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## Uncertainty Monitoring and Resiliency in Middle Childhood

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# **UNCERTAINTY MONITORING AND RESILIENCY IN MIDDLE CHILDHOOD**

A Master's Thesis

Presented to

The Graduate College of

Missouri State University

In Partial Fulfillment

Of the Requirements for the Degree

Master of Science, Early Childhood and Family Development

By

Stephanie Greenquist-Marlett

May 2021

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# UNCERTAINTY MONITORING AND RESILIENCY IN MIDDLE CHILDHOOD

Child Education and Family Studies

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Master of Science

Stephanie Greenquist-Marlett

## ABSTRACT

This study explores correlations between uncertainty monitoring and resiliency in middle childhood, an age not previously studied. Eighty-three 9- to 11-year-olds ( $M = 9.98$ ;  $SD = .693$ ) completed a researcher-created perceptual discrimination task, followed by a confidence judgment decision to determine uncertainty monitoring. Resiliency was determined via The Resiliency Scale for Children and Adolescents (RSCA) including a sense of mastery and its subsets (self-efficacy and optimism) as parts of resiliency. Significant positive correlations were found between uncertainty monitoring and sense of mastery ( $r = .23$ ,  $p = .037$ ) and its subsets (self-efficacy:  $r = .22$ ,  $p = .04$  and optimism:  $r = .25$ ,  $p = .025$ ). These results show that awareness of one's uncertainty (uncertainty monitoring) influences their approach and adaptation to challenges in their environment (resiliency). Individuals with a heightened level of uncertainty awareness may show confidence in their ability to make behavioral changes that support their life goals and exhibit a more positive outlook on life.

**KEYWORDS:** uncertainty monitoring, resilience, self-regulation, self-awareness, metacognition, self-efficacy, optimism, middle childhood, RSCA, perceptual discrimination

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May 2021

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In the interest of academic freedom and the principle of free speech, approval of this thesis indicates the format is acceptable and meets the academic criteria for the discipline as determined by the faculty that constitute the thesis committee. The content and views expressed in this thesis are those of the student-scholar and are not endorsed by Missouri State University, its Graduate College, or its employees.

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Additionally, it was a true pleasure to learn from one of the masters of uncertainty monitoring, Dr. Michael Beran, who graciously offered his wisdom and advice that guided my research design and broadened my understanding of a complex construct.

Above all, this study would not have come to fruition were it not for the inspiration from my daughter, Peridot, whose ability to express uncertainty monitoring from a young age left me in awe long before I even knew what uncertainty monitoring was. I love you with all of my heart, little one.

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## INTRODUCTION

A fourth-grade girl surveys a squirrel as it effortlessly jumps from limb to limb of an old oak tree, pausing only to grab an acorn before it scurries its way to the top. The girl ponders whether she too could reach the top and begins to climb. Halfway up, she pauses as her breath shallows. She feels her body tense a bit. Uncertain whether she can safely continue, she looks up at the next branch, inspecting its attachment to the tree. She looks down to the ground – there’s a great distance now between her and the land below. After assessing the risk, she decides to begin her descent.

Children often use cognition to assess their surroundings before adapting their behavior in a way that meets their needs. This self-regulatory skill, aptly named uncertainty monitoring, occurs when an individual evaluates a situation that requires a decision to be made, and is aware of how certain (or uncertain) they are in their response to that particular decision (Koriat & Goldsmith, 1996). Cognizance of one’s own uncertainty in a situation and having the ability to assess the risk, regulate emotions and cognitively consider the best options in terms of behavioral modifications could be advantageous traits for that individual when navigating through a particular challenge, with the potential outcome of strengthened resilience as a result.

Resiliency is largely thought about in the context of adversity, as the product of a behavioral modification made by an individual as a reaction to significant risk, hardship or trauma in order to recover in a swift and positive manner (Windle, 2011). When faced with adverse or traumatic situations, children who have developed high levels of resiliency are better equipped to recognize their feelings of uncertainty and adapt behaviors that lead to more positive outcomes overall (Newman & Blackburn, 2002). Beyond that scope, resiliency can additionally

be “exercised just in the process of living and making one’s way through the world and includes some aspect of positive functioning or wellbeing” (Denckla, Cicchetti, Kubzansky, Seedat, Teicher, Williams, & Koenen, 2020, p.14). While resiliency can exist outside of adversity (Denckla et al., 2020), this study will specifically focus on resiliency in the context of challenges or hardships an individual faces and behavioral adaptations made in response to these obstacles.

Resiliency has been found to be a genetically determined, latent trait of one’s personality (Waaktaar & Torgersen, 2012). However, these critical life skills can be developed by strengthening emotional and behavioral self-regulation capabilities (Alvord & Grados, 2005), thereby increasing opportunities for those individuals that endure hardship to “survive and thrive” (Khalid, 2019). Resilient youth have cultivated coping skills (such as stress management) that allow them to navigate through hardships in ways that reduce potential for damaging consequences (Newman, 2004).

Because the presence of resiliency has been found in youth (Zolkoski & Bullock, 2012), the proposed study explores the relationship between uncertainty monitoring and resilience in middle childhood (ages 9 to 11) to determine the potential for developing uncertainty monitoring skills as a way to strengthen an individual’s resiliency early in their development. Since resiliency development is positively correlated to self-regulation, and as uncertainty is an often-present component of adversity, this study intends to examine the associations between uncertainty monitoring and resiliency in middle childhood. Specifically, one component of resilience, sense of mastery, will be examined as it relates to uncertainty monitoring. Additionally, two subsets of sense of mastery (self-efficacy and optimism) and their associations with uncertainty monitoring will be explored. The following research questions will guide the study:

1. What is the correlation between uncertainty monitoring and resiliency in middle childhood?
  - a. What is the correlation between uncertainty monitoring and sense of mastery (a component of resiliency) in middle childhood?
    - i. What is the correlation between uncertainty monitoring and self-efficacy (a subset of sense of mastery) in middle childhood?
    - ii. What is the correlation between uncertainty monitoring and optimism (a subset of sense of mastery) in middle childhood?

