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Mastery Behavior and Brain Injury in Infancy

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Abstract

This study aims to determine the combined effect of degree of brain injury and age on mastery behavior among infants. Specifically, it investigates whether degree of brain injury in infancy can predict later competence, or mastery motivation behavior at both 7 and 10 months of age. In this context, mastery motivation is defined as "persistence" or the percent of time spent engaging in persistent behavior. To test the hypothesis that there would be a significant interaction between age and brain injury on mastery scores, participants engaged in 12-15-minute toy play sessions at 7- and 10-months-old. Data was analyzed using a two-way mixed ANOVA. Although a statistically significant interaction between age and brain injury was not found, the results showed a small main effect in the direction hypothesized: more brain injury was associated with lower mastery motivation scores. Also found in the direction hypothesized was that on average, mastery motivation scores were higher at age 10 months than at age 7 months among infant participants. Lastly, there was a significant difference in mastery motivation scores found among the severe brain injury group, where scores were statistically significantly higher at 10 months old than 7 months old. These results suggest that brain injury may remain relatively stable throughout infancy, unless the brain injury is severe. In the case of severe brain injury, mastery behavior appears to show a natural incline, as there were no interventions used in this study. On this understanding, varying degrees of brain injury should be considered when investigating brain injury in infancy and its effects on mastery behavior.

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Mastery Behavior and Brain Injury in Infancy

by

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Mastery motivation (referred to as mastery behavior) can be observed within several contexts, assessed in a number of ways, and result in different outcomes, depending on the extent to which a person has or displays it. To date, we know that parenting and early home environment play a major role in fostering mastery behavior (Wang, Vallotton, & Bowles, 2019), mastery behavior can be a predictor of academic success (Ramakrishnan & Masten, 2020), mastery behavior differs among ethnicities (Wang, Vallotton, & Bowles, 2019), as well as cultures (Wang, Vallotton, & Bowles, 2019; Macphee, 2018), and more. The current study focused on extending the existing literature by examining different brain injury groups as being possible precursors of mastery behavior.

It is *important* to analyze brain injury's effect on mastery behavior in infancy because to date, this continues to be a novel area of both brain injury research and mastery behavior research. This will help to fill a gap in the literature; a gap that might help to explain early signs of brain injury and what these signs mean as it pertains to the developmental trajectory of mastery behavior skills. Further, looking into the relationship between brain injury and mastery behavior can help educate parents and professionals about warning signs and the appropriate ways to intervene. Brain injury's influence on mastery behavior in infancy can be a possible precursor of later competence—and for that reason—this topic deserves attention and exploration.

Background

Defining mastery motivation has been a source of debate in developmental psychology over the last few decades in developmental psychology. Robert White (1959) proposed that human organisms have the innate need to feel competent to master their environment and that

this competence was "slowly attained through prolonged feats of learning." He defined this concept as actually being "*competence,*" which at its essence contained a motivational aspect. Although he shared White's perspective in seeing motivation as intrinsic at its essence, J. McV Hunt (1965) viewed motivation as a product of cognitive processes.

Mastery behaviors are seen as inherently pleasurable, i.e., engaged in for their own sake without immediate biological or social reward. These behaviors are deemed to play a central role in the children's construction of their view of the world. Robert McCall (1970) further postulated that organisms have two dispositions which represent the essence of adaptive and intelligent behavior: (1) to obtain information, which is accomplished by recognizing novelty, exploring and remembering their environment, and (2) to influence and exert control over their world or environment.

Leon Yarrow (1983) defined mastery motivation as "striving for *competence*; manifested in attending to the environment, as well as attempting to acquire information about it and persisting in goal-oriented activities." In addition, he operationalized the construct and standardized its measurement. The infant behaviors he studied formed a hierarchy, with behavior such as inattention, looking, mouthing and holding not deemed as reflecting mastery motivation; while task and goal directed behavior, such as trying to get a toy from behind a barrier or trying to put pieces in a puzzle, were assumed to index mastery motivation. The summed duration of these task directed behaviors was the primary measure of mastery motivation (Yarrow et al., 1983; Morgan, Harmon Maslin-Cole, 1990).

More recently, McCall (1995) proposed describing the construct of mastery motivation as "the disposition to persistently attempt to attain a goal in the face of moderate uncertainty about whether the goal can be achieved." While Nancy Ross Buschnagel (1998) further posits that

mastery motivation is "an inherent force that stimulates exploration of the environment to master moderately challenging tasks." She views mastery motivation as a precursor of achievement motivation and predictive of later school success.

Consistent among these definitions for mastery motivation, is that it is both innate and persistent, continues in the face of moderate uncertainty, and requires a mutual relationship between self and the environment. It helps to examine mastery behavior through the lens of factors which influence or are influenced by it. The level of mastery motivation possessed by an individual requires broad understanding as it is influenced by a number of external and internal factors; it also influences a number of factors, such as overall competence, school readiness, occupational performance, and more.

A few factors are outstanding and important to understand in terms of how mastery motivation or behavior develops and to what extent; they are also important to understand in terms of what is occurs or manifests as the result of level of mastery behavior possessed by an individual. Culminated from the current literature, these factors influencing and influenced by mastery behavior include but are not limited to sensory processing, parenting, gender, culture, school readiness, and intervention.

Existing Literature

Sensory Processing

Kim (2020) studied the relationship between mastery motivation and sensory processing difficulties in children with Developmental Coordination Disorder (DCD). The aim of the study was to identify the effect of sensory processing on mastery behavior in children with DCD (Kim, 2020). The study included a sample of 99 South Korean children between ages 4 and 7, all

diagnosed with DCD. To measure children's mastery level, the Dimensions of Mastery Questionnaire was administered; to measure children's sensory processing difficulties, the Short Sensory Profile was administered (Kim, 2020).

The findings revealed that all participants scoring lower on mastery behavior measure showed differences in sensory processing. Further, the researchers found a significant correlation between mastery motivation and sensory processing, as mastery motivation was able to predict sensory processing 41% of the time. Sensibly, both the 'negative reaction to failure in mastery situations' and 'general competence compared to peer's scales were significant predictors of mastery behavior scores (Kim, 2020). Essentially, the study has identified sensory processing as an important factor in mastery behavior. The study's results revealed that issues with sensory processing and low mastery motivation level are both characteristic of children with DCD in South Korea.

Additionally, the results revealed that children with higher mastery motivation scores had less issues with sensory processing. Thus, researchers concluded that improving sensory processing may be effective for increasing mastery motivation in South Korean children with DCD (Kim, 2020). One limitation of the study was that researchers overlooked the significance of dyslexia in children with DCD, and how that may have impacted the results of the study (Kim, 2020).

Parenting

Jozsa, Kis, & Barrett (2018) investigated mastery motivation, parenting, and school achievement among Hungarian adolescents. The study aimed to gain clarity on how parenting influences mastery behavior, which in turn influences/helps predicts school achievement. As

mastery motivation is known to decline in adolescence, the researchers ultimately sought to identify possible effective ways to intervene, thus preventing or minimizing the decline (Jozsa, Kis, & Barrett, 2018).

The sample included a total of 296 (n=296) Hungarian 7th graders. Hungarian students completed the mastery behavior measures at school and mothers completed parenting questionnaires at some point during parent-teacher conferences. The measures used to collect the data were the Dimensions of Mastery Questionnaire, Parental Bonding Instrument, Parental Education, and School Achievement. Structural Equation Modeling (SEM) was used to analyze and conclude the data (predictions for youth achievement) (Jozsa, Kis, & Barrett, 2018).

