I THINK I CAN, I THINK I CAN: SELF-EFFICACY IN THE CONTEXT OF PEDIATRIC MAGNETIC RESONANCE IMAGING

by

Melissa Howlett

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ABSTRACT

Procedural distress is common among children and has been shown to interfere with cooperation and response during medical procedures. Predictors of procedural distress have been widely studied in an effort to inform identification of children who are at higher risk for procedural distress and those who may benefit from intervention in the form of preparation or support during the procedure. However, many of the predictors identified in previous research do not inform what should be the target of efforts to reduce procedural distress, nor whether such efforts are successful. While not yet studied in the context of pediatric medical procedures, self-efficacy theory suggests that self-efficacy is a reliable predictor of behaviour, that is also measurable and modifiable. Self-efficacy may be useful in the area of pediatric medical procedures as it could provide a target for intervention with direct impacts on procedural distress. The current dissertation sought to examine the role of self-efficacy in the context of pediatric medical procedures, using magnetic resonance imaging (MRI) as a model procedure. Study 1 focused on the development of the MRI Self-Efficacy Scale for Children (MRI-SEC), including both child and parent forms, followed by an assessment of the preliminary psychometric properties. An iterative approach to measure development was followed, in which feedback was incorporated from experts in pediatric MRI, in addition to children and parents with and without prior MRI experience. Subsequently, 127 child-parent dyads completed the MRI-SEC, in which acceptable internal consistency, test-retest reliability, and convergent validity were demonstrated. Study 2 consisted of a randomized-controlled trial, examining the modifiability of MRI self-efficacy when targeted with preparation, and MRI self-efficacy as a mediator of the beneficial effects of preparation on procedural distress. Among a sample of 104 child-parent dyads, children in the preparation condition self-reported higher MRI self-efficacy and lower anticipated fear toward MRI, as compared to children in the control condition. An increase in MRI self-efficacy through preparation was shown to mediate the reduction in anticipated fear. Group differences were not observed for parent measures, with the exception of anticipated child response toward MRI. Lastly, Study 3 investigated MRI self-efficacy and parent-reported confidence in their child's ability to complete MRI, as predictors of procedural distress and procedural outcomes, among 139 children scheduled for a clinical MRI scan. Child-reported MRI self-efficacy was shown to be a significant predictor of observed procedural anxiety and cooperation at the beginning of the scan, and the need for general anesthesia. Parent confidence in their child's ability to complete MRI significantly predicted image quality and the need for general anesthesia. Taken together, the findings of this dissertation provide evidence that self-efficacy is a measurable and modifiable predictor in the context of pediatric MRI. A number of theoretical and clinical implications are derived from this research that directly inform how to best support children through potentially stressful medical procedures, like MRI.

LIST OF ABBREVIATIONS AND SYMBOLS USED

ADHD	Attention Deficit Hyperactivity Disorder
ANOVA	Analysis of Variance
ASD	Autism Spectrum Disorder
B	Unstandardized Coefficient
CAM-S	Child Anxiety Meter – State Anxiety
CASI	Childhood Anxiety Sensitivity Index
CFS	Children's Fear Scale
CONSORT	Consolidated Standards of Reporting Trials
α	Cronbach's alpha coefficient
d	Cohen's d
F	*F* statistic for ANOVA
f^2	Cohen's *f*-squared
FSS-R-SF	Fear Survey Schedule for Children-Revised-Short Form
g	Hedge's g
GA	General Anesthesia
ICC	Intraclass Correlation Coefficient
κ^2	Kappa-squared
M	Mean
Med	Median
MRI	Magnetic Resonance Imaging
MRI-SEC	MRI Self-Efficacy scale for Children
MRE	Magnetic Resonance Enterography
mYPAS	Modified-Yale Preoperative Anxiety Scale
n	Sample Size
NRS	Numerical Rating Scale
p	*p*-value for Testing of Significance
r	Pearson Correlation Coefficient
R^2	Squared Multiple Correlation Coefficient
RA	Research Assistant
RCT	Randomized-Controlled Trial

SD	Standard Deviation
SE	Standard Error
STAI	State-Trait Anxiety Inventory
SPSS	Statistical Package for the Social Sciences
t	*t*-test Statistic
TMCQ	Temperament in Middle Childhood Questionnaire
χ^2	Chi-square Test Statistic
95% CI	95% Confidence Interval
95% BCa CI	95% Bias Corrected and Accelerated Confidence Interval

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CHAPTER 1. INTRODUCTION

This dissertation examines the role of self-efficacy in the context of pediatric medical procedures, using magnetic resonance imaging (MRI) as a model procedure that is commonly distressing for children. It includes three publication-style manuscripts. The first manuscript focuses on the development and preliminary validation of the MRI Self-Efficacy Scale for Children (MRI-SEC). Both child and parent versions of the MRI-SEC were developed and assessed. The second manuscript describes a randomized-controlled trial (RCT) examining the modifiability of MRI self-efficacy, as measured by the MRI-SEC. Group comparisons and mediation analyses were employed to first examine the modifiability of MRI self-efficacy, and second to assess self-efficacy as a mediator of the relation between preparation and child-reported fear toward MRI. The third manuscript describes an empirical study that investigated child- and parent-report on the MRI-SEC as predictors of child procedural distress and procedural outcomes.

