, attention may have a differential effect relative to tasks guided by a social other within a learning task. It stands to reason that children who are more likely to engage in self-guided focused attention would demonstrate more advanced vocabulary; in day-to-day activities, these children would be able to take advantage of word learning opportunities outside of parent/caregiver/teacher learning situations. While it is important that children are able to focus attention when being directly taught language skills, it is an extremely lucrative and opportunistic skill to attend when not directly told to do so. It would be useful in future research to verify the extent to which focused attention in guided versus non-guided exploration tasks impacts task performance. I return to the issue of postural deviation in greater detail in the DST section that follows.

These findings notwithstanding, there were a number of limitations to the present investigation. First, it is a possibility that the limited sample size provided insufficient statistical power to detect predicted effects. Although this is a possibility, the obtained sample size is comparable, if not larger than, similar investigations within the language acquisition literature. Nevertheless, future attempts at exploring relationships between components of attention and word-learning should take sample size into account, to the extent that observed effects may not be especially large.

In addition to sample size, the inclusion of only a single self-guided attention task prevents any opportunity to test the hypothesis that self-guided attention tasks pull for the kinds of attention allocation that are especially relevant for word-learning. Still, although attention allocation during the Gary the Snail task was predictive of language outcomes reported by parents, it is not clear what characteristics of this task were most influential in the association.

Another potential limitation of the current study is the exclusion of executive function (EF) components outside of attentional control. As noted above, EF includes attentional control, working memory, and inhibitory control. The present investigation focused exclusively on attentional control as it relates to language ability, as this component is considered foundational to later developing EF components and higher-order goal directed behavior. The current study demonstrated associations among attentional focus and language ability in the second year. Future research should focus on contributing a better understanding of attentional control and its relationship to language, but also take into consideration potential relationships among language outcomes and additional components of EF. For example, children who engage in focused verses casual attention may exhibit individual differences in working memory capacity or the ability to inhibit dominant responses, impacting word learning. Furthermore, those children considered to be “off-task” may also provide unique insight into individual differences in the relationship between EF component abilities and language development. These particular relationships are not well understood, especially in relation to individual language measures (i.e., open- and closed-class language) but this language distinction may be critical when considering EF abilities and language development.

Dynamic Systems Theory Approach to the Current Study

Considering these findings collectively, the overarching take-home message of this study seems to be that relationships between measures of attentional control and language acquisition are highly context dependent. Accordingly, factors that may underlie associations between predictor and outcome measures in some contexts, may fail to underlie them in other contexts. Context-dependent relationships such as these are perhaps best explained by a Dynamic Systems Theory approach (DST; Thelen, 2005). DST approaches view development as highly contextual, nonlinear, and emergent across multiple levels and time scales. Such a holistic approach can be applied to all developmentally emerging behaviors, including highly contextualize events such as the present ones which involve the potential relevance of infant body posture and attentional processing for novel word learning. The present study revealed an unexpected, novel association between infant postural deviation and language ability that may be highly dependent on system contexts, such as those involving the allocation of attention during self- or other-guided exploration.

A DST perspective would particularly direct research attention to the unique role played by the Gary the Snail task, in eliciting parameters of attention allocation that are uniquely associated with word learning. Typically, we might assume that when children pay focused attention, the types of focused attentional states are equal regardless of the attentional target. That is, an infant's focused attention to one target is equivalent to her focused attention toward another target. But in the present study, because infants' focused attention was differentially associated with word learning, depending on the target of infants' focused attention, it seems clearly the case that not all attentional targets are equal. Focused attention to some targets predicts vocabulary size, while focused attention to others does not.

As mentioned above, at least one difference between the Gary the Snail task and the imitation tasks is that the former allows for self-guided exploration, while the latter provides other-guided explanation. It could be the case, then, that focused attention is most predictive of cognitive development outcomes when that attention is sampled from self-guided exploration. If so, then all focused attention is "not created equal," and researchers would be well advised to consider the kinds of stimuli they use to elicit it.

The kind of context-dependency observed in the present investigation, from a DST perspective, highlights the kinds of control parameters that are at work in various kinds of attentional tasks. As has been seen, postural deviation and attentional focus measures may be informed by whether a task is self- or other-guided, but it would be useful to take a step further to consider the specific kinds of instruction or guidance that are provided in an "other-guided" task. It may be that some kinds of guidance elicit the kinds of focused attention that reflect a young child's general learning dispositions, whereas other kinds of guidance yield focused attention that do not. By taking a DST approach, and considering how posture behavior unfolds dynamically across the first two years of life, it may prove possible to identify the contextual elements present during both self- and other-guided explorational tasks, as well as to distinguish between different contextual elements present during different kinds of other-guided explorational tasks.

Conclusions

The current work highlights gaps within the literature examining relationships between attentional focus, resistance to distraction, and language ability in the second year of life. More specifically, results indicate that language ability is related to attentional state during a self-guided attention task, maternal reported attentional focus, and infant postural orientation.

The most unique contribution of the current work is that of the association between infant posture and language ability. Although we should be cautious as to the interpretation of this finding, it has not previously been demonstrated. Future research should attempt to replicate this relationship so as to help identify the situational contexts in which posture might significantly impact infant attentional focus. By identifying these unique links between attentional processing and language development, efforts to uncover potential interventions for those children demonstrating inefficient attentional processing, as well as language delays may be emphasized.

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