## LITERATURE REVIEW

Social scientists have long praised the contributions of self-awareness for regulating emotions and adapting behaviors that conform to the values and beliefs of an individual (Leary, 2018). An individual's capacity for self-awareness can have a profound effect on one's learning capabilities (Plude, Nelson, & Scholnick, 1998) and can augment positive adaptation skills that are associated with the strengthening of resiliency (Cowden & Meyer-Weitz, 2016). Under the far-reaching umbrella of self-awareness is the construct of uncertainty monitoring, or one's awareness of their confidence in the outcomes of potential behavioral responses when a decision needs to be made (Lyons & Ghetti, 2011). Uncertainty monitoring is of particular interest when understanding how specific self-regulatory behaviors can be modified to develop resiliency, and associations between uncertainty monitoring and resiliency as they relate to middle childhood will be explored herein.

### **Uncertainty Monitoring**

Koriat and Goldsmith (1996) defined uncertainty monitoring as one's ability to assess a situation that requires a decision to be made, and to be aware of how certain (or uncertain) they are in their response to that particular decision. They noted that children who have a greater capacity to monitor their level of confidence before implementing an action or contributing a decisive answer will make more competent decisions later in life. Uncertainty monitoring allows for an individual to use caution when risk-taking and ask questions when the subjective feeling of uncertainty arises and more details are needed to make a decision or give a response (Ghetti, Hembacher, & Coughlin, 2013).

**Uncertainty Theory.** Having awareness of one's own uncertainty in a given situation allows the individual to assess their environment and consider different outcomes, creating behavior adaptations that best suit their preferred outcome choice. Uncertainty theory "assumes that we are not sure which of the areas [bio, psycho, and social] interact and are important in a given instance and provides us with the freedom to question and explore" (Strauss, 2017, p. 306). Uncertainty theory maintains that when faced with a situation that seeks an explicit or implicit behavioral response, an individual has the opportunity to collect as much information as is available to form a more comprehensive depiction of the situation in order to respond in the most competent way (Strauss, 2017). Monitoring one's uncertainty is an effective way to assess a situation that has an uncertain outcome, and based on the information gathered, make an informed decision as to the best way to proceed.

**Uncertainty Monitoring in Middle Childhood.** Researchers have discovered uncertainty monitoring in children as early as three years of age, specifically identifying this period in an individual's development as to when these self-awareness skills begin to materialize (Ghetti, Hembacher, & Coughlin, 2013). When children are aware that they are missing information about a particular thought or idea, they are able to ask questions that are appropriate for filling in the missing information (Chouinard, 2007). Further, when asked questions that they are unsure about the answers to, children will ask for clarification more often if the information given to them is muddled as opposed to when the message is clear (Patterson, Cosgrove, & O'Brien, 1980). Uncertainty monitoring develops exponentially as age groups increase (Lyons & Ghetti, 2011) and higher levels of uncertainty monitoring in children positively correlates with greater abilities to be efficacious in society and to be a productive citizen (Koriat, Goldsmith, Schneider, & Nakash-Dura, 2001).

While there is a considerable amount of information pertaining to maturation of metacognitive skills such as uncertainty monitoring in adulthood (Beran, Decker, Schwartz, & Smith, 2012), relatively little research has been conducted on the ability of children to monitor their own uncertainty. One potential reason for the discrepant amount of research on metacognition of adults versus that of children is the sophistication of verbalization skills in the former. Beran et al. (2012) argue that most research tasks constructed to test uncertainty monitoring require significant verbal competence from the participants of these studies, a considerable limitation when analyzing uncertainty monitoring potential among a variety of age groups. They further suggested that creating tasks that were behavior-based and more heavily reliant on non-verbal cues have a greater opportunity to accurately assess the existence (and degree of) uncertainty monitoring in children. Beran et al. were influenced by the abundance of studies that measure uncertainty monitoring in animals when creating their own, as the animal-subjects were tested with tasks that required behavioral responses and did not involve language, and therefore could be used as a framework when studying uncertainty monitoring in young children. Their research studied 22 children, approximately 4.5 years old, who were asked to participate in a perceptual discrimination task where they were to make a determination about the color they observed in a patch on a computer screen. The color patch was chosen at random from a spectrum of twenty color shades, with bright pink on one end and dark blue on the other. As the shades advanced to the middle, the opposite color blended into the shade progressively until the two colors met in the center and became a pink-blue combination, where classification of the color was most difficult to assess. In order to measure uncertainty, confidence judgments were made when participants used their option to ask for help if they were unsure of the answer. Beran et al. found that children asked for help more often when asked to identify a color near the

middle of the pink-blue spectrum, which were more difficult to classify as either pink or blue. Their study found evidence that young children exhibit uncertainty monitoring skills and have the capability to adapt their behaviors in an appropriate way.

Lyons & Ghetti (2011) conducted one of the few research studies that specifically identify uncertainty monitoring abilities in children as young as three years of age. In this particular study, each age group (3-, 4- and 5-year-olds) was given a perceptual identification and a lexical identification task in order to test their ability to express a level of confidence (or lack thereof) when providing answers or making decisions. Their findings concluded that children as early as age three have the capability to express varying degrees of certainty or uncertainty when asked to give a response in which they had different levels of confidence in the correct answers. These compelling studies make a strong case for the potential development of uncertainty monitoring skills well before adulthood. Due to the lack of research on middle childhood as it relates to uncertainty monitoring, studying this particular age group adds missing pieces to the body of knowledge in existence on uncertainty monitoring.

**Uncertainty Monitoring and Risk.** Opportunities for risk-taking occur when an individual must make a decision in which the outcome is uncertain to them (Little, 2010). While the perception of risk is generally a negative one (often used synonymously with hazard) (Greenfield, 2003), researchers have found that “risky play” can develop a child’s ability to endure stressful circumstances and shed fears of particular stimuli as their exposure to them increases (Sandseter & Kennair, 2011). While the term hazard implies that an individual’s exposure to danger was not a decision-based result (Greenfield, 2003), risks are “thrilling challenges”, the benefits of which include an increased ability to understand and deal with risk in the future (Little, 2010). Deciding on outcomes and adapting behaviors for situations involving

risk advance cognitive growth, allowing for individuals to more skillfully navigate through similar situations in the future (Plumert, 1995). Uncertainty monitoring allows for children to reflect on a particular risk, along with their level of certainty regarding possible outcomes, before proceeding with their chosen course of action.