For the purposes of this research, MRI self-efficacy was operationally defined as children's self-perceived ability to manage the salient aspects of MRI and carry out the skills necessary for successful scan completion. Before presenting the three individual studies, the current chapter will provide an introduction to the relevant literature that informs this research, and a brief overview of the objectives and hypotheses of each study.

Procedural Distress

Children undergo a number of medical procedures as part of routine (e.g., immunizations) and specialty care (e.g., surgery, diagnostic imaging). For many children, medical procedures can cause high levels of procedural distress, defined as strong negative affect in response to a medical procedure, fueled by anxiety, stress, and fear (Birnie et al., 2018; Kain et al., 1996). Procedural distress is common among children, with estimates suggesting that 50-70% of children experience severe procedural distress in response to surgery alone (Kain et al., 1996).

Consequences of Procedural Distress

High procedural distress has been shown to be associated with many adverse consequences during the procedure, immediately after the procedure, and even longer-term (Racine et al., 2015; Taddio et al., 2012). During the procedure, high procedural distress often leads to poor behavioural compliance and cooperation, prolonged completion time, and interference with the ease with which the procedure is completed (Chorney & Kain, 2009; Lerwick, 2016). High procedural distress can also result in typically non-sedated procedures (e.g., diagnostic imaging) requiring sedation for successful completion, thereby increasing the risks, costs, and time associated with the procedure (Carter et al., 2010; Tornqvist et al., 2015). In the time after the procedure, procedural distress has been shown to influence pain (e.g., higher pain reports, greater need for analgesia), the length of recovery, and post-procedure behaviour (e.g., separation anxiety, eating and sleep challenges) and mental health (e.g., increase in general anxiety; Kain et al., 2007; Kain et al., 1996). For these reasons, high procedural distress can result in an overall negative medical experience, often associated with even higher procedural distress toward future procedures (Bijttebier & Vertommen, 1998; Kain et al., 1996; Lumley et al., 1993; Racine et al., 2015). The effects of procedural distress in childhood have been shown to persist into adulthood, through fear of medical events, avoidance of medical care, and reduced compliance with preventative care (Chen et al., 1999; Pate et al., 1996; Taddio et al., 2010).

Intervention for Procedural Distress

Given the immediate and potentially longer-term adverse consequences of procedural distress, a large literature base focused on minimizing distress has accrued. Cognitive and behavioural management strategies have been widely studied, targeting all timepoints of a procedure; before, during, and after (Cohen et al., 2017).

Preparation programs have been shown to be effective for a range of procedures (Cohen, 2008; Kain & Caldwell-Andrews, 2005; Melamed et al., 1978) and typically involve providing children and parents with information and teaching effective coping behaviours in advance of a procedure (Blount et al., 2003; Blount et al., 2006). Key components of preparation programs include the provision of procedural information (e.g., how long the procedure will take, what tools will be used, why the procedure is necessary, what the child will be asked to do) and sensory information (e.g., physical and emotional sensations that may be experienced during the procedure), modeling, exposure to and practice of the skills associated with the procedure, and teaching effective use of coping behaviours (e.g., distraction, relaxation techniques) (Blount et al., 2003; Blount et al., 2006; Blount et al., 2008; Cohen, 2008; Cohen & MacLaren, 2007; Cohen et al., 2017; Dalley & McMurtry, 2016; Jaaniste et al., 2007; Tak & van Bon, 2006; Wright et al., 2007). The overall goals of preparation are to reduce children's uncertainty and potential fear of the unknown, allow children to feel they have as much control and choice as possible, and ensure children have the skills they need to engage in effective coping during the procedure (Bijttebier & Vertommen, 1998; Boles, 2016; Kain &

Caldwell-Andrews, 2005).

In addition to preparing children before procedures, there are also a number of empirically supported interventions that can be delivered during procedures to minimize procedural distress and encourage use of learned coping behaviours. Such techniques include distraction (e.g., music, audio-visual systems, videogames, virtual reality), desensitization, mental imagery, deep breathing, hypnosis, positive reinforcement of adaptive behaviours, positive self-statements, modeling, and coaching to prompt coping strategies (Birnie et al., 2018; Chambers et al., 2009; Kazak & Kunin-Batson, 2001; Keefe et al., 1992; Powers, 1999; Young, 2005). Parental presence is another strategy often employed, but highly debated in the literature in terms of its effectiveness in reducing procedural distress (Erhaze et al., 2016; Manyande et al., 2015; Piira et al., 2005; Wright et al., 2017; Wright et al., 2010).

Despite ample research demonstrating the benefits and efficacy of intervention for procedural distress, there are barriers to clinical implementation. Routine delivery of preparation can be costly, in terms of personnel, hospital resources, and time (Brewer et al., 2006). Further, not all children will require or benefit from preparation. The success and sustainability of preparation programs require evidence-informed identification of children who may benefit from preparation and/or additional support for medical procedures. Awareness of the factors that contribute to procedural distress and of the mechanisms of successful preparation are necessary to help healthcare providers accurately identify children who may be at risk of procedural distress and thus provide information around when preparation and/or support during the procedure is required.

