

Sustained Attention, Self-regulation, and Motivation
During a Maze Task for Preschool Children:
A Motivational, Cognitive Analysis of the Process of Sustained Interest

by

Lorraine Lander (Gianvecchio)

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Professor Craig Barclay

Margaret Warner Graduate School of Education and Human Development

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Dedication

To my husband, Tom, and my children, Michael, Steven, Cheryl, and Michelle, for all the support they have given over the years of my education and particularly the writing of my dissertation.

Curriculum Vitae

The author was born and grew up in Dansville, New York. In 1982 she completed her Bachelors of Science in Nursing degree along with a minor in psychology at the State University of New York College at Brockport. She continued her studies in psychology in the fall of 1992 and received a Masters of Arts Degree in Applied Psychology in the spring of 1994 at the State University of New York College at Brockport. A year later she began her doctoral studies in the Human Development in Educational Contexts program at the University of Rochester's Warner graduate School of Education and Human Development. She received the Sproull Fellowship from the University for the 1995 and 1996 academic years and was a Scandling Scholar in the 1997 academic year. She pursued her interest in children's attention which provided a basis for her dissertation research into influences on preschool children's sustained attention and completed her doctoral studies in the spring of 2002.

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Abstract

Sustained attention in children has long been conceptualized as a capacity that increases with age (Levy, 1979), a view that has done little to promote investigation and implementation of methods to promote sustained attention in children. However, recent research (Ruff, Capozzoli, & Weissberg, 1998) presents evidence that contextual factors may exert an important influence on sustained attention, supporting the need for research into what and how contextual factors may influence this process. In order to pursue this need, the research presented here examined the roles of age, skill level, and self-regulation in influencing sustained attention in young children completing maze puzzles.

Participants were 35 preschool children. Children were given maze puzzles of various difficulty levels and with varying amounts of choice. The first portion of the study assessed the ability level of each child for the maze puzzles. Sustained attention times for working on easier, ability level, and harder mazes was then assessed (No Choice Phase). Next children were provided with all three levels simultaneously (Choice Phase) and allowed to vary their choice of difficulty level in order to investigate the influence of choice on sustained attention. During the Choice Phase, children's self-regulation of their choices was investigated to determine what influence the

types of choices they made would have on sustained attention. Lastly, children were given a session of choice where all three piles contained the same level of difficulty in order to investigate the influence of an apparent, but meaningless choice. In addition, children's awareness of task difficulty was assessed.

Results found sustained attention to be considerably longer during the Choice Phase of the study, supporting the importance of choice in promoting attention and calling into question the conception of sustained attention as a maturational skill. Results also suggest that children self-regulated their choices during the Choice Phase in different ways which influenced the overall difficulty of the mazes they completed. This research supports the usefulness of this methodology for examining the relations between sustained attention, motivation, and metacognitive self-regulation of choice. Results also have implications for promoting sustained attention in preschool children and promoting future academic achievement.

Table of Contents

Section	Topic	Page Number
0.00	Table of contents.....	Page iv
	Opening Quote by Robert White.....	Page 1
	Chapter One.....	Page 2
1.10	Introduction.....	Page 2
1.11	Overview.....	Page 2
1.20	Attention and Sustained Attention in Context.....	Page 4
1.21	Attention Theory.....	Page 4
1.22	E. Gibson's Model of Attention.....	Page 6
1.23	Sustained Attention.....	Page 8
1.24	Vigilance and Sustained Attention.....	Page 9
1.25	Research Findings on Sustained Attention.....	Page 11
1.26	Sustained Attention Increases with Age.....	Page 12
1.27	Task Characteristics Influence Duration of Attention... ..	Page 16
1.28	Behavioral Manifestations of Sustained Attention.....	Page 21
1.30	Motivation.....	Page 22
1.31	Motivation - Interest.....	Page 22
1.311	Interest and Motivation.....	Page 23
1.32	Individual Interest.....	Page 26
1.33	Motivation - Competence.....	Page 28
1.40	Arousal.....	Page 35
1.41	Motivation and Arousal.....	Page 38
1.42	Competence, Arousal, and Task Difficulty.....	Page 39
1.43	Additional Evidence.....	Page 40
1.50	Self-regulation.....	Page 41
1.60	Task difficulty.....	Page 44
1.70	Proposed Study.....	Page 47
1.71	Implications of Study.....	Page 51
1.80	Pilot data	Page 55
1.90	Summary.....	Page 65
1.91	Hypotheses.....	Page 67
	Chapter Two: Method.....	Page 71
2.10	Sample.....	Page 71
2.20	Procedure.....	Page 72
2.30	Assessments.....	Page 75
2.40	Analyses Procedures.....	Page 77

	Chapter Three: Results.....	Page 78
3.10	Validity of Maze Difficulty Levels.....	Page 78
3.20	Subject Refusals.....	Page 79
3.30	Attention Checklist Results.....	Page 80
3.40	Potential Order Effects.....	Page 80
3.50	Hypothesis One.....	Page 81
3.60	Hypothesis Two.....	Page 88
3.65	Choice vs. Meaningful Choice.....	Page 90
3.70	Hypothesis Three: Choice Phase.....	Page 93
3.80	Exploratory Question.....	Page 98
	Chapter Four: Discussion.....	Page 101
4.10	Task Difficulty and Sustained Attention.....	Page 101
4.20	Age, Skill, and Sustained Attention.....	Page 103
4.30	Choice, Self-regulation, and Sustained Attention.....	Page 106
4.40	Metacognition.....	Page 110
4.50	Predictors of Sustained Attention.....	Page 118
4.60	Process vs. Activity Choice.....	Page 119
4.70	Weaknesses of Study.....	Page 120
4.80	Implications.....	Page 123
	References.....	Page 128
	Appendix A - Maze Construction.....	Page 146
	Appendix B - Procedure and Script.....	Page 149
	Appendix C - Attention Checklist.....	Page 154
	Appendix D - Text of Questions.....	Page 156
	Appendix E - Maze Procedure Coding Sheet.....	Page 157
	Appendix F - Parent Letter/Consent Form.....	Page 159
	Appendix G - Task Difficulty Not Controlled.....	Page 162
	Appendix H- Children and Choice in Choice Phase.....	Page 165
	Appendix I - Preference for Mazes.....	Page 173
	Appendix J - Knowledge of Task Difficulty.....	Page 174
	Appendix K - Exploratory Analyses.....	Page 177

Tables and Graphs

Table 1.1	Mean Minutes of Engagement with Toys.....	Page 18
Table 1.2	Pilot Results - Sustained Attention Times.....	Page 58
Table 1.3	Pilot Results - Order of Choice.....	Page 59
Table 1.4	Pilot Results - Errors.....	Page 62
Graph 2.1	Age in Months.....	Page 71
Table 2.1	Skill Level.....	Page 72
Graph 3.1	Interaction of Age and Skill for Average SA.....	Page 85
Graph 3.2	Interaction of Age and Skill for Highest SA.....	Page 86
Table 3.1	Task Difficulty Preference - No Choice.....	Page 82
Table 3.2	Sustained Attention for Choice and No Choice.....	Page 89
Table 3.3	Sustained Attention for Choice, No Choice, and No Meaningful Choice.....	Page 91
Graph 3.4	Interaction of Age and Skill in Choice Phase.....	Page 95
Table A.1	Table of Differences in Maze Levels of Difficulty.....	Page 147
Graph G.1	Time for 6D Mazes by Age in Months with Horizontal Line Representing Linear Model.....	Page 163
Graph G.2	Time for 7D Mazes in No Choice Phase with Horizontal Line Representing Linear Model.....	Page 164

Picture an infant or child at play with a new toy. They look, they touch, they turn, and they study. Imagine looks of concentration, the smiles of pleasure or even laughter taking place as they explore the new object. Robert White (1959) asks these questions,

“Motivated toward what goal?....stimulation,.....need for activity,.... achieving knowledge,.....mastery, power, control.....self-assertion? It looks as if we have found too many goals and perhaps our first impulse is to search for some key to tell us which is really important. But this, I think, is a mistake that would be fatal to understanding.

We cannot assign priority to any of these goals without pausing arbitrarily in the cycle of transaction between child and environment and saying, ‘This is the real point’. I propose instead that the real point is the transaction as a whole. If the behavior gives satisfaction, this satisfaction is not associated with a particular moment in the cycle. It does not lie solely in sensory stimulation, in a bettering of the cognitive map, in coordinating action, in motor exercise, in a feeling of effort and of efforts produced, or in the appreciation of change brought about in the sensory field. These are all simply aspects of a process which at this stage has to be conceived as a whole.....

We must bear in mind the continuous nature of behavior. This is easier said than done; habitually we break things down in order to understand them.....yet when we apply such an analysis to playful exploration we lose the most essential aspect of the behavior. It is constantly circling from stimulus to perception to action to effect to stimulus to perception, and so on around; or more properly, these processes are all in continuous action and continuous change” (p. 322-324).

Chapter 1: Introduction and Literature Review

1.10 Introduction

1.11 Overview

As the quote from White (1959) reminds us, human behavior is the result of complex processes with a variety of cognitive and motivational influences transacting to accomplish activity. Many of these internal influences are also themselves bound with environmental characteristics. In our quest to comprehend human behavior we may become too specialized in our focus and lose sight of the human condition. Explanations and predictions of behavior may require a broader look at processes, including both cognition and motivation.

One byproduct of specialization in theoretical constructs and fields of research with an associated, limited focus may be a loss of authenticity to research work and an inability to apply findings to the real world. One example of this problem with specialization is the common separation of studies in cognition and motivation. This has led to numerous laboratory studies on cognition, particularly attention, where motivation is discounted and tasks are decontextualized (see later discussion in this paper on vigilance research, section 1.24). These types of studies may tell us little about cognition or behavior in the real world or how to promote cognitive processes. Recognizing these potential limitations, this research integrated

theory on cognition, specifically sustained attention, with theoretical work on motivation.

By using this approach, current research on sustained attention can be extended. For example, attentional research has tended to conceive of sustained attention as a fixed capacity (Blum & Adcock, 1968). Yet, capacity models have been criticized (Chi, 1976; Brown & DeLoache, 1978) as poor explanations for differences in performance of children on other types of cognitive tasks, including memory and problem solving. According to Chi, capacity models are not really theories, they are simply restatements of the data since they merely describe differences in performance, without explaining them. This project attempted to demonstrate that a capacity model of sustained attention is neither very accurate in describing the attentional behavior of young children, nor very useful for explaining behavior.

Another of the problems with research that examines attention as a fixed capacity is that it tends to ignore the influence of external factors such as task characteristics and internal factors such as motivation. In this study I attempt to amend this deficit by examining normal attention with regard to reciprocal relations between factors in the environment and internal states. In order to understand how attention is influenced by the environment, this project will investigate how task demands interact with motivation to influence sustained attention.

This project will also attempt to integrate theoretical and research work on several constructs within the field of cognition including, sustained attention, arousal, self-regulation, metacognition, and the field of motivation, including intrinsic motivation, interest, competence, and optimal challenge. This may seem a formidable challenge, but an examination of theory and research results will reveal these concepts have much in common in understanding sustained attention.

1.20 Attention and sustained attention in context

In order to understand the background for this study, there will be a review of literature including attention theory, particularly in relation to sustained attention. Research findings on sustained attention in children will next be discussed. A review of motivational concepts related to task engagement including intrinsic motivation, interest, competence, optimal challenge, self-efficacy, and effectance motivation will follow with theoretical and research evidence on how these concepts may be related to sustained attention. Next the connection of arousal to sustained attention and motivation will be considered, followed by a discussion of the process of self-regulation. Lastly, a theory will be discussed concerning how these processes may operate through children's behavior to optimize motivation and thus promote sustained attention in activities.

1.21 Attention theory

Attention has long been a topic of interest to psychologists. One early researcher who studied attention was E. B. Titchener (1880). Titchener believed attention was the determinant of the contents of consciousness and the quality of conscious experience. However, when he and his students attempted to study attention by eliminating all phenomena that could be labeled either perception or cognition, they found little left to be measured and called attention. As the opening quote from White would indicate, attempting to isolate one portion of a complex process may prove disappointing or even misleading.

Historically, there have been many definitions of what attention is and even today there is no consensus on this topic (Burack and Enns, 1997; Maitlin, 1989; Ruff and Rothbart, 1996). In fact, according to Posner (1975, p. 441) “attention is not a single concept, but the name of a complex field of study”. In addition, there have been multiple attempts to describe attention and how it functions. According to Luria (1973), attention is a multidimensional phenomenon consisting of many components. Korkiman and Peltomaa (1991) describe attention as having the following components:

1. Alertness or arousal,
2. Selective attending,

3. Sustained attending,
4. Apprehension span (breadth of attention, ability to attend to many relevant stimuli or aspects of performance simultaneously),
5. Search and application of strategies of performance,
6. Inhibitory control of behavior.

Others have a more limited view of attention. Posner (1975) suggests there are three categories of attention: alertness, selection, and effort. Ruff and Rothbart's book on attention (1996) proposes three similar aspects of attention: selectivity, voluntary control, and intensity.

Historically there has also been emphasis by different researchers on one or more individual aspects of attention. However, all aspects of attention appear to coordinate together to accomplish the attentional process and adaptive functioning. For example, Barkley (1988) proposes that examining the nature of whatever task is used for assessment of the construct or components of attention may be necessary to fully understand what is being measured, thus supporting the view that attention is an interactive process that should be considered in relation to both the individual and the environment.

1.22 E. Gibson's Model of Attention

Not all theorists have ignored the influence of the environment on attention. Eleanor Gibson (1969, 1991) has constructed an ecological theory

of attention where attention is considered in terms of people's activity and their needs and motives. According to Gibson, "A motivated organism living and adapting to an environment is considered attentive as he or she searches for information that is necessary to performance" (Gibson & Rader, 1979, p. 6).

Gibson defines attention as "perceiving in relation to a task or goal, internally or externally motivated" (Gibson, 1969. p. 2). In this view, attention is an active process, where information is extracted from ongoing events in a selective, active, and economical way (Gibson, 1991; Gibson & Rader, 1979). Attention is guided by the reduction of uncertainty, either through self-regulated or automatic processes (Gibson, 1969). According to Gibson, there is a need for children to learn about the world around them. Individuals actively search for relations and the results of this search is an increasing ability to find structure and order in what is perceived.

Gibson proposes three types of attention: involuntary (or captured), self-directed (voluntary), and other-directed attention (such as by a teacher) where children must follow the attention of another. Captured attention tends to be effortless due to innate propensities to attend to certain types of stimuli. Self-directed attention also occurs effortlessly as the individual experiences the world. Other-directed attention, however, may be quite effortful as natural cognitive processes do not support its implementation and maintenance.

Although Gibson provides no evidence, it is her belief that self-directed attention is far superior in quality to other-directed attention. Support for this view may come from research on intrinsic motivation where task engagement and task persistence are superior when self-determined (Deci & Ryan, 1985).

1.23 Sustained Attention

According to Krakow and Kopp (1983), sustained attention is the ability to become and to remain engaged. While a great deal of research has focused on selective attention, much less has examined sustained attention, particularly in context. For example, in a 243 page volume recently published on attention and development (Ruff & Rothbart, 1996) only six pages are devoted to the topic of sustained attention and 16 pages to engagement (a behavioral manifestation of sustained attention).

Ruff and Rothbart (1996) indicate that few theorists have given much consideration to sustained attention as a separate aspect of attention, outside the study of vigilance (to be discussed in the next section). They identify two exceptions. Although Cohen (1972) found attention-getting stimuli appeared to differ from attention-holding stimuli in a study of infants, to date there has been little investigation of such attention-holding properties. When discussing possible origins and treatment of ADHD, Porges and Smith (1980) propose a two component model of attention which includes reactive and sustained aspects. However, these authors do not speculate on what

environmental characteristics might influence reactive and sustained aspects of attention.

1.24 Vigilance and sustained attention

Sustained attention has been studied in several indirect ways. One way that sustained attention has been examined is through research on vigilance. Davies and Parasuraman (1982), define vigilance tasks as those in which attention is focused on one or more sources of information over long, unchanging periods of time, in order to detect small changes in the information being presented. They also call these tasks “monitoring” or “watchkeeping” tasks.

According to Koelaga (1995), the vigilance situation typically results in a decline in performance which seems to result mainly from the necessity of looking or listening for an infrequent signal. He believes this progressive decline in performance is the result of changes in central processes, such as inhibition, attention, arousal, motivation, etc., rather than changes in perception.

Within research on vigilance, there are three types of theories that attempt to explain sustained attention performance (Davies and Parasuraman, 1982). Inhibit theories attempt to explain the decrement in performance in vigilance tasks by proposing that either response extinction takes place as the task progresses (subjects are less reinforced by success

when they perceive targets so become less likely to respond accurately as time progresses) or the non-response necessary for non-target signals generalizes to the target signals. Expectancy theory states that the observer forms expectancies about future probability of signals. As time progresses, expectancy for non-signals or no signal predominates the anticipation of the observer and target signals are missed when they occur.

According to Davies and Parasuraman (1982), arousal theory is the third types of theory of sustained attention in the vigilance paradigm. Arousal theory emphasizes the general state of the individual and basically proposes that a progressive reduction in arousal occurs during task performance in the vigilance situations, based largely on what they call “the monotonous nature” of the task.

What is noticeably absent from these theories is any acknowledgement of the role of motivation is influencing this process of sustaining attention during the vigilance procedure. Davies and Parasuraman (1982) do acknowledge one theory of performance in the vigilance task that incorporates motivation (Smith, 1966). Smith proposes an individual difference view where there are two types of observers who take part in the vigilance task. Both types are relatively unmotivated to pursue the task, but one group is conscientious and performs as best they can, despite the nature of the task. The other group are only transiently and irregularly

conscientious during the task, with the quality of their attention fluctuating throughout. According to Smith, the result of vigilance task research then becomes the averaging of the performance of these two types of individuals and actual results are greatly influenced by the proportion of the two types that happen to take part in the particular vigilance study.

There is clearly a problem with the nature of the vigilance task and its applicability to many real world tasks. According to Davies and Parasuraman (1982) vigilance tasks in laboratory settings may even have little to do with watchkeeping types of tasks in the real world, such as assembly line work or monitoring in power plants, where breaks are more frequent and social interaction is available.

Vigilance research may say little about attentional processes in real world contexts because of the unique situation it creates in laboratories. In addition, there is some evidence that vigilance performance may have little relation to sustained attention on normal tasks. For example, Silverman and Gaines (1996) found no relation between toddlers' performance on a vigilance task and their task persistence in solving problems.

1.25 Research findings on sustained attention

Much research on sustained attention in children has focused on developmental issues. Attention has been identified by several researchers as a process that develops throughout childhood in the direction of increasing

control and strategic use of mental resources (Anderson & Lorch, 1983; Hagen & Hale, 1973; Wartella & Ettema, 1974). However, there appears to be conflicting conclusions from the results of these studies. Some studies which employ a single task or type of task report an increase in sustained attention with maturity, suggesting an increased capacity or ability which either simply grows with age or with experience. This increase is usually measured by the percentage of time a child attends or engages versus a total time available for attending. (For example, in several free choice studies where play materials were provided (Ruff & Lawson, 1990; Ruff, et al., 1998; Breznitz & Friedman, 1988), children were considered engaged or attending when they were maintaining interaction with an object. Children were not considered engaged when they were looking around, performing repetitive actions with objects, talking to their mother or to the researcher).

In contrast to these studies with a single type of task which appear to find age-related changes in sustained attention, other studies which have employed multiple tasks appear to show that task characteristics are more influential in determining the length of sustained attention. First, I will discuss studies that report increases with age.

1.26 Sustained attention increases with age

One study that appears to support sustained attention increasing with age was conducted by Levy (1979) and involved 230 children from three to

seven years of age. Children were tested using a continuous performance test (a computerized test of attention where letters are continually displayed on a computer screen one after the other. Children are to press a button when they see the letter “x”. This task is somewhat similar to the vigilance task, except stimuli are not infrequent). The percentage of children who were able to sit and complete the entire test in one session increased from 27% at 3 years of age to 100% at 4.5 years of age and above, suggesting the ability to sustain attention increases with age.

As mentioned in the introduction, tasks such as these where the stimuli are boring and repetitious are unlikely to engage children’s attention unless they are externally motivated. According to Ruff and Rothbart (1996), self-control skills may be an important factor in attending for children in externally motivated situations. Levy concludes her study with the statement that “the study demonstrated a clear age development in capacity for sustained attention” (p. 83), yet the results may be as easily explained by the learning of self-control skills among other possible explanations. In order to avoid this potential confounding of self-control and sustained attention, it may be more useful to examine sustained attention using tasks which naturally gain the attention of children.

For example, Breznitz and Friedman (1988) found sustained attention to play objects increased significantly with increases in age in a group of

children from 16 to 40 months of age. Similar results were found by Ruff and Lawson (1990), who studied 1, 2, 2.5, 3.5, and 4.5 year olds during free play. In each study, children were given a variety of age-appropriate toys. Sustained attention was measured by the percentage of time that children engaged with the toys during a set time period versus other behaviors such as looking around, talking with others, wandering the room, sitting and doing nothing, etc.