**Uncertainty Monitoring as it Relates to Self-Regulation.** Through their research of uncertainty monitoring as it is exhibited in preschool-aged children, Lyons and Ghetti (2011) inferred that higher levels of uncertainty monitoring capabilities in children should indicate improved self-regulation skills in an individual. Self-regulation is a component of self-awareness in which an individual, by expanding their understanding about themselves and learning about their environment, manages how they will choose to interact with their environment in order to reach their goals (Campbell, 2002). Greater abilities to monitor uncertainty in the early years of a child's life "likely contribute to age-related improvements in strategic regulation across a variety of domains" (Lyons & Ghetti, 2011, p. 1786). Cognitions required for self-regulation to occur include making a decision as to what interaction will be made and how to implement it, disregarding outside information that is not pertinent to the interaction or goal, and staying focused on the goal in order to achieve it (Liman & Tepeli, 2019). In order to filter out irrelevant information and remain motivated on the goal (and decide on actions to attain the goal), one could presume that uncertainty monitoring would be a useful mechanism to do so.

## **Resilience**

An individual's capacity for self-awareness can strengthen positive adaptation skills associated with resiliency (Cowden & Meyer-Weitz, 2016). Resilience can be cultivated and affected by an individual's external environment, or internally via cognitive thought (Margalit,

2004). Often, resilience is exhibited when an individual faces a pronounced adversity and finds ways to successfully attain a positive consequence (such as by putting forth an adaptive behavior that is propitious) (Pratima, 2019). Resiliency in children can be identified in adverse situations where the child shows coping skills when met with uncertainty, and proceeds to elude or overcome a potentially damaging circumstance (Newman, 2004). Richaud (2013) recognized that one of the defining skills that children with high resiliency possess is the ability to withstand uncertainty in their lives.

**Sense of Mastery.** To understand resilience as a construct, one must acknowledge its measurable characteristics. Prince-Embury (2007b) suggests that sense of mastery (MAS), a component of resiliency defined as the belief in one's ability to command their environment, is resiliency's core quality. The concept of sense of mastery was proposed by Robert White (1959), who suggested that one's inherited curiosity propels them to navigate cause-and-effect scenarios in satisfying ways. How one perceives the control they have over their chances and opportunities in life signifies their sense of mastery (Milan, 2006).

As a coping mechanism, sense of mastery has been found to play an important role in a person's overall well-being, including both one's physical and mental health (Eriksson & Lindstrom, 2006). Those who exhibit a greater sense of mastery trust in their abilities to achieve goals through their approach to varied circumstances within their environment; conversely, individuals with lower sense of mastery may feel helpless and ineffective in dealing with challenges in their environment or within themselves (Lachman & Weaver, 1998). Sense of mastery can be developed over time and adapts and changes to varying circumstances, and therefore is not thought to be a stable personality trait (Pearlin, Nguyen, Schieman, & Milkie, 2007). Factors such as stressors, economic hardship and poor academic performance can hinder

one's sense of mastery (Shanahan & Bauer, 2004). A positive association found between sense of mastery and harmony suggests that those who feel strong in their capabilities to make positive adaptations to their surroundings will experience greater satisfaction in life (Garcia, Nima, & Kjell, 2014).

Self-efficacy. One subset of sense of mastery, self-efficacy, can be defined as an individual's perception of their ability to respond to challenges in a way that is beneficial for them (Prince-Embury, 2007b). Bandura (1993), who is highly regarded for his social learning theory, found correlations between one's confidence in their capabilities in maneuvering through challenges and their motivation and resulting behavioral adaptations, regardless of whether their beliefs in their abilities and their actual abilities aligned. White (1959) additionally found self-efficacy to be a critical element of human development and growth.

One's belief in their own efficacy impacts a person's cognitions, behaviors and motivation strategies (Zulkosky, 2009). Self-efficacy has been additionally linked to effort and perseverance (Pajares, 2002) and can often predict performance levels in most scenarios (Heslin & Klehe, 2006). In a study by Wyman, Cowen, Work, & Kerley (1993), students who exhibited greater self-efficacy often exhibited reduced anxiety and greater success in school. Bandura (1977) argued that systematically incorporating efficacious experiences for students can strengthen their self-efficacy. Higher levels of self-efficacy in youth between 10- and 12-years-old often relates to more positive adaptations and resilience towards stressors (Cowen, Pryor-Brown, Hightower, & Lotyczewski, 1991).

Optimism. Optimism (another subset of sense of mastery) is one's positive outlook on their life, both in the present and in the future, as well as how they view the world around them (Prince-Embury, 2007b). An optimistic viewpoint is positively associated with greater coping

abilities and overall well-being when experiencing adverse conditions (Carver, Scheier, & Segerstrom, 2010). Optimism has been found to be a stable personality trait, with a 25% heritability estimate (suggesting that there is a genetic component contributing to one's level of optimism) (Plomin, Scheier, Bergeman, Pedersen, Nesselroade, & McClearn, 1992). However, optimism is also influenced by environmental factors (such as parental warmth and economic stability, for example) (Heinonen, Rääkkönen, Matthews, Scheier, Raitakari, Pulkki, & Keltikangas-Järvinen, 2006).

According to Carver, Scheier and Segerstrom (2010), an individual's resilience and ability to gauge their environments is one determining factor of their optimism. They found that likewise, optimism in the face of adversity or trauma allows for greater persistence and resolve when navigating difficult circumstances. Optimism acts as a powerful motivating quality that allows an individual to manage their behaviors and block emotions that might conflict in order to achieve life goals (Paul, 2011). A study by Supervía, Bordás, and Lorente, (2020) additionally found significant positive correlations between optimism and life satisfaction, with goal-oriented behaviors acting as a link between the two.

**Resiliency as it Relates to Self-Regulation.** Self-regulation is an internal skill that can be attributed to developing and strengthening resiliency within an individual (Alvord & Grados, 2005). While producing behaviors that are positive and productive are a result of self-regulatory control, preventing potentially negative behavior is an additional benefit of this crucial life-skill (Korucu, Selcuk, & Harma, 2017). In the area of trauma (particularly chronic trauma), Khalid (2019) discovered that self-regulation promotes resiliency in ways that allow impacted individuals to “survive and thrive.” Eisenberg, Spinrad, and Morris (2002, p. 122) find that “well-regulated people are expected to be relatively high in the ability to voluntarily control

themselves as needed to respond in an adaptive manner.” Therefore, it could be suggested that those individuals who can regulate their behaviors by using uncertainty monitoring as a tool to assess a particular risk or uncertain outcome would be able to adapt well to adversity or hardship and strengthen their resiliency in the process.