Predictors of Procedural Distress

Research involving children undergoing common procedures (e.g., immunizations, blood draws, intravenous needle insertions, dental work, surgery) suggests a number of factors that contribute to the onset and maintenance of procedural distress. Racine and colleagues (2015) recently reviewed the evidence for commonly cited predictors of procedural distress, revealing a dynamic interplay of individual child, parent, and procedural factors. Individual child factors with clear evidence include difficult, fearful, or shy temperament (e.g., increased inhibition, withdrawal, high activity), psychopathology (e.g., pre-existing anxiety), prior negative and painful medical experiences (e.g., high frequency of procedures, intense pain, distress, or procedural complications), behaviour during previous medical events, maladaptive cognitions (e.g., feelings of lack of control, high threat appraisal), and limited knowledge about the procedure (Racine et al., 2015; Salmela et al., 2010; Kain et al., 1996; Wright et al., 2013; Davidson et al., 2006; Wollin et al., 2003). While child age and developmental level are often cited as contributory to procedural distress, the evidence is largely inconclusive (Racine et al., 2015). Parent factors with clear evidence include parental trait and state anxiety, parent's own pain and medical experiences, parent's own anxiety toward medical events, parental knowledge about the procedure, behaviour during and leading up to the procedure (e.g., modelling, overprotection, reinforcement, encouragement), and parent's anticipation of child distress (Racine et al., 2015).

While the presence the aforementioned factors can alert healthcare providers of children and families who may be at risk for higher procedural distress (Racine et al., 2015), they do not necessarily inform how to best support children during procedures nor what should be targeted through intervention in an effort to reduce procedural distress, improve cooperation, and ensure a positive medical experience. The identification of modifiable risk factors of procedural distress is of interest to clinicians, as such knowledge would suggest when intervention is recommended and provide insight into a specific target for assessment and the mechanisms of effective treatment (Brown et al., 2018). The theoretical bases for the development and management of procedural distress is lacking. One potentially predictive construct that has yet to be studied in the context of pediatric medical procedures is self-efficacy. Self-efficacy may provide valuable insight in the area of procedural distress given its well established predictive capability in other constructs and its modifiable nature (Bandura, 1986; Bandura, 1997; Guttuso et al., 1992). Investigation of potentially modifiable risk factors, such as self-efficacy, will greatly inform both theoretical and clinical advancements in the procedural distress and pediatric care fields.

The Theoretical Framework

The primary guiding theoretical and conceptual framework for this research is self-efficacy theory. Self-efficacy theory was developed by Albert Bandura, within the larger framework of social cognitive theory (Bandura, 1986). Social cognitive theory emphasizes the interplay between cognitive (e.g., knowledge, expectations, attitudes), behavioural (e.g., skills, complexity, practice), and environmental factors (e.g., social influences, physical environment) in determining human motivation and behaviour (Bandura, 1977). A guiding tenet of social cognitive theory is that individuals intentionally seek and interpret information in their environment, as contributors to their motivations and behaviours (Nevid, 2009). Self-efficacy is a vital construct of social cognitive theory as it accounts for the application of knowledge, skills, and environmental factors into behavioural attainments (Maibach & Murphy, 1995).

Self-Efficacy

Self-efficacy is formally defined as an individual's judgement of their capability to perform the actions required to attain a desired outcome (Bandura, 1977; Bandura, 1997). Bandura's theory of self-efficacy (1977) posits that self-efficacy is a personal control cognition that accounts for an individual's ability to organize and execute the actions required to achieve set goals. Self-efficacy judgments are specific to the situation in which they occur and to the skills and behaviours required to achieve the desired goal in that situation (Bandura, 1986; 1977; Hofstetter et al., 1990). Thus, self-efficacy can vary depending on the situation, and can also vary within a situation depending on environmental factors, the behaviours required at different stages, and the degree of similarity with other prior experiences (Maibach & Murphy, 1995; Riggio, 2012). Proponents of self-efficacy theory suggest that while having the knowledge, information, and skills in a particular situation will play a critical role in determining one's performance, it is imperative that one also interprets and truly believes they are able to perform what is being asked of them in order for successful performance to follow (Bandura, 1997; Muris, 2001; Schunk & Meece, 2006).

Self-Efficacy as a Predictor of Behaviour

Perceptions of self-efficacy play a key role in determining behavioural functioning, such as expended effort, the initiation of coping behaviours, and persistence when faced with challenging situations (Bandura, 1986; Maibach & Murphy, 1995). Self-efficacy is also tightly aligned with the nature of thought patterns that can enhance or undermine performance (e.g., encouraging or self-deprecating thoughts) and the regulation of affective states during task performance (Bandura, 1986; Barlow et al., 2001). Together, these characteristics of self-efficacy position it well to be a valid predictor of behaviour in a specific situation (Guttuso et al., 1992). Self-efficacy theory asserts that one's beliefs around capability are more important than actual capability and the knowledge one has about the situation at hand (Bandura, 1997). For example, the evaluation of self-efficacy in childhood has been especially prominent in educational research, revealing that regardless of previous achievement or ability, students with higher self-efficacy work harder, persist longer, persevere, have greater optimism and lower anxiety, and in general achieve more than peers with lower self-efficacy (Pajares, 2005).