It is possible that studies that show increases in sustained attention with age are simply reflecting improved skills and knowledge about the activities. Children may be more likely to maintain engagement (or sustain attention) in activities which are not too simple or too complex for their abilities. Studies which show this increasing trend for attention may simply employ tasks or play objects where increasing capability lead to increased attention. In addition, the match between children's capabilities and the requirements of the situation may never have reached the point of being too simplistic for children (there was never a downturn in attention when the toys became too simplistic, but imagine the same toys with 12 year olds and predict their sustained attention).

In addition to the possibility of ability influencing the results, Ruff and Lawson (1992) note that children interacted differently with toys at older ages (for example, older children focused more on construction and problem

solving) and they hypothesize that increased variety and/or complexity of children's activities may contribute to increased attention. Renninger (1992) also noted that children seemed to have a qualitatively different set of activities they perform with objects of interest (see section 1.32 for more on Renninger's findings). Also, both Case and Khanna (1981) and Sugarman (1982) have proposed that increased complexity of both plans and activities may increase the duration of attention. Again the results of studies where attention improves with increasing age, may indicate increased complexity of response with objects or tasks, rather than a change in attention itself. This increased complexity of response also promotes controlled allocation of attention which then leads to increases in attentional efficiency and effectiveness.

It is also possible that increased complexity of response alone is not the only reason that more complex responses may promote sustained attention. A larger repertoire of behaviors within an activity may allow children more choice and although performing all the increased number of possible behaviors may simply take longer, it is also possible that children may vary or self-regulate their choices in order to optimize their pleasure in intrinsic activities. This possibility will be discussed in more detail in section 1.60.

It becomes unclear then whether increased age alone is the best

predictor of increases in sustained attention. In addition, not all studies of sustained attention have found such changes. Other studies suggest that characteristics of the task may be more important to determining sustained attention.

1.27 Task characteristics influence sustained attention

Studies that vary both the tasks and the ages of children appear to find that task characteristics interact with age to yield differences in sustained attention. In 1955 Moyer and Gilmer conducted a study on the attention span of children for experimentally designed toys. They defined attention as the length of time a given activity continues without external persuasion. Their study included 681 children 18 months to seven years of age. The researchers employed a simple plastic toy car (as an example of a typical toy) and developed six toys of their own design specifically altered after several testing sessions to increase their ability to hold children's attention.

Results indicate that each toy appeared to lead to a maximum attention span within different age groups (i.e., one toy maximizes at four years then declines, another at five, etc.). The authors attributed the low attention spans with certain toys in certain age groups to toys being too difficult or too easy. "Under conditions of little or no distractions, our studies show that the primary influences on the length of attention spans in children are age and toy functioning together" (p. 197).

In addition, their study failed to reveal any evidence of a regular increase in attention span from year to year. Individual toys tended to have a range of interest for three to four years and during this span there was no measurable trend up or down. They conclude that the concept of attention span used in the singular, is meaningless. The attention span at any particular age appeared to be particular to the toy engaged with.

As an example of the great range in attention span found in this study, the simple plastic car yielded an attention span of 3.1 minutes (age three) to 5.4 minutes (age five). In contrast, the experimental toys averaged 26 minutes for three year olds (range 16 minutes for the people wagon to 34 minutes for the chips and wagon toy), and 29 minutes (range 20 minutes for the circus wagon to 36 minutes for the take-apart-airplane) for five year olds (not a significant difference). Children were given a maximum exposure of 45 minutes to the toy under consideration in the study. When children did not care to engage with a toy, they were observed to walk around the room, hum, play with their clothing, or try to speak with the observer instead.

Since the authors wished to investigate what maximum attention spans might be, a few children were allowed to go beyond the 45 minute maximum time. Several went up to two hours with certain toys. Each toy yielded a peak age for sustained attention that appeared to correspond to a match between developing abilities of children of that age and characteristics

of the toy. In addition, the longest attention spans were not recorded for the oldest group of children engaging with the most developmentally advanced toys. For example, Moyer and Gillmore calculated the mean for minutes for engagement for whichever toy seemed to engage children of each age the longest. These means are displayed in Table 1.1.

Table 1.1

Mean of minutes of engagement with toys with best sustained attention for each age

Age	Minutes
18 months old	24.3
2 years old	34.0
3 years old	32.9
4 years old	39.2
5 years old	35.0
6 years old	39.7
7 years old	28.5

The results of this study would seem to support that complexity of response influences sustained attention, with optimum complexity of response yielding the longest spans of attention.

In another study where there were variations in task characteristics, Levin and Anderson (1976) examined 70 children between one and four

years of age for sustained attention to television watching. They analyzed content of programming for effect on attention and found children at differing ages appeared to have different preferences for what sustained their attention. In addition, they encountered individual differences between children for what appeared to influence their attention and also found consistency over three assessment sessions for sustained attention in individual children (indicating a individualized relation between sustained attention and task characteristics). This study would appear to indicate again that children's sustained attention was better when there was a match of task characteristics to their own internal characteristics, although it is unclear if this was motivational or cognitive or both.

More recently, Ruff, Capozzoli, and Weissberg (1998) measured sustained attention in several different contexts: watching videos, playing with toys, and performing reaction time tasks. They report the results of three studies with 2.5 to 4.5 year olds that were followed over time. They divided their sample into three groups, 30 months, 42 months, and 54 months of age. Overall sustained attention (the mean for all three types of activities) increased significantly ($p < .001$) with age. Mean times for attention were 168.2 seconds at 30 months of age, 294.3 seconds at 42 months of age, and 334.8 seconds at 54 months of age.

However, Ruff and colleagues (Ruff et al., 1998) also reported only low

to moderate correlations across the different activities at any one point in time. The correlation was .24 and nonsignificant when comparing sustained attention for play to the reaction time task. The correlation between the videos and play was .33 and significant at the .05 level. These results may suggest a relation between task characteristics and attention, and call into question the idea of a capacity model for sustained attention. In addition, increases in sustained attention for video watching and playing with toys tended to occur earlier in age than increases in attention for the reaction time task. Since it is likely the video watching and toy play were internally motivated and the reaction time task was externally motivated, it is possible some of the difference in the responses on these tasks were related more to self-control than a maturation of attentional ability.

In addition, the authors found that there was a high consistency over time within a type of activity for individual children's sustained attention. The researchers propose that children may have stable tendencies to focus and sustain their attention in particular contexts, and that attention varies with demands of tasks and both children's abilities and interest in meeting those demands.

However, Ruff and colleagues (1998) did find some increases in sustained attention for the same activities over time suggesting a possible relation between age and sustained attention. While it is possible that there

may be age-related changes in capacity for sustained attention within an activity, these results could also be explained in terms of increased knowledge and experience with tasks and the subsequent changes in interaction which may occur.

1.28 Behavioral manifestations of sustained attention

Vigilance research and research on sustained attention may not be the only ways sustained attention have been studied. Engagement, task persistence, and time on-task would all appear to be similar behavioral manifestations of sustained attention. Each term represents a way of describing prolonged interactions with an object or task which would suggest sustained attention. For example, one operational definition of persistence is the length of time a child will engage in task-directed behavior (Yarrow & Messer, 1983). (Persistence in this case refers to characteristics of an activity rather than the use of the term as an enduring characteristic of temperament). In addition, according to Lloyd and Loper (1986), time-on-task is a common way of conceptualizing sustained attention in schools.

Engagement or task persistence would not be possible without sustained attention and the results of studies of these behaviors may be useful to consider in understanding how sustained attention is influenced by motivation. The next section of this paper will discuss motivational theories and research that relate to engagement in activities in order to understand

what types of motivational principles may be influencing participation and thus promoting sustained attention.

1.30 Motivation

According to Eccles, Wigfield, and Schiefele (1998), motivation is the study of “individuals’ choices about which tasks to do, persistence with which they pursue these tasks, and their thoughts about their performance and their goals” (p. 1017). Motivation may have much to do with the quality of task engagement and several motivational concepts may be useful to consider in developing an understanding of how motivation influences task persistence and thus sustained attention.

1.31 Motivation - Interest

According to Schiefele (1991) there are two types of interest: situational interest and individual interest. Situational interest involves an emotional state that occurs as a result of situational stimuli particular to a moment in time (see Anderson, Shirey, Wilson, & Fielding, 1987; Hidi, 1990; Hidi & Baird, 1986). Individual interest is related to past experiences and the relation between individual characteristics (for example knowledge and skills, temperament) and task characteristics (for example, potential for enjoyment, see Renninger, 1992; Renninger & Wozniak, 1987).

Berlyne (1960) also acknowledges a dichotomy in interest when he states the attractiveness of stimuli may depend on either past history or what

he calls collative interest. Schiefele's concept of situational interest appears similar to what Berlyne (1960) calls "collative" interest (while individual interest is similar to the interest that Berlyne attributes to past history). Berlyne proposes that collative properties (novelty, complexity, uncertainty, and conflict) are important for motivating exploration and these variables control selective attention and exploratory behavior by stimulating arousal which elicits attention.

Situational interest variables may be especially important when encountering new stimuli when there is no history of interaction with the actual object or activity. In fact, these variables are often employed to capture human attention, through the use of bright colors, complex patterns, unexpected sounds, etc., while individual interest may be a more useful concept in understanding behavior with familiar tasks or objects.

1.311 Interest and motivation

According to Deci and Ryan (1985), individuals tend to approach activities that interest them and thus interest has an important "directive role" in intrinsically motivated behavior. This suggests that interest directs attention for engagement in activities. This conception of interest would also suggest that interest would be necessary to maintain engagement in activities. Novelty and optimal challenge have been identified as two characteristics of tasks and objects that tend to create interest and describe

the potential relation between an object and an individual (Csikzentmihalyi, 1975,1990; Deci, 1992). Sansone and Morgan (1992) further propose that interest comes from perceptions of competence and activities that promote interest are more likely to be pursued in the future.

According to Deci (1992), interest exists in the relation between a person and an activity and is experienced only if the needs or desires of the individual are supported by the activity. Further Deci and Ryan (Deci & Ryan, 1991) propose that interest is experienced when activities that are novel, challenging, or aesthetically pleasing allow satisfaction of basic needs (competence, autonomy, and relatedness) and promote development. Needs in this sense are taken to mean requirements that are either innate to an organism or acquired through interactions with the environment. This conception of interest appears to thus include both interest acquired through situational variables and individual interest.

Interest may also be considered in terms of motivation for participation. Sansone and Harackiewicz (1996) theorize the existence of two types of motivation for task participation, one is outcome-driven and the other is process-driven. Outcome-driven motivation is governed by the desire to reach a goal at task completion. Process-driven motivation is governed by optimizing pleasure in doing the activity. These authors refer to process-driven motivation as the experience of engaging in a task because you “feel

like it”, in other words the engagement feels good to the individual. According to Sansone and Harachiewicz, when engagement feels good there is cognitive and affective absorption in the task and this combination of cognitive and affective absorption (that accompanies “feels good” task engagement) is the reason many people do the activities they do. This theory is partially based on the idea that interest may function as a proximal motivator for moment to moment action

Sansone and Morgan (1992) claim that there are multiple goals relevant to interest in a task and these goals include among others-level of perceived competence. They propose that intrinsic motivation is created and maintained through an ongoing temporal process. For example, in a series of studies, Sansone and colleagues (Sansone, Weir, Harpster, & Morgan, 1992; Sansone, Wiebe, & Morgan, 1999) found evidence to suggest the existence of strategy use that helps regulate the experience of task participation. According to the authors, “Individuals may strategically initiate behaviors with the intention of making the activity more positive to perform” (p. 218).

In Sansone and colleagues (1992) undergraduates were given a boring, but necessary activity. Subjects were observed to general interest-enhancing strategies that appeared to change the activity into something more positive to perform. Use of strategies was positively and significantly correlated ($r_s=.45$, $p<.05$) with subsequent engagement. In a second study,

Sansone and colleagues (1999) found that participants who engaged in strategies which increased interest in the task engaged longer than those who did not ($t=2.16, p<.05$). They propose that persistence at an activity should vary as a function of the use of strategies that promote interest.

1.32 Individual interest

Individual interest is one aspect of interest that appears to influence engagement and subsequent sustained attention. Individual interest appears to be a relatively enduring preference for certain topics, subject areas, or activities (see Hidi, 1990, Prenzel, 1988, Renninger, 1990, Renninger & Wozniak, 1985), varying over days or weeks to years. Individual interest seems to arise when things acquire a history of positive experiences and become associated with opportunities for exploration and competence experiences. It is possible that activities of individual interest are those where an individual has experienced intrinsic motivation during past engagement, so that individual interest may develop when feelings of competence, autonomy, and relatedness (characteristics of intrinsic motivation) accompany repeated interactions with objects.

Renninger (1992) has conducted two studies with preschool age children investigating the relations between individual interest and attention. In one study (Renninger and Wozniak, 1985) 16 children were observed during play and researchers attempted to identify two objects of interest for

each child. Observed interests were easily identified for each child and although different, the strength of individual interests were similar across the group of children. Strength of interest was measured by noting the length of time that children engaged with various play objects. Strength of interest then in this study would seem to be another behavioral manifestation of sustained attention. Renninger and Wozniak used children's objects of interest to test attention shift, recognition, and free recall memory. Interest exerted a significant effect on speed of shifts in attention (selection of new foci) versus noninterest items ($t_{(15)}=4.44$, $p<.001$), the likelihood that an item would be correctly recognized when encountered again versus a noninterest item ($t_{(15)}=2.79$, $p<.01$), and on recall of position of interest item versus noninterest items at other positions in a display field ($F_{(1,112)}=3.92$, $p<.05$).

In a more recent study, Renninger (1992) observed 44 children ages 2.9 to 4.2 years of age in nursery school. She identified objects of interest for each child and observed that children played significantly longer (sustained attention) with objects of interest. Renninger classified play with objects of interest in free play situations into five types: investigative, functional, operational, transformational, and facilitative play. She found that children had more types of play behavior available to them when playing with objects identified as interests. Children played for longer amounts of time, repeating particular sequences of action with objects of interest and there

were more variations of action during play with such objects. Renninger suggests that children may be using objects of interest to create challenges for themselves building on prior experience and actions with these objects.

Renninger's description of the greater complexity of play behavior with objects of interest also appears to indicate that children possessed a competence with these objects. Ruff and Lawson (1990) also reported more complexity to the sustained attention of the older children in their study (1 to 4.5 years of age), suggesting a greater competence in their interactions. There appears to be a strong connection between individual interest and competence, as well as complexity. Competence will be discussed next.

1.33 Motivation - Competence

Several constructs appear to relate to individual's need for effectance when participating in activities, including: actual competence (including skills and knowledge), perceived competence, optimal challenge, mastery motivation, self-efficacy, and effectance motivation. Competence and these associated concepts may be responsible for promoting interest which subsequently leads to task persistence and increased sustained attention. Each will be discussed in relation to their connection to task engagement.

White (1959) first introduced the phrase "sense of competence" to represent the subjective feelings that individuals develop as a consequence of past successes or failures. According to White there are two types of

competence. There is competence motivation (overall drive), as well as competence in its more familiar sense of achieved capacity, what might be called situational competence. Both types of competence may be important to understanding how motivation influences sustained attention.

Competence is an important component of many theories of intrinsic motivation, where feelings of competence or a sense of efficacy are considered directly responsible for task interest (Bandura, 1982; Deci, 1975; White, 1959). Within these motivational theories, competence often implies, as mentioned, feelings of competence, or what some have called perceived competence, rather than competence as ability. According to Bandura, when the outcome of performance evaluation is positive, the resulting feelings of satisfaction foster intrinsic interests.

Research on intrinsic motivation has shown a relation between actual competence and persistence. Redding, Morgan, and Harmon (1988) found task persistence (sustained attention) was greatest for moderately challenging tasks, followed by easy tasks, and least persistence was seen for difficult tasks in children from one to three years of age. In addition, Lewis, Alessandri, and Sullivan (1992) replicated this finding when they found children show greatest persistence when tasks are moderately difficult.

Perceived competence is another construct that describes an individual's conception of their competence. The perception of competence

may or may not be accurate, but perceived competence appears to be an important concept in understanding motivation to engage in activities. Deci and Ryan (1985) describe three important situational factors in enhancing perceived competence including the presence of a sense of optimal challenge for the individual, immediate feedback on performance, and feedback that is informational, not controlling. Several studies have found perceived competence correlated with interest and intrinsic motivation (Grolnick, Ryan, & Deci, 1991; Ryan & Grolnick, 1986).

Studies on optimal challenge would also seem to support the relation between perceived competence and persistence since success at a challenging task would normally lead to feelings of competence. Deci and Ryan (1985) propose that individuals who engage in optimally challenging activities in the absence of control or contingency (when also accompanied by a sense of social relatedness) will experience intrinsic motivation.

Danner and Lonky (1982) looked at engagement in their research on intrinsic motivation, optimal challenge, and choice. They found children from 4 to 10 years of age were most likely to pick a task just beyond their ability level (challenge) and these children spent the greatest amount of their available time on tasks (sustained attention) one step ahead of their skill level.

There are several potential limitations in the procedures of this study in

considering factors that influence engagement. First, the tasks in Danner and Lonky's study were qualitatively different, involving a developmental gradation from a sorting task, a classifying task, and combinatorial reasoning task. It is unclear how their results might predict activity engagement where a single task varies in its difficulty. There were also some limitations on children's choices of activities in the Danner and Lonky study. According to the journal article, children were asked to.... "try to work at the center that was just right for them"(p. 1045) and not really given free choice. In addition, children were further requested to do only one kind of task at each center.

Danner and Lonky's study also provides no information on what other activities children may have pursued during the time span of observation or in what order they may have chosen the tasks they worked on. Their results omit potentially valuable information about what took place during engagement. Examining the process that takes place during engagement may be especially important to understanding what takes place during task engagement, how engagement may be self-regulated by children, and how sustained attention is subsequently influenced by mechanisms within engagement.

Csikszentmihalyi (1975) introduced the concept of flow to describe the experience that take place when individuals are optimally challenged. Flow refers to a state of deep concentration where individuals report a loss of self-

consciousness. In a newer book (1990), he describes flow as an optimal experience where individuals experience a “feeling of a sense of exhilaration, deep sense of enjoyment” (p. 3) and “a state in which people are so involved in an activity that nothing else seems to matter (p. 4).

While flow is proposed by Csikszentmihalyi (1975, 1990) to represent an experience or feeling (as noted above) it is also proposed to result from a relation between an individual’s skills and task requirements. In order to investigate the experience of flow in daily life, Csikszentmihalyi (1990) has operationalized flow as an experience that occurs when there is a balance of challenge and skills with the skills required for the task beyond the ability level of the participant, but not beyond their capability. This particular conception of flow was used as an operational definition in several research articles, including Csikszentmihalyi and Nakamura (1989) and Massimini, Csikszentmihalyi, and Carli (1987) and appears to contradict earlier work on flow experiences where they were conceived as being rare and only experienced by a few individuals. In fact, Csikszentmihalyi (1990) has more recently discussed what he terms “extremely complex flow experiences” as those which represent the highest levels of challenges, fewer than 1 percent of responses. These extreme flow experiences seem closer to what many people consider the essence of Csikszentmihalyi’s work on flow and supports that Csikszentmihalyi’s conception of flow may have evolved to represent a

range of more typical experiences and challenge.

Other studies have considered the experience of feelings during task participation to support the importance of challenge to positive experience. In studies of task difficulty and feelings associated with challenge, Harter (1980) proposed the expression “effectance motivation” to describe motives to produce effects on and deal effectively with the environment. According to Harter and Zigler (1974), effectance motivation includes: the use of different responses on subsequent encounters with a problem that can be solved in different ways, preference for novel stimuli, preference for having actual competence acknowledged rather than being given tangible rewards, and preference for challenging tasks.

According to Harter, effectance motivation is weakened by the failure of mastery attempts. Task difficulty also influences motivation. Harter (1974, 1978) found that maximum gratification (pleasure) is derived from the active solution of challenging problems in elementary school-aged children, whereas easy problems resulted in little pleasure. Harter and Zigler (1974) also found similar results with first and second graders.

Research on mastery motivation is another way competence has been studied. Mastery motivation is the study of exploration and persistence with the goal of gaining competence (Messer, 1993). In fact, according to Messer, many researchers equate task persistence to mastery motivation. Ruff

(1990) proposes that measures of mastery motivation and sustained attention are measuring similar characteristics. Studies of mastery motivation would appear to support the strong association of competence and task persistence (sustained attention). In a study of young children (30 months of age), Messer, Rachford, McCarthy, and Yarrow (1987) found task engagement was a valid method of assessing mastery motivation. According to the researchers, even in this young age group there were signs of organization in their play that suggest self-regulatory mechanisms displayed in a motive to master and acquire information.