The results found that youth's ratings of their parent's care/warmth predicted youth's ratings of their own motivation (Jozsa, Kis, & Barrett, 2018). Further, mothers' ratings of their own care/warmth predicted mothers' ratings of their child's motivation (Jozsa, Kis, & Barrett, 2018). Both youths' ratings of their own motivation, and mothers' rating of their child's motivation predicted school achievement (Jozsa, Kis, & Barrett, 2018). The researchers also found that youths' ratings of parental independence encouragement and mothers' ratings of motivation both influence/predict school achievement (Jozsa, Kis, & Barrett, 2018). Additionally, mothers' ratings of volitional support predicted both youth and mothers' ratings on motivation which both predicted higher achievement (Jozsa, Kis, & Barrett, 2018).

In sum, the study's results alert us to the importance of being caring and warm as a parent as well as showing volitional support when socializing children's mastery motivation. The study also emphasizes mastery motivation's role in school achievement (Jozsa, Kis, & Barrett, 2018). Some limitations of the study include utilizing a self-report questionnaire and poor

generalizability, due to the sample being limited to Hungarian adolescents. Also, the study did not consider or obtain data from the fathers of the youth in the sample (Jozsa, Kis, & Barrett, 2018).

Gender

Fung, Chung, & Cheng (2019) analyzed gender differences in social mastery motivation, and its relationships to vocabulary knowledge, behavioral self-regulation, and socioemotional skills. The study included 134 child participants from China, with the children being 3 years old, on average. Appropriate measures were used for gathering data on the children's level of social mastery motivation, vocabulary knowledge, behavioral self-regulation, and nonverbal intelligence. The researchers found that boys showed a higher level of social mastery motivation during interactions than girls, while girls showed a higher level of behavioral self-regulation and socioemotional skills than boys, on average (Fung, Chung, & Cheng, 2019).

They also found that girls who scored higher on the social mastery motivation interaction also scored higher on vocabulary knowledge and socioeconomic skills, while boys who scored higher on the social mastery motivation interaction scored lower on behavioral self-regulation (Fung, Chung, & Cheng, 2019). Further, boys who exhibited positive affect while engaging in social mastery interactions also seemed to do better with expressive vocabulary, suggestively improving their behavioral self-regulation (Fung, Chung, & Cheng, 2019). In sum, the study illuminates on the idea that social mastery motivation plays a crucial role in the early development of children, but more specifically, we are able to better understand differences in social mastery behavior between genders.

Culture

Wang, Vallotton, & Bowles (2019) evaluated differences across cultures as it pertains to parenting and the socialization of mastery motivation. The study focused on three ethnic groups (White, African American, and Hispanic) and sought to discover differences and similarities in parental response styles utilized to socialize children's mastery motivation (Wang et al., 2019).

The study included a sample of 1,558 families. Parents were interviewed when the child was around 14 months old and demographic information was obtained. When the child was 3 years old, the child-parent dyads were asked to engage in a series of puzzle games. The dyad was videotaped, and the recording was coded by evaluators. The three puzzle games increased in difficulty and while the child played, the parent was instructed to allow the child to complete the puzzle without assistance unless it was needed (Wang, Vallotton, & Bowles, 2019). Both child mastery behavior and parental behavior were coded using scales from 1 to 7, 1 being very low and 7 being very high. Persistence and frustration were traits observed to indicate and identify child mastery behavior and autonomy supportiveness, cognitive stimulation, and intrusiveness were traits observed to indicate and identify parental behavior (Wang, Vallotton, & Bowles, 2019).

A number of Latent Profile Anaylsis (LPA) models with z-scores for each ethnic group, were run. This analysis revealed that each ethnic group's parental behaviors were characterized by varying combinations of autonomy supportiveness, cognitive stimulation, and intrusiveness (Wang, Vallotton, & Bowles, 2019). Across the three samples, it was found that parental autonomy supportiveness and parental cognitive stimulation were positively correlated with child persistence and frustration (Wang, Vallotton, & Bowles, 2019). Also found, was a negative correlation between parental intrusiveness and child persistence and child frustration (Wang, Vallotton, & Bowles, 2019). Generally, the study found that there were indeed, ethnic variations

in parenting styles when supporting or fostering mastery motivation in children, as well as ethnic specific parenting styles as it relates to encouraging mastery motivation in children (Wang, Vallotton, & Bowles, 2019).

The study lends us a new perspective on mastery motivation and sheds light on the importance of context. Existing research tell us that parenting plays an important role in the development of mastery motivation (Wang, Vallotton, & Bowles, 2019), and the current study helps us to understand variations in ethnic groups' parenting styles as it refers to socializing children's mastery motivation (Wang, Vallotton, & Bowles, 2019).

The researchers concluded that it may be more useful to focus on positive parental behavior such as autonomy supportiveness and cognitive stimulation, rather than focusing on parental behaviors viewed as generally negative such as intrusiveness (negative behaviors require further evaluation and understanding due to varying contexts, thus varying meaning. Another novelty approach of this study was that it examined parenting styles as both a form and a function, making it easier to identify distinctions between ethnic groups (Wang, Vallotton, & Bowles, 2019). Through LPA results derived from each ethnic group, this study gives us solid evidence of differences in parenting styles as it relates to socializing children's mastery motivation (Wang, Vallotton, & Bowles, 2019).

School Readiness

Ramakrishnan & Masten (2020) examined mastery motivation and school readiness among young children experiencing homelessness. The study included homeless children exposed to psychosocial risk, who as a result were predisposed to emotional, behavioral, and/or academic problems (e.g. children who experience homelessness have shown more emotional, behavioral, and academic problems when compared to all other children, including those

experiencing poverty) (Ramakrishnan & Masten, 2020). However, among this high-risk group, there are some that display resilience and adaptability in response to challenging situations that accompany homelessness. This study sought to identify interventions that may possibly be effective for encouraging resilience and adaptability in high-risk youth, specifically those who are homeless (Ramakrishnan & Masten, 2020).

The study included a sample of 85 children between ages 3 and 5 who lived with their parents in a shelter. To measure mastery motivation, children were asked to complete a series of behavioral tasks; to obtain information about school-readiness, parents were observed and assessed or they self-reported answers (Ramakrishnan & Masten, 2020). Parents and children were assessed in separate rooms; parents completed demographics, family, and adjustment questionnaires, while children completed a battery of school-readiness tasks (Ramakrishnan & Masten, 2020). Appropriate measures were used to obtain the data.

To measure child lifetime adversity exposure, the Child Life Challenges Scale (CLCS) was administered. To measure socioemotional problems and prosocial behavior, the Strengths and Difficulties Questionnaire was administered. To measure emotional regulation, the Emotion Regulation Checklist was administered. For measuring math achievement, the Applied Problems subtest of the Woodcock–Johnson-III-NU Tests of Achievement was administered. To measure vocabulary, the Picture Vocabulary Test was administered (Ramakrishnan & Masten, 2020). Lastly, to measure executive functioning, an average of three measures was taken, the three measures include: Dimensional Card Change Sort (DCCS), Flanker task, and peg tapping (Ramakrishnan & Masten, 2020).

Results revealed that emotion-regulation abilities are linked to mastery motivation, giving it an indirect association with prosocial behavior (Ramakrishnan & Masten, 2020). The results also, the results indicated a correlation between children's age and math achievement, vocabulary, and executive functioning, as their performance improved with age (Ramakrishnan & Masten, 2020). Additionally, the results revealed that higher mastery motivation levels were associated with more prosocial behavior (Ramakrishnan & Masten, 2020). Also found, was that higher exposure of risk and adversity was associated with more socioemotional problems (Ramakrishnan & Masten, 2020). Thus, the children exposed to more adversity had lower mastery motivation levels and more emotional lability. Worth noting, is the finding that emotion regulation was a mediating factor in the relationship between mastery motivation and prosocial behavior (Ramakrishnan & Masten, 2020). Meaning, mastery motivation's influence on prosocial behavior is dependent upon emotion regulation.