A fairly large literature base on the topic of self-efficacy among children has grown, originating in the domains of educational and social self-efficacy (Pajares, 2005). Studies in pediatric chronic illness have also emerged, in which self-efficacy has been shown to be an important predictor of disease management and adherence to treatment (Dunbar-Jacob & Mortimer-Stephens, 2001). Specific evidence for the predictive capability of self-efficacy has emerged in the areas of diabetes (Griva et al., 2000), asthma (Bursch et al., 1999; Miles et al., 1995), chronic pain (Bursch et al., 2006; Tomlinson et al., 2017), epilepsy (Caplin et al., 2002), arthritis (Barlow et al., 2001), and cystic fibrosis (Thompson et al., 1998). The widespread range of such research demonstrates feasibility in assessing self-efficacy among school-aged children and adolescents, and consistent evidence that self-efficacy is an important variable within the area of children's health.

Self-Efficacy as a Modifiable Construct

Self-efficacy is considered to be a modifiable construct that is amenable to clinical intervention (Bandura, 1986; Bandura, 1994a; Litt, 1988; Guttuso et al., 1992) through four main pathways: enactive mastery, vicarious exposure, verbal persuasion, and interpretation of physiological and affective states (Bandura ,1982; Bandura, 1997; Pajares, 2005; Tsang & Law, 2012). The first and most influential pathway is enactive mastery, developed through personal experience and success with a particular task (Bandura, 1982). Theoretically, Bandura (1994b, 1997) asserts that mastery experience is the most effective way to enhance self-efficacy, as it provides direct and observable proof of capability and subsequent success. The assertion that enactive mastery is the most influential pathway has been supported by research findings. Specifically, when compared to vicarious exposure and verbal persuasion, enactive mastery has been found to account for the most variance in self-efficacy enhancement (Ashford et al., 2010; Muretta, 2005; Ott et al., 2000; Wise & Trunnell, 2001).

The second proposed pathway is vicarious exposure, through modeling. Vicarious exposure is a form of social comparison, in which observing another individual (e.g., peer, parent) have success, can enhance an individual's own perceived efficacy toward completing the same task successfully (Bandura, 1997; Tsang & Law, 2012). Vicarious exposure has been shown to be the second strongest predictor of self-efficacy, when compared to enactive mastery and verbal persuasion (Wise & Trunnell, 2001).

The third proposed pathway is social or verbal persuasion, which is most influential when provided in the form of honest and encouraging feedback and praise from those important to the individual (e.g., parents, peers, teachers; Bandura, 1997;

Tsang & Law, 2012). Verbal persuasion has been shown to enhance self-efficacy, particularly when combined with mastery experiences, and if subsequent performance on the task is successful (Pajares, 2005; Wise & Trunnell, 2001). While verbal persuasion is a commonly used technique, it is both theoretically and empirically the weakest individual source of self-efficacy (Ashford et al., 2010; Bandura, 1997; Ott et al., 2000), as individuals tend to respond to such persuasion with disbelief if they do not hold similar beliefs in their abilities (Warner et al., 2011).

The fourth proposed pathway is interpretation of physiological and affective states. Physiological indicators of fear and anxiety (e.g., increased heart rate) can signal that one lacks the capability to perform the task successfully, thus leading to lower self-efficacy (Bandura, 1997; Pajares, 2005; Tsang & Law, 2012). The influence of physiological and affective states on self-efficacy depends on an individual's cognitive appraisal of such physiological symptoms (Artino, 2012; Bandura, 1997).

Evidence of the modifiability of self-efficacy and its subsequent benefits on outcomes has been demonstrated across a number of areas and patient populations (i.e., child, adolescent, adult). For example, self-efficacy has been shown to increase through the use of multi-component interventions that emphasize the enhancement of self-efficacy and the development of behavioural skills, in the context of promoting recreational physical activity (Ashford et al., 2010; Dutton et al., 2009; Dishman et al., 2004; Williams & French, 2011), adherence to treatment for arthritis (Barlow & Barefoot, 1996; Barlow et al., 1999), changing addiction behaviours (Hyde et al., 2008), increasing knowledge of healthy nutrition practices (Tuuri et al., 2009), and reducing disability and increasing emotional functioning and pain acceptance among individuals with chronic pain (Tomlinson et al., 2017). The enhancement of self-efficacy through intervention has also been shown to mediate intervention effects. For example, in an attempt to increase physical activity among adolescent girls, Dishman and colleagues (2004) demonstrated that an intervention tailored to enhance self-efficacy (e.g., mastery experiences, skill development) resulted in an increase in participation in physical activities, and this effect was mediated by an increase in self-efficacy. Taken together, interventions leading to enhanced self-efficacy have been associated with improved medical adherence and health knowledge, reduced illness activity, and increased positive health behaviours across various health populations. These findings provide further evidence that self-efficacy can be enhanced through intervention and that enhancement subsequently leads to improved outcomes (Bandura, 2004).