Bandura (1982) proposes the concept of self-efficacy to explain how self-perceptions of efficacy may influence thought patterns, actions, and emotional arousal. In his theory, self-referent thought is believed to mediate the relation between knowledge and action, along with initiation and regulation of activity within the environment. This regulation of activity is partly governed by judgment of what Bandura calls “operative capabilities” (p. 122). This concept would appear to be similar to perceived competence.

Bandura proposes that self-efficacy, whether accurate or not, influences choice of activities, choice of environmental settings, and determines how much effort people expend and how long they persist. He reviews studies showing that a self-efficacy mechanism may help account for behavior in a wide variety of situations including: changes in coping, level of

physiologic stimulus reactions, self-regulation of refractory behaviors, resignation and despondency to failure experiences, achievement efforts, growth of intrinsic interest, and career pursuits.

If we accept that children's engagement and sustained attention may be influenced by motivation through feelings of competence, then an explanatory theory that accounts for this result would be useful. A proposed connection accounting for how sustained attention is influenced by motivational variables requires first a discussion of arousal.

1.4 Arousal

The cognitive construct of arousal that appears to theoretically connect motivation and task engagement. According to Ruff and Rothbart (1996), arousal is a complex construct with multiple definitions. Eysenck (1982) distinguishes between physiologic definitions of arousal which include metabolic activity in tissues and the psychological definitions of arousal where a wide variety of factors, including incentives, feedback, ego threat, intense noise, time of day, sleep deprivation, introversion-extroversion, and stimulant/depressant drug effects may influence the activation of behavior.

According to Hebb (1958), arousal has the essential characteristics of a drive, it does not provide the energy for response, but it determines whether the energy will be available, without determining how it will be directed.

Some theorists have acknowledged a relation between arousal and attention

(while others consider it an aspect of attention, see Korkiman and Peltomaa, 1991). For example, Pribam and McGuiness (1975) propose arousal as an important mechanism for the regulation of attention. They see arousal as responding to changes in intensity, timing, or figure-ground relations of sensory input, factors that bear a resemblance to the collative variables proposed to influence interest by Berlyne (1960).

According to McClelland and colleagues (McClelland, Atkinson, Clark, & Lowell, 1953) arousal may also possess an affective valence (associated mood). This valence is the result of a discrepancy during the process of engagement between the stimulus input and existing knowledge or capability. Small discrepancies produce pleasant affect and a tendency to approach, and large ones produce unpleasantness and a tendency to avoidance. Young (1949, 1955) also acknowledges this positive/negative distribution for affective aspects of arousal. He proposes that organisms behave to maximize positive affective arousal (delight and enjoyment) and to minimize negative arousal (distress).

Lang, Bradley, and Cuthbert (1997) also propose two types of arousal, what they call appetitive (approach with the anticipation of something positive) and aversive (avoid with the anticipation of something negative). They found evidence to support this view when they recorded arousal and reactions to pictures. Subjects were shown two types of pictures, pleasant

and highly aversive. The results indicate similar levels of heightened arousal from each type of picture, but subjects displayed longer attention to pleasant pictures and much shorter attention to highly aversive pictures. This suggests arousal alone is not sufficient to maintain engagement, arousal must be positive in nature.

Arousal may also be influenced by affect. In a series of studies, Berlyne (1960, 1963) found arousal is influenced by affective variables (as well as intensity variables). Berlyne and Lewis (1963) also found higher levels of arousal in the presence of higher amounts of novelty and complexity suggesting a relation between collative variables and arousal.

Arousal, as mentioned in the previous section on vigilance, has also been used to explain the decrement in attention encountered in vigilance research. According to Davies and Pasuramon (1982), this decrement is due to a progressive reduction in arousal of the central nervous system that takes place during task performance which they attribute mainly to the “monotonous” nature of vigilance tasks. This finding would suggest initial arousal may decline in the absence of sufficient positive experience with task engagement.

The possibility that arousal may have an affective valence and that valence may be influenced by characteristics of stimuli is important to understanding influences on sustained attention. Eysenck (1982) proposes

that active involvement in task performance can influence arousal in positive ways. (He believes that in addition to the effects of arousal on performance, there is an equally important effect of task performance on arousal and thus that engagement is a transactional process). Feelings of competence that accompany task performance may lead to increased arousal and sustained attention during engagement in tasks. Berlyne (1960) acknowledges the importance of appropriate levels of arousal for attention. He proposes that the tasks most challenging are those which produce the right amount of arousal (enough to facilitate task engagement, but not lead to overstimulation).

1.41 Motivation and arousal

Motivation may be important to sustained attention through its relation to arousal, yet according to Deci and colleagues (Deci, Vallerand, Pelletier, & Ryan, 1991) “most current theories of motivation.....fail to address the issue of the energization of behavior” (p. 327). These authors propose the existence of basic psychological needs that are inherent in human life (competence, autonomy, and relatedness). It is entirely possible that in situations where these needs are being successfully pursued, arousal may be high and positively valenced. This would allow individuals maximum potential for taking advantage of such situations. Engaging in a task within ability level with accompanying feelings of competence may contribute to task

persistence (sustained attention) by stimulating arousal and lending a positive valence to that arousal.

1.42 Competence, arousal, and task difficulty

An individual may encounter various levels of task difficulty in free choice situations or choose to engage at various levels of complexity with objects in the environment. The relation between the knowledge and skills required of this participation (actual task difficulty relative to capability of the individual) and the person's actual abilities will have an ongoing influence on the experience of the engagement. It is proposed that level of task difficulty interacts with levels of actual competence ability to influence feelings of competence, arousal levels, and subsequent attention.

There is some experimental support for this proposed connection. For example, Berlyne and Lewis (1963) used galvanic skin response to measure changes in arousal during stimulus exposure. In the presence of increased arousal longer episodes of exploration took place. They found heightened arousal increased the duration of exploration in a button-pressing task that triggered pictures to be shown on a screen. They conclude that arousal is affected by stimulus properties that attract exploratory behavior. In a more recent study (Ridgeway & Waters, 1987) studied preschool children's arousal

(measured by heart rate) and task persistence. Results suggest higher levels of arousal accompany increased task persistence.

There is also evidence that negative affect (associated with negative arousal) from mood induction correlates with poorer task persistence in preschool children (Fabes, Eisenberg, Fultz, & Miller, 1988). In addition, in situations where children are externally motivated for tasks previously experienced as intrinsic (where there may be negative-valenced arousal over the lack of free choice remembered from a previous encounter), a decrease in time spent on the same activity (task persistence) was noted in preschool children (Loveland & Olley, 1979).

1.43 Additional evidence

There is evidence from other types of studies that sustained attention may be related to arousal and competence. Breznitz and Friedman (1988) found that depressed mothers and their children focused attention on play objects for shorter durations. Depressed mothers initiated attention to play objects and attempted to interact with their children using these objects as often as nondepressed mothers, yet their attention terminated sooner (interestingly, their children seemed to imitate this behavior). The presence of depression has been associated with low arousal and low feelings of competence (Eysenck, 1982; Burack & Enns, 1996). The results of this study appear to support the importance of what takes place during engagement to

the persistence of that engagement. In the case of this study, it appears that the depressed mothers tried to interact with their children using the toys provided, but internal problems resulting from their depression may have interfered with their ability to maintain these interactions.

Another type of evidence may come from clinical work with ADHD children. Sustained attention is a particular problem for these children (Barkley, 1990; Ruff & Rothbart, 1996) and the treatment of choice is often either a stimulant or an antidepressant medication, suggesting that increases in arousal induced through medications may lead to improvements in attention.

1.50 Self-regulation

Discussion to this point has focused on how individuals may seek positive experiences when they engage in activities. The basis of these positive experiences may come from several sources including novelty, challenge, etc. There is some evidence from the study of self-regulation that individuals may engage in behaviors that maintain or augment task engagement in order to optimize positive experience and prolong it.

According to Kopp (1982), self-regulation has multiple definitions and has been studied in a variety of ways. Kopp defines self-regulation as the ability to comply with requests and monitor behavior accordingly (Kopp, 1982). This definition appears too narrow for current purposes and carries a

connotation of external control. Other definitions do not appear to have this limitation. For example, self-regulation has also been defined as the capacity to modulate arousal to meet the demand of different tasks or situations (Luria, 1973; Passler, Isaac, & Hynd, 1985). Diaz, Neal, and Amaya-Williams (1987) define self-regulation as “the capacity to plan, guide, and monitorbehavior from within and flexibly according to changing circumstances” (p. 130). They attempt to distinguish between situations where children are regulating their behavior in relation to their own internal control versus external control and proposed a difference between self-control and self-regulation. In their conceptualization, self-control is considered to be compliance with a command or request in the absence of an authority figure, while self-regulation is a self-formulated plan of action which guides a child’s engagement. Self-regulated behavior is initiated by a plan or goal that is formulated by the person and flexibly adjusted as necessary during task engagement. This is in contrast to self-controlled behavior which may lead to more rigid behavior.

Trudewind (1991) makes a similar distinction concerning locus of motivation when she proposes the term self-direction to describe the process of self-regulation of behavior which takes place in situations where there are no standards. She further proposes that where there are no standards of behavior and an individual can self-direct, the individual is likely to feel

intrinsically motivated.

Several theorists (Kopp, 1982; Ruff & Rothbart, 1996) have proposed an important antecedent of self-regulation arises from caregiver-infant interactions that begin with the modulation of arousal states . Adults are described as increasing or decreasing the intensity of the stimulus they provide to a child in a variety of ways including increasing or decreasing auditory and visual stimulation. One example includes the use of color and sound to attract and maintain the attention of an infant. Another example might include removing an infant that expresses upset from possible overstimulation from either auditory, visual or other possible sources of sensory stimulation.

The purpose of this adult-initiated modulation appears to be the optimization of sensory input to help the infant gain maximum information while avoiding overstimulation. Theoretically this adult-mediated modulation of arousal allows infants to experience optimum states for acquiring sensory information and with development children are eventually able to take over this function for themselves. According to both Kopp (1982) and Diaz (Diaz, et al., 1987), the ability to self-regulate emerges in the preschool years.

Scheier and Carver (1988) have proposed a theory of how self-regulation may operate. According to these authors, self-regulation operates in a manner similar to a feedback control system. They propose that the

purpose of this feedback control process is not to produce behavior, rather, its function is to create and maintain a perception of present behavior that corresponds to an internal value.

Bandura (1996) has proposed a theory of the self-regulation of motivational states. According to Bandura, both anticipatory and self-reactive mechanisms operate to self-regulate motivational states. These mechanisms include anticipation of outcomes, setting of goals, and selection of a course of action which will lead to a valued result. Level of motivation can be measured in terms of the choice of courses of action and the intensity and persistence of effort. Bandura's theory would support the existence of self-regulatory practices that maintain motivation through decisions made within an activity. This self-regulation of motivation may also contribute to persistence of effort and thus task persistence and sustained attention.

1.60 Task difficulty

Considering the relation of task difficulty to motivation for engagement, task difficulty appear to effect an individual's choice of activity, as well as the duration of their engagement with it. There is a long tradition for the use of variations in task difficulty to examine motivational issues (as reviewed in many of the studies earlier in this paper).

Research evidence suggests that children are aware of differences in task

difficulty and these differences influence their thinking and subsequent behavior. Heckhausen (1981) found differences in difficulty of tasks become apparent in children between 24 and 36 months of age. According to Stipek (1992) tasks perceived by individuals as difficult in relation to ability may lead to lower expectations of success, perceptions of control, and perceptions of self-efficacy. Nicholls and Miller (1984) found success on easy tasks did not promote feelings of competence, only tasks of intermediate difficulty appear to lead to feelings of competence.

Reactivity to failure experiences may also be a developing capacity. Stipek (Stipek, Recchia, & McClintic, 1992) found she was unable to expose children younger than two years of age to a failure experience (in a study of two to five year olds, intended to be a study of 18 months to five years). Children under two years of age simply restructured the task. However, she found as children increased in age, they were increasingly likely to reduce their attention in the failure portion of her research, suggesting a developing sensitivity to failure. However, no age-related changes in results were found for the success condition.

Failure may also lead to anxiety in some children. According to Stevenson and Hill (Stevenson & Hill, 1965) anxiety over performance was a significant predictor of performance for 7 year olds in a marble dropping task. In another study with the same age group, Hill (1967) found both reported

anxiety and anxiety from previous failure served to influence subsequent performance.

Evidence from research on mastery motivation reviewed earlier suggests that preschool children (and even younger) actively seek challenge. According to Heckhausen (1982) children by preschool age are aware of differences in task difficulty, and there is some evidence that children in this age group (and slightly older) avoid the experience of failure.

More often studies of task difficulty have focused in terms of task choice or persistence, but some have dealt with task participation. For example, Higgins and Turnure (1984) found that children look away from tasks more often after they have learned them, suggesting that easier tasks do not promote engagement. Imai, Anderson, Wilkinson, and Yi (1992) found that sustained attention declines as the difficulty of stories increased in reading class in a group of second and third graders, suggesting that increased difficulty of task at some point does not facilitate engagement.

In addition the children's reaction to task difficulty through their choice of activities and the duration of those activities, it is proposed that individuals may vary the difficulty of their participation within a task (when such choices are available) in order to encourage their own further participation. Although few studies have examined the process of task engagement for such evidence, goals chosen within task participation appear to influence

engagement. According to Bandura and others (1981; Manderlink & Harachiewiez, 1984; Schunk, 1990) intermediate goals promote engagement and the presence of feelings of developing mastery.

1.70 Proposed Study

To date, studies that have considered sustained attention in young children in nonlaboratory settings have presented contradictory findings. Several studies indicate that sustained attention increases with age (Breznitz & Friedman, 1988; Levy, 1979; Ruff & Lawson, 1990) thus supporting a capacity model, while other studies find that sustained attention varies due to task characteristics (Levin & Anderson, 1976; Moyer & Gilmore, 1955; Ruff, Capozolli, & Weissberg, 1998). This contradiction raises the question of whether a capacity model for sustained attention is an accurate depiction of behavior and if a capacity model is not accurate in describing children's sustained attention, then there is clearly a need for a theory that includes various cognitive and motivational influences on this process.

There is another problem with existing studies of sustained attention in young children (see for example Levy, 1979; Ruff et al., 1998). They fail to differentiate between tasks that are internally versus externally motivated. Studies in motivation, particularly intrinsic motivation (see Deci & Ryan, 1985 for a review of this work) have indicated a clear difference in individual's

tendencies to either choose or engage over periods of time with tasks based on their locus of motivation for task completion. This has been particularly demonstrated with tasks where children are internally motivated for engagement and then their motivation is changed through some type of reward system and future engagement with these tasks is negatively affected (see for example, Fabes, 1987).

Studies such as Levy's (1979) where repetitive, computerized tasks are used to measure sustained attention in young children may require external motivation for completion. Ruff and Rothbart (1996) propose that when children are externally motivated, a portion of the quality of their sustained attention may be based on their ability to apply self-control and make effortful engagement. Results of Levy's study and similar studies may simply be showing an improvement in this type of self-control with age. Results of these studies may begin to explain more about how sustained attention varies due to motivational differences, but only if their results are interpreted in terms of the underlying differences in source of motivation.

There is clearly a need for research that examines sustained attention in young children with these issues in mind. In order to properly investigate sustained attention and changes related to age it is necessary to control the type of motivation which will influence children's behavior by controlling the overall motivational set. This study will attempt to do that by setting up the

experimental task to encourage internal motivation.

In order to adequately investigate sustained attention it proposed that it is necessary to consider competence. One alternative explanation for studies that find sustained attention increasing with age is that the children are simply more competent with the task. The results of these studies may be reflecting increased knowledge and skills with the activity. Increased skill may alone increase engagement and sustained attention through providing children with more knowledge of tasks. This increased knowledge may allow more and different responses to tasks. Varying task difficulty in this research project will allow an investigation of sustained attention at various levels of difficulty in relation to the child's own capabilities. Allowing children a free choice period where they may choose task difficulty will also allow an investigation of characteristics of more natural situations where children have autonomy in determining the complexity of their responses.

This study will go further than simply considering the influence of cognition and motivation as static contributors to sustained attention. Sustained attention takes place over a period of time. In order to understand sustained attention which results from a process of engagement it may be necessary to look more closely at what takes place within that process. Sansone and Harackiewicz (1996) propose that individuals may employ self-regulatory strategies during task engagement in order to optimize the

pleasurable experiences of that task participation. Sansone (Sansone, Weir, Harpster, & Morgan, 1992; Sansone, Wiebe, & Morgan, 1999) has found some support for the existence of such processes in examining strategies employed by individuals during boring tasks which appear to improve task persistence.

This project will extend this work by looking for such strategies in young children in an internally motivated situation. There is some evidence from previous studies (Renninger, 1992; Ruff & Lawson, 1990) that sustained attention in free play situations is promoted when children possess and employ more and different responses with objects. This project will investigate the possibility that the use of self-regulatory strategies (in the presence of freedom of choice and choice of behaviors at various levels of difficulty) may promote engagement and subsequent sustained attention. Children's decision making will be examined within task engagement in order to determine if their use contributes to increased task persistence and associated sustained attention. Little research has focused on such contributors to sustained attention.

In this study sustained attention will be investigated by giving young children maze puzzles to complete. Maze puzzles have been chosen for this study for several reasons. According to Krikovian and Bartok (1998), mazes are nonverbal measures of metacognitive processes and general adaptive

capacity. Mazes can be constructed at various levels of difficulty based on number of decision points (intersections where one turn leads to the solution and the other turn leads to a dead end), length of line necessary for completion, and visual complexity, and these levels can be matched to the ability of children. Mazes have been used with children as young as 20 months of age (Dichter-Blancher, Busch-Rossnagel, & Knauf-Jensen, 1997) and mazes with decision points in children as young as 36 months of age (Brockman, 1977).

The preschool age has been chosen for this study for several reasons. These years are a time of rapid change in cognitive ability, including attention. It is also at this age that the earliest educational experiences begin to occur for most children. The creation and continued expansion of universal preschool programs creates an increased need for knowledge of developmentally appropriate practices for children in this age group. It may not be advisable to simply “push down” what is done with older children in regular schools. Another important reason for utilizing the preschool age group is motivational considerations. According to Veroff (1969), children move from motivation that is primarily internal and intrinsic in nature to a social comparison motivation after entering school, thus changing or obscuring normal processes. .

1.12 Implications of results

The results of this study may yield important information to advance the study of sustained attention. Several researchers have suggested that processes underlying attention to a location in anticipation of a low-information signal (vigilance research paradigm) may be different from the processes operating while attending to ongoing events for the purpose of gathering information (Posner & Peterson, 1990; Posner & Rothbart, 1991; Ruff, et al., 1998). Considering the possible confounds of varying motivational sets (internal versus external) in research on age-related changes in sustained attention and the relative low number of studies in this area, there is a need for more research to understand how sustained attention is influenced by motivation and self-regulation. This study will in particular focus on activity within task participation as an important source of influence on the duration of that participation. This approach to understanding sustained attention may contribute much needed knowledge to the field.

This project may have implications for the field of motivation. The focus of this study will be examining the process of children's engagement with mazes of various difficulty levels. Much of motivation research, particularly in relation to task engagement, concerns an individual's choice of activities and less is known about behavior and choice within activities. It is these within-activity behaviors that may contribute to task persistence and sustained attention. Motivational theories may need to be developed,

expanded, or altered to explain process mechanisms.

For example, several lines of motivational research, including mastery motivation, optimal challenge, self-efficacy theory, and effectance motivation (discussed in section 1.33) are based on a drive for competence. All appear to support that individuals in a choice situation where several activities are available will tend to choose the activity which is somewhat challenging in relation to their capability. Once an activity is begun, it is less clear whether choices will correspond to this drive for competence. For example, when a child engages with a toy in a free play situation, will they choose the most challenging behavior in their repertoire for their first activity with this toy? If a child has chosen a somewhat challenging puzzle, will they then choose a challenging piece to fit in first, then follow it with the next most challenging, etc., until only easy pieces are left? Motivation theories based on a drive for competence may not be adequate in predicting behavior during the process of engagement, yet it is these behaviors within engagement that are proposed to facilitate that engagement and sustained attention.

The results of this study may also support the need for research work that considers both cognition and motivation. Human behavior is obviously the result of multiple processes, including cognition and motivation. In order to understand and predict human behavior it may be essential to acknowledge the contribution of both in theory and in research work. According to Eysenck (1982), there is not only a lack of acknowledgment of

motivational processes and their influence on attention, there is an equal lack of consideration for attention in books on motivation.

The results of this study may have important implications for fields other than psychology. The operation of attentional abilities may be particularly important for education. Attention has been identified as an essential cognitive process necessary for learning (Ruff & Rothbart, 1996, Simon, 1986) and successful participation in the educational process (Ashman & Schroeder, 1986). Several studies have found sustained attention-to-task to be an important predictor of achievement test scores (Cobb, 1972; Frederick & Walberg, 1980; Lahaderne, 1968; Meyers, Attwell, & Orpet, 1968). An epidemic of school children diagnosed with attentional problems and receiving medication as a solution adds to the importance of understanding attention in school contexts.