**Resiliency and Risk.** Two fundamental elements that are instrumental in growing a person’s resiliency are risk and uncertainty (Niehues, Bundy, Broom, & Tranter, 2015). Age-appropriate risk-taking opportunities in childhood can influence an individual’s abilities to manage uncertainty and face adversity or hardship (Niehues et al., 2015). Risk-taking play in childhood is positively correlated with increased resiliency skills later in life (Gull, Goldenstein, & Rosengarten, 2017). In a qualitative study by Niehues et al. (2015), a group of 37 parents with children ages 5 to 17 were interviewed about characteristics they found to be advantageous or preferable traits for their children to possess. In addition to happiness and good health, a majority of the parents expressed their desires for resilient children. Parents who understood risk as a natural and common aspect of life discussed the ever-present uncertainties their children face daily and felt that risk was beneficial in growing resilience. Those parents who had lived through trauma or other significant obstacles appreciated uncertainty as an opportunity for their children to take age-appropriate risks in order to gain valuable life skills such as resiliency (Niehues et al., 2015).

The previously mentioned study on risk-taking by Gull, Goldenstein, and Rosengarten (2017) explored the benefits associated with tree-climbing and the opportunities for resilience-building. Over 1500 participants with children ranging in age from 3 to 13 years were asked to complete a questionnaire (with both qualitative and quantitative questions) about their children’s tree-climbing habits and the benefits the parents believed were associated with this potentially

risky activity. The researchers discovered that climbing trees affords children the opportunity to come face to face with uncertainty, assess the risk and adapt their behaviors accordingly. The researchers concluded that these opportunities for risk-taking and the decisions made based on them help develop a child's resiliency (Gull, Goldenstein, & Rosengarten, 2017). It seems plausible that using uncertainty monitoring to assess one's certainty in taking a particular risk (such as tree-climbing) would build one's confidence in making future decisions with positive outcomes when confronted with a risk and would strengthen one's resiliency in the process.

### **Uncertainty Monitoring and Resilience**

After extensive research on this topic, this author has yet to find any studies directly relating uncertainty monitoring to resiliency. While uncertainty monitoring has been established as a component of self-regulation (Lyons & Ghetti, 2011), and whereby self-regulation has been positively correlated to resiliency (Alvord & Grados, 2005; Cowden & Meyer-Weitz, 2016), it is an easy conclusion that there may be a connection between uncertainty monitoring and resilience. The present study seeks to provide more direct insight on uncertainty monitoring as a possible predictor for resiliency in middle childhood. My hypothesis is that children who have greater awareness of their degree of uncertainty in a challenging situation and are able to reflect on that uncertainty before deciding on how to respond (uncertainty monitoring) will have a greater capacity to cope with uncertainty, and thus exhibit greater resiliency.

## METHODS

### Participants

A total of 92 children from across the United States participated in the study. Of those, 83 children completed both measures, and it was data from those which was used for data analysis. Participants who completed the study were 83 9- to 11-year-old children (41 boys and 42 girls) ( $M = 9.98$ ;  $SD = .693$ ). Percentages of children who were in fourth and fifth grade were 56.5%, 43.4% respectively. The participants were 75% White, 9.6% Asian, 2.4% African American, 2.4% American Indian or Alaska Native and 2.4% Native Hawaiian or Other Pacific Islander.

### Measures

The Institutional Review Board approved IRB-FY2021-192 on 12/08/2020 (see Appendix). Resiliency was measured via the Resiliency Scale for Children and Adolescents (RSCA) through an electronic Qualtrics survey. Uncertainty monitoring was measured using a perceptual discrimination computer program. Both measures were conducted over a Zoom video conferencing session.

**Resiliency.** The Resiliency Scale for Children and Adolescents (RSCA) is a peer-reviewed survey that competently assesses resiliency in children ages nine through 18 and is designed for a third grade reading level (Prince-Embury, 2008). One scale of the RSCA which is of particular interest is the “sense of mastery” (MAS) scale. This scale incorporates adaptability, self-efficacy and optimism in order to examine an individual’s behaviors as they relate to cause-and-effect experiences in their environment. An example statement from this subscale is, “I can

think of more than one way to solve a problem.” (Prince-Embury, 2007b). The statements that make up the sense of mastery component of the RSCA survey were scored on a Likert scale that ranges from 0 (signifying a “never” response) to 4 (signifying an “almost always” response). The raw scores from these scales, along with several specifically chosen subscales (self-efficacy and optimism) were calculated and evaluated in relation to the uncertainty monitoring variable. The subscale of adaptability was omitted from analysis, as the RSCA questionnaire does not interpret this variable for the age-group represented in the study.

Reliability of the RSCA was determined using Cronbach’s alpha coefficients (Cronbach, 1951) that were computed for the sense of mastery scale for the 9 – 11 age group to ensure internal consistency. Moderate to high alpha coefficients were found (.85). A confirmatory factor analysis found a strong validity of the RSCA that was consistent for the sense of mastery scale and its subscales (Prince-Embury, 2007b).

**Uncertainty Monitoring.** Uncertainty monitoring was measured via a series of perceptual discrimination computer tasks. The first part of each trial featured a pair of boxes that were varied in the amount of pixels they exhibited (ranging from sparsely to densely populated boxes) (Figure 1). For each trial, participants were given seven seconds to choose the more densely populated box. Upon making a selection, a new screen was presented that featured a “more sure” button and a “less sure” button, with the title “Are you confident in your answer?” (Figure 2).