The Theoretical Application of Self-Efficacy to Pediatric Medical Procedures

To the author's knowledge, self-efficacy has yet to be examined in the context of pediatric medical procedures. Self-efficacy is relevant to the pediatric procedural literature, as it is situation-specific (i.e., a good predictor of behaviour in a specific situation), modifiable, and thus amenable to clinical intervention.

Self-efficacy theory suggests that having the knowledge and skills required for a procedure is not adequate for successful outcomes; rather, an individual must believe they can be successful (Bandura, 1997; Muris, 2001; Schunk & Meece, 2006). This assertion is consistent with previous research demonstrating that information provision alone is not sufficient in adequately preparing children for medical procedures (Jaaniste et al., 2007; Kain & Caldwell-Andrews, 2005; Wright et al., 2007). For this reason, multi-component preparation interventions have been developed and deemed to be effective in improving procedural outcomes. Notably, key components of many evidence-based interventions for procedural distress correspond to the pathways of self-efficacy enhancement. For example, exposure to and practice with aspects of the procedure can provide mastery experience. Videos that display procedural and sensory information often include clips of another child successfully completing the procedure and/or discussing their experience, which can provide vicarious exposure through peer modelling. Praise and reinforcement by parents and staff during exposure and practice, as well as leading up to the procedure, can provide verbal persuasion. Lastly, teaching coping behaviours (e.g., deep breathing, mental imagery) can inform the experience and interpretation of physiological symptoms. Given the stark overlap between the pathways of self-efficacy enhancement and many of the key intervention components, it is plausible that preparation may function through an enhancement of self-efficacy.

As previously discussed, there are a number of factors that contribute to the onset and maintenance of procedural distress (e.g., difficult, fearful, or shy temperament, psychopathology, experience and behaviour during previous medical events, parent anxiety and expectations). Whereas many of these predictors may indicate risk for procedural distress, most are non-modifiable and thus do not necessarily inform direct targets for intervention or provide information on whether an intervention was successful (Blount et al., 2000; Racine et al., 2015). For example, if a child is considered to be high risk for distress on the basis of temperament or prior negative medical experiences, these factors would not be expected to change during intervention and therefore would not be an indicator of whether preparation was successful. In contrast, having a modifiable predictor that can be both assessed and targeted through intervention, like self-efficacy, provides a pathway for the assessment of intervention success (i.e., increase in self-efficacy). As such, post-intervention assessment of self-efficacy could indicate whether the child feels prepared for the procedure and inform planning for the day of the procedure to facilitate a positive medical experience.

In summary, self-efficacy is distinct from many previously identified predictors of procedural distress, in that it may provide a target for intervention and insight into how effective treatments work. Identification of self-efficacy as a measurable and modifiable predictor of behaviour in the context of pediatric medical procedures has the potential to contribute substantially to both theoretical and clinical advancements, with the goal of improving medical experiences for children.

General Measurement of Self-Efficacy

Given that self-efficacy is situation-specific, each domain of interest and study of self-efficacy requires tailored measurement (Bandura, 2006). Self-efficacy is an internal belief and therefore it is measured through self-report, by having individuals indicate their level of perceived efficacy toward a variety of skills associated with the situation of interest. Sound and valid measurement of self-efficacy is critical in understanding and predicting behaviour in a given situation. In addition to general best practices for measure development (Boateng et al., 2018; Holmbeck & Devine, 2009), guidelines for the development of self-efficacy scales have been shared in an effort to promote comprehensive and theoretically rigorous measures of self-efficacy (Bandura, 2006; Maibach & Murphy, 1995).

As relevant to the development of all measures, items should accurately reflect the construct to achieve appropriate content validity (Boateng et al., 2018). First, a thorough conceptual analysis of the situation or domain of interest is required, to specify which aspects of perceived efficacy should be measured (Bandura, 2006). Guidelines suggest focus should be on factors in which individuals can exercise some level of control, and all necessary behaviours and skills relative to the domain must be included. The inclusion of all behaviours is important in order to allow for the most accurate overall measure of self-efficacy. In the case of self-efficacy scales, it is also important that items be presented as “can do” statements to reflect a judgement of capability, rather than “will do” statements, which reflect a statement of intention (Bandura, 2006).

Self-efficacy measures should include items that assess multiple levels of task demands, with items covering the varying degrees of challenge associated with successful performance (Bandura, 2006; Maibach & Murphy, 1995). Task demands refer to aspects about the situation that can either impede or facilitate behaviour. Potential challenges will vary based on the situational demands in a given domain, but common examples include the level of exertion, accuracy, threat, or self-regulation required to complete the behaviour (Bandura, 2006). For example, when measuring perceived self-efficacy to increase healthy eating behaviours, it is important that items assess judgements of how well individuals believe they can adhere to the healthy eating plan under various levels of task demands, such as when tired or feeling down, going to a restaurant with peers, or under stressful time constraints at work. Approaching self-efficacy measurement in this way provides a refined assessment that accounts for potential barriers and facilitators of self-perceived capability, allowing for even more accuracy in predicting the behaviour of interest. Identification of barriers also offers targets for intervention to increase perceived capability and tailoring programs to meeting individual needs (Maibach & Murphy, 1995).