Information about how attention functions in educational settings may inform educators about methods to optimize classroom climates and practices. Since this study will look at preschool-aged children, results may be especially useful in designing preschool educational practices. Several types of educational programs exist for preschools. For example, Stipek (1991) has identified a continuum of programs in preschools with teacher-centered at one end and student-centered at the other. Stipek, Feiler, Daniels, and Milbern (1995) also found different motivational climates in their comparison of preschools. A variety of approaches to student learning also

exist in classrooms, educational tasks may be open-ended versus close-ended, or work may be individually-based versus project approaches to learning. If this study finds sustained attention is facilitated by certain motivational and self-regulatory mechanisms, then some classroom programs and climates may provide these opportunities better than others.

A better understanding of how motivation and self-regulation influences children's work at various difficulty levels and subsequent influences on sustained attention will not only allow educators to more effectively design classroom activity that will improve learning, there may also be a decrease in the influence of distractions, and improved behavior as children attend more reliably.

If we accept that attention is a process that is influenced by the environment and that it develops across time with the assistance of environmental conditions, then there is much that educators and parents can do to foster ongoing attention in children and promote the development of children's emerging ability to manage their own attention (French & Song, 1998). The results of this research when disseminated to educators would help to move the conceptualization of attention away from that of a fixed quality structure within a child to a more dynamic view of attention as a process responsive to environmental influence both contextually and developmentally.

1.80 Pilot Data

In order to test the maze tasks and procedure, piloting was conducted with 10 children between the ages of 52 to 63 months of age. The main purpose of the piloting procedure was to refine maze construction and the associated procedure for presenting mazes to the children. The results of piloting data are reported here to support the viability of the maze task and the procedure for administering it.

Mazes for the proposed study were constructed to represent increasing levels of difficulty for young children. Common features of all mazes include that all mazes begin at the bottom of the page and solution points (end of the maze) are at the top of the page. Mazes increase in difficulty in several ways: the path to the correct solution becomes longer, mazes contain more decision points (places where the path separates into two directions and the child must choose which way to proceed), and paths share their “walls” (the lines that define the edges of the paths in the maze) with other paths at higher difficulty levels (See Appendix A for a more complete description of maze construction).

Piloting consisted of an assessment and training phase where each child’s ability level was determined, a no choice phase where children were given the opportunity to work as long as they wished on mazes at one level of difficulty, and a choice phase where children were given the opportunity to freely choose among three levels of maze difficulty as they worked on maze solutions.

The assessment phase of the piloting procedure was used to determine the child's ability level within the hierarchy of levels of difficulty in the mazes created for this study. The assessed level of maze ability for each individual child was then used to designate which mazes would be considered easier, harder, and at ability level for the remainder of the study. This designation was accomplished by taking the actual maze level that was equal to a child's capability and considering this level, the medium level of difficulty for that child (M level). In order to keep task difficulty relative to each individual child's ability, mazes two levels below the child's level of ability were then designated as the easier level (E level) and mazes two levels above the level of ability were then designated as the harder level (H level).

For example, in the group of children piloted, two children tested with an ability level which contained three decision points. For these two children, their E level became a maze with zero decision points (two levels below a three decision point maze) and their H level became mazes with seven decision points (two levels above a three decision point maze). Six children were found to have an ability level with maze completion of six decision points. Their E level mazes then contained one decision point and their H level mazes contained eight decision points. (An examination of the chart of maze construction features contained in Appendix A may help clarify this procedure).

A No Choice Phase was completed with the children. During this

phase each child was given an opportunity to work as long as they would like on their E level mazes, their M level mazes, and their H level mazes, separately. The number of mazes completed in each of the session varied depending on both the difficulty (easier mazes by their design have shorter lines to their solution and thus are completed more quickly than more difficult mazes) and the skill of the child completing the mazes. As mentioned previously, children were free to engage as little or as long as they wished with the mazes provided in each portion of the study. Time of engagement was recorded as an indication of sustained attention to the task. The results of these times along with number of mazes completed and the age in months of each child are included in Table 1.2.

Children were also given a Choice Phase where they were given three piles of mazes (one pile at their E level, one pile at their M level and one pile at their H level). They were given an opportunity to choose any mazes they wished to work on, in any order they chose, and to work as long as they would like on these mazes. Again the length of engagement was recorded.

Results of these lengths of engagement are also presented in Table 1.2.

Table 1.2

Pilot Results for Sustained Attention in No Choice versus Choice Phases

Child/ Sex	No Choice Easier Level	No Choice Medium Level	No Choice Harder Level	Choice Phase
Girl 1	5:45(13)*	2:27(8)	No Choice Refused	14:53(29)
Girl 2	5:15 (13)	2:46 (?)	0:30 (1)	6:35(13)

Girl 3	4:52 (13)	4:25 (6)	1:50 (2)	10:30 (12)
Boy 1	5:41 (9)	2:00 (2)	3:58 (6)	20:00 (31)
Boy 2	-----	-----	-----	14:25 (13)
Boy 3	6:06 (13)	2:35 (4)	Refused	6:00 (10)
Boy 4	3:15 (13)	4:45 (15)	5:27 (6)	15:00 (17)

*Number of mazes completed is in parentheses.

Results indicate that children chose to engaged far longer when doing mazes in the choice phase versus any of the levels of difficulty in the No Choice phase. The mean length of sustained attention for the Choice Phase was 14.45 (14 minutes 27 seconds, SD=5.07). The means and standard deviations for the individual levels of difficulty are as follows: E level, mean was 5.15 (SD=1.02), for M level, mean was 3.34 (SD=1.41), and H level, mean was 1.97 (SD=2.30).

Clearly children’s engagement and subsequent sustained attention is considerably better for most children when they are provided the opportunity to work at all three levels of difficulty, rather than at any one level of difficulty.

An examination of the order of their choices is useful in understanding why choice has this effect. Results are presented in Table 1.3.

Table 1.3

Pilot Results for order of choice of task difficulty in choice phase

Child/Gender - Order of Choice (E=easier, M=ability, H=harder levels)*

Girl 1 - E,E,E,E,E,E,E,E,E,E,E,E,M,M,M,E,H,H,H-,H,E,E,E,E,E,E,E

Girl 2 - E,E,E,E,E,M,M,H-,E,H-,M,M,H-

Girl 3 - E,M,H,M,M,E,E,E,M,E,E,E

Boy 1 -E,M,M,E,M,M,E,M,E,M,E,M,H,E,H,M,E,H,M,E,H,H,H,M,M,E,HH,H-,H-

Boy 2 - H-,M,E,M,E,H-,H-,H,M,E,H-,E,M

Boy 3 - E,H-,E,E,M,M,E,E,E,M

Boy 4 - order unavailable, number of choices 14-E, 1-M, 2-H

*All mazes at the E and M level were always correctly completed, mazes at the H level were completed correctly unless followed by a “-“ sign.

Pilot results for activity during the maze task seem to show a trend for children to vary their choices. Choices, however, do not appear to be entirely random. Examination of results show several trends. Six of the children first choose mazes at their E levels before attempting more difficult work.

Beginning a relatively new task with easier, rather than more difficult work is evidence of self-regulation and in the presence of a fairly novel task, children may have simply preferred mazes with fewer decision points. Evidence has shown that novices may not self-regulate immediately on new problems (Bransford, Nitsch, & Franks, 1977). Brown and DeLoache (1978) propose that self-regulation becomes more frequent and effective with practice, although they admit there is little research evidence to support this. Most children when they picked a second level of difficulty after completing easier mazes, picked the M level (medium level) to attempt after spending some time working at the easier level. Another observation concerns the selection of H level (harder mazes). Examinations of pilot results show that most

children chose very few H or harder level mazes to attempt in relation to the

number of E or M level mazes. .

Examination of results also suggest some variations in levels chosen. One possibility is that children might be basing their decisions, at least in part, on their previous maze performance. Two factors may be important in determining how children evaluate the outcome of their previous performance. One factor is evidence of successful performance and the factor represents evidence of failure in performance. It is theorized that successful factors would include correct completion of the previous maze and few or no wrong turns in completion of the previous maze. Evidence of failure might include inability to complete a maze or taking wrong turns at decision points while completing the previous maze.

Further in the presence of evidence of prior success, children will feel competent to attempt more challenge and in the presence of evidence of prior failure, children will feel less competent and seek to avoid more failure by choosing less difficulty mazes. Children often had difficulty in finishing the mazes at their H level (only about half of the H level mazes attempted were correctly completed, although there was some variability in individual children in how successful they were when they attempted the H level).

Further piloting was conducted to investigate whether factors such as making the correct choice at a decision point or making wrong turns might also give children positive or negative performance feedback that would influence their subsequent decision. Results of this piloting is presented in

Table 1.4.

Table 1.4

Pilot results of maze choice and wrong turns at decision points during choice phase

Child/Gender Order of Choice with number of wrong turns*

Girl 1	E(0W), M(0W), H(2W), E(0W), H-, M(0W), E(0W), E(0W), H-, E(0W)
Girl 2	E(0W), M(0W), M(1W), E(0W), M(1W), E(0W), E(0W), M(1W)
Boy 2	H(1W), H(1W), E(0W), H(2W), M(0W), E(0W), H(2W), H(0W), H(4W), H(0W), H(2W)

*W=wrong turn, number of wrong turns is in parentheses.

Results were examined for two trends, evidence of success predicting choices of increased difficulty and evidence of failure predicting choices of decreased difficulty. It has been hypothesized that evidence of previous success would foster children's decisions to pursue further success.

Examination of results show that of the 27 maze choice decisions reported in Table 1.4, nine of those decisions involved the child choosing to increase the level of difficulty of their next choice of maze. In all nine of these decisions,

the previous maze had been correctly completed with no wrong turns during completion. Examination of these results also show there were nine decisions made that involved choosing a lower level of difficulty for the next maze. In seven of nine of these decisions, the previous maze had either been unsuccessfully completed or the child had made wrong turns at decision points in completing the maze. Examination of decisions to stay at the same level were less predictable to analyze. There were eight incidences where children chose to work again at the same level of maze as the previous choice. In five of these decision, the previous maze had been correctly completed with no wrong turns at decision points. In three of these decisions, there were wrong turns. All three of the decisions to stay at the same level despite wrong turns were made by the same child. It is possible that there are individual differences in children that may contribute to their behavior when they choose to stay at the same level of difficulty.

Pilot results suggest a good predictor of children's decisions to seek a higher level of difficulty is a previous performance with no errors (no wrong turns at decision points). A good predictor of children's decisions to seek a lower level of difficulty is previous performance with failure (inability to complete a maze) or errors (wrong turns at decision points). These patterns will be further investigated in the proposed study.

There is another interesting set of observations which can be made on

the pilot data that lend support to the legitimacy of the ranked levels of difficulty. Of the 26 mazes chosen for engagement in this section of the pilot data, 11 were at the E level and all mazes at the E level were always completed correctly and without any wrong turns at decision points. Six mazes were completed at the M level and three of these were completed with no wrong turns and three were completed with wrong turns. Lastly, there were 11 mazes completed at the H level. Of these mazes, two were unable to be completed, seven were completed with wrong turns at decision points, and only two were completed with no wrong turns. In terms of children's performance on completing these mazes, there appears to be good evidence that the rankings of difficulty of easier, medium, and harder are valid.

One implication of examining the results of pilot data is the observation the children did not tend to always chose what many would consider the most challenging maze or the most likely maze to lead to mastery motivation. Overall more choices were made at the easier level or E level. This may seem a contradiction to previous research, particularly theory on optimal challenge or mastery motivation. One possible explanation is that a great deal of motivational research, much of it reviewed early in the sections on competence, has focused on the overall selection of an activity based on its difficulty in relation to some type of pretesting. It is possible that choices within an activity may not be as well predicted by some of these motivational

theories.

However, there is another possible explanation for the lack of support of piloting results for motivational theories based on drive for competence, such as optimal challenge theories or mastery motivation theories. The problem may lie in the way these theories have been applied to tasks. Many studies that have examined these issues have pretested children's abilities at a test and then defined a level of difficulty as challenging. Perhaps optimal challenge or mastery motivation can not be adequately defined in terms of a static relation between a person's ability and the skills needed to complete a task. This definition may only be adequate when the prediction concerns the selection of an activity.

Engagement (as has been discussed previously) is a process and it is possible that there are moment to moment fluctuations in perceptions of competence in relation to ongoing performance. These perceptions of competence may then subsequently influence the ongoing definition of what might be optimally challenging or optimally lead to mastery motivation for that person. The importance of considering the process of engagement when examining results of engagement such as task persistence and sustained attention would appear to be essential for answering this type of question. Other possible explanations for these patterns of behavior may exist as well. This study will only begin to look at some of these issues.

1.90 Summary

There is confusion in research on sustained attention particularly concerning whether a capacity model is applicable to behavior in normal settings. The preceding review of theoretical and research literature on sustained attention and related concepts in the field of motivation, particularly in relation to competence has demonstrated the existence of confusion in current conceptualizations of age-related changes in sustained attention. This study will attempt to clarify the relation between age and sustained attention and extend research by Ruff and her colleagues (1998) who found variations in sustained attentional ability related to task characteristics. According to these authors, these differences in sustained attention to different tasks may be the result of different motivations interacting with different contexts. What they fail to acknowledge, however, is the changing nature of motivation during the process of engagement.

The purpose of this study is to investigate sustained attention and motivation during the process of engagement in order to examine how self-regulation may influence this process. Motivational research results reviewed strongly suggest that task persistence and subsequent sustained attention is influenced by concepts related to competence. Therefore, sustained attention is investigated in relation to varying levels of task difficulty. In addition, children will be given a free choice period where they may choose to

work on any level of maze. In addition, the influence of choice of task difficulty of sustained attention is examined , particularly in terms of the self-regulation of choice.

1.91 Hypotheses

This research is based on several propositions. The first of these is that sustained attention is strongly related to behavior described in research studies as task engagement, task persistence, or time-on-task. The significance of this proposition is that it unites the psychological literature on motivational concepts such as task persistence with the cognitive-based literature on sustained attention.

The second proposition is that in order to understand sustained attention which results from the process of task engagement, it is necessary to examine this engagement. A great deal of motivational literature has focused on how motivation influences the choice of an activity for engagement. Much less is known about the factors that influence choices within an activity, yet these choices may be very important in determining the quality and duration of engagement and thus sustained attention.

A third proposition is that it is essential to consider motivational, as well as cognitive processes in understanding engagement and sustained

attention. The significance of this proposition is that prior work on sustained attention has failed to investigate all potential influences on sustained attention, such as motivation and self-regulation. This failure to account for other influences may limit the design of interventions to promote sustained attention or the development of applications that require sustained attention.

The fourth proposition is that sustained attention is influenced by aspects of tasks and objects that interact with children's skill level at a task. Skill level interacts with task requirements in two ways. The first way is direct.

It is proposed that children will sustain their attention longer when tasks are close to their ability level, not easier or harder¹. This proposal is based on research on the motivational construct of competence. Competence has been well supported as a motivational source that facilitates task persistence and competence should be greater when tasks are neither easier or harder than the skills children possess.

Skill at a task may also exert an indirect effect on engagement. During the course of task engagement, when children attempt certain aspects of a task, they may be more or less successful in their performance. In a situation where there is no overall performance goal (outside simple participation),

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The limited data from the pilot results do not support this proposition. However, there are only a small number of children in the pilot study and the results from this small group of children do not seem to provide a strong enough reason to contradict the existing literature on this issue.

children may be influenced by previous performance feedback to make choices concerning how they will implement their knowledge and skills in order to optimize the pleasure of their participation, particularly in terms of feeling competent. It is predicted that when children have an opportunity to vary their choices of task difficulty of mazes during task participation in relation to performance on the previous maze selected, their sustained attention will be improved over working on mazes at only one level of difficulty.

The significance of this fourth proposition is that it begins to expand on the possible influences on sustained attention beyond age-related capacities.

It will establish a relation between the match of individual's capabilities and task requirements that will allow better design of interventions and applications, particularly in the field of education. It will also establish the importance of considering process variables, particularly those related to motivation and self-regulation when attempting to understand sustained attention. This increased understanding will also foster more effective interventions and application development.

The three hypotheses and one exploratory question are as follows:

1. In a no-choice situation where children will work on just one level of maze difficulty, increased sustained attention will be predicted by increased skill level (ability level) and increased age. This hypotheses recreates some of the

previous research on sustained attention where children had only one task to engage in and differing levels of ability at that task may have influenced the results of these studies.

2. Sustained attention will be greater when children are able to self-regulate selection of task difficulty. This hypotheses will compare the results of the sustained attention shown by children in the Choice and No Choice Phases of the study.
3. In the Choice Phase of the study, when children may vary the level of maze difficulty they engage in, increased sustained attention will be predicted by increased skill level, increased age, and self-regulation. This hypotheses will test whether use of self-regulation in the Choice Phase makes an unique contribution to increased sustained attention.
4. The last question is exploratory. At the end of the study children were given an opportunity to choose one packet of mazes (which will contain only one level of difficulty, either E level, M level, or H level) to take home for further engagement. This procedure investigated whether children's choices of maze difficulty when set up as an activity choice would differ from choices within an activity. Several motivational studies reviewed earlier in this paper have indicated children tend to chose somewhat challenging material when given a choice of activities (See Section 1.33).

Chapter Two: Method

2.10 Sample

The sample for this study consisted of 35 preschool-aged children from 2 local day care centers. Approximately half of the children in the sample came from each day care (Day Care One had 17 children and Day Care Two had 18 children). Sex was also evenly distributed with 17 males and 18 females. Children ranged in age from 41 to 66 months of age. Table 2.1 contains a graph of the distribution of ages for all children in the study.

Graph 2.1

Graph of Age in Months.

Skill level was assessed for each child during the training and assessment phase (see Procedure section 2.2). Table 2.2 contains results for these skill level assessments.

Table 2.1

Assessed Skill Level for Maze Completion

Level	Number Decision Points	Number of Children	Percentage
1	3	8	23%

2	6	17	49%
3	7	7	20%
4	8	3	8%

2.20 Procedure

All children of appropriate age at the two day care centers were given a letter to take home concerning the study and those who provided parental consent were included in the study (a copy of this letter is included in Appendix F). The potential existed that children with fine motor skill problems might have difficulty complete mazes, however no children in the sample with such problems were identified by their teachers.

The study consisted of four sessions: (1) assessment phase where children were trained on maze completion and their competence at completing mazes was determined, (2) a Choice Phase where children were allowed to choose which mazes they wanted to complete, (3) a No Choice phase where children were given an opportunity to engage with various mazes, but only one level of difficulty at a time, and (4) a No Meaningful Choice Phase where children were given three piles of mazes at a time, but all three piles contained the same level of difficulty (all three levels of difficulty were presented separately during the session). All maze procedures took place in a quiet area at the day care centers (teacher's office or the cafeteria

area of the day care centers). The assessment portion of the study and the Choice Phase were always completed in a single session. No Choice Phase and No Meaningful Choice Phase were sometimes completed over two days. Appendix E contains a copy of the coding sheet for the study.

The assessment portion of the study began by training children to complete mazes. Children were shown how to complete a maze with no decision points (a point where the path divides and the child must decide which way to proceed with only one choice leading to the correct solution) and one decision point (A detailed description of maze levels of difficulty and maze construction. A script of what was said to the children and the exact procedure for training is available in Appendix B).

After a child's skill level was determined, they were assigned groups of mazes that were at their easier level of difficulty (E level, two levels below their skill level), at their skill level (M level), and at their harder level of difficulty (H level, two levels above their skill level). Next each child was given the three phases of the study, Choice Phase, No Choice Phase, and No Meaningful Choice Phase on separate days and in a counterbalanced order.

During Choice Phase, a child was presented three piles of mazes, including a pile of mazes at the child's E level, M level, and H level. The position of the three types of mazes was counterbalanced between children. The child were invited to do any mazes (s)he would like and as many as (s)he

would like and to let the researcher know when (s)he would like to do something else. The child was asked to put completed mazes in the special box provided and told completed mazes will be made into a special book they could take home. The researcher pretended to be occupied with other work while the child completed mazes, but unobtrusively used a stopwatch to record the length of the child's sustained attention with the mazes. The order of choice from the piles was also recorded. Completed mazes were scored later for correctness of solution and the number of wrong turns the child made. Conversation was minimized between the child and the researcher during this activity by minimizing responses to the child's attempts at conversation.

The No Choice phase of the study consisted of measuring each child's sustained attention for the individual levels of difficulty: E level, M level, and H level. The order of presentation of the three levels of difficulty was counterbalanced between children. The same observations were made as during the Choice Phase, including total time of engagement for the each level of difficulty and number of wrong turns, as well as number of incomplete mazes. No Meaningful Choice Phase consisted of the same procedure as No Choice Phase except when each level of difficulty was presented to the children, they were given three piles, rather than one. Thus, children had an apparent choice, but the choice was not meaningful in terms of differences in

difficulty.