Participants were instructed to provide confidence judgments by selecting “more sure” (showing that they were confident in their selection) or “less sure” (that they were not confident in their selection). They were given seven seconds to make a selection in this portion of the trial as well. Trials were timed so that a speeded judgment was forced. If a confidence judgment was

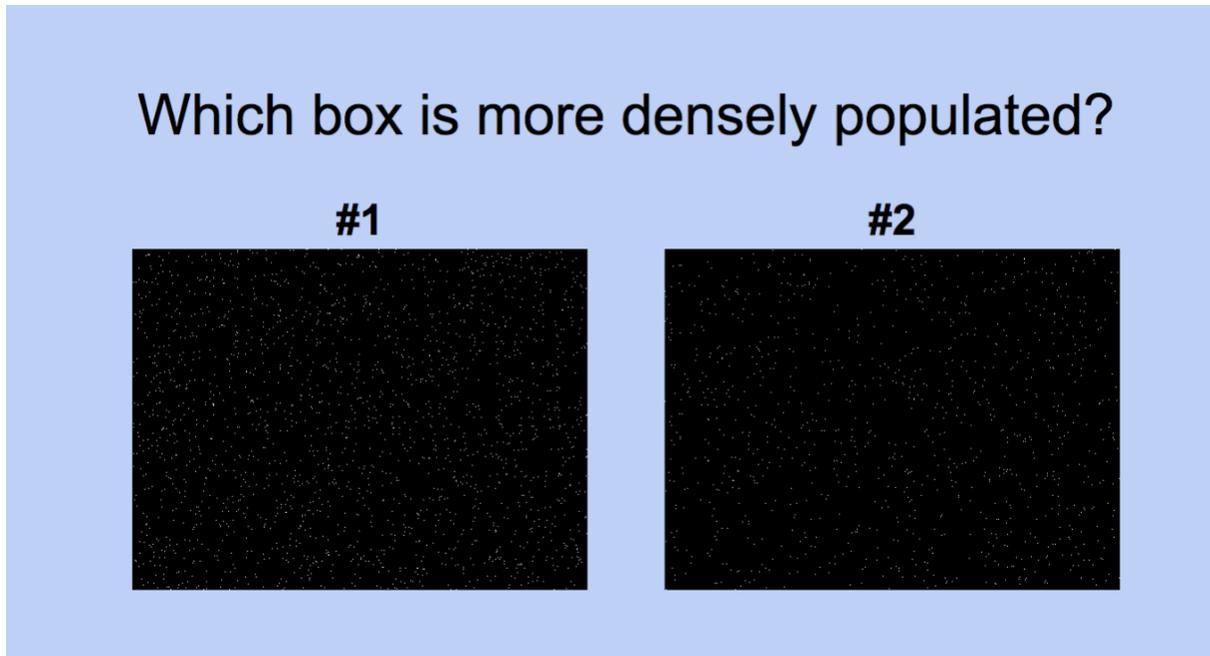


Figure 1. Trial window featuring two pixelated boxes. Participants are instructed to select the more densely populated box.

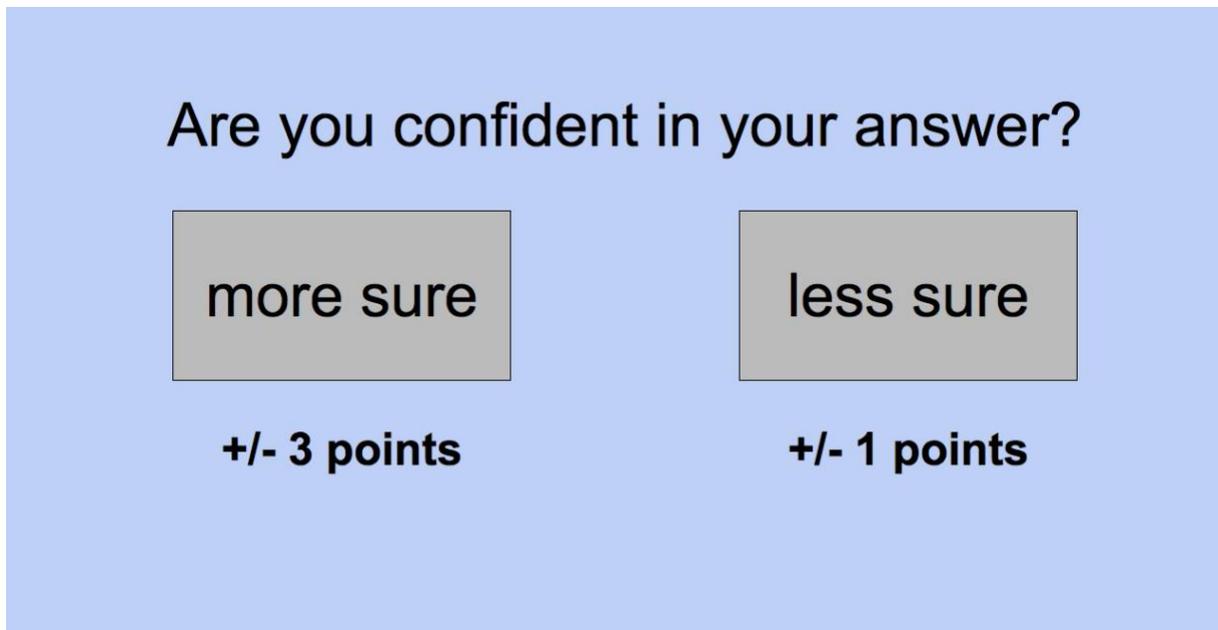


Figure 2. Trial window featuring two confidence judgments. Participants are instructed to select the “more sure” confidence judgment if they are confident they chose the most pixelated box in the previous trial window. Conversely, participants are instructed to choose the “less sure” confidence judgment if they lack confidence in their choice of boxes.

not chosen within the seven seconds allotted, the trial would “time out” and the next trial would appear on the screen. There were no inter-trial intervals, as a click on a confidence judgment immediately took the participant to the next trial.

In order to motivate participants to give each task their best attempt, it was explained at the head of the study that points would be awarded for correct answers and taken away for incorrect answers. Participants were told that they were competing against their peers to win a prize (with those receiving the most points determined as the winners). Upon completion of the study, however, all participants were awarded a prize regardless of their final point count. Prior to beginning their trials, participants were instructed on the point system, in which three points would be awarded for correct responses and the accompanying “more sure” confident judgment, while three points would be lost if they chose the wrong answer along with a “more sure” confidence judgment. Participants were additionally given the option to choose the “less sure” confidence judgment, in which case they would gain only one point for a correct answer but only risk losing one point for an incorrect answer. Should participants fail to make a selection within the seven-second window, zero points would be awarded for those particular trials.