Reporting on perceived self-efficacy requires individuals to indicate whether or not they believe they can accomplish the behaviours required in a specific situation and the strength of their efficacy belief (Maibach & Murphy, 1995). Most often these two judgements are incorporated into one response for each item, in the form of a numerical rating scale (0 'cannot do', 50 'moderately certain can do', 100 'highly certain can do'; Bandura, 2006). While the original recommendation for response scales was a wide numerical rating scale, shortened response formats (e.g., ranging from 0 to 10) have been widely utilized and accepted as well.

Specific Considerations for Self-Report with Children

There are many cognitive and developmental considerations that must be prioritized in developing and using self-report measures with children. The assessment of self-efficacy requires children to think about their mental state, skills, and behaviour in a hypothetical sense and apply it to a future scenario. There are a number of cognitive abilities required to mentally generate and provide self-report in the context of a future event. Jaaniste and colleagues (2016) recently completed a detailed review of the cognitive-developmental factors that influence children's ability to report on non-present pain experiences (e.g., past, future, hypothetical). Many of the cognitive abilities identified can be applied to the assessment of self-efficacy among children, including theory of mind, the ability to generate secondary representations, the ability to anticipate future needs, metacognition, and self-awareness and self-evaluation. Each of these abilities uniquely contributes to an individual's ability to report on their physical and emotional needs in a scenario situated in the future. *Theory of mind* describes the ability to attribute mental states to oneself and others, enabling one's ability to develop multiple perspectives and thus identify the self in future physical states (Arbuckle & Abetz-Webb, 2013; Astington & Dack, 2008). The *ability to generate secondary representations* (i.e., mentally picture a scenario that differs from the present) leads the way for children to engage in imagination, pretend play, and the generation of goals (Perner, 1991; Suddendorf & Corballis, 2007). The *ability to anticipate future needs* allows children to foresee and take action in a way that will support them in achieving favorable outcomes in the future (Atance & Meltzoff, 2005, Suddendorf & Busby, 2005). *Metacognition* (i.e., thinking about thinking) is a prerequisite for considering possible future scenarios (Suddendorf, 1999). Lastly, *self-awareness and self-evaluation* are both abilities deemed necessary to estimate and understand one's response and ability to cope with certain situations (Harter, 1998; Wang & Koh, 2015). A substantial literature base, supported by cognitive and development theories, suggests that the aforementioned cognitive abilities develop during the younger preschool and childhood years and are largely developed around five to six years of age (Jaaniste et al.,2016).

Much research has been devoted to assessing the age at which children can reliably and validly self-report. Piaget's stages of cognitive development provide a useful framework (Borger et al., 2000). According to Piaget, as children approach six-years-old, their cognitive skills gradually transition from the preoperational stage to the concrete operational stage. This transition accompanies greater ability to think logically and provide self-report ratings on concrete domains asked in simple and clearly worded formats (Arbuckle & Abetz-Webb, 2013). As such, Piaget's stages support the developmental age of six as a cognitively appropriate age for self-reporting (Arbuckle & Abetz-Webb, 2013; Borgers et al., 2000; Inhelder & Piaget, 2013). Corresponding evidence has been demonstrated in the areas of health outcomes, health-related quality of life, and pain, in which children as young as five have been shown to reliably and validly complete age-appropriate measures (McGrath, 1990; Riley, 2004; Varni et al., 2007; von Baeyer, 2006).

Response Scales for Self-Report with Children

There are a number of options when deciding on how to gather self-report ratings from children. Self-report measures developed for children have made use of a variety of scale options, including visual analog scales, pictorial and faces scales, and Likert-type scales. Many researchers have demonstrated that young children tend to respond in an extreme manner (i.e., endorsing options at either end of the response continuum), irrespective of the scale type used (Besenski et al., 2007; Chambers & Craig, 1998; Chambers & Johnston, 2002; Ersig et al., 2013; Goodenough et al., 1997; Hunter et al., 2000; Shields et al., 2003; von Baeyer et al., 1997). Such effects are observed most prominently for self-report involving ratings of more subjective and emotion-focused constructs, as compared to more objective and physical constructs (Chambers & Johnston, 2002).

In terms of assessing self-efficacy specifically, Bandura (2006) highlights that the choice of descriptors (e.g., cannot do it, not too sure, pretty sure, certain I can do it) is particularly important for children and pictorial descriptors have been suggested for use with very young children (e.g., progressively larger circles representing increasing self-efficacy). Although numerical rating scales are preferred for self-efficacy scales

(Bandura, 2006), previous research has highlighted children's difficulty expressing themselves using quantitative terms (Creemans et al., 2006; von Baeyer, 2006). While faces scales have received extensive validation in the area of pain and fear assessment with children (von Baeyer, 2006; McMurtry et al., 2011), the use of faces scales for self-efficacy has been discouraged due to misinterpretation and attribution of the facial expressions presented on the scale as being happy or sad (Bandura, 2006). For these reasons, many self-efficacy scales within the pediatric chronic illness literature have made use of 4- or 5-point Likert scales, with a clear and specific descriptor for each option (Barlow et al., 2001; Bursch et al., 2006; Caplin et al., 2002; Colella et al., 2008; Izaguirre & Keefer, 2014).