Following the last phase of the study, each child was asked several questions in order to identify whether they were aware of the variance in task difficulty. Further details of this procedure and the text of these questions is in Appendix D. Mazes were not labeled by relative terms such as easy, medium, or hard at any time during the study by the researcher, since mention of these labels might have influenced children's future decisions of which mazes to choose. After answering these questions, children were given an opportunity to select one of three packets of mazes (at their E level, M level, and H level) to take home with them to finish later. The type of packet they chose was recorded.

2.30 Assessments

In addition to age, gender, and skill level, sustained attention in all phases of the study was measured by the total duration of task engagement in that portion of the study (time in seconds). Self-regulation for this study was defined as the percentage of a child's decisions to increase or decrease levels of difficulty in mazes chosen during the Choice Phase correctly predicted by the following rules. Decisions to increase to a higher level of difficulty were accurately predicted by prior performance that contained a successfully completed maze with no wrong turns at decision points. Decisions to decrease to an easier level of difficulty were accurately predicted

by a prior performance that contained either an incorrectly completed maze or a maze that was finished with wrong turns at decision points. For example, in the Choice Phase, if all the decisions a child made to increase the level of difficulty of their next choice of maze were preceded by the child having completed a maze successfully and with no wrong turns, this would be 100% self-regulation following success. If all the decisions a child made to decrease the level of difficulty of their next choice of maze are preceded by the child failing to correctly finish a maze or making wrong turns in completing a maze, then this would be 100% self-regulation following failure. The two types of self-regulation would then be averaged to yield a percentage for both types of self-regulation.

In addition to the data collected during the maze procedure, one assessment measure was employed in the study. Children's overall attentional ability was measured by the Attention Checklist (ACL: Das, Snyder, & Mishra, 1992), a rating scale designed to measure attentional abilities in normal children. Teachers were asked to complete this form for all children in the study.

2.40 Analyses Procedures:

The analysis of the data collected from this study included the independent variables of age, sex, skill level, sustained attention measured by the ACL, knowledge of task difficulty, and self-regulation of task difficulty

during Choice Phase. The main dependent variable was sustained attention times during each of the phases of the study.

Main effects of independent variables were analyzed with simple regressions investigating their predictiveness for sustained attention times. Sustained attention times for various portions of the study were compared using dependent measure t-tests and simple regression. The combined effect of all variables considered in the study were analyzed using multiple regression for each phase of the study in order to investigate the best predictors of sustained attention during the different contexts of the study.

Chapter Three: Results

3.10 Validity of Maze Difficulty Levels

As previously described, skill level was used to select easier, ability level, and harder mazes for each of the children. In order to estimate the validity of task difficulty assignment, the number of errors (wrong turns) was computed for each child working on their easier, ability level, and harder mazes (since wrong turns may give one indication of how difficult mazes were

for a child). It was found that only 3% of mazes that were at the easier level for an individual child were completed with any wrong turns. Forty-four percent of ability level mazes were completed with wrong turns, and 96% of harder level mazes were completed with wrong turns.

Problems with completion of mazes (ability to correctly draw a line from start to finish) may also indicate the relative difficulty of mazes for a child. In examining the results of this study, easier level and ability level mazes were always successfully finished, while only 57% of harder level mazes were actually completed successfully.

3.20 Subject Refusals

In the course of conducting this study there was one child (male, 45 months of age) who was too shy to remain seated long enough to finish more than two mazes at a time, although he genuinely seemed to enjoy doing them. He was removed from the study. There were also two children who refused to finish one phase of the maze presentation (the last session they were to receive). They were both males and one refused Choice Phase, while the other refused the No Meaningful Choice Phase. The sustained attention times for these two children were treated as missing data for that portion of the study.

In addition, there were also children who refused portions of one of the phases of the study. For example, one child refused the easier mazes in the

No Choice Phase and four children refused the harder level mazes in the No Choice Phase. Also, four children refused the ability level mazes in the No Meaningful Choice Phase and 4 children refused the harder level mazes in this phase of the study. Children who refused only one or two difficulty levels within a phase were given a 0 for their sustained attention time for that portion of the study. Of the 12 children who refused portions of phases of the study, on 9 occasions they refused the last parts of their last session. One child refused their easier mazes in a middle session and 2 children refused harder mazes in a middle session. Overall, refusals seem motivated by loss of interest in the activity or an aversion to working on difficult material or both combined.

3.30 Attention Checklist Results

An estimate of children's sustained attention ability was obtained via a questionnaire given to their teachers, the Attention Checklist (ACL). Scores for the ACL ranged from 21 to 48 (maximum possible), with a mean of 40.3 (SD=6.9). A series of regressions were completed using ACL scores as a predictor of sustained attention times, as well as age and skill level. Attention Checklist scores were not a significant predictor of any of these measures. Although it may seem surprising that sustained attention to mazes wasn't related to this global measure of attention ability, similar results have been found in other research where global measures of attention did not appear

related to sustained attention in a particular context (see Gianvecchio & French, unpublished manuscript; Ruff, Capozzoli, & Weissberg, 1998).

3.40 Potential Order Effects

Since the order of presentation of the three phases was counterbalanced, the first step in the analysis of the study consisted of looking for “order effects” on sustained attention times for the three phases. A linear regression using the order of presentation of the three phases found no significant differences in sustained attention times for any phase based on the order of its presentation. A regression was also calculated to investigate whether the order of presentation of task difficulty within the No Choice Phase might have influenced sustained attention times in this part of the study. Order was not a significant predictor for sustained attention times in the No Choice Phase.

3.50 Hypothesis One: Sustained Attention Without Choice

Hypothesis One was concerned with investigating how age and skill level may have contributed to sustained attention in the No Choice Phase of the study. It was predicted that in a no-choice situation where children will work on just one level of maze difficulty, increased sustained attention will be predicted by increased skill level (ability level) and increased age.

An examination of the distribution for children’s age in months (seen in

Graph 3.1), finds a distribution with negative kurtosis (-.70, with a standard error of .78) due to a large number of children in the sample clustered around 52 to 54 months of age. According to Morgan and Griego (1998), skewness and kurtosis values should be no more than 2.5 times the value of the standard error if the distribution is to function as a normal distribution in analyses. According to these guidelines, age values are acceptable to employ in subsequent analyses without transformation. An examination of the distribution for children's skill level was also conducted, showing a positively skewed distribution (.53, with a standard error of .40). Again according to the guidelines of Morgan and Griego (1998) the values for skill level can be used in analyses without transformation.

Sustained attention during the No Choice Phase of the study was measured in minutes engaged with mazes. The analyses of the influence of age and skill level on sustained attention were conducted in two ways. First, the average sustained attention for all three levels of difficulty was used for analysis. Analyses were also conducted using the highest score for any of the three levels of difficulty. Using the highest score, as well as the average score, was performed because children appeared to demonstrate individual preference for certain levels of difficulty, so that some children had longer sustained attention for easier mazes, while others had longer sustained attention for ability level or harder mazes. Highest sustained attention time

may therefore give a clearer picture of sustained attention in a situation where a child has chosen to work at a preferred level of task difficulty. Table 3.1 contains number and percentages of children's preference for task difficulty in the No Choice Phase of the study. As seen in Table 3.1, about equal numbers of children had highest sustained attention time to either easier or ability level mazes, with far fewer children attending longest to harder mazes.

Table 3.1

Task Difficulty Preference During No Choice Phase

Task Difficulty of Longest

Sustained Attention	Number of Children	Percentage
Easier	16	46%
Ability Level	15	43%
Harder	4	11%

The mean for the average sustained attention during the No Choice Phase was 4.6 minutes ($SD=2.7$) with a range from 1.2 to 13.0 minutes. The mean for highest sustained attention time during the No Choice Phase was 7.9 minutes ($SD=5.5$) with a range from 1.9 to 20.4 minutes. Both distributions of values for time were positively skewed (skewness of 1.1, with a standard error of .40), with the majority of sustained attention times being shorter in duration. Log transformations of these values were then computed

and log transformed values of times for both average and highest sustained attention were used in subsequent analyses.

The influence of age on sustained attention in the No Choice Phase was investigated using linear regression. Age was a significant predictor of average sustained attention time in the No Choice Phase of the study ($F_{(1,33)}=4.81$, $p=.04$, $R^2=.10$, $\beta=.36$), while age was not a significant predictor of the highest sustained attention time in this portion of the study. A series of linear regressions were calculated to examine whether age predicts sustained attention times for each level of task difficulty individually. (Log transformed values were used for easier, ability level, and harder sustained attention times due to problems with skew). These analyses showed that age was not a significant predictor of either easier maze time or ability level maze times. Age was a significant predictor of time spent on harder mazes ($F_{(1,29)}=9.74$, $p=.004$, $R^2=.23$, $\beta=.50$).

The lack of relation between age and sustained attention in most analyses of the No Choice Phase contradicts several previous studies (e.g., Breznitz & Friedman, 1988; Levy, 1979; Ruff & Lawson, 1990) which have found age related to sustained attention times. However, those studies did not assess children's ability with the tasks in those studies, nor did they control for the task difficulty of the activity for each child as this study has

done. Appendix H contains further information on how age may appear related to sustained attention in studies if task difficulty has not been individualized for each child.

The influence of skill level on average sustained attention in the No Choice Phase was also investigated using linear regression. Skill level score was a significant predictor of sustained attention ($F_{(1,33)} = 12.89$, $p = .001$, $R^2 = .26$). Using the beta coefficient ($\beta = .53$) to calculate the significance of these findings, for each increase of one level in skill, there was an approximate 29 second increase in the length of time a child would engage with mazes in the No Choice Phase.

Results were similar for the relation between skill level and highest sustained attention times. Skill level was a significant predictor of highest sustained attention in the No Choice Phase ($F_{(1,33)} = 11.85$, $p = .002$, $R^2 = .24$, $\beta = .51$). For each increase of one level in skill there was approximately a 28 second increase in the longest length of sustained attention time in the No Choice Phase.

Graph 3.1: The Interaction Between Age and Skill Level Predicting Average Sustained Attention Time in No Choice Phase.

The possibility exists that age and skill level may interact to influence sustained attention times, so a linear regression was conducted to investigate whether the interaction between these two factors might predict sustained attention. The interaction of age and skill level was a significant predictor of average sustained attention ($F_{(1,33)} = 10.76$, $p = .002$, $R^2 = .22$, $\beta = .50$). The interaction between age and skill level was also a significant predictor of highest sustained attention ($F_{(1,33)} = 8.78$, $p = .006$, $R^2 = .19$, $\beta = .46$). Graph 3.2 illustrates the nature of the interaction for average sustained attention times.

Graph 3.2. The Interaction Between Age and Skill Level Predicting Highest Sustained_Times in No Choice Phase.

The next step in the analysis was to consider age, skill level, and the interaction between the two in a multiple regression examining their relation with average and highest sustained attention during the No Choice Phase. The first set of analyses will considered average sustained attention. Due to high correlations between these three predictors, a multiple regression combining all three, while significant, does not contain any significant predictors ($F_{(3,31)}=5.32$, $p=.004$, $R^2=.28$), although skill level was at significance level ($p=.05$). A stepwise regression entering all three finds a very low value for tolerance for collinearity (.024) between the interaction of age and skill and the other two variables. Systematically pairing of each of these predictors finds the best model for predicting average sustained attention in the No Choice Phase was skill level while controlling for age with skill level a significant predictor ($F_{(1,32)}=12.56$, $p=.001$, $R^2 =.26$, $\beta=.53$). While controlling for age, for each increase in skill level there is a 31 second increase in average time working on mazes in the No Choice Phase.

Regressions analyses were then completed for highest sustained attention times in the No Choice Phase. First a multiple regression was

calculated to examine the influence of skill level, age, and the interaction of age and skill level on the highest sustained attention time for the No Choice Phase. This regression model was a significant predictor of highest sustained attention times ($F_{(3,31)}=6.31$, $p=.002$, $R^2=.32$). Skill level was a significant predictor of highest sustained attention times ($p=.02$, $\beta=.3.4$), when controlling for age and the interaction between age and skill.

3.60 Hypothesis Two: Influence of Opportunity to Self-Regulate Task Difficulty on Sustained Attention

It was predicted that sustained attention will be greater when children are able to self-regulate selection of task difficulty. The Choice Phase of this study allowed children the opportunity to chose to work on easier, ability-level, or harder mazes in any order or pattern they wished to employ, so a comparison of time for the No Choice Phase and the Choice Phase was conducted to investigate how choice may have influence the time children sustained their attention to mazes.

The mean sustained attention time for the Choice Phase was 14.95 minutes ($SD=6.3$) and times ranged from 2.4 to 21.9 minutes. According to the research plan, children were given a maximum of 20 minutes to work on any portion of the maze study, although all children were allowed to finish any

maze they were working on when they went over the 20 minute limit.

Fourteen of the 34 children who completed the Choice Phase of the study needed to be stopped at this time limit. Table 3.2 compares the times (average and highest sustained attention times) for the No Choice Phase with the times from the Choice Phase, along with a comparison of the number of children stopped at the 20 minute limit for each of these phases of the study.

Table 3.2

Comparison of Sustained Attention (SA) During No Choice (NC) and Choice Phase

Source of SA Time	Mean	Range	# of Children Stopped
Average SA in NC Phase	4.6	1.2-13.0	4
Highest SA in NC Phase	7.9	1.9-20.4	4
Choice Phase	14.95	2.4-21.9	14

An examination of the distribution of times for the Choice Phase yields a distribution with negative skew (skew equal to $-.71$, standard error equal to $.40$) and negative kurtosis (kurtosis equal to $-.88$ and a standard error of $.79$).

Time for the Choice Phase was within the limits for a normal distribution

recommended by Morgan and Griego (1998), so no transformation was necessary.

The next portion of the analysis consisted of dependent measure t-tests comparing the means for average and highest sustained attention times during the No Choice Phase with sustained attention time for the Choice Phase. Results found that average sustained attention time during the No Choice Phase was significantly different than sustained attention during the Choice Phase ($t_{(35)} = 13.54, p < .001$). Results also found that highest sustained attention time during the No Choice Phase was significantly different than sustained attention during the Choice Phase ($t_{(34)} = 13.32, p < .001$).

The next portion of the analysis consisted of regression analyses of the predictiveness of choice for sustained attention times. This portion of the analysis was conducted using each engagement with mazes as the unit of analysis. This means that each child had a maximum of 3 time scores for the No Choice Phase, including their time for easier mazes, ability level mazes, and harder mazes (this explains the large degrees of freedom for the F value). In contrast, each child who completed the Choice Phase (34) had one time for sustained attention where they had choice. Analysis results found that choice was a significant predictor of time engaged with mazes ($F_{(1,138)} = 93.99, p < .001, R^2 = .40, \beta = .64$).

3.65 Choice versus Meaningful Choice

One possible explanation of increased sustained attention during the Choice Phase might be that choosing from three piles of mazes increases the time a child will attend to mazes. In order to control for this possibility, a third phase of maze presentation, the No Meaningful Choice (NMC) Phase was conducted with the children. In the NMC phase, children were presented three piles of easier mazes, rather than the one pile of easier mazes they were given in the No Choice Phase, then given three piles of ability level mazes, and then given three piles of harder mazes (in counterbalanced order across children). Table 3.4 contains descriptive data comparing the means, standard deviations, and ranges of all three phases of maze presentation, along with number of children stopped at the 20 minute limit.

Table 3.3

Comparison of Sustained Attention (SA) Times for No Choice, Choice, and No Meaningful Choice (NMC) Phases

Phase	Mean		Stopped	Number of Children
	(Minutes)	RangeSD		
No Choice-Average SA	4.6	1.2-13.0	2.7	4
No Choice -Highest SA	7.9	1.9-20.4	5.4	4
Choice Phase	15.0	2.4-21.9	6.3	14
NMC Phase -Average SA	4.7	0.8-11.2	2.7	3
NMC Phase -Highest SA	7.7	1.8-20.4	5.0	3

Examination of the distributions for average sustained attention times

for the NMC Phase finds average times within acceptable guidelines for a normal distribution. Highest times, however, exhibited positive skew (skew equal to 1.43, standard error equal to .40). Log transformations of these time values appears to correct for problems with this distribution. Log transformed values were used in subsequent analyses.

As seen in Table 3.4, there appears to be little difference in sustained attention times between the No Choice Phase of the study and the NMC Phase of the study. Dependent measure t-tests support that there was no significant difference between these means when comparing either average sustained attention times between these two phases or in comparing highest sustained attention times for the two phases. Next dependent measure t-tests were conducted to compare sustained attention times for the Choice Phase with the average and highest sustained attention times for the NMC Phase. There was a significant difference between sustained attention times in the Choice phase and average sustained attention times in the NMC phase ($t_{(32)} = 13.17, p < .001$). There was also a significant difference between sustained attention times for the Choice phase and highest sustained attention times in the NMC Phase ($t_{(32)} = 12.91, p < .001$).

The next portion of the analysis focused on looking at whether choice of task difficulty versus simply having choice from three piles would predict time engaged with mazes in a regression model. Again this portion of the

analysis was conducted using each engagement with mazes as the unit of analysis. This means that each child had a maximum of 3 time scores for the NMC Phase, including their time for easier mazes, ability level mazes, and harder mazes, so that there was a total of 103 sustained attention times for all children from the the NMC Phase. In contrast, each child who completed the Choice Phase (34) had one time where they had choice. Results of this analysis finds that having choice of task difficulty is a significant predictor of time engaged with mazes ($F_{(1,134)} = 109.370$, $p < .001$, $R^2 = .45$, $\beta = .67$).

Another way to compare the importance of choice in the Choice Phase may be to examine the amount of increase in sustained attention times for the Choice Phase versus other phases of the study. For example, average times for the No Choice and the No Meaningful Choice Phase were 4.6 and 4.7, respectively. Choice Phase represented an approximately 10.4 minute increase (223%). While highest times for the No Choice and the No Meaningful Choice Phase were 7.9 and 7.7 minutes, respectively. Choice Phase represented approximately a 7.2 minutes increase in time (92%).

3.70 Hypothesis Three: Choice Phase

Hypothesis number three concerned whether sustained attention times in Choice Phase were predicted by age, skill level, and the self-regulation of task difficulty. It predicts that in the Choice Phase of the study, when children may vary the level of maze difficulty they engage in, increased sustained

attention will be predicted by increased skill level, increased age, and self-regulation.

Self-regulation was measured by the accuracy of changes in task difficulty in relation to previous performance. The mean for accuracy of self-regulation was 83% ($SD=.17$) with a range from 50% to 100%. Three children had no self-regulation value since they did all easy mazes in the Choice Phase which made it impossible to estimate the accuracy of their self-regulation. The distribution for self-regulation was characterized by negative kurtosis (kurtosis equal to $-.1.54$, standard error equal to $.82$) which is within recommended guidelines (Morgan & Griego, 1998). However, arcsine transformations were conducted on the accuracy of self-regulation because they were calculated as proportions. This procedure is recommended by Winer and colleagues to correct for possible irregularities in the distributions of proportions and percentages (Winer, Brown, & Michels, 1991).

A series of simple regressions was then conducted looking for main effects of age, skill level, and accuracy of self-regulation on sustained attention times in the Choice Phase. Age was a significant predictor of sustained attention time ($F_{(1,32)}=15.15$, $p=.001$, $R^2=.30$, $\beta=.57$). Skill level was also a significant predictor of sustained attention time in the Choice Phase ($F_{(1,32)}=8.74$, $p=.006$, $R^2=.19$, $\beta=.46$) and accuracy of self-regulation was also

a significant predictor of time in the Choice Phase ($F_{(1,29)}=8.50$, $p=.007$, $R^2=.20$, $\beta= -.48$). However, this result was in the opposite direction from predicted.

Next, possible interactions between age, skill level, and self-regulation were investigated. The interaction of age and skill level was also a significant predictor of sustained attention times in the Choice Phase ($F_{(1,32)}=9.50$, $p=.004$, $R^2=.21$, $\beta=.48$). Graph 3.4 illustrates the nature of the interaction between age and skill level for the Choice Phase. The interaction between age and self-regulation, skill and self-regulation, and the three way interaction among age, skill level, and self-regulation were not significant predictors for sustained attention times in the Choice Phase. Stepwise regression found that age was the best predictor of sustained attention times in the Choice Phase ($F_{(1,29)}=12.16$, $p=.003$, $R^2=.24$, $\beta=.51$). Appendix H contains expanded information on how children may have employed two different strategies in using their choices in the Choice Phase.

Graph 3.4. The Interaction Between Age and Skill Level Predicting Sustained Attention in Choice Phase

The finding that accuracy of self-regulation was actually related in a negative manner to sustained attention times for children prompted a further look at how this self-regulation may have been functioning during the Choice Phase. The variable of self-regulation was composed of accuracy in increasing task difficulty after successful completion of mazes and the accuracy of decreasing task difficulty after experiencing problems with maze completion. In order to investigate whether one of these types of accuracies had more influence on sustained attention than the other, simple regressions were completed using each as a potential predictor of sustained attention

times in the Choice Phase. Only the accuracy of decreasing task difficulty was related to sustained attention times ($F_{(1,26)}=5.48$, $p=.03$, $R^2=.14$, $\beta=-.42$),

suggesting that children who decreased the task difficulty of their choices (even though they had not experienced any difficulty with completion of the previous maze) were more likely to sustain their attention longer.

One of two possible problems was identified with the measure of self-regulation. First, by following the procedures used in this study, there were restrictions on choice when children had finished easier and harder mazes which led to the measure of self-regulation used in this study being less accurate. Basically, since easier mazes were almost always completed successfully and without wrong turns, any choice away from easier mazes would be a more difficult maze and would look like more accurate self-regulation. The same potential problem holds for harder mazes. Harder mazes were seldom completed without problems and any choice away from a harder maze would look like accurate self-regulation. Therefore a new measure of self-regulation was calculated which just examined results of choices involving ability level mazes. An ANOVA indicated that the group of children who did complete ability level mazes (24) did not differ significantly from those who did not (no difference was found for age, sex, skill level, or any of the sustained attention times measures collected in this study). Therefore, the mean for this new variable of accuracy of self-regulation for ability level mazes was .51 (51%) with a range from 0 to 1.00 (SD=.37)

A second potential problem arose concerning the self-regulation

measure for this study. This problem arises from that fact that some children made far more changes in task difficulty than others, thus putting themselves at a greater risk of making an error. In order to control for this possibility, it was considered important to examine the rate of accurate choices which was determined by dividing the number of accurate choices for ability level mazes by the number of ability level mazes completed. The mean for this new variable, rate of accurate ability level choices was .18 or 18% ($SD=.30$) with a range from 0 to 100%. A simple regression found that this new variable was predictive for sustained attention time in the Choice Phase ($F_{(1,21)}=12.42$, $p=.002$, $R^2=.34$, $\beta= -.61$), although the results were still in the opposite direction from what was expected indicating that accuracy of self-regulation for choices concerning ability level mazes was associated with shorter sustained attention times. Arcsine transformation was used on this variable for further analysis since it was expressed as a proportion.

New analyses were conducted using rate of accurate choices for ability level rather than the previous variable of accuracy of self-regulation to predict sustained attention times during the Choice Phase. Analyses with this measure duplicated previous findings. For example, multiple regression using the stepwise regression procedure found that both the rate of accurate ability level choices and age were significant predictors of sustained attention times in the Choice Phase when controlling for skill level and the interaction

of age and skill ($F_{(2,20)}=11.55$, $p<.001$, $R^2=.49$, with a significance of $p=.001$ and $\beta= -.59$ for the rate of accurate ability level choice and a $p=.02$ and a $\beta=.41$ for age).

3.80 Exploratory Question: Choice of Activity versus Choice Within Activity

The last question in this study was exploratory and examined how children's choices of an activity (a packet of mazes) would compare with their choices within the maze activity. At the end of the study children were given an opportunity to choose one packet of mazes (containing 5 mazes which will contain only one level of difficulty, either E level, M level, or H level) to take home for further engagement. Several studies in motivation literature have focused on children's choice of the task difficulty of an activity as evidence of children's drive for optimal challenge (Danner and Lonky, 1982; Messer, Rachford, McCarthy, and Yarrow, 1987). It was an exploratory question in this study how the task difficulty of the packet children chose to take home would relate to the task difficulty of their choices within the study itself.

Twenty-two children (65%) chose easier maze packets to take home, seven (20%) chose ability level mazes to take home, and five (15%) chose the harder packet of mazes to take home. This finding would appear to conflict with motivation research which has found children tend to chose to work slightly beyond their current ability level.

An analysis was conducted to investigate whether a child's choice of

packet was related to their choices within the phases of the maze study. A linear regression was calculated to examine whether the type of maze that represented children's highest sustained attention time in the No Choice Phase might correspond to the type of packet that took home. This regression was not significant. There was also no relation between the type of maze that yielded the highest time for No Meaningful Choice Phase. There was no significant relation between the type of maze chosen more often in Choice Phase and the task difficulty of the packet taken home. There appeared to be no relation between any variable examined in this study and the choice of what level of task difficulty mazes were chosen to take home. It remains unclear what, if anything, might have motivated children's choices at the end of this study. Appendix K contains a full analysis of all independent variables identified in this study along with the exploratory variables of knowledge of task difficulty and preference for mazes.

Chapter 4: Discussion

The purpose of this research project was to examine factors that influence preschool children's sustained attention. This was accomplished through an experimental design where the demand characteristics of the task were held constant while task characteristics were manipulated. In effect, children were placed in a fairly autonomous situation where they were invited to complete maze puzzles for as long as they wanted while the task difficulty and amount of choice within the activity was varied by the experimenter.

4.10 Task Difficulty and Sustained Attention

Studies of preschool children's sustained attention in natural settings where they are actively involved in a task have focused on playing with toys

(studies have also examined passive activities such as watching videos or watching live activities like a puppet show). Children's skill in interacting with toys in these situations has not been assessed or controlled, so little is known about how sustained attention might be influenced by task difficulty in preschool children. Appendix G takes a brief look at how sustained attention times might have looked if task difficulty had not been assessed and controlled in portions of this study. For example, when most of the children in one portion of the study were completing mazes at the same level of difficulty relative to their skill, there did not appear to be any age-related influences on sustained attention. However, in another portion of the study where the children were divided in the relative difficulty of the task, there did appear to be an age influence. It has apparently too often been assumed in previous research that skill level and age are the same, so children's skill at tasks is not usually assessed. The results of this research suggest that it is important to assess skill and control relative task difficulty in research looking at sustained attention.

Motivation research has suggested that children prefer optimal challenge in their engagement with activities (Danner & Lonky, 1982; Messer, Rachford, McCarthy, & Yarrow, 1987). Although it may seem obvious that the difficulty of a task would influence how long a child voluntarily engages with it, the results of this study were thus surprising in several respects. First,

there was little consistency for any particular level of task difficulty to be preferred by children in this study. Children appeared to show individuality in their preference for levels of task difficulty (as measured by the length of their sustained attention) and this preference tended to be consistent between choice and no choice portions of the study.

Another surprising finding was that the majority of children preferred to work the longest on mazes at their easier level of difficulty. At first, this result seems to contradict motivation research, but actually I believe this finding supplements the already existing research literature by looking at motivation in a different context, that of choice within an activity. In most studies of task difficulty and motivation, children are asked to choose an entire activity or group of activities for engagement over an extended period of time. This choice may be an entirely different type of choice from choices made during smaller portions of an activity. For example, a child may choose a challenging puzzle to complete, but vary the difficulty of pieces chosen when completing that puzzle. It is possible that children may not be comfortable continually maintaining the high degree of effort needed to work at a challenge level throughout an activity. During this research children who attempted and even successfully completed harder level mazes were often noted to then decrease the difficulty level of their next choice. As one child remarked, "Doing hard ones makes me tired."

For many of the children in this study, the Choice Phase of the procedure allowed them an opportunity to engage with challenging mazes (harder task difficulty), but also allowed them to complete less challenging mazes when they chose to do so. It is interesting to note that a majority of children completed more harder level mazes when given choice than they did during the portion of the study without choice. In contrast, numbers of easier and ability level mazes were highly consistent between phases.

4.20 Age, Skill Level, and Sustained Attention

The results of this study cast some doubt on the belief that age (as a maturational process) is an important determinant of sustained attention. In several portions of this study age did not predict sustained attention and in others portions it lost its predictiveness when skill level was controlled. This finding contradicts several previous studies (e.g., Breznitz & Friedman, 1988; Levy, 1979; Ruff & Lawson, 1990). I believe the reason for the contradictory results found in this study is related to the close relation between skill level and age. Previous studies may simply have been measuring the influence of higher skill, rather than older age, when they found this relation.

Results of this study support skill level as a good predictor of sustained attention times. Higher skill levels would appear to facilitate longer sustained attention times. One important difference between various skill levels for completing mazes in this study consists of the need for more complex

responses to the mazes at higher skill levels. Children who complete mazes at these higher levels may be stimulated to engage longer by the increased complexity of their responses. This possibility is in line with anecdotal reports in studies completed by Ruff and Lawson (1990) and by Renninger (1992) who reported that older children tended to engage differently than younger children with the toys in their studies.

Age did appear to influence sustained attention when children were given choice. In fact, both age and skill level appeared to influence the length of time children engaged with mazes when given choice. This is a somewhat puzzling finding. If age, as previous studies have suggested, represents a maturational factor, then it is unclear why it did not appear to influence sustained attention times during the portion of the study without choice. One possibility is that age may represent another factor that influences sustained attention when choices are available. This possibility is suggested by the finding that the age influence on sustained attention times only held for children who chose to regulate their choices by changing task difficulty, not children who were repetitive in their choices. One potential possibility is that these children were exhibiting a certain metacognitive strategy when making their choices and the execution of this strategy was facilitated by an age-related factor. This possibility will be discussed further in a moment.

This study found the interaction of age and skill to be a predictor of

sustained attention times. However, the influence appears to be in opposite directions during portions of the study with and without choice. For example, results would suggest that when there is no choice of task difficulty, older children with low skill have shorter sustained attention times relative to older children with high skill. In contrast, when choice is available, older children with low skill have longer sustained attention while older children with high skill have shorter engagement times.

The opposite direction of this effect makes it difficult to generate explanations for this result. One possible reason for this difference may be due to the primary difference between these two aspects of the study which was the presence or absence of choice. For example, when there is no choice of task difficulty, age and skill may work together to give older children with higher skill an increased sustained attention. While older children with lower skill may have a decreased sustained attention due to decreased complexity of their response (as proposed earlier in the discussion on task difficulty).

In contrast, when choice is available and engagement times in general were longer, older children with high skill may become more fatigued and have more need of breaks from the higher levels of their tasks. One choice which may increase over time with older children who pursue more difficult mazes is to terminate their engagement with the mazes sooner which would

lead to decreased sustained attention times. Older children with lower skills may not have such a need. This possibility is supported by the fact that only in children who engage in variation in task difficulty (nonrepetitive strategy) is the interaction of age and skill significant. In children who are repetitive in their choices and have a lower overall level of task difficulty, this interaction does not appear related to their sustained attention times.

4.30 Choice, Self-regulation, and Sustained Attention

One of the most important findings of this study is the large increase in children's sustained attention to mazes when they were given the opportunity to choose to vary the task difficulty of mazes. This result would appear to support the importance of contextual factors in influencing sustained attention in preschool children, a finding suggested by results of Ruff, Capazolli, and Weissberg (1998). An important next question though is why choice led to such an increase in sustained attention times, particularly when the opportunity to choose from three piles of the same difficulty level had no measurable influence on sustained attention times. It would appear then that the important contextual element was the choice of various levels of task difficulty.

One hypothesis of this study proposed that choice allowed children to self-regulate and that the accuracy of children's self-regulation of choice (whether they chose to increase or decrease the difficulty of their next choice

based on previous performance) would facilitate their sustained attention.

This study did not support the later portion of that hypothesis, namely, accuracy of self-regulation did not appear to promote children's sustained attention times. In fact, in some children it may have had the opposite effect.

There are several reasons why support for this position may not have been found.

The view of self-regulation in this study as the accuracy of children's choices when changing levels of task difficulty may not have been supported since it may have conceived of self-regulation of choices in too narrow a way.

It became clear in completing this study, that children were engaging in at least two very different strategies in self-regulating their use of choice. While some children were self-regulating their choices in apparent response to previous performance, other children chose to be repetitive in their maze selections and favored a certain level of difficulty (most often easier level) and then repetitively chose this type of maze. Based on this discovery, an exploratory re-investigation of results from this study were completed in order to look at how the different use of choice might have influenced the sustained attention of these two groups of children (see Appendix H and Appendix K).

There are many aspects of this study where the results for the group of children who employed a repetitive strategy were very different from those who chose to vary their task difficulty. For example, there was no difference

in sustained attention times between portions of the study with and without choice for children who employed a repetitive strategy. Apparently, choice was not necessary for this group of children's engagement strategy, while it was essential for the other group of children who varied their choices of task difficulty. Children with nonrepetitive strategies had large and significant differences in sustained attention times between portions of the study with and without choice. Another important difference between these two groups of children was the relative task difficulty of their choices with repetitive children having lower overall task difficulty in comparison to those who varied their choices. This finding may suggest educational implications for engagement with this strategy.

Among the children with nonrepetitive strategies, the accuracy of their self-regulation did not help promote longer episodes of sustained attention. What actually appeared to take place during the study was that children who engaged with mazes would often chose to decrease task difficulty without necessarily having any problems with their previous performance. I believe this may be due to tiredness after engaging with mazes and that these children's needed to "rest" a little by working with a less difficult maze. Whatever the reason, children who chose to take these "rests" appear to sustain their attention longer than those who do not. Results do not appear to support any relation between either age or skill level as a predictor of the

accuracy of reducing task difficulty.

It does appear that the type of self-regulation where children vary the task difficulty of their choices in response to previous performance is a natural process that all children may be familiar with since there was no evidence of age or skill influencing this type of self-regulation. It is possible that children's accuracy for this type of self-regulation is based on experience or some other individual characteristic, but further study should be done on this behavior.

The finding of two different types of strategies for choice (and the consistency of these strategies) suggest that children may have been self-regulating their choices in a metacognitive fashion based on two different type of goals for task participation. It is important to consider these two strategies further since analysis of exploratory results suggest that sustained attention was influenced in different ways by these strategies.

4.40 Metacognition

According to Brown (Brown, 1978; Brown & DeLoache, 1988) metacognitive skills include checking, monitoring, planning, and predicting. Children who exhibited variation in choice of task difficulty appeared to be engaging in such skills as they varied the task difficulty of their choices in relation to previous performance. Children who were repetitive may also have been using these skills to guide their choices. Effective metacognitive

strategies for problem solving have also been identified in preschool children (Flavell, Friedrichs, & Hoyt, 1970). In addition, Kluwe (1987) found identical problem solving strategies generated by four to seven year olds, suggesting little age-related influences on the generation of these strategies.

Flavell (1979) suggests that metacognitive experience supplies “quality control” for cognitive activities. Flavell proposes a model of metacognition which includes three components which are suggested by children’s behavior in this study, including metacognitive knowledge, metacognitive experience, and metacognitive goals.

The first component of metacognition according to Flavell (1979) is metacognitive knowledge which includes knowledge about tasks, task demands, strategies for accomplishing task goals, and monitoring progress of cognitive strategies. Two kinds of knowledge may have influenced children’s strategies in this study. First, children in this study evidenced knowledge of task difficulty which appeared to influence their sustained attention times. Results suggest that children who had accurate knowledge for identifying the harder level of mazes as “hard” were more likely to sustain their attention when given choice. This type of knowledge may have been useful for children who varied their task difficulty when they chose to do a harder level maze they were aware of the challenge and could move to an easier level

more effectively after completing a harder level maze, if that choice was desired. For children who were employing the repetitive strategy, knowledge of which mazes were “hard” may have helped them avoid engagement with this level.

Another way metacognitive knowledge may have influenced strategies and subsequent engagement is through concern for mistakes. Results suggest that children who expressed concern about the possibility of making “wrong turns” or fear of failure to complete mazes had shorter sustained attention times. According to Dweck (2000) preschool children may exhibit two different attitudes in relation to concern for mistakes. Hebert and Dweck (1985) conducted a study where children role played adult reaction to mistakes. One group of children demonstrated an expectation of encouragement and useful suggestions for improvement in the presence of mistakes, while the other group demonstrated an expectation of criticism and punishment for mistakes. In their research the former children were much more likely to persist when they encountered difficulties in task engagement, while the later did not. Researchers also found that children who were not willing to persist when they encountered difficulty were willing to continue to work repetitively on easy puzzles that they had successfully completed just a few minutes earlier.

The second component of metacognition proposed by Flavell’s model

(Flavell, 1978) is metacognitive experience which includes conscious or affective experiences during engagement. There are several ways that such experiences may have influenced children in this study. First, the occurrence of self-regulation of varying task difficulty shown in this study, unrelated to either age or skill, suggests this type of decision making may be part of a natural process that children engage in during activities as part of managing their task participation. In this way, it may be a form of metacognition aimed perhaps at maximizing their potential enjoyment through optimizing feelings of competence. This possibility would appear to be supported by the fact that increased task difficulty almost always occurred after successful completion of a maze with no wrong turns. In addition, a high percentage of decisions to decrease task difficulty occurred after mazes where children experienced difficulty either by taking wrong turns or failing to complete a maze.

There is some support for the existence of this type of decision making where individuals make choices within an activity to increase their enjoyment. Sansone (1986, Sansone & Harackiewicz, 1996) found that adults would actively engage in changing task characteristics in order to increase motivation within a task. This may be similar to what children who varied their task difficulty choices were doing with the maze task of this study. By altering the task difficulty of their choices, children may have been facilitating positive motivation for the task and thus prolonging their engagement.

Children's preference for completing mazes also appears to have exerted an important influence on sustained attention. Among the children who varied task difficulty, two-thirds showed the highest level of preference and those who engaged in the repetitive strategy were more likely to sustain their attention if they showed preference for doing mazes. The influence of this preference was accentuated in older children. Perhaps the affective experience of liking what you are doing and knowing that you like it, adds to an individual's desire to persist in an activity.

The last component of Flavell's model of metacognition (Flavell, 1978) is metacognitive goals. Metacognitive research has typically focused on children's activities in terms of strategy choices in problem solving situations (e.g. Crowley & Siegler, 1999; Flavell 1987, 1979; Kluwe, 1987; Kreutzer, Leonard, & Flavell, 1975; Siegler, 1987). Children in this study did exhibit different strategies in negotiating wrong turns which may correspond to metacognitive problem-solving strategies. Goals of metacognitive problem-solving strategies are solving the problem effectively. However, goals for strategies of choice of task difficulty would appear to be somewhat different in nature than goals for metacognitive problem-solving strategies. If choice in an activity is unclear and open for a child to provide (as in the choice portion of this study) then choice may be governed by metacognitive goals. Choice of task difficulty in this study may have provided such an opportunity for

children where they may have superimposed their own goals which then influenced their choices in the activity. For example, some children may have seen the choice portion of this study as an open-ended activity where they varied their choice of task difficulty in order to promote their pleasure in the task. Other children may have had the metacognitive goal of creating mazes with some relevant attribute, such as a low level of mistakes. Little research has looked at metacognitive goals in preschool children. According to Brown (1987, p. 87) there is “little data on children’s executive control while performing a task or the planning-in-action phase”.

John Atkinson (1958) proposes a theory of achievement motivation which describes a disposition in individuals to both approach success and to avoid failure. The strength of approach/avoidance is both an aspect of personality, as well as influenced by situational cues. Atkinson’s model presents one possible explanation for the choices of task difficulty seen in the choice portions of this study. His model predicts that those who possess a higher motive for achievement (drive to approach success is stronger than the drive to avoid failure) will increase task difficulty of choices after success and decrease the task difficulty of choices after failure. In contrast, those who have lower motive for achievement (drive to avoid failure is stronger than the drive to approach success) will either continually choose very hard or very easy tasks. Choices of very hard tasks that can not be accomplished can

actually decrease the anxiety related to fear of failure since these tasks are impossible to complete, while those which are very easy can always be finished and this type of choice also decreased the anxiety associated with fear of failure.

Atkinson's model (1958), while accurately predicting the content of choices for the different strategies seen in this study, does not seem to adequately address the complexity of the situation where there are immediate expectancies of success and failure which influence the immediate choice, but there may also exist an activity-wide purpose for the task which may influence the overall goals of that task. Therefore, it is unclear whether Atkinson would see the results of this study as simply reflective of personality differences between individual children or whether he might acknowledge that situational context at the level of the activity can also be creating a larger influence that may push children toward a dominance of one drive over the other. Thus some children who saw the activity as an opportunity for enjoyment may have been influenced to increase their drive to approach success. While other children who saw the activity as the creation of an important product may have decreased their drive for approaching success and increased their drive to avoid failure. It is certainly clear from previous research and the results of this study that the persistence of sustained attention is influenced by a variety of contextual characteristics. Thus a good

explanation of the behavior of children in this situation would require that both the immediate motivation of their choices be accounted for, while also accounting for the larger contextual factors. The proposition that different metacognitive goals may have been imposed by the children in addition to the immediate influence of success and failure may be one useful way of conceptualizing these results, even though explicit reflective goals may not be explicit or obvious to children as young as those in this research.

A child's choices of which strategy to employ in these two different situations may actually be similar to the different responses (found in motivation literature) which result from intrinsic motivation (where engagement is guided by internal goals of competence, autonomy, and relatedness) versus extrinsic motivation (where engagement is controlled by external restrictions, see Deci & Ryan, 1985). Children who varied task difficulty may have had a goal of enjoyment and were thus intrinsically motivated. Children who were repetitive in their strategy may have been extrinsically motivated by external standards for accuracy. One question, however is why children would persist if they were extrinsically motivated? These children did persist when they exhibited preference for the mazes, but not when they did not. Perhaps this suggests a different kind of motivational situation where preference encourages their engagement, while an external motivator discourages them from seeking competence through varying their

choices.

Why some children may have chosen to impose an apparent goal of engagement and manipulate their choices to maximize enjoyment in the process, while other children may have chosen to impose outward values on the result of their work and thus appeared motivated to avoid errors is another important question. The source of these goals is unclear. Further studies should attempt to investigate whether contextual cues such as the idea of producing a book to take home might have triggered the different strategies. Another possibility is that this difference was related to something children have learned about metacognitive goals for tasks, it may represent an individual characteristic such as trait anxiety, or some combination of these and other factors.

4.50 Predictors of Sustained Attention

In this study sustained attention times appeared to be influenced by different factors when choice was available. For children who were repetitive, the variables of skill level, preference for mazes, and knowledge of harder task difficulty were the best predictors of sustained attention times. This result is not entirely surprising. First, skill level was the best predictor of sustained attention times when children worked on one level of task difficulty

at a time. Since children who were repetitive were essentially doing almost the same thing in the choice versus no choice portions of the study, the influence of skill level was not surprising. The influence of preference is also not surprising since preference for mazes increased sustained attention times for all children in the study. As previously discussed, recognizing the harder level of task difficulty may also have been advantageous for this group.

The fact that the three factors of skill level, preference, and recognizing harder interact in this group of children who employed a repetitive strategy suggests that there is a cumulative advantage to possessing all three together for optimizing sustained attention times. Conversely, not recognizing harder level, having no liking for mazes, and having low skill at doing them appears to cumulatively depress sustained attention times.

Children who choose to vary the task difficulty of their choices were influenced by slightly different factors in extending their sustained attention times. Results found two separate factors, including the rate of accurate ability level choices (the revised self-regulation measure) and the interaction of age and skill level. It would appear that when children are engaging with a task and self-regulating their choices that those who are more likely to spontaneously decrease task difficulty for “rest” periods are more likely to have longer sustained attention times. In fact, this behavior may potentially be evidence of another aspect of metacognitive strategy in task engagement.

In addition, children who are older with lower skill sustain their attention longer, while children who are older with higher skill are more likely to stop engaging with mazes sooner. As previously discussed this may suggest that the additional work of engaging with more difficult mazes may contribute to fatigue that even “rest” periods cannot relieve and children who work at a more complex level have more difficulty sustaining their engagement. It may be useful to look further at metacognition in order to understand factors that influence sustained attention.

4.60 Process versus Activity Choices

The last portion of this study looked at how children’s choices of an activity (a packet to take home) might relate to their choices within an activity (process choices). No relation was found. As previously discussed, this may not be unusual. Choices within an activity may involve differently cognitive and motivational processes than the choice of an activity. However, it is unclear why children didn’t chose more challenging material to take home for later completion. This result appears to contradict optimal challenge research. One potential possibility is that children were tired at the time of choosing the packets to take home since they had just finished the third phase of the study. Choices made on a different day when children were not potentially suffering from “maze fatigue” might have yielded different results.

4.70 Weaknesses of this Study

One potential weakness of this study is the small number of children it employed, particularly since some of the exploratory results were conducted on the sample of children split into two groups. The small number of children may have led to another of the potential weaknesses which was the lack of differentiation of skill levels in the younger children. The lower median of children only contained 2 skill levels and there was little overlap as the youngest children had the lowest skill level and the next older children had the next higher skill level. It was only in the older median of the group that overlapping skill levels are found in children of the same age. This may present a statistical problem for results of this study, particularly in terms of findings in relation to the interaction between age and skill level.

Another potential problem was the 20 minute time limit, particularly on the Choice Phase of the study. It is possible that children may have attended for much longer lengths of time when they had choice, if given more time. Longer available times might have yielded somewhat different results.

Another potential problem was the possibility of practice effects changing the skill level of a child during the course of the study. This may have differentially effected some children more than others and might account for some of the results of the study. For example, it is potentially possible that some children may have rated ability level mazes as “easy” at the end of the study because they had become less difficult for them through practice.

Interpretation of the meaning of variables such as recognition of task difficulty may also be a potential problem. This possibility exists in terms of the variable of recognizing harder task difficulty which might be interpreted in another way. Many children who correctly recognized harder mazes, rated ability level and easier level mazes as the same (confused the two in labeling them). The possibility exists that children may have interpreted the labels of “easy” and “hard” in different ways than as relative terms used to describe task difficulty. They may have used the terms to describe mazes they felt comfortable and confident in working on as “easy” and those they felt cautious or somewhat incompetent to work on as “hard”. This reinterpretation may also explain why children so often exhibited a dichotomy between easy and hard with few children recognizing a middle level, a finding that contradicted previous research on preschool children’s ability to identify task difficulty.

This study was also limited in looking only at total engagement time in studying sustained attention. It might be useful in the future to look at distractability, another important component of sustained attention. This could be done through videotaping and coding for visual attention to the mazes.

Results of this study may not apply to situations where children are

pressured in some way to engage and use effortful attention. This study was designed to make the testing situation as autonomous as possible so children would feel free to stop whenever they wanted. The results appear to suggest that children did feel free to do just that. All the children had quite varied times for various aspects of the study which suggested they were not experiencing any problems in communicating their desire to stop doing whatever portion of the study they were completing. Results would probably be different if children were told to try to “finish a pile” or “do as many as you can.” These are situations where outside goals are imposed on children and sustained attention, motivation, and metacognition may be different.

Another potential problem concerns how some children used the strategy of either looking ahead or using their finger to check out potential “wrong turns”, rather than drawing them with their marker. This left no written evidence of their taking the wrong path. While some children may have felt they avoided a “wrong turn” with this strategy, others may still have felt like they made an error when they followed the wrong path visually or manually. Their knowledge of taking the wrong path might have led to changes in the next task difficulty, but since “wrong turns” were only counted when they were actually made with the marker by the child, these “wrong turns” were unrecorded. This may also explain why some children decreased task difficulty without any evidence of difficulty in the previous maze completed.

Another potential limitation of this study concerns the issue of generalizing findings. While the purpose of this study was to create a situation where children would engage freely with the mazes and represent children's active engagement in an activity, there is a potential that engagement patterns and sustained attention shown by children in this study were not typical of children's normal task engagement. First, children may have been operating in some way to please the researcher who was sitting nearby. Another potential problem is that some or all of the children may have altered their normal engagement patterns because they were aware that they were taking the mazes home in a book to show their parents. This may have led some children to be more careful or concerned about mistakes than others. A future study might try to minimize the risk of these influences by having children do mazes alone without an adult nearby and also by telling children the mazes were "practice" or "for fun".

4.80 Implications

This study supports several implications for continued research, both in the field of sustained attention and in the fields of motivation, self-regulation, and metacognition. First, it casts some doubt on the widely accepted idea that sustained attention is an ability which matures with age. Age appeared to have little direct influence on children's sustained attention, while other factors which tend to correlate with age, such as skill level and metacognitive decision making may be much more important in influencing

children's engagement and subsequent sustained attention. Sustained attention, rather than a maturational ability, may simply be representative of the cognitive processes it serves, so that more complex responses which may accompany activities that children are skilled at or enjoy are more likely to foster sustained attention. These findings underscore the importance of assessing children's skill and controlling the task difficulty of materials children engage in when studying sustained attention.

This research supports the importance of looking at sustained attention as a process and the decision making within that process in an effort to understand what is influencing engagement. I believe the sustained attention field needs a new paradigm for investigating sustained attention as an alternative to the widely used vigilance paradigm. This study may represent such a paradigm since it allows investigation of the process of sustained attention in a new way.

Researchers to date have used the vigilance paradigm (which bears little resemblance to natural engagement in an activity) in order to investigate sustained attention. Very little interest has been directed to sustained attention in more natural settings. One reason for this lack of research may be that the field of cognitive psychology has reached the point where it cannot make sense of the findings in terms of sustained attention in natural activities unless they are willing to consider motivation and metacognitive factors. Unfortunately, in recent years the field of psychology has seen

cognitive psychology often go in one direction while social psychology goes in another. Current trends in graduate school where the two fields may exist in separate psychology departments and trends for specialization within psychology make a study such as this unlikely, yet to continue to discount the influence of other factors on sustained attention makes little sense. The creation of studies such as this which incorporate theory from several fields of psychology may be necessary to understand development and behavior in natural settings.

The results of this study suggest implications for motivation research where new effort should be made to investigate motivation as an ongoing, fluctuating influence on activity, rather than a static influence at the beginning of an activity that merely guides the choice of starting engagement. Results may also provide implications for future research in self-regulation and metacognition. Self-regulation research has often focused on looking at children's choices in social situations where there are adult standards for behavior. Sustained attention studied in such a setting would most likely be motivated in an entirely different way from natural engagement with activities.

Metacognitive research has examined how children regulate their engagement within activities, but mainly the field has focused on memory and problem solving strategies. The results of this study suggest that it may be useful to investigate task engagement in terms of metacognition and further, to examine how metacognitive goals may be influencing task engagement.

Optimizing sustained attention and engagement is an important topic for educators. The results of this study suggest implications for educating children and promoting potential learning. In order to foster longer periods of sustained attention and better learning, educators should first give children “ability” appropriate tasks, rather than “age” appropriate tasks since the results of this study support that the two are not always the same. Second, educators should allow children choices of task difficulty in relation to their skill level. Choices of task difficulty may not be necessary for children who are engaging with a repetitive strategy, but in the absence of knowing what type of strategy a child might use, choice of task difficulty appears to facilitate both engagement strategies.

One way that engagement may be fostered is through the use of open-ended versus close-ended tasks. These types of activities would allow children freedom to work at whatever level of task difficulty is comfortable for them and vary the difficulty of the task or not. In this way, engagement can be encouraged and learning optimized.

The group of children who were repetitive in their choices and who often worked on easier level mazes exhibited significantly fewer errors and incomplete mazes than the group that varied their choices. However, as a consequence of this strategy the overall task difficulty of their engagement with mazes was significantly lower, suggesting the possibility of lowered learning and future achievement should this strategy for engagement be

replicated in school settings. Further research should investigate whether this type of strategy is common in educational settings or whether it may be inadvertently promoted by parents and teachers. It may also be useful to find ways to encourage children to employ the strategy of varying task difficulty which may ultimately promote improved skills and learning.

One of the most important implications of this research may be the usefulness of conducting a study which incorporates theory from several fields in psychology in order to understand children's behavior. First, I think this study shows that such research can be successfully carried out. Recent research in sustained attention had reached a point where results can not be explained without consideration of other variables such as motivation and metacognition. I believe the results of this study will form the foundation of a series of studies which will inform theory, as well as applied work in multiple fields. Most of all I believe this research will stimulate new thinking about a research paradigm to look at activity and engagement as a process and how choice within an activity can provide information on how attention is sustained.

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Appendix A: Maze Construction

The maze task in this study and the mazes themselves were constructed as much as possible to be high interesting to children in order for the task to be internally motivating for the children. First, mazes were constructed in two styles. Some of the mazes have geometric shapes where all lines are straight lines and all corners are 90 degree corners. In the maze task, these types of mazes are alternated with mazes that are constructed like paths with rounded, irregular curves and various angles at intersections. These two types of mazes were considered representative of the two types of paths that children might encounter in real life, with the first being similar to city streets, paths through buildings, etc. and the second being similar to paths through natural areas such as woods, meadows, parks, or country roads.

The interest value of mazes was also optimized by constructing multiple mazes at each of the levels. There are a minimum of 30 different mazes, including both types at the easier levels (0 to 6 decision points) and

20 different mazes at the more difficulty levels. This makes it highly unlikely that children will encounter the same maze and experience any loss of interest due to repetition.

The following chart details the differences in the levels of mazes constructed for this task. In general mazes increased in difficulty by increasing the number of decision points. Mazes with increasing number of decision points have been previously used in children as young as 20 months of age (Dichter-Blancher, et al., 1997). The length of the path to correct completion and the length of the path to “dead ends” also increase with increasing levels of task difficulty. This is in part to increase the difficulty of the maze, but also becomes somewhat of a necessity in order to increase the number of decision points. The width of maze paths also decreasing with increasing number of decision points. This is not intended to increase the difficulty of the maze, but becomes a necessity due to increasing the number of decision points. There is no penalty when children work on a maze if they happen to accidentally go outside the lines when drawing their solution line. The two easiest level of mazes also do not have paths that turn away from the goal. This has been identified as a difficult task for younger children to comprehend (Brockman, 1977).

There is one qualitative difference in mazes which occur between the level of 6 decision points and 7 decision points. At this point, in order to fit an entire maze on a regular size sheet of paper and also in order to increase the

difficulty of the maze, mazes at 7 decision points begin to share the walls of one path with the walls of another portion of the maze (samples of mazes at all difficulty levels are included in this appendix). Mazes up until this point are constructed so that all paths are surrounded by shaded areas which clearly separate them from other paths.

(Table A.1 is on next page).

Table A.1

Table of differences in maze levels of difficulty.

Level	Path turns away from goal	number of decision points	path width	background texture	sharing of path walls with other paths	length of path to solution	length of wrong turns	Current name
1	no	0	large	yes	no	very short	none	00D
2	slight	0	large	yes	no	short	none	0D
3	yes	1	med-large	yes	no	short	very short	1D
4	yes	3	medium	yes	no	med-short	short	3D
5	yes	6	medium	yes	no	med-short	short	6D
6	yes	6	medium	some	some	medium	medium	7D
7	yes	8	med-small	no	yes	medium-long	medium	8D
8	yes	10	small	no	yes	long	med-long	10D
9	yes	12	small	no	yes	long	long	12D

Appendix B

Procedure and Script for Contacting and Interacting with Children in the Study

Procedure: before approaching any children in the study, I spent approximately 1 to 2 hours in each class during free time (prior to beginning the study) circulating among the children and interacting with their play so I would be familiar to them.

Script:

“Hello, _____ (Child’s name). Would you like to do some special puzzles with me?” (Escort to quiet area).

Assessment Phase:

“These are my maze puzzles. Have you done mazes before?” (Even if the child identified that they had done mazes before, I showed them how to complete mazes for the study).

Training Phase:

I began by showing them a very easy maze with no decision points.

“Let me show you how it works. There are two rules for doing maze puzzles. The first rule is that you always start at the bottom and finish at the top (I will point to the bottom and to the top when I say this). The second rule is that you try to stay inside the lines when you draw your line. Watch me”. (I would slowly draw a line with a large watercolor marker along the path of the maze from the bottom to the top of the page).

“Now you try”. (If the child seemed confused, I would repeat the demonstration. If the child still seemed confused I offered to help by giving the child a marker and guiding their drawing through the maze). “Would you like me to help you?” (If they answer was “yes” I would help, if they answered “no” I would take them back to class. I would then try on one additional day to teach them again and then if they continued to refuse, withdraw them from the study).

All completed mazes will be placed in a brightly colored box on the table top. “When we finish a maze we put it here in this special box. Later I will take the ones you finish and make them into a special book for you to take home.”

(If the child was able to follow the simple path from object to goal, I would next demonstrate a maze with one decision point). “Let’s try this one.”

(I would deliberately make a wrong turn and stop the marker where the path “dead ends”). “Oh, oh. This is the wrong way. Let’s go back.” (Then I

would draw a line with my marker back to the decision point and then finish the maze).

Next I gave the child the same maze. "Now you try." (If the child was unsuccessful, I repeated the demonstration and offered to guide their hand. If all methods fail I returned them to class and tried on one more day. If still unsuccessful this child would be withdrawn from further participation in the study since all mazes with the exception of the first two levels of difficulty have decision points as part of their design).

If the child was successful with completion of the maze with one decision point, I gave them a packet containing 4 mazes at each level of difficulty. I said, "why don't you try doing these. Let me know if you get tired and want to do something else." I then pretended to be busy doing some paperwork while the child worked on the maze packet. When I noticed they had reached a level where they were unable to correctly complete a maze, I said, "You've done a great job working on those mazes, why don't you take the rest of them home with you." The child was then given the maze packet to take home.

The following procedure was used if children attempted to talk with me during maze tasks. First, if a child showed me his/her work, I would tell them, "that's nice. Why don't you try another one?" If a child attempted to gain help from me, I would tell them, "why don't you try a different one and I will help you finish that one later." If a child attempted to talk with me about

something else, I would give a minimal response. If I noticed a child incorrectly finishing a maze, I reminded them of the rules. (After two corrections, children who continue to incorrectly complete mazes would be dropped from the study).

Choice Phase:

I approached each child in their class and asked, “Would you like to do more mazes with me?” (If they accepted, I escorted them to the area, if they declined I tried on two more occasions to gain their interest, then withdrew them from the study).

On the table top were three piles of mazes, one pile at their E level, one pile that is at their M level, and one pile that is at their H level. I said, “Here are some mazes for you to do. You can do any ones you want and as many as you want. Put them in the box when you finish and let me know when you get tired. I have some work to do”. (I began to work on paperwork on my clipboard).

If the child did not begin to do a maze, I prompted by asking, “Which one would you like to start with?” Then I took the maze they indicated from the pile and put it in front of them and put a marker on it. (If I was unable with other prompts to get them to choose a maze to begin with, I would give them a copy of the last maze they were successful at in the assessment phase and say, “How about trying this one?” Then I would put this maze in front of the child and lay a marker on top of it). I prompted children who

finished the first maze to try another if they needed encouragement by saying, "would you like to try another?" When a child either expressed loss of interest in the mazes or demonstrated loss of interest by leaving the table or ceasing to work on mazes for 1 minute, the child was returned to class.

No Choice Phase:

The same procedure used for the choice phase was repeated with the exception that all the mazes in all three piles were at the same level of difficulty. Children were given an opportunity to work on all E level mazes, all M level mazes, and all H level mazes. This phase took place all on one day or carried over onto a second day, only if necessary.

No Meaningful Choice Phase:

The same procedure for No Choice Phase was used with the exception of having three piles of each level of difficulty.

Appendix C: Attention Checklist

Child's Name

Instructions: Listed below are questions about this child's behavior. Place a circle around the number in the column that best describes this child. Answer all items.

<u>Observation</u>	<u>Not at all</u>	<u>Just a little</u>	<u>Pretty much</u>	<u>Very much</u>
1. Does the child have a short attention span?	4	3	2	1
2. Does the child appear detached from class activities?	4	3	2	1
3. Does the child accurately heed directions?	4	3	2	1
4. Does the child daydream in class?	4	3	2	1
5. Does the child have				

trouble concentrating?	4	3	2	1
6. Does the child stay with one activity long enough to complete it?	4	3	2	1
7. Does the child work independently?	4	3	2	1
8. Is the child easily distracted?	4	3	2	1
9. Is the child able to concentrate on a task until completed?	4	3	2	1
10. Does the child listen attentively?	4	3	2	1
11. Does the child become easily engrossed in an activity?	4	3	2	1
12. Does the child disregard some or all directions?	4	3	2	1

Appendix D

Text of Questions for End of Study

These questions concerned whether children recognized differences in level of difficulty. All questioning began with the most open question and if necessary questions were narrowed in focus. I began by placing three packets of mazes on the table. Each packet contained 5 mazes of either E level mazes, M level mazes, or H level mazes. The order of questioning was counter-balanced between children to begin with either the H level, M level, or E level.

1. (Researcher pointed to the H level of mazes for that child). I noticed you sometimes picked this kind of maze, can you tell me why?
2. (Researcher pointed to the M level of mazes for that child). I noticed you picked this kind of maze other times, can you tell my why?

3. (Researcher pointed to the E level of mazes for that child). I noticed you picked these mazes sometimes, can you tell me why?

If children was unable to answer these types of open ended questions, they were asked which pile they thought was easier, which pile they thought was harder, and then to identify the last pile as either easier, harder, or “in between”. After each child had answered the questions as best they could, I asked them to pick a packet of mazes to take home with them and this choice was recorded.

Appendix E
Maze Procedure Coding Sheet

Name _____ Age _____ Level:: 00D 0D 1D 3D 6D 7D 8D
10D 12D

Choice Phase: Order of Piles _____ Total
time: _____
Order of choice (with wrong turns and failures)

No Meaningful Choice Phase: Order of presentation: _____

(E) Times: _____ Number completed: _____ Order with incomplete
and wrong turns: _____

(M) Times: _____ Number completed: _____ Order with incomplete
and wrong turns:

(H) Times: _____ Number completed: _____ Order with incomplete
and wrong turns:

No Choice Phase: Order of

presentation: _____

Actual Level: 00D 0D 1D 3D 6D 7D 8D 10D 12D Relative level: E M H

Time _____ Number completed _____ Order with incomplete and wrong turns:

Actual Level: 00D 0D 1D 3D 6D 7D 8D 10D 12D Relative level: E M H

Time _____ Number completed _____ Order with incomplete and wrong turns:

Actual Level: 00D 0D 1D 3D 6D 7D 8D 10D 12D Relative level: E M H

Time _____ Number completed _____ Order with incomplete and wrong turns:

End of Procedure Questions:

Recognized Easier Pile: Y N

Recognized Harder Pile: Y N

Recognized Medium Pile: Y N

Comments:

Appendix G
Parent Letter and Consent Form
“Sustained Attention, Self-regulation, and Motivation for Maze Puzzles”

Dear Parent(s),

My name is Lorraine Gianvecchio and I am a graduate student at the University of Rochester. I am currently working on a research project as part of completing my doctoral degree in education. In order to complete my degree, I am investigating young children’s interest in and engagement with maze puzzles. I am working at your child’s day care center on this project and with the director’s permission, I am contacting all the parents of children who visit the center about this project. With your permission, I will invite your child to participate in this investigation. I will spend approximately 45 minutes, over 3 to 4 short sessions with each child, working with them to solve maze puzzles. This will take place during “free-time” (or non-educational) periods at your child’s day care center.

Your child will be invited to work with me in a quiet, but public area in the school. I will show children how to solve maze puzzles and give them puzzles at various difficulty levels to complete. On 2 to 3 other days, children will be invited to complete additional mazes. Completed mazes will be assembled into a booklet for each child to take home. Also, children’s teachers will complete a short questionnaire about each participating child’s attention during regular classroom activities such as story time, art activities, and free play.

It is important to me and the results of this study that your child works on the mazes voluntarily. At no time will any child be pressured to begin or continue to participate in activities with the maze puzzles. Children who express a desire to stop doing mazes will immediately be returned to regular classroom activities. If a child loses interest in the puzzles on one occasion, I will invite them to participate up to two additional times.

Participation in this study is completely voluntary. You and your child may decline to participate or may withdraw from participation at any time without incurring any negative consequences from me, the day care center, or the University of Rochester.

Benefits of participation for your child include one-on-one coaching in solving puzzles and pleasure in the success of solving them; benefits at the larger level include a greater understanding of the factors that influence children's learning and attention in the classroom environment. There are no risks associated with participation.

Results of this study, including copies of completed mazes, videotape, and the teacher questionnaire will be viewed only by me and a research associate that assists me with record keeping. All results identifying individual children will be kept in a locked file cabinet in my home. Summarized results will be presented at conferences and in published articles and will not identify individual children in any way.

The results of this study will contribute to a better understanding of children's attention and the relation between attention and children's learning. As the parent of four children, I can relate to parents' concern for their children and their children's education. I hope you will decide to allow your child's participation in this study. Thank you for your time and consideration.

Sincerely,
Lorraine Gianvecchio

If you have any questions concerning this investigation or your child's participation, please feel free to contact me in any of the following ways:

Lorraine Gianvecchio
Warner Graduate School of Education and Human Development
University of Rochester, Dewey Hall
Rochester, NY 14627
Phone: 716-227-7599 E-mail: llgian@juno.com

or Dr. Craig Barclay (Faculty Advisor) at the above address.
 Phone: 716-275-3963 E-mail: crba@troi.cc.rochester.edu

If you have any questions about your child's rights as a research subject, please contact:

Rev. Gloria Fish, D. Min. at Strong Memorial Hospital, 601 Elmwood Avenue, Rochester, NY 14642 or call: 716-275-2187.

Please complete the form below, indicating whether or not you give permission for your child's participation in the investigation: "Sustained Attention, Self-regulation, and Motivation for Maze Puzzles". You are receiving an extra copy of this letter and permission form to keep for your records.

I have read the letter above describing Lorraine Gianvecchio's investigation "Sustained Attention, Competence, and Complexity for Maze Puzzles" and had an opportunity to ask and receive answers to any questions I may have.

(Check One): I agree _____ I do not agree

to give permission for my child _____ (child's name) to participate in the investigation "Sustained Attention, Self-Regulation, and Motivation for Maze Puzzles" and for my child's teacher to complete a questionnaire about my child's attention during various classroom activities.

Child's Birthdate:

Parent's Name (Print Name)

Parent's Signature _____ Date

Appendix G

Sustained Attention and Age If Task Difficulty Is Not Controlled

In order to investigate how sustained attention and age might appear to be related if task difficulty is not controlled, it is useful to examine the responses of children in this study to either the 6D or the 7D mazes. Graph G.1 contains the distribution of scores for children's sustained attention time while completing 6D mazes. Twenty children completed 6D mazes in the No Choice Phase, for two of these children 6D represented their easier level and for 18 of the children it was their ability level. The straight line drawn across the distribution represents the fit of a linear model of sustained attention as age increases for the 20 children who completed 6D mazes. Since the majority of children in this group completed 6D mazes as their ability level maze, the slope of this line is fairly flat. A simple regression examining age

and sustained attention in this group finds no significant predictiveness of age for time engaged.

Graph G.1

Time for 6D mazes by Age in Months with Horizontal Line Representing
Linear Model

An examination of Graph G.2 which contains the distribution of sustained attention times for 7D mazes represents another situation with task difficulty. Fourteen children completed 7D mazes and for seven of them it

was their ability level of difficulty and for the other seven it was their harder level of difficulty. The straight line across the distribution in Graph G.2 represents an estimation of a linear model for this data and

suggests there was an increase in time spent on 7D mazes with increasing age. This observation was supported by the results of simple regression where age is a significant predictor of sustained attention time for children completing 7D mazes ($F_{(1,13)} = 6.75$, $p = .023$, $R^2 = .13$). This situation, where children completing the task are working at different task difficulties, relative to their own skill level, may very well represent the situation in many research studies and would result in the finding that sustained attention increases with age.

Graph G.2

Time for 7D mazes in No Choice Phase With Horizontal Line Representing

Linear Model

Appendix H

What Children Did With Choice in Choice Phase

One proposal raised by this research project was a hypothesis concerning how choice of task difficulty in Choice Phase would influence sustained attention times. It was proposed that choice based on the accuracy of children's self-regulation (in relation to their previous performance on the mazes) would promote sustained attention. This hypothesis was not supported. In fact, the opposite was found, less accurate self-regulation in task difficulty choices or lower rate of inaccurate choices was related to longer sustained attention times.

In actually observing the children in this study during Choice Phase, it became clear that children were employing different approaches or strategies which influenced their choices during this portion of the study. I completed some exploratory statistical analyses of these different approaches which may be of interest to the reader.

Some children clearly expressed tendencies in Choice Phase to vary the difficulty level of their choices. An examination of the rate for changes in task difficulty (the use of rate helps control for the different number of mazes chosen during this phase) during Choice Phase reveals a wide range from 0% (3 children who did all easier level mazes) to 92% (children who varied their task difficulty almost every time they chose a different maze).

Another unexpected observation made during data collection was that there were groups of children in this study who seemed to prefer working at a particular difficulty level during Choice Phase, particularly working on easier mazes. In fact, there were three children who chose to work exclusively on easier mazes during Choice Phase and two of these children worked the entire 20 minutes allowed on these mazes. While this might seem to be a strategy for a child who was bored or tired, these children had no difficulty expressing their desire to stop at much shorter times during other portions of the study. One example of this willingness to express desire to stop involves one female subject (62 months of age) who was stopped at 20.12 minutes and completed 37 mazes in Choice Phase, all easy, with wrong turns in only 2 of them. In the No Choice Phase of the study, she completed 29 easier mazes in 20.15 minutes, 4 ability level mazes in 5.54 minutes and 2 harder mazes in 5.30 minutes.

Another example of the willingness of children to express their desire to stop a portion of the study was a boy (56 months of age) who completed

25 mazes of which 21 were easier, 3 were ability level, and 1 was harder during Choice Phase and he was stopped at 20.08 minutes. During No Choice Phase, he completed 17 easier mazes in 10.75 minutes, 10 ability level mazes in 7.68 minutes, and 2 harder mazes in 2.20 minutes.

A re-examination of results was conducted which separated the children of this study into two groups based on their tendency to be repetitive during Choice Phase. Children who completed more than 60% of the mazes in Choice Phase at one level of difficulty were considered repetitive, while those who distributed their choices more evenly were considered nonrepetitive. This separation created a group of 15 children who were considered nonrepetitive and 19 children who were considered repetitive in their choices (one child did not complete Choice Phase). It is interesting to note that of the 19 children who were classified as repeaters, 12 showed a preference for easier mazes, 6 a preference for ability level mazes, and 1 a preference for harder level mazes. A similar ratio of preference for easier, ability, and harder task difficulties was exhibited among nonrepeaters (9 preferred easier, 4 ability level, and 1 harder), as measured by the type of maze they chose more often, but these children were far less repetitive in their choices.

A potential problem appeared to exist with the one child who showed a preference for harder level mazes in Choice Phase. He exhibited extreme differences which appeared to indicate he was statistically an outlier as a

member of the repetitive group. For example, this child recorded 50 wrong turns during Choice Phase. The next nearest number of errors for any child who was repetitive was 14 wrong turns. The mean for wrong turns was 5.89 ($SD=11.4$) with him included in the repetitive group and mean was 3.40 ($SD=3.9$) without, so this child's data was eliminated from comparisons of repetitive and nonrepetitive children.

One of the exploratory aspects of this study was to record remarks made by children concerning fear of failure or making mistakes. Eleven children made such remarks at some point during the study when working on mazes. An analysis of the influence of this anxiety on sustained attention times was conducted. There was no evidence that this anxiety was more likely to occur in children who engaged in repetition versus those who did not. However, in examining each group separately it was found that this anxiety measure was a significant predictor of sustained attention times during Choice Phase in children who were repetitive ($F_{(1,17)}=7.23$, $p=.02$, $R^2=.26$, $\beta=-.54$), while it was not predictive for those who were not repetitive.

Results of the series of analyses completed for all children for Hypothesis 3 were duplicated with just the children who were not repetitive during Choice Phase, looking at the influence of age, skill level, and rate of accurate choices on sustained attention times. Results were similar to those obtained for the group of children as a whole. Results of simple regressions

found age a significant predictor of sustained attention times in Choice Phase ($F_{(1,13)}=12.68$, $p=.003$, $R^2=.46$, $\beta=.70$). Skill level was not a significant predictor of sustained attention times. Rate of accurate ability level choices was a significant predictor of sustained attention times ($F_{(1,12)}=40.07$, $p<.000$, $R^2=.75$, $\beta= -.88$) for this group. Next the interactions of age and skill, age and accurate choices, skill and accurate choices, plus the three way interaction of age, skill, and accurate choices were investigated with a series of simple regressions. The interaction of age and skill was found to be a significant predictor of sustained attention times in Choice Phase ($F_{(1,13)}=6.32$, $p=.03$, $R^2=.28$, $\beta=.57$). The interaction of age and rate of accurate ability level choices was a significant predictor of sustained attention times in Choice Phase ($F_{(1,12)}=23.20$, $p<.001$, $R^2=.63$, $\beta=-.81$). The interaction of skill and rate of accurate ability level choices was a significant predictor of sustained attention times ($F_{(1,12)}=5.78$, $p=.03$, $R^2=.27$, $\beta=.57$). Results of a stepwise regression which examined age, skill, and rate of accurate ability level choices, along with the three significant interactions found that both rate of accurate ability level choices and the interaction of age and skill were significant predictors of sustained attention times in Choice Phase ($F_{(2,11)}=33.53$, $p<.001$, $R^2=.83$, with $p<.001$ with a $\beta= -.81$ for the rate variable and $p=.02$ with a $\beta=.31$ for the interaction of age and skill).

The results were considerably different for children who were repetitive

in their choices. A series of simple regressions calculated to examine the influence of age, skill level, and rate of accurate choices on sustained attention times in Choice Phase found age a significant predictor of time ($F_{(1,16)}=4.58$, $p=.048$, $R^2=.17$, $\beta=.53$). Skill level was also a significant predictor of time ($F_{(1,16)}=6.16$, $p=.03$, $R^2=.23$, $\beta=.53$). Rate of accurate ability level choices was not a significant predictor of sustained attention times in Choice Phase.

Next a simple regression was conducted to examine the interaction between age and skill level on sustained attention times and it was a significant predictor of sustained attention times in Choice Phase ($F_{(1,16)}=5.48$, $p=.03$, $R^2=.21$, $\beta=.51$). Results of a stepwise regression with age, skill level, and the interaction of age and skill found only skill level was a significant predictor for this group ($F_{(1,16)}=6.16$, $p=.03$, $R^2=.21$)

There were some other interesting differences noted between these two groups. An analysis of variance compared these two groups on sustained attention times for their highest time recorded during No Choice Phase. There was a significant difference between these two groups in terms of time spent on their preferred level mazes ($F_{(1,31)}=5.98$, $p=.02$), with repeaters having a mean of 10.1 minutes ($SD=6.2$) and the mean for nonrepeaters was 5.7 minutes ($SD=3.5$). This result may not be unusual when you consider that repeaters did not need to have choice (as provided in Choice Phase) to execute their preferred strategy of engagement. These

groups also had a significant difference between them in the number of wrong turns made during Choice Phase ($F_{(1,31)}=18.50$, $p<.001$) with the mean for repetitive children of 3.4 wrong turns ($SD=3.9$) and the mean for nonrepetitive children of 13.6 wrong turns ($SD=9.1$).

Another interesting difference between these groups was the relative difficulty of the mazes they attempted during Choice Phase. By assigning each maze chosen a value (1=easier, 2=ability, 3=harder), and dividing the total of this sum by the number of mazes completed, a relative difficulty of mazes attempted in Choice Phase was calculated for each child. An analysis of variance was conducted examining task difficulty for these two groups of children and there was a significant difference in relative task difficulty for the two groups ($F_{(1,31)}=18.38$, $p<.001$). The mean of task difficulty for 15 nonrepetitive children who varied the difficulty of their choices was a 1.83 ($SD=.16$), while the task difficulty of 19 repetitive children who tended to repeat the same difficulty level was lower at 1.39 ($SD=.37$).

Consistency of strategies was another aspect of the study investigated in exploring the differences between these two groups. The consistency of strategies during Choice Phase was investigated by looking at task difficulty of the first half of choices in Choice Phase versus the task difficulty of choices during the second half. Also, examined was the number of changes from one difficulty level to another in the first half versus the second half. Children showed surprising consistency in the task difficulty of first half ($M=1.65$,

SD=.49) and second half of Choice Phase (M=1.57, SD=.44). Dependent measures t-tests found no significant differences between these two means. An analysis of variance compared the results for task difficulty for repetitive and nonrepetitive children and found no significance difference in the consistency of first half and second half task difficulty.

Consistency of number of changes was also similar between first half of Choice Phase (M=3.74, SD=3.78) and second half (M=3.01, SD=3.68). A paired sample t-test did find a significant difference between these means, suggesting that children made slightly more changes in task difficulty in the first half of the Choice Phase ($t_{(33)}=2.67$, $p=.01$). An analysis of variance compared the results for number of changes for repetitive and nonrepetitive children and found no significance difference in the number of changes in task difficulty between first half and second half of Choice Phase for these two groups.

Another potential way of examining consistency of strategy use is to compare the number of mazes chosen in different portions of the study. Children were surprisingly consistent in the number of mazes chosen in No Choice Phase separately versus as a portion of the Choice Phase. Paired sample t-tests found no significant difference between average number of easier mazes chosen in Choice Phase (10.35, SD=9.2) versus number of easier mazes chosen in No Choice Phase (10.09, SD=10.0). There was also no significant difference between number of ability level mazes chosen in

Choice Phase (5.77, SD=4.9) and No Choice Phase (7.06, SD=8.1).

However, there was a significant difference ($t_{(34)}=2.24$, $p=.03$) between the average number of harder mazes chosen during Choice Phase (2.8, SD=3.0) and No Choice Phase (1.7, SD=1.2), suggesting the children attempted more harder mazes when given the chance to choose among various levels of task difficulty.

Appendix I

Preference for Working on Mazes and Sustained Attention Times

Another exploratory variable examined in this study was whether children's preference for doing mazes would influence their sustained attention times. Preference was measured by allowing children the opportunity to choose to do mazes after all phases of the study were completed. During a free time period at their day care centers, children were allowed to choose to work on mazes or a variety of other activities in many sections of the room. All children in the room, whether subjects in the study or not, were given access to a table where mazes of various levels of difficulty were available for engagement.

Mazes were available for approximately 20 minutes and preference was scored in this way. Children who were subjects in the study who did not

chose to come to the table to do mazes were given a score of 0 for preference. Children who came to the table, but did not stay were given a score of 1 for preference and children who came and stayed the entire time were given a score of 2 for preference.

Of the 35 children in the study, eighteen (51%) received a score of 2, seven (20%) received a score of 1, and nine (26%) received a score of 0, while data was unavailable for 1 child (3%). Preference was not correlated with either age or skill level.

The next step in examining the potential influence of preference was to complete simple regressions looking at whether preference might predict sustained attention times for No Choice Phase or Choice Phase. These regressions were not significant. As a further investigation of the potential influence of preference, these regressions were repeated for the children who showed repetitive engagement strategy and for those who did not. For children using repetitive strategies, preference appears to influence their sustained attention times for Choice Phase ($F_{(1,16)}=9.52$, $p=.008$, $R^2=.35$, $\beta=.62$). Regressions examining the influence of preference on No Choice Phase (highest time or average time) were not significant. Simple regressions looking at the influence of preference for children who were not repetitive were also conducted and results suggest that preference was not influential in sustained attention times during Choice or No Choice Phase for these children.

Appendix J

Knowledge of Task Difficulty

As previously described, an attempt was made to explore how children's knowledge of task difficulty might influence children's choices in Choice Phase and thus their sustained attention. At the end of the study, children were asked to identify which pile of mazes they thought was easier, which pile they thought was harder and then asked what the remaining pile was considered. Only three children were able to correctly identify all three levels of difficulty and one child refused this portion of the study. Only the ability to correctly identify the harder pile of mazes was predictive of longer sustained attention times. Twenty-seven of the children in the study correctly identified the harder level, while seven did not correctly identify the harder level of mazes. The seven who did not correctly identify harder piles were incorrect because they chose ability level mazes as harder when initially

asked to pick the pile they thought was “hard”. They later identified the harder pile as also being “hard”.

For children who correctly identified the harder level of task difficulty, it is possible that this judgment did not reflect an actual estimation of relative difficulty, but a judgment on the part of children as to how much confidence they had or how competent they felt when working on this level of maze. Since this perception might have influenced sustained attention times, it was investigated whether children’s strategy of repetition might be related to the perception of ability level being easier or harder. No relation was found. However, children who perceived ability level as easier and clearly saw the difference between the harder level and the other two portions of the study were significantly more likely to sustain their attention for a longer time during Choice Phase ($F_{(1,32)}=15.88$, $p<.001$, $R^2=.32$, $\beta=.59$). Whether this was the result of seeing more of the mazes as harder decreasing sustained attention or seeing most of the task as easier is unclear.

Appendix K

An Exploratory Analysis of the Influence of Age, Skill Level, Self-Regulation, Preference, and Knowledge of Task Difficulty on Sustained Attention Times in Choice Phase

One final set of analyses were conducted to investigate the influence of all variables assessed in this study including the investigation of age, skill level, and self-regulation and also adding the exploration of preference and knowledge of task difficulty. In keeping with previous results which were considerable different for the two groups of children (who differed in the repetitiveness of their strategy), this investigation was completed looked at each group separately.

First analysis was conducted to investigate the influence of these multiple factors (age, skill level, preference, judging ability level as easy, and

all possible interactions) on sustained attention times for repetitive children. A series of simple regressions indicate that all potential interactions of age, skill level, preference, and knowledge of task difficulty were potential predictors of sustained attention times. Results of a stepwise regression found collinearity problems with the four way interaction of the main predictors and it was removed. Results indicate the best predictor of sustained attention times in Choice Phase for children with repetitive strategies was the three way interaction of skill level, preference, and knowledge of task difficulty ($F_{(1,14)}=24.58$, $p<.001$, $R^2=.61$, $\beta=.80$). This result appears to indicate that repetitive children with higher skill, preference for completing mazes, and who judged ability level as easier (knowledge of task difficulty) were more likely to sustain their attention during Choice Phase.

Children who engaged in a nonrepetitive strategy were also investigated. Main predictors for this group were age, skill level, knowledge of task difficulty, and rate of correct ability level choices during Choice Phase.

A series of simple regression again looked at all possible interactions between these factors. The following interactions were found to be significant predictors: interaction of age and skill, interactions of age and knowledge of task difficulty, interaction of skill and knowledge of task difficulty, the three-way interaction of age, skill, and knowledge of task difficulty, and the interaction of rate of accurate ability level choices and preference. All potential predictors were then entered into a stepwise regression analysis.

Collinearity problems eliminated one predictor, the interaction of age and knowledge of task difficulty. Analysis of the stepwise regression was repeated and results were essentially the same as found in earlier analysis (Appendix I) with two significant predictors for sustained attention times for Choice Phase in nonrepetitive children, rate of accurate ability level choices and the interaction of age and skill ($F_{(2,11)}=33.53$, $p<.001$, $R^2=.83$, with $p<.001$ with a $\beta= -.81$ for the rate variable and $p=.02$ with a $\beta=.31$ for the interaction of age and skill). These results suggest that children who had a lower rate of accurate ability level choices and were older with higher skill were more likely to sustain their attention longer during Choice Phase.