**Use of Trials and Test Phases.** Participants were given ten practice trials considered to be “easy trials” (a pair of boxes in which one is very sparsely populated and the other is very densely populated) at the top of this measure. Practice trials allowed the participants to familiarize themselves with the task, build confidence in discerning between sparsely and densely populated pixel boxes, and ask for clarification if unclear about the instructions. Once the practice trials were complete, participants entered the test phase. During the test phase, participants completed 139 trials (which ranged from medium to high difficulty continuously but were randomly organized).

## **Procedures**

Participants were recruited via social media posts and through correspondence to principals who reached out to their population of middle childhood students in order to seek out interest for participation. Permission to reach out to potential participants and families were extended to the principals of three southern California schools, via an email message. Researcher communicated directly with interested families to schedule study times and obtain parental and child consent. Additionally, social media posts advertising the study were shared with interested parties responding to the messages, during which time the researcher offered details of the requirements of the study and scheduled times for participation.

Upon the outset of the study, which was held individually via Zoom virtual conferences, participants and their parents were required to read and complete an electronic consent form, signifying their willingness to participate in the study. Participants then filled out a demographics survey before completing the Resiliency Scale for Children and Adolescents (RSCA) (Prince-Embury, 2007b) via an online Qualtrics survey. Once the participants reached the end of the survey, they were met with the following message: “We thank you for your time spent taking this survey. Your response has been recorded”. Participants were then instructed to close the survey and were directed to a link which pulled up the perceptual discrimination which measured uncertainty monitoring. The researcher explained the directions for the trials and gave the participants an opportunity to ask any questions before proceeding with the trials.

Participants pressed a “start” button when they were ready to begin and proceeded to make density choices and confidence judgments for ten practice trials and 139 test trials. When completed the perceptual discrimination task, participants were debriefed and given a prize, regardless of the final score that they achieved on the uncertainty monitoring measure. Verbal

instructions for the task are as follows:

On your screen, you will see a pair of boxes that have varying amounts of dots. For each trial, click on the box that is more densely populated than the other box. The more densely populated boxes are the ones that have more dots in them than the other box. You will have seven seconds to make your selection. After you have chosen a box, another screen will pop up that asks the question, “Are you confident in your answer?”. On this screen, you will click on the box that says “more sure” if you believe you chose the correct box, and you will click on the box that says “less sure” if you are unsure that you chose the correct box. There will be points associated with the answers you choose, and a prize will be awarded to the top participants who score the most points. If you choose the correct box that has the most dots in it and answer “more sure”, you will be awarded three points. However, if you make an incorrect choice and choose the box that has less dots than the other box, and then answer “more sure”, then three points will be taken away. On the other hand, if you choose the correct box that has the most dots in it and answer “less sure”, you will be awarded one point. If you make an incorrect choice and choose the box that has less dots than the other box, and then answer “less sure”, then one point will be taken away. Remember, if you are unsure, you may want to choose the “less sure” button so that you don’t lose as many points if you choose a wrong answer. Do you have any questions about what you have to do?

## **Analyses**

To determine resiliency, the item scores from the sense of mastery (MAS) scale of the RSCA were added to make one total “raw” score per section. Each item in a subscale was associated with a number depending on the given responses, with a score of 0 given to “never” responses, 1 for “rarely” responses, 2 for answers of “sometimes” and 4 for “almost always” responses. Summing up the scores for each item in the sense of mastery scale produces a raw score ranging from 0 – 80. A higher number on the sense of scale indicates higher levels of those variables. Subscale scores were similarly calculated, by adding the scores of all items with each variable (self-efficacy and optimism).

To determine uncertainty monitoring, the trials in the perceptual discrimination task deemed “difficult” and “very difficult” were correlated with uncertain confident judgments (the “less sure” response button). Trials that were considered “difficult” were those which had a difference of 300 – 599 pixels between the more dense and less dense pixel boxes (Table 1).

Table 1. Uncertainty Monitoring Trial Types and Pixel Differentiation

	Types of Test Trials			
	Easy	Medium	Difficult	Very Difficult
Pixel Difference	900 - 1240	600 - 899	300 - 599	9 - 299
Number of Trials	16	23	49	54

Out of 139 total trials, 49 trials fit into the “difficult” category. Trials that were considered “very difficult” had a difference of 9 – 299 pixels between more dense and less dense pixels. Fifty-four trials were deemed “very difficult” in this measure. It was considerably more difficult to discriminate between the two boxes in terms of pixel density than it was for the “easy” to “medium” trials, which featured boxes that had a difference of 600 – 1240 pixels between the two. The easy to medium levels consisted of 39 trials (specifically, 16 easy trials and 23 medium trials were used). This is in addition to the ten “easy” trials of between 900 – 1240 pixels used for the practice trials at the head of the measure.

The score of the sum of the “difficult” and “very difficult” trials were chosen for analysis as it would be more difficult to make a distinction between the more densely populated box and the less densely populated box (as they had a similar amount of pixels in each). Likely, participants would have a more difficult time determining which of the two boxes had the greater amount of pixels in these trials as they were closer in density than in the “easy” and “medium” trials in which one box is significantly more sparse than its pair in comparison. This study assumed that a greater feeling of uncertainty would be attributed to the “difficult” and “very difficult” trials as participants would have a harder time discerning between which box is more densely populated for those. Upon making a selection between pixelated boxes, those participants who made a “less sure” confidence judgment about their choice were considered to show awareness of their uncertainty (uncertainty monitoring). Because it is harder to differentiate between the denser of the two boxes in these trials, those individuals who exhibited uncertainty monitoring when making a selection would presumably choose a “less sure” confidence judgment. In doing so, they are expressing their understanding of their own lack of confidence when choosing the more populated box in the first part of the trial (they are aware of their uncertainty).

The data from both quantitative measures were analyzed via a Pearson Correlation Coefficient (the *Pearson r*) to discern strength of the relationship between resiliency and uncertainty monitoring. A bivariate correlation was run for each of the chosen resiliency variables independently with the uncertainty monitoring variable (which was the total combined raw score of the “difficult” and “very difficult” perceptual discrimination tasks together, referred to as the Difficulty Index). A correlation matrix represented the degree to which each variable

correlation showed significance and the output containing this data was reviewed for implications. The findings were synthesized in the conclusion of the study.

## RESULTS

### Research Questions

The goal of this research study was to explore the relationship between uncertainty monitoring and the components of resiliency in middle childhood. The three factors of resilience measured via the RSCA included one broader component, sense of mastery, and two subsets, self-efficacy and optimism (Table 2). Uncertainty monitoring (UM) was measured by tabulating

Table 2. RSCA Resiliency Scales and Subsets

Scale	Subset
Sense of Mastery (MAS)	Self-Efficacy
	Optimism

the instances when participants selected the “less sure” confidence judgment for the perceptual discrimination trials deemed “difficult” or “very difficult”. A Difficulty Index was created by summing the uncertain responses (“less sure” selections) for both the “difficult” and “very difficult” trials. Descriptive statistics were calculated for the mean of the Difficulty Index (difficult and very difficult trials).

*Question 1 – What is the correlation between uncertainty monitoring and sense of mastery (a component of resiliency) in middle childhood?*

A Pearson correlation coefficient was calculated for the relationship between participants' uncertainty monitoring and sense of mastery. A positive correlation was found,  $r = .23, p = .036$ , indicating a significant relationship between the two variables. An association between uncertainty monitoring and sense of mastery is shown (Table 3).

Table 3. Pearson Correlations Among Uncertainty Monitoring and Components of Resilience

Variable	<i>n</i>	<i>M</i>	<i>SD</i>	1	2	3	4
1. UM <sup>1</sup>	83	43.8	28.26	-			
2. MAS <sup>2</sup>	83	59.22	10.42	.23*	-		
3. Self- efficacy	83	28.92	5.95	.22*	.94**	-	
4. Optimism	83	21.04	3.99	.25*	.84**	.65**	-

\*. Correlation is significant at the 0.05 level (2-tailed).

\*\*. Correlation is significant at the 0.01 level (2-tailed).

<sup>1</sup> UM is the abbreviation for "uncertainty monitoring".

<sup>2</sup> MAS is the abbreviation for "sense of mastery".

*Question 2 - What is the correlation between uncertainty monitoring and self-efficacy (a subset of sense of mastery) in middle childhood?*

One particular subscale of sense of mastery that was of interest in this study was the component of self-efficacy. A Pearson correlation coefficient was calculated for the relationship between participants' uncertainty monitoring and self-efficacy. A positive correlation was found,  $r = .22, p = .04$ , indicating a significant relationship between the two variables. There is a relationship between uncertainty monitoring and self-efficacy in an individual.

Question 3 - *What is the correlation between uncertainty monitoring and optimism (a subset of sense of mastery) in middle childhood?*

Another subset of sense of mastery that this study focused on was optimism. A Pearson correlation coefficient was calculated for the relationship between participants' uncertainty monitoring and optimism. A positive correlation was found,  $r = .25$ ,  $p = .03$ , indicating a significant relationship between the two variables. An association between uncertainty monitoring and optimism has been found.

### **Summary**

As predicted by the hypothesis, significant positive correlations were found between uncertainty monitoring in middle childhood and sense of mastery (MAS), a component of resiliency. The research data also showed an association between uncertainty monitoring and self-efficacy, a conceptually-related subset of sense of mastery. Additionally, a positive relationship has been found between uncertainty monitoring another subset of sense of mastery, optimism. Below, implications of these findings will be explored.

## DISCUSSION

Although this study is an extension of previous research focusing on uncertainty monitoring in early childhood through adulthood, this marks the first time that uncertainty monitoring has been examined as it relates to resiliency. The results of the analyses indicate that there is a significant positive correlation between uncertainty monitoring and sense of mastery, a component of resiliency. Further findings show an association between uncertainty monitoring and self-efficacy, a subset of sense of mastery. Another subset of sense of mastery, optimism, was found to have a positive association with uncertainty monitoring as well.

Speculating on the findings, one might conclude that the skills developed in those individuals who have high levels of uncertainty monitoring abilities easily translate into one's development of sense of mastery. As mentioned earlier, sense of mastery can be learned and grown as one interacts with their environment (Pearlin et al., 2007), and therefore, has the potential to be influenced by uncertainty monitoring. As sense of mastery is the belief that an individual can control their own opportunities and life outcomes (Pearlin & Schooler, 1978), if an individual had confidence in their ability to exhibit awareness of their uncertainty and make beneficial adaptations accordingly in the presence of risk, they would also likely exhibit confidence in their abilities to control their environment through their behavioral adaptations in order to achieve a favorable outcome that aligns with their personal goals and values.

Likewise, it is possible that high levels of sense of mastery may predict greater uncertainty monitoring. If an individual owns the perception that they can easily control their environment, they may exhibit less stress or intimidation when met with uncertain situations and therefore may have greater clarity in their awareness of their uncertainty. As research on the

topic of uncertainty monitoring is relatively new (spanning just over two decades), it has not yet been uncovered whether uncertainty monitoring is a biological trait or learned characteristic (or a combination of both, and to what degree). It is known, however, that uncertainty monitoring develops exponentially over time from childhood into adulthood (Lyons & Ghetti, 2011), which may suggest an evolving characteristic that has the potential to be grown in an individual. As such, a correlation between sense of mastery and uncertainty monitoring suggests that both skills may have the opportunity to influence the development of one another to varying degrees.

Given that uncertainty monitoring and sense of mastery are positively correlated, it is not surprising that self-efficacy (a component of sense of mastery) also shows a positive relation with uncertainty monitoring. An individual who possesses the ability to be aware of their uncertainty (uncertainty monitoring) and can confidently navigate through it would also likely show greater confidence in their abilities to successfully navigate through other situations (self-efficacy) regardless of whether uncertainty is present or not. If self-efficacious people have a greater belief in their ability to set out to achieve goals, having an awareness of uncertainty they may encounter on the way would allow for them to label that feeling and adapt their behavior in ways that propel them towards their goals rather than away from them. Additionally, a greater self-efficacy in a person may lend itself to greater awareness of one's uncertainty, in that their motivation to attain successful outcomes would influence their desire to be more aware of their environment, so that they could make decisions that were more beneficial to them.

Another finding of interest was the positive correlation of uncertainty monitoring with the optimism subset of sense of mastery. If someone has a heightened level of awareness of their uncertainty in an environment, that individual may be better equipped to make positive behavioral adaptations that lead to more favorable outcomes. As a result, they may possess a

more optimistic outlook on life and on their own capabilities than those who exhibit less awareness of their surroundings and less confidence in their abilities to navigate new or risky situations that could lead to positive outcomes. As studies have shown a positive relationship between optimism and coping skills (Carver, Scheier, & Segerstrom, 2010), those who possess greater uncertainty monitoring may be better able to endure hardship. Alternatively, a person who has a more optimistic outlook on their life may find that in situations of uncertainty, it is more advantageous to have heightened awareness of uncertainty they may encounter if it means that more positive outcomes result (and help maintain or strengthen their level of optimism in the given circumstance).

## **Implications**

Practical implications of the findings in this study may be considered through educational, family and psychological contexts. This information has the potential to be utilized in varied learning environments in order to develop resiliency skills or awareness in the presence of a risk. Further, school curriculum, child and family development programs and clinical treatment strategies could incorporate the research findings for their benefit as well.

Possible contributions from this study may support curriculum supplements in early education which teach and promote increased self-awareness as well as awareness of one's environment. Cultivating this mindfulness, particularly in the early stages of a child's development, may increase their ability to assess risk in uncertain circumstances and inform their behavioral adaptations in order to achieve more positive outcomes (as well as more positive outlooks). Social-emotional learning opportunities in the classroom would be enriched with a focus on awareness (an awareness of awareness, even) as a way for children to be more

cognizant of their surroundings. As they build their own awareness, children may be better prepared to face real-world scenarios in which they are faced with uncertainty and may build confidence in their decision-making, as they may have a greater understanding of potential outcomes.

Families who face significant hardship or adversity may strengthen the resiliency of the individuals who make up their family system by developing their uncertainty awareness. They may identify circumstances of uncertainty and related responses, and then by suggesting behavioral adaptations that could warrant the most beneficial outcomes. Likewise, resilient families may find benefit to promoting awareness of uncertainty in their children so that they may be better equipped to navigate risk.

As resiliency and uncertainty monitoring are positively correlated, clinicians specifically may find it advantageous to build strategies for uncertainty awareness in their patients to promote resiliency development (sense of mastery skills in particular). Resiliency programs could potentially use the information from this study to strengthen their methods for providing proper counseling. Individuals who have developmental disorders such as ADHD and high functioning autism often find ways to alleviate their symptoms (such as risky behaviors) by building their resiliency (Dvorsky & Langberg, 2016). Clinicians may find that uncertainty awareness may build resiliency in these individuals and reduce negative outcomes in a risk-taking scenario. In like manner, therapists may find benefit in building resiliency through uncertainty monitoring strategies in clients who are experiencing major life transitions and are more likely to experience uncertainty in their particular states.

## **Limitations**

Conducting a study virtually (over Zoom conferencing) presents a limitation, in that only participant families who have access to internet and a computer (or iPad, phone or other tablet-like technology) are able to complete the associated tasks. Due to this restriction, participants of lower socioeconomic statuses or who are located in rural regions where internet is unavailable may not be represented in the data. While the study attempted to cast a wide net in order to obtain participants that represented different ethnic backgrounds, due to the nature of the social media posts, the specific groups that information about the study was posted in and the interest in response, the participants were largely of a White background and few other ethnicities were represented.

Another condition of the virtually-conducted survey was that the researcher allowed a parent to stay with the participant if they felt more comfortable, to alleviate any safety concerns. Additionally, some parents requested to read the survey questions directly to the participants for various reasons (such as a reading impediment, for example). Due to occasional parental presence, the researcher recognizes that the participants in these instances may have altered their answers to reflect those that would appease their parents rather than responding authentically when truthful answers may have made the parent or participant uncomfortable. For future research, it would be well-advised to provide a more controlled environment where distractions and outside influences would be less likely to impact the data.

## **Further Research**

Due to the lack of research on uncertainty monitoring as it related to middle childhood, it was appealing to target this specific sample population for my study and add to the body of

knowledge available on uncertainty monitoring. However, further research would benefit from studying an older population of children (say, adolescents), as their uncertainty monitoring abilities in general likely would have been more developed than in middle childhood age (Lyons & Ghetti, 2011) and thus may have produced more significant findings. In addition, the Resiliency Scales for Children and Adolescents (RSCA) survey measures adaptability and tolerance in older children, an opportunity that was not afforded to this current study as these variables were interpreted in the RSCA starting at age 15 and 12, respectively (Prince-Embury, 2007b). It could be inferred that the presence of uncertainty monitoring when faced with a risk or decision could result in a behavioral adaptation, and therefore it would be helpful to understand how, specifically, the adaptation component of resiliency correlates with uncertainty monitoring.

## **Conclusion**

This study adds to the expanding body of knowledge intended to understand uncertainty monitoring in children, adding information specifically about the presence and degree of this variable in middle childhood (a population that hadn't previously been researched in this aspect). Knowing that uncertainty monitoring is more than a philosophical concept and is very much a real, measurable skill allows for researchers to discover what potential positive attributes it possesses or the influence it may present when correlated with other life skills. On the basis of this research, future studies could consider associating other variables with uncertainty monitoring, such as emotional and physical regulation, to understand the strength of those relationships and their significance.

Uncertainty is an ever-present part of the human condition, and the inability to be certain about the details of a particular situation may cause stress and other negative emotions. If

we can grow our awareness of our own feelings of uncertainty, we may be better equipped to adjust our behaviors and emotions in accordance, thus avoiding unwanted outcomes and alleviating potential discomfort or trauma associated with the experience. Building the essential skills to accept and then positively adapt to uncertainty in one's environment may enhance one's awareness or grow conflict resolution skills that could lead to a more efficacious lifestyle in those who develop these attributes.

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# APPENDIX: Human Subjects IRB Approval

Date: 3-31-2021

**IRB #:** IRB-FY2021-192  
**Title:** Evaluating Uncertainty Monitoring and Resiliency in Middle Childhood  
**Creation Date:** 10-7-2020  
**End Date:**  
**Status:** Approved  
**Principal Investigator:** Joanna Cemore Brigden  
**Review Board:** MSU  
**Sponsor:**

## Study History

<b>Submission Type</b> Initial	<b>Review Type</b> Expedited	<b>Decision</b> <span style="color: red;">Approved</span>
<b>Submission Type</b> Modification	<b>Review Type</b> Expedited	<b>Decision</b> <span style="color: red;">Approved</span>

## Key Study Contacts

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