To overcome the limitations of rating scales with children, screening children's ability and training them how to use the self-report measure is highly recommended (Besenski et al., 2007). The inclusion of practice items can support the assessor in determining children's cognitive capacity of the skills mentioned in the previous section, and thus their ability to provide accurate responses. Detailed instructions and practice items are particularly important in assessing self-efficacy, as it provides an opportunity to gauge the strength of general efficacy beliefs, identify any confusion with the scale, and provide clarification and correction to ensure valid responses (Bandura, 2006).

Child versus Parent Report

Parent report of child-specific constructs and health-related information is common. Given considerable evidence of children's reliability and accuracy as self-reporters and the advances in child-reported instruments and methodologies, child self-report should be gathered for constructs concerning children. In a meta-analysis of 119 studies, correlations between parent and child reports was .22 (Achenbach et al., 1987), consistent with the often-observed low rates of parent-child concordance on measures, particularly those assessing health outcomes (Bevans et al., 2010; Chambers et al., 1998; Davis et al., 2007; Eiser & Morse, 2001; Upton et al., 2008). Concordance varies depending on the construct being assessed. For example, in the area of health-related quality of life, generally good agreement is observed between child and parent report for domains reflecting physical activity, functioning and external symptoms, while poor agreement is often illustrated for domains reflecting emotional and social functioning (Eiser & Morse, 2001). However, poor agreement and concordance does not necessarily indicate that either parents or children are more accurate and reliable reporters than the other (Barker et al., 2007; Bevans et al., 2010; Upton et al., 2008). Parents may provide a unique and complementary perspective on their children's ratings, but it is not recommended that parent-report be used to discount or replace perspectives of children themselves (Bevans et al., 2010; Ravens-Sieberer et al., 2006; Upton et al., 2008; Varni et al., 2007). Indeed, a number of factors can account for parent-child disconcordance (e.g., age, construct assessed, quality of parent-child relationship, unique perspectives and experiences; Barker et al., 2007; Upton et al., 2008) and both reporters bring different, valuable perspectives, and distinct biases (Riley, 2004). Parent and child ratings should be considered in the context of the construct being assessed, as the patterns and direction of parent-child disagreements can provide valuable information.

Self-Efficacy Applied to Magnetic Resonance Imaging

The role of self-efficacy in the context of acute, stressful medical procedures has yet to be examined. Theoretically, self-efficacy holds potential as a measurable and modifiable predictor, with direct clinical applications and implications. Magnetic Resonance Imaging (MRI) is an ideal model for the investigation of self-efficacy in the context of medical procedures for a number of reasons, as outlined below.

Pediatric MRI

MRI is a commonly used diagnostic imaging procedure, as it offers excellent image quality and resolution without the exposure to ionizing radiation found in other diagnostic imaging procedures (Rosenberg et al., 1997). MRI is a low risk and painless procedure, with the exception of the possibility of a venipuncture for the administration of contrast, if required. While most often painless, the requirements necessary to obtain good quality images can be challenging and distressing for children, as they must remain still for the duration of the scan (up to 60 minutes), in a narrow-enclosed space, while enduring loud noises (Westra et al., 2011).

Many children are unable to cope with the demands of MRI and consequently require general anesthesia in order to complete the procedure. It is estimated that approximately 50% of six-year-olds, more than 30% of seven- and eight-year-olds, and 10% of nine- to 12-year-olds require general anesthesia for MRI (Rosenberg et al., 1997). The use of general anesthesia for a distressing, but pain-free, procedure comes with a variety of potential risks and costs. A study of complications for anesthesia and sedation conducted for procedures outside of the operating room found that the rate of having one of 17 potential complications was one in 29 (Cravero et al., 2009). While major complications (e.g., cardiac arrest, seizure) were very rare, minor complications (e.g., reductions in oxygen saturation in blood, vomiting, apnea) were more prevalent. Additionally, there is emerging evidence about the risk of exposure to anesthesia on the developing brain, as greater exposure has been associated with higher risk of later neurodevelopmental problems (e.g., learning disorders; Wang et al., 2014; Wilder et al., 2009). The use of general anesthesia also involves a substantial cost in time, personnel, and equipment necessary to prepare, monitor, and help children recover (Bigley et al., 2010; Mastro et al., 2019; Tornqvist et al., 2015; Vanderby et al., 2010). Lastly, in some health centres, the wait time for MRI with general anesthesia can be more than quadruple that of an MRI without general anesthesia, delaying potential diagnosis and treatment. Even for children who do not require general anesthesia for MRI, procedural distress can still be problematic (Marshall et al., 1995). In fact, 20 to 30% of children and parents report significant distress in response to MRI (Tyc et al., 1995; Westra et al., 2011). As indicated by previous research, such procedural distress can influence children's cooperation during the procedure and a negative experience with MRI may lead to greater distress toward future medical procedures (Lumley et al., 1993; Wollin et al., 2003).