The findings of this study are important to consider as intervention focused on mastery motivation could be a major solution for children living in high-risk contexts or environments as it can assist in preventing maladaptive or wayward trajectories of functioning which emerge (Shonkoff, 2010) which emerge from the initial or early maladaptation in one domain (living environment) (Moilanen, Shaw, & Maxwell, 2010). Primarily, the finding reveals the importance of fostering emotion regulation when implementing interventions that encourage mastery behavior. Some limitations of this study include its small sample size, failure to observe data over time (or longitudinally), and poor generalizability or external validity (due to the sample being limited to those living in a homeless shelter) (Ramakrishnan & Masten, 2020).

Intervention

Gullion et al. (2020) explored mastery motivation in children at high risk for developmental delays and some implications for early interventionists. The study examined the child-rearing environment and mastery motivation in children as they relate to school-readiness. The study identified mastery motivation as the mediating factor in the correlation between children's home environment and their school readiness (Gullion, Blasco, & Saxton, 2020). The sample included 207 families with children aged 2 to 5 years old, and qualified as "low-income," as they were recruited through Head Start and Preschool Programs (Gullion, Blasco, & Saxton, 2020). Baseline assessments of child rearing, learning environment at home, and level of mastery motivation were used to predict parents' reports of mastery motivation, mastery tasks, and cognitive school readiness (Gullion, Blasco, & Saxton, 2020). Data was obtained longitudinally at certain intervals (Gullion, Blasco, & Saxton, 2020).

Measures were completed in the following order: measure of cognitive school readiness, observed mastery tasks, and a measure of interpersonal problem solving (Gullion, Blasco, & Saxton, 2020). All data collection mentioned was obtained as a culmination of information used to measure school readiness in the participants (Gullion, Blasco, & Saxton, 2020). The measures administered in the study included the Limit Setting Scale of the Parent-Child Relationship Inventory, the HOME Inventory, the DMQ-16, the Behavior Rating Scale, and the Battell Developmental Inventory (Gullion, Blasco, & Saxton, 2020).

The results of the data obtained from the sample of Head Start families revealed that significant predictors of children's school readiness include parent coercion, encouragement of learning, and parent-rated mastery motivation (Gullion, Blasco, & Saxton, 2020). The perception and understanding gained from the findings of this study are informative as they broaden the way mastery motivation is assessed and defined. Additionally, the results help to equip parents and

teachers with the knowledge needed to support and encourage academic success in low-income children through a focus on mastery motivation development intervention (Gullion, Blasco, & Saxton, 2020).

Also, worth noting, is the study's ability to highlight where and how mastery motivation originates and evolves, how this directly relates to parenting or early home environment, and how both are able to predict school readiness (Gullion, Blasco, & Saxton, 2020). One limitation of this study was its high attrition due to a need for follow-up measures.

A practical implication of this study includes the idea that temperament and mastery motivation are correlated. This information is useful for and applicable to domains of early childhood and education, and more specifically, medical settings (Morrow & Camp, 1996). For instance, nurses can use cues from infants' temperaments to predict and encourage infant development (Morrow & Camp, 1996).

To date, many studies exploring mastery behavior included samples of toddlers or older. Results from these studies enlighten us on children's ability to communicate. socialize, and engage in physical activity. While studies with infants are unable to examine these areas of competence due to premature age and development. However, although studies exploring mastery behavior in infants are unable to examine the realms of communication, socialization, and physical activity, they are able to examine early warning signs, patterns, manifestations, and inferences about mastery behavior and its trajectory. Infant mastery motivation has been assessed with a focus on early home environment, moderately challenging tasks, consistency, stability, and predictability over time, competence in early childhood, and temperament.

Studies with Infants

   Home environment. Wang et al. (2011) examined the stability of mastery motivation and its relationship with home environment among infants and toddlers. The purpose of this study involved two components which were to examine the nature of mastery motivation stability and how it differs between genders; as well as the relationship between early home environment and mastery motivation (Wang et al., 2011).

   The experiment included a sample of 102 infants and toddlers recruited from a birth cohort study at Northern Taiwan (Wang et al., 2011). The children were assessed at 2 and 3 years old for level of mastery motivation and child-parent pairs were assessed at birth, 4 months, 6 months, and 2 and 3 years old for quality of home environment (Wang et al., 2011).

   To measure mastery motivation participants were administered the Dimension of Mastery Questionnaire-17th version. The Home Observation for Measuring Environment Inventory (HOME) was used to assess the early home environment at 6 months and years old; while the Revised Infant Temperament Questionnaire was used to assess early home environment at 4 months old and the Comprehensive Developmental Inventory for Infants and Toddlers was used to assess early home environment at 2 years old.

   The results revealed a difference in mastery motivation stability between genders from 2 to 3 years old. Researchers found that girls' mastery motivation stability over time was higher than boys' (Wang et al., 2011). Also found from the results was that 6-month HOME measures were positively and significantly correlated with higher levels of mastery motivation whereas 2-

year HOME measures were not (Wang et al., 2011). These results were revealed even after controlling for gender and activity level (Wang et al., 2011).

The study's results suggest that early home environment in infancy has major impact on toddler's mastery motivation (Wang et al., 2011). Thus, it is important that parents or caregivers ensure an early home environment of high quality during infant and toddler stages; the earlier the intervention, the better mastery behavior in infancy develops.

Moderate challenges. Redding, Morgan, & Harmon (1988) examined mastery motivation in infants and toddlers and whether or not it is greatest when tasks are *moderately* challenging. The aim of this study was to investigate how level of task difficulty influences task persistent and task pleasure among infants and toddlers (Redding, Morgan, & Harmon, 1988). The study's method involved separating the children by age group. These age groups were 12,24, and 36 months old. All children were asked to complete six puzzles with different levels of difficulty.

The results of the study show that children were more persistent when doing moderately challenging tasks than when doing difficult tasks (Redding, Morgan, & Harmon, 1988). There was no significant correlation found between level of task difficulty and task pleasure, but task pleasure did increase between 24-36 months of age (Redding, Morgan, & Harmon, 1988). In conclusion and thinking practically, there was less of a correlation between cognitive measures and correlations as participants got older, so this means there is a big possibility that mastery motivation and cognition become less related as people develop (Redding, Morgan, & Harmon, 1988).

Consistency, variation, and stability. Huang & Lay (2017) explored mastery motivation in infancy and early childhood, the consistency and variation of its stability over time, and it's

predictability of general competence. This study examined mastery motivation as a possible

indicator of overall competence and did so at various intervals in both infancy and early

childhood (Huang & Lay, 2017). The goal of this longitudinal study was to examine if and how

mastery motivation is related to general competence in infancy and early childhood (Huang &

Lay, 2017). The study's sample included 10-month infants and their mothers; there were 53

participants in total. Mastery motivation and general competence scores were collected after

having infants' mothers complete the Dimensions of Mastery Questionnaire at months 10, 21,

26, 37, and 53 (Huang & Lay, 2017). Both stability and predictability analyses were conducted 3

times over 6-month periods.

The results revealed stability in children's task persistence, specifically in cognition and

physicality realms, throughout both infancy and early childhood (Huang & Lay, 2017). Also

found stable, was the negative reactions to failure, which remained constant during each set of

16-month intervals (Huang & Lay, 2017). Contrarily, mastery pleasure only showed consistency

when children were under the age of two (Huang & Lay, 2017). Finally, even after controlling

for variables such as demographics and prior competence, task persistence proved to be a

significant predictor of competence throughout infancy and early childhood (Huang & Lay,

2017).

Taken all together, the results of this study illuminate the idea that infancy may not be the

best stage to identify early competence and use it as an effective predictor of general competence

during pre-school years. Instead, parents and educators may gain from encouraging children to

continually seek to master the environment through persistent action in the face of moderate

challenge, from infancy into preschool years in order to foster overall competence and school

readiness. That is, developmental tests may not be as meaningful during infancy as they are from

infancy into preschool years. Additionally, children's negative reactions to failure did not prove to be significant in the overall development of competence. These findings can be useful for the domains of home environment and education. The results of this study find their practical purpose in parenting and educating and can be applied to both domains.

      Early childhood competence. Messer et al. (1986) investigated the relationship between mastery behavior in infancy and competence in early childhood. This study focused on developmental tests' inability to predict later competence and possible causation for this. The researchers suggest this failure may be due to certain missing dimensions of infant functioning, such as mastery behavior (Messer et al., 1986). More specifically, the researchers identify mastery behavior as a significant and telling dimension of infant functioning (Messer et al., 1986). The sample included 53 infants who engaged in 24-minute play sessions at 6 and 12 months. At both ages, the Bayley-II Scales of Infant Development was administered. Following these two intervals was the McCarthy Scales of Children's Abilities, which was administered at 30 months.

      The results indicated no correlation between infancy competence, which consisted of successful toy task play and Bayley-II scores, and McCarthy Scales obtained at 30-months (Messer et al., 1986). Although there was no correlation found between those two variables, there *was* a significant finding revealing that mastery behavior during play was a predictor for the McCarthy scale scores, or competence (McCarthy scores) (Messer et al., 1986). That is, the toy play at 6 months and task persistence at 12 months were both significantly and positively correlated with McCarthy scale scores. We learn from these results that mastery behavior in infancy is better at predicting later development than infants' toy play scores or developmental test scores.

Temperament. Morrow & Camp (1996) analyzed mastery motivation and temperament among a sample of 7-month-old infants. This study sought to explore links between mastery motivation in infancy, temperament in infancy, and cognition in infancy. The purpose of the study was to identify significant infant behaviors that nurses should look out for in order to encourage and achieve optimal development in infancy.

The sample consisted of 26 7-month infants who were recruited from a clinic; the researchers used a descriptive correlation design to conduct the study. The Bayley-II Scales of Infant Development, Fagan Test of Infant Intelligence, the Dimensions of Mastery Questionnaire, and the Revised Infant Temperament Questionnaire were all administered.

The findings revealed several interesting correlations. To begin, the researchers found that the results indicated no correlation between cognition and mastery motivation or cognition and temperament (Morrow & Camp, 1996). However, there were several correlations between mastery motivation and temperament found. Infants who scored high on mastery pleasure were rated as being more cooperative, not as difficult, more active, and less irritable than those who scored lower (Morrow & Camp, 1996).

Infants with higher rating scores in persistence were rated as being more cooperative, having more rhythm, and being less difficult on the temperament questionnaire (Morrow & Camp, 1996). Additionally, infants with higher rating scores in persistence were rated as being more approachable and less irritable. Further, infants rating high in competence were rated as being less difficult, as well (Morrow & Camp, 1996).

Taken together, existing literature has observed mastery behavior in infancy while analyzing specific factors such as early home environment, how mastery behavior is observed in the face of moderate challenges, mastery behavior's consistency, variation, and stability over

time, and how well mastery behavior in infancy can predict early childhood competence. In conclusion, from early infancy on, mastery motivation is thought to provide an important impetus for the development of self-concept, which in turn affects the expression of mastery motivation (Jennings, 1993). Jennings advances the position that between birth and 15 months of age, infants are developing the awareness that they are "active, independent causal agents" and that "this is the beginning of a sense of agency."

"The use of behaviors that reflect mastery motivation has been shown to have significant predictive validity with respect to later competence" (Hupp and Abbeduto, 1991). In fact, studies involving the use of mastery motivation as a tool for identifying and predicting cognitive development have been conducted over the last two decades on various populations. These have included typically developing infants at 6 and 12 months (Yarrow, McQuiston, MacTurk, McCarthy, Klein and Vietze, 1983), (Messer, McCarthy, McQuiston, MacTurk, Yarrow and Vietze,1986), children with Down Syndrome (Vietze, McCarthy, McQuiston, MacTurk and Yarrow, 1983), (MacTurk, Hunter, McCarthy, Vietze and McQuiston, 1985) children with cognitive delays (Hupp and Abbeduto, 1992) toddlers with developmental disabilities (Hauser-Cram, 1996), children of depressed mothers (Frodi, Grolnick, Bridges, and Berko, 1990) and deaf infants of hearing mothers (McTurk, Meadow-Orlans, Koester, Spencer, 1993).

Empirical studies suggest that early mastery motivation may be a better predictor of outcome in perinatal risk infants than early cognitive measures (Harmon and Murrow, 1995). The studies suggest that an assessment of mastery motivation, in addition to developmental level, may expand our understanding of the perinatal infant risk and provide us with a more realistic view of the child's developmental status.

Lev Vygotsky (1998) described the infant as "a maximally social being," since all of its relations are mediated by others and are always refracted through the prism of relations with another. Vygotsky posited that, in order to accurately reflect the abilities of a child, one must ascertain his potential when he works cooperatively with another. He described it as follows: when we study what a child is capable of doing independently, we study yesterday's development, whereas studying what the child is capable of doing cooperatively allows us to ascertain tomorrow's development. He defined the "area of immature, but maturing processes," as the *zone of proximal development*.

Although much of Vygotsky's work was not translated into English until after the death of Leon Yarrow, the importance of the interaction between child and adult is inculcated in Yarrow's writings on the development of mastery motivation. Yarrow (1975) emphasized the essential role of dynamic and reciprocal interaction between the infant and the caregiver in the developmental progression, to wit; "it is likely that feelings of competence and a sense of mastery develop in this reciprocal interchange with the inanimate environment and with his caregivers and other social beings." Yarrow proposed that in order to sustain cognitive growth, "stimulation from objects must be balanced by the mediation of materials by people and the direct stimulation and contingent responsiveness involved in social interaction."

On this basis, there is a current necessity to investigate infant brain injury and how it influences mastery motivation. Fundamentally, brain injuries predict developmental problems and there are limited studies that examine the effect of brain injury on mastery motivation. Mastery motivation is a pivotal part of development and is widely regarded as an important predictor of later competence. The understanding of what characterizes the effects that brain

injury has on mastery motivation is pertinent information, useful for both parents and professionals.

Present Study

Goal of the current study. The present study examines brain injury and age and how they each relate to mastery motivation behavior. The current study seeks to determine whether level of brain injury is an effective predictor of competence in low birth weight infants at 7 and 10 months of age (age is corrected for). Infants in this study were classified into 3 brain injury groups (no brain injury, moderate brain injury, and severe brain injury). according to initial assessment of functional and structural criteria (See Table 1).

Our research questions are as follows:

(1)   Is there a difference in mastery behavior scores when infants are 7 months old and when they are 10 months old?

(2)   Is there a difference in mastery behavior among different brain injury groups?

(3)   Are differences in mastery behavior when infants are 7 months old and 10 months old dependent on their degree of brain injury? (Is there a statistically significant interaction between age and brain injury group on mastery motivation scores? Are there significant differences between brain injury groups over time?)

Our hypotheses are as follows:

(1)   We expect that mastery behavior scores across all brain injury groups will be higher when infants are 10 months old than they will be for infants at 7 months old, on average.

(2)   We expect that mastery behavior scores will be statistically significantly higher for

infants in the no brain injury group than for infants in both the moderate brain injury

group and severe brain injury group; and that mastery behavior scores will be statistically

significantly higher for infants in the moderate brain injury group than for infants in the

severe brain injury group.

(3)   We expect that there will be a statistically significant interaction between brain injury

group and age of infants; we expect that there will statistically significant differences

between brain injury groups, over time. (The effect of brain injury group on mastery

behavior will be dependent on age).

Method

Participants

A total of 255 low birth weight infants participated in this study. Families were recruited

from an existing population of children born at St. Vincent hospital in Staten Island and in the

Neonatal Intensive Care Unit (NICU) between the years of 1990 and 1999. Racial and ethnic

minority groups accounted for 60.78% of the participants (45.49% African American, 13.33%

Hispanic, and 1.96% Asian) while Caucasian infants accounted for 39.22% of the participants.

Of the low birth weight infants, 100 had no brain injury, 64 had moderate brain injury and 91 had

severe brain injury.   These 255 infants were a subset of 1,212 infants who belonged to a

database derived from a larger 25-month longitudinal study addressing predictors and effects of

brain injury in infancy. They were classified in 6 categories according to their condition at birth

as indicated below according to their condition at birth (Gardner et. al, 1990).

Original dataset and present study subset. In the current study, the infants were tested

at two intervals. At Interval 1, the average age was 7 months old, corrected for number of weeks

premature if born before full term. At Interval 2, average age was 10 months old. For

consistency, if ages were corrected for prematurity at Time 1, they continued to be corrected at

Time 2. There were originally 6 brain injury categories used. For the present study, these 6 were

collapsed into 3 categories: no brain injury, moderate, and severe. Categories were collapsed as

follows: group 1infants are categorized as having no brain injury, groups 2, 3, and 4 are

categorized as having moderate brain injury, and groups 5 and 6 are categorized as having severe

brain injury. See Table 1 for brain injury criteria and categorization. All parents of the infants

completed informed consent for research approved by the Institutional Review Board (IRB) of

the NYS Institute for Developmental Disabilities (IBRDD).

The infants were tested at 18 weeks old (4 ½ months) on the Bayley-II Scales. At 7

months old (30 weeks), they were tested again on the Bayley-II Scales. Following that, at 10

months old (44 weeks), they were tested again on the Bayley-II Scales. The average mental

score on the Bayley-II Scale at Time 1 (58 days old) was 100. The average motor score on the

Bayley-II Scale at Time 1 (58 days old) was 96. Thus, the average scores were in the normal

range at 4 ½ months.

Brain injury categories. As mentioned, the current study is a subset of an original data

set, with the original data set having 6 brain injury categories. These were collapsed into 3

categories: no brain injury, moderate, and severe. Infant categorization system was adopted from

a study conducted by Gardner & Karmel (1990). In the original data set, group 1, categorized as

the "NICU-normal" group, consisted of high-risk neonates who were not typical term healthy

neonates despite having normal BAERs and USs (Gardner & Karmel, 1990). While Group 2,

categorized as the "abnormal BAER-only" group, had no documentable structural abnormality

(Gardner & Karmel, 1990) and were at risk for subsequent developmental problems (Cox, Aram,

Weissman, Borowski, & Hack, 1989; Majnemer et al., 1988; Murray, 1988). Group 3,

categorized as the "slightly insulted" infants, had US pathology that was not typically associated

with acute medical problems in the NICU (Gardner & Karmel, 1990). However, it is worth

noting that these infants showed some potential for early insult (Gardner & Karmel, 1990).

Table 1

Criteria for Brain Injury Groups

Group	Description
1. NICU-normal	Normal US, normal BAER.
2. BAER-only	Normal US, abnormal BAER
3. Slight	IVH alone (without cysts or ventriculomegaly); lobular or prominent SE hemorrhage alone or with tiny SE cysts, choroids (questionable intraventricular extension); tiny SE or choroid cysts; questionable or uncertain US.
4. Mild/moderate	IVH with SE or choroid cysts; ventriculomegaly < 5 mm; cerebral edema alone.
5. Strong/LM	IVH; ventriculomegaly 5-10 mm; periventricular or parenchymal LM, hyperechoic echogenicity, or multiple

	cysts > 3 mm; subarachnoid hemorrhage; cerebral edema > 48 hr with IVH or LM
6. Severe	IVH/PVH; ventriculomegaly > 10 mm; hemorrhage or dilatation ofIIIrd or IVth ventricle; large or multiple sites of porencephaly, parenchymal hemorrhage, or other parenchymal infarct; seizures > 1 week.

Note. NICU = neonatal intensive care unit; BAER = brainstem auditory evoked response; US = cranial ultrasonography; SE = subependymal; IVH = intraventricular hemorrhage; LM = leukomalacia

Group 4, categorized as the "mild/moderately insulted" group, were evidenced as having CNS insult but not nearly as involved as Group 5 (Gardner & Karmel, 1990). Group 5, was categorized as the "strongly insulted and predominantly leukomalacia" group, and typically had some form of IVH, although their IVH would not be easily classified into a specific Papile grade (Gardner & Karmel, 1990). Lastly, while group 6, categorized as the "severely insulted" group, had extensively involved structural pathology (Gardner & Karmel, 1990). Typically these infants had some degree of IVH, in some cases there was parenchymal involvement, gross hydrocephaly or seizures with no IVH reported (Gardner & Karmel, 1990). These 6 categories were collapsed into three categories for this study: No Brain Injury (Group 1 above), Moderate Brain Injury (Groups 3, 4 and 5 above) and Severe Brain Injury (Groups 5 and 6 above).

Procedure

Data Collection

Data were originally collected as part of a 25-month longitudinal study of mastery behavior (mastery motivation) levels in children with brain injury. Each parent-infant dyad participated in visits at 7, 10, 13, 16, 19, 22, and 25 months, resulting in a total of 7 data collection points in the original data set. The first mastery motivation data collection visit for all parent-infant dyads occurred at 7 months and the last visit took place at 25 months. The data analyzed for this current study are limited to two data collection visits: 7 months old, and 10 months old. The following terms will be used to describe the data collection visits analyzed for this study: Interval 1 (7 months), and Interval 2 (10 months).

Data collection visits at each interval took place in an examination room designated for the experiment at a lab at the NYSIBRDD. The experiment room had a table and two chairs facing each other and each session lasted between 12 and 15 minutes, as the 4 toys were presented for 3 minutes each. During the assessment, the infants sat at a table on their parent's lap, opposite the assigned examiner. The room where the experiment was held had a one-way mirror; the parent-infant dyad on one side, and a video camera on the other. The video camera was able to capture the infant toy-play, but the parent-infant dyad and examiner were unable to see the camera. The examiner would introduce the 4 toys individually and in order. For each toy, the examiner would demonstrate its function and then say, "Now you try it." Parents were instructed not to speak to or coach the child (no interference). The expectation for no interference was emphasized and motivated by the examiner during the experiment. Each opportunity for individual toy play lasted for 3 minutes and was videotaped for later review and coding.

In this study, mastery motivation or mastery behavior is operationally defined as a persistent behavior which could result in "success." Generally, "success" is operationally defined as "engaging with the toy according to each function," with "success" being different for each

toy, as toys vary in function. The duration of persistent behavior for each toy was used as

mastery motivation scores; all infants had 1 score for each toy, coded and recorded by coders

who reviewed videotapes after toy-play sessions. Final mastery behavior scores were derived

from totaling infant "success" scores for each toy. Total mastery behavior scores were the data

used to run analyses. Each infant had 1 total mastery motivation score at both 7 and 10 months

old. As mentioned, these final scores were used to run analyses.

Materials/Measures

In the current study, the free-play sessions analyzed were conducted using Yarrow and

colleagues' Mastery Motivation Assessment (MMA), which utilizes various toys to elicit 3

aspects of mastery motivation: effect production, practicing sensorimotor skills, and problem

solving (See Table 2). A total of 4 different toys were presented to the infants at each age

interval and infants were given 3 minutes of play time with each toy. The list of toys used

includes the following: The activator/pull-toy, the chime ball, the peg board, the toy behind

barrier, the surprise/pop-up box, the peg boat, the drop-a-ball, and the detour box. When 7

months old, the infants were presented with the activator/pull-toy, the chime ball, the peg board,

and the toy behind barrier. When 10 months old, the infants were presented with the

surprise/pop-up box, the peg boat, the drop-a-ball, and the detour box. The activator/pull-toy's

function was to *pull* two small balls on a string causing an effect, the chime ball's function was

to *hit* or *roll* a ball causing an effect, the peg board's function was to *put* and *remove* removable

pegs, the toy behind barrier's function was to *reach* behind a barrier to retrieve a toy, the

surprise/pop-up box's function was to open the box by operating the manipulanda (*push* buttons,

dials, and levers), the peg boat's function was to *place* pegs in holes, the drop-a-ball's function

was to *drop* balls in holes so that they roll to the end, and the detour box's function was to *reach* around a plexiglass panel to retrieve a toy.

Essentially, infants were being asked to display the ability to engage with toys according to function by pulling, hitting, rolling, putting, remove, reaching, pushing, dialing, placing, or dropping. The activator/pull-toy, chime ball, and surprise/pop-up box exhibited infant's ability to achieve effective production, the peg board, peg boat, and drop-a-ball exhibited infant's sensorimotor skills, and the toy behind barrier and detour box exhibited infant's problem-solving ability (See Table 2).

During the assessment, the infants sat at a table on their parent's lap, opposite the assigned examiner. The room where the experiment was held had a one-way mirror; the parent-infant dyad on one side, and a video camera on the other. The video camera was able to capture the infant toy play, but the parent-infant dyad and examiner were unable to see the camera. The examiner would introduce the 4 toys individually and in order. For each toy, the examiner would demonstrate its function and then say, "Now you try it." Parents were instructed not to speak to or coach the child (no interference). Each opportunity for individual toy play lasted for 3 minutes and was videotaped for later review and coding.

Table 2

Toys/Tasks for Assessing Mastery Motivation

Component	Task Name	Description
7 Months		

Effective Production	Activator/Pull toy	An apparatus consisting of two small balls on strings, which when pulled, causes a lever to hit a bell or hollow cylinder. It is hung on a boom stand in front of the infant.
	Chime ball	A transparent spherical toy containing small toy animals that move and make noise when the ball is hit or rolled.
Practicing Sensorimotor Skills	Peg board	A yellow plastic board containing six removable pegs.
Problem Solving	Toy behind barrier	A lion squeeze toy is placed behind a clear plastic rectangular barrier. The child can obtain the toy by reaching.

10 Months

Effect Production	Surprise/Pop-up box	A yellow rectangular box with five red or blue trap doors that can be opened by operating the manipulanda (push buttons, dials, and levers).
Practicing Sensorimotor Skills	Peg boat	A wooden flat boat with three holes and wooden pegs that can be placed in the holes.
	Drop-a-ball	A rectangular box with four holes in the top. Colorful wooden balls can be dropped in the holes and emerge through a side opening.
Problem Solving	Detour box	A large white box containing a clear plexiglass panel that slides from side to side on the lower front wall. A squeeze toy is placed behind the panel and can be obtained by

reaching around the

plexiglass.

Notes.

Data Analysis

A two-way mixed ANOVA was conducted using SPSS, with one repeated measure (age) and one between measure (brain injury group) to assess duration of mastery (goal-directed maneuver) behavior data collected from infant toy play at 7- and 10-months old. Post-hoc tests were run to determine and uncover specific differences between the groups. Inspection of a boxplot was used to detect outliers. To assess whether the assumption of normality had been violated, we used the Kolmogorov-Smirnov and Shapiro-Wilk tests for each group combination of the between- and within-subjects factors. Further, we assessed the assumption of homogeneity of variances by Levene's test of homogeneity of variance; homogeneity of covariances was assessed by Box's test of equality of covariance matrices. Closely assessed preliminary results included the within-subjects factors, between-subjects factors, descriptive statistics and estimates, and profile plots produced by SPSS. To assess differences in mastery behavior between groups at each age interval, we tested for the simple main effects. Following this, we also assessed the multiple comparison and pairwise comparison tables. We then interpreted the main effects for the between- and within-subjects factors and statistically significant main effects were followed up with pairwise comparisons.

Coding

Following infants' completion of the tasks, a coder, without knowing infants' brain injury group, coded the recorded video using a digital coding system. A second coder coded 25% of the sessions with average percent of agreement reaching 90%. Cohen's kappa's were also calculated, and the average was .83 for tapes for 7-month olds and .86 for 10-month olds.

To obtain mastery motivation scores, infant play was coded using a signal detection model. A few facets of infants' behaviors during toy-play were coded by coders in the original data set in which the data subset in the current study was derived: latency, frequency, and duration. For this study, as mentioned, "duration" data was the only data that was used and analyzed. When the original data set was coded, coders observed and recorded codes for 28 different behaviors; each behavior had its own code (See Table 3). For the current study, only duration data recorded for code "41," "goal-directed maneuver," was used as we only intended to examine infants' duration of persistence as it pertained to this behavior (See Table 3). These duration of persistence scores, or duration of goal-directed maneuver behavior scores, are ultimately referred to as infants' mastery motivation scores.

The original coding system uses mutually exclusive and exhaustive codes (See Table 3). The coder's task was to key in a code every time the infant emitted a new behavior. Each time a code was keyed in, a timestamp was produced. Since the codes were exhaustive and mutually exclusive, this allowed the duration of each behavior to be automatically recorded each time one was entered as coders were able to see the duration of each behavior by referring to the start and end timestamps.

Table 3

Coding used by coders for infant toy play (mastery behavior)

Level	Code	Behavior
0	00	Only look at apparatus
1	11	Only touch apparatus
	12	Only mouth apparatus
	13	Only passively hold apparatus
2	21	Manipulate
	22	Examine
	23	Bang
	24	Shake
	25	Hit or bat
	26	Drop object
	27	Reject object
	28	Offer, give
3	31	Task-related behavior (relating two objects)
	33	Grasping or holding
	34	Reach for apparatus
4	**41**	**Goal-directed maneuver (correct)**
	42	Resets problem or task

5	51	Effect produced (EP)
	52	Problem solved (PS)
	53	Motor task accomplished
8	81	Looks at experimenter (E)
	82	Vocalizes to E
	85	Looks at mirror
	86	Looks at mother (M)
	87	Vocalizes to M
	88	Leans back on M
9	95	Engaged with nontask object
	99	Other

Note. Goal-directed maneuver (correct) behavior = mastery behavior.

The toy-play sessions were videotaped on a Sony Camcorder. Coding videotapes were viewed using computer software after the free play segments were recorded onto coding tapes.

Results

As mentioned, a two-way mixed ANOVA was conducted with one repeated measure (age) and one between measure (brain injury group) to assess duration of mastery (goal-directed maneuver) behavior data collected from infant toy play at 7- and 10-months old.

Research Question #1: Is there an age difference in mastery behavior between 7- and 10-month-old infants? There was a statistically significant mean effect of *age* on mastery motivation scores for the *severe* brain injury group, $F(1, 90) = 5.77$, $p < .05$ ($p = .02$), partial $\eta2$ = .060. However, there was not a statistically significant effect of age on mastery motivation scores for the no brain injury group, $F(1, 99) = 0.46$, $p > .05$ ($p = .83$), partial $\eta2$ = .000. Additionally, there also was not a statistically significant effect of age on mastery motivation scores for the moderate brain injury group, $F(1, 63) = 2.75$, $p > .05$ ($p = .10$), partial $\eta2$ = .042 (See Table 4).

Table 4

Average Mastery Motivation Scores at 7 and 10 Months for all Brain Injury Groups

	Mastery Motivation Scores		
	N	**Mean Duration**	**Std Deviation**
Group			
7 Month	255	9.0867	7.57618
10 Month	255	10.2010	7.17219
Note.			

N = number of participants

Mean Duration = Average scores for duration/persistence

For the *severe* brain injury group, mastery motivation mean difference scores were statistically significantly improved between 7- month and 10-month age intervals (M = -2.102, SE = .87, p < .05 (p = .02)). However, for the no brain injury group, mastery motivation mean difference scores were not statistically significantly different between 7- month and 10-month age intervals (M = .254, SE = 1.18, p > .05 (p = .83)). Similarly, the moderate brain injury group, mastery motivation mean difference scores were not statistically significantly different between 7- month and 10-month age intervals (M = -1.848, SE = 1.11, p > .05 (p = .10)).

Infants in the severe brain injury group had statistically significantly higher mastery motivation scores at age 10 months old than they did at age 7 months old, suggesting that negative effects of brain injury on mastery behavior improved over time and development.

Research Question #2: Is there a difference in mastery behavior among different brain injury groups? Mastery motivation mean difference scores were statistically significantly greater in the no brain injury group when compared to the moderate brain injury group (M = 2.16, SE = .84, p = .03). Mastery motivation mean difference scores were also statistically significantly greater in the no brain injury group when compared to the severe brain injury group (M = 2.46, SE = .76, p = .004). Additionally, mastery motivation mean difference scores were not statistically significantly greater in the moderate brain injury group when compared to the severe injury group (M = .30, SE = .87, p = .94) (See Table 5).

Table 5

Average Mastery Motivation Scores for All Brain Injury Groups

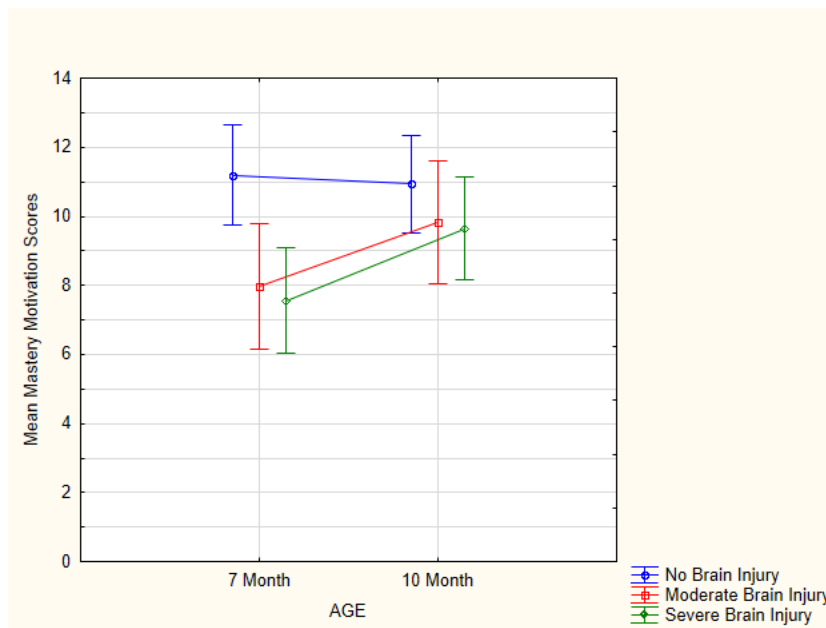|	**Mastery Motivation Scores**		
	N	**Mean Duration**	**Std Error**
Group			
No BI	100	11.071	.532
Moderate BI	64	8.899	.665
Severe BI	91	8.599	.558

Note.

Research Question #3: Is there a difference in mastery behavior between 7- & 10 -month-olds according to their degree of brain injury (is there a significant interaction between age and brain injury group on mastery behavior?) The interaction between age and brain injury was not statistically significant, which indicates that the effect brain injury had on mastery motivation scores did not depend on age. This is pictured in the line graph below (See Fig. 1). Thus, because the interaction between age and brain injury was not found as statistically significant, we

interpreted the main effects for age and brain injury. Following the interpretation of the main

effects, we reviewed the pairwise comparisons.

Figure 1

Mean Mastery Motivation Scores by Age and Brain Injury.

Figure 1

The main effect of age revealed a statistically significant difference in mean mastery motivation

scores at the two age intervals (7 and 10 months) for infants with severe brain injury, $(F_{(1, 90)} =$

$5.77, p < .05$ ($p = .02$), partial $\eta 2 = .060$). The main effect for brain injury group showed a

statistically significant difference in mean mastery motivation scores between the no brain injury

group and moderate brain injury group ($F(2, 42) = 4.32$, $p = .020$, partial $\eta 2 = .171$), and between

the no brain injury group and the severe brain injury group ($F(2, 252) = 5.98$, $p < .05$ ($p = .003$),

partial $\eta 2 = .045$) (See Table 6).

Table 6

Average Mastery Motivation Scores for Each Brain Injury Group at 7 and 10 Months

		Mastery Motivation Scores				
		7 Month			**10 Month**	
	N	**Mean Duration**	**Std Deviation**	**N**	**Mean Duration**	**Std Deviation**
Group						
No BI	100	11.1980	8.33242	100	10.9440	7.52599
Moderate BI	64	7.9750	6.61396	64	9.8234	7.32770
Severe BI	91	7.5484	6.83913	91	9.6500	6.65304

Note.

There were no outliers, as assessed by boxplot. The data was normally distributed, as assessed by Shapiro-Wilk's test of normality (p > .05). There was homogeneity of variances (p > .05) and covariances (p > .001), as assessed by Levene's test of homogeneity of variances and Box's M test, respectively. Mauchly's test of sphericity indicated that the assumption of sphericity was met for the two-way interaction as there were not three or more conditions or intervals. There was no statistically significant interaction between age and brain injury group on mastery motivation scores, $F(2, 252) = 1.56$, $p = .21$, partial $\eta2 = .012$.

Discussion

Interpretation of Data

The results indicate that there was a statistically significant effect of age on mastery motivation scores for the *severe* brain injury group, $F(1, 90) = 5.77$, $p < .05$ ($p = .02$), partial $\eta2 = .060$. More specifically, for the *severe* brain injury group, mastery motivation scores were statistically significantly improved from 7-month interval to 10-month interval (M = -2.102, SE = .87, $p < .05$ ($p = .02$)), suggesting that the negative effects of brain injury on mastery motivation improved over time and development.

As predicted, we also found a main effect of brain injury group as mastery motivation scores in the no brain injury group were higher than scores in the moderate brain injury group, and scores in the moderate brain injury group were higher than scores in the severe brain injury group. This means, the higher the degree of brain injury, the lower the mastery motivation scores. Additionally predicted, the data also showed an increase in average mastery motivation

scores between age 7 months old and age 10 months old when totaling scores for all brain injury groups.

This data emphasizes the emergence of a possible new theory—that mastery behavior may remain stable throughout infancy, unless it is severe. If brain injury is severe in infancy, this data illuminates the idea that there is a possibility that negative effects of the brain injury may improve over time and development during the infancy stage, possibly quicker and more than infants with lesser degrees of brain injury.

As mentioned, the data revealed two of our hypotheses were met, with brain injury group being a main effect and total scores across brain injury groups being higher at 10 months old than at 7 months old. Mastery motivation scores were statistically significantly lower for the moderate and severe brain injury groups than for the no brain injury group, on average; also, mastery motivation scores for the severe brain injury group were statistically significantly lower than scores for the moderate brain injury group, on average. While total averaged infant scores across all brain injury groups being 8.907 at 7 months and 10.139 at 10 months. This data met our first two hypotheses. The other hypothesis, that there would be an interaction found between age and brain injury (the effect brain injury has on mastery motivation scores would be dependent on age), was not supported by the data. Although age was not found as a significant main effect when scores in all brain injury groups were totaled, taken separately, the data revealed a statistically significant increase in scores at 7 months old and scores at 10 months old, only in infants with severe brain injury. So, although we hypothesized scores would increase significantly from 7 months old to 10 months old across all brain injury groups when totaled, it was found that a statistically significant increase in scores over time only occurred in infants with severe brain injury.

Contextualizing our findings within previous research and theory, degree of brain injury in infancy does prove to be a good predictor of later competence or mastery behavior, with scores being higher for infants with lesser degrees of brain injury. One unexpected result was there was no statistically significant interaction between age and brain injury group on mastery behavior. That is, the effect of age on mastery behavior scores did not depend on brain injury group; the change in mastery behavior scores over time was not different depending on brain injury group membership. However, mastery behavior scores were statistically significantly different from 7 months old to 10 months old in infants who had severe brain injury. Strikingly, infants with severe brain injury showed persistence over time regarding mastery behavior, even more so than their no brain injury and moderate brain injury counterparts.

One explanation for no significant main effect of age being found, could be that our longitudinal study was short-term, only covering the span of 3 months. This may not have allowed enough time for changes in the developmental trajectory to take place, and cognitive functioning may have been fairly stagnant between those two intervals.

Another explanation for age not being a significant main effect, could be that there was no intervention between age 7 months old and age 10 months old, so infants had to rely on innate motivation to engage in mastery behavior. Over the course of 3 months, this innate motivation may not have showed much improvement.

Thus, the results suggest that the impact of degree of brain injury on mastery behavior scores is not dependent on age. However, based on the findings of similar studies (Morrow & Camp, 1996; Messer et al., 1986), a more plausible explanation is that the time intervals for testing (7 and 10 months) were too close together to show a significant difference (improvement

or decline); as mentioned previously, there was not enough time given to allow development or changes to occur before retesting.

Our results do agree with previous research in that degree of brain injury is an effective precursor of mastery behavior. The results of the present study add novelty information to the existing literature as we found that severe brain injury in infancy, and its effects on mastery behavior, may possibly increase between the age of 7 and 10 months—if there is no intervention. This suggests that severe brain injury improves faster than lesser degrees of brain injury during infancy; reasons why are unknown, but this finding is a considerable start to understanding the naturally occurring trajectory of the effects of brain injury in infancy.

The understanding of this fast and early incline is an insightful addition to previous research as it identifies degree of brain injury as an important distinction to be made in early infancy. While infants with moderate brain injury maintained fairly stable mastery behavior throughout infancy in the current study, assuming this data as being applicable to other infants with brain injury, this may not be the case for infants with severe brain injury. Infants with severe brain injury appear to make strides in mastery behavior in infancy, possibly due to consistent and adequate parenting or healthy and nurturing early home environments. This may also be the result of 3 months of interacting with and manipulating the external environment (assuming the intrinsic motivation is present), thus improving their ability to master their environment. Essentially, this may simply be the result of a natural development in cognitive functioning.

The results challenge existing theories which suggest mastery motivation is *not* an innate desire that develops on its own. The current study shows a stagnancy in mastery motivation among infants with no brain injury and moderate brain injury, suggesting that there was no

improvement in mastery behavior over the course of 3 months, unless brain injury was severe. This may suggest that although the desire to master one's environment is innate, the skill and appropriate application of mastery motivation may need to be fostered or encouraged through early intervention implemented by parents and professionals.

These results should be accounted for when considering parenting approaches and caretaking for infants with brain injury and also when considering engagement with infants as a professional. The results of this study further contribute a clearer understanding of important distinctions between the effects of no brain injury, moderate brain injury, and severe brain injury as it pertains to initiating and engaging in mastery behavior. While previous research has focused on infants with brain injury without considering varying degrees of brain injury, these results demonstrate that degree of brain injury is important in understanding exactly how mastery behavior develops without the use of interventions.

The present study is strong in that reliability of this data is supported by its consistency across testing and retesting, internal consistency, and its interrater reliability (e.g. infant-parent dyad participants were tested in the same location over both time intervals, with the same researcher, and using the same procedure (aside from different toys designated for different ages). The study also approaches mastery motivation and brain injury over the course of two age intervals; an approach that has not been utilized to date. Further, the study examined mastery motivation and brain injury in infancy, which also has not been examined exclusively, to date. The Mastery Motivation Assessment used has also been proven a reliable measure.

Limitations of Study

Although the current study lends itself to the existing literature through its novelty and detailed approach, there were a few limitations that require mentioning. One limitation of the study was the sample size, as a larger sample size may have yielded different results. However, the current study only used 255 participants' data from 7 to 10-month intervals due to high attrition. Additionally, the study used a longitudinal design but the 3-month time span between intervals may not have been enough time to yield appropriate results. A longer longitudinal study would provide the opportunity to identify changes in mastery motivation across time. A longitudinal study throughout the entirety of the infancy stage of development may yield better results. Further, the original data set is not current, as data was collected from 1990 to 1999, so results may not be entirely reflective of the present. An additional limitation of the current study was our access to literature; because this is a novelty topic of both mastery behavior and brain injury research, existing literature on the topic was hard to find, thus limiting theories and measures useful for our study. Lastly, the chosen methodology could have been flawed in that the mothers' attendance could have possibly influenced the infants' behavior either negatively or positively. Similarly, lack of stimulation and familiarity in the experiment room could have influenced the infants' behavior either negatively or positively.

Due to the lack of data on differences in mastery behavior scores over multiple time periods, the results cannot confirm information regarding mastery behavior in infants younger than 7 months or older than 10 months. It is beyond the scope of this study to speak for mastery behavior after the age of 1 and/or inferences about mastery behavior in a stimulating or familiar environment.

Recommendations for Future Research

Future research is needed to establish where changes in mastery behavior occur, in early infancy, before the age of 1. Future research is also needed to identify distinct nuances which characterize varying degrees of brain injury. For instance, do small degrees of brain injury show improvements later on (after infancy)? Do severe degrees of brain injury have a late and fast decline (after infancy)? It may help to understand infants with brain injury according to their degree of brain injury and characteristics associated with their degree of brain injury.

Future studies should take into account the varying degrees of brain injury and the differences that characterize each degree of brain injury as aging and development transpire. This may help to reveal and understand patterns and correlations associated with each brain injury group, ultimately helping parents and professionals and parents to intervene effectively and accordingly.

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