There is currently no evidence-based and standardized method in place to facilitate decision-making around general anesthesia for MRI. Predictors of procedural distress and compliance toward MRI are understudied and not well understood. Often the decision is based on professional judgement by the referring physician or the MRI technologist at the time of scheduling, largely informed by non-modifiable factors (e.g., age, developmental level). Although age is often cited as an important factor for screening purposes, previous research demonstrates that age is not on its own a reliable predictor of distress and/or compliance toward MRI (Cahoon & Davison, 2014; Racine et al., 2015). To date, one study has examined predictors of non-compliance during MRI, in which children's previous compliance with medical procedures, attention, adaptability (i.e., ability to cope with novel situations), and parent expectations were shown to be significant predictors (Cahoon et al., 2014). Findings from this study have not been implemented into clinical practice when screening the need for general anesthesia. Further, the clinical utility of such predictors is limited. For example, while they may be useful in identifying children at risk of non-compliance and those who may benefit from preparation, they cannot provide information around whether preparation was successful and the likelihood of a successful awake scan. Evidently there is a research-to-practice gap around screening the need for general anesthesia, and there are risks in making incorrect predictions. In some cases, children scheduled to receive general anesthesia may not need it, meaning they are subjected to unjustified risk. Alternatively, if a child is predicted not to need general anesthesia and is unsuccessful with MRI, they will need to be rescheduled for an appointment on another day in which anesthesia is available. This leads to family inconvenience, undue stress, and system inefficiencies. There is a clear need for a predictor that can directly inform how well a child will respond to MRI. Self-efficacy may be particularly useful in the context of MRI as a screener for the need for preparation and/support during the procedure, the success of preparation efforts, as well as a screener for the need for general anesthesia.

Intervention for MRI

A substantial literature base has been established demonstrating the benefits of preparation and support during MRI in terms of reducing distress, improving compliance, and significantly reducing rates of general anesthesia use (Barnea-Goraly et al., 2014; Bharti, Malhi, & Khandelwal, 2016; Carter et al., 2010; Hallowell et al., 2008; Munn &

Jordan, 2013; Nordahl et al., 2008; Rothman et al., 2016; Rosenberg et al., 1997; Tornqvist et al., 2015). Hallowell and colleagues (2008) revealed that 96% of 227 children between the ages of three and 17 were able to complete MRI without general anesthesia when adequately prepared and supported during the procedure. Many of the studied interventions include evidence-based preparatory components such as information provision, exposure to the procedural demands, and practice of the skills required, most often presented through storybooks, videos, working with a Child-Life Specialist, and mock-MRI exposure. Intervention during the procedure has also been shown to be effective in facilitating successful scans, through the use of audio-visual distraction (i.e., listening to music or watching a movie), parental presence, and providing children the option of asking for breaks (Tornqvist et al., 2015). While the evidence for preparation and intervention during MRI is clear, such resources are not routinely implemented as part of standard practice and guidelines in identifying children who will benefit from intervention are lacking.

Summary

MRI is a unique procedure in that the potential for procedural distress can greatly influence how the procedure itself is delivered. Investigation of predictors of distress and compliance in the context of MRI is warranted, in an effort to inform accurate screening and decision-making around general anesthesia and to understand how to best support each child during the procedure. With the aim of reducing the need for general anesthesia, research should focus on potential predictors that are modifiable and thus can be targeted through intervention. The predictive capability and modifiable nature of self-efficacy in other areas of health psychology suggest that it may be an informative factor in predicting distress and compliance toward MRI, as well as providing a target for intervention. Preliminary investigation among adult populations has demonstrated that targeting self-efficacy through intervention leads to improved behavioural and emotional scan outcomes, and that an increase in self-efficacy mediates the beneficial effect of intervention on scan behaviour (Powell et al., 2015). Better understanding of self-efficacy in the context of pediatric MRI will lead to direct applications in clinical settings. Once established in MRI, this research can be modified and applied to a range of pediatric medical areas, increasing its reach both clinically and scientifically.

Overview of Dissertation Objectives

The current dissertation sought to provide a comprehensive and novel assessment of self-efficacy as a measurable and modifiable predictor of procedural distress, cooperation, and procedural outcomes among school-aged children, using MRI as a model procedure. The overall objectives of this dissertation were to: 1) develop and validate a measure of MRI self-efficacy, 2) assess the modifiability of MRI self-efficacy, and 3) determine the predictive capability of MRI self-efficacy in the context of pediatric MRI. Three separate research studies were conducted to meet the overarching goals of this dissertation and a manuscript for each study is presented in the following chapters.

The first manuscript (Chapter 2), outlines the development and preliminary psychometric validation of the MRI Self-Efficacy Scale for Children (MRI-SEC). A child form was developed and assessed among school-aged children (ages 6 to 12 years), accompanied by a parent form measuring parent confidence in their child's ability to complete MRI. An iterative approach to measure development was employed, following established guidelines (Boateng et al., 2018; Holmbeck & Devine, 2009). Item refinement, content validity, and face validity were determined through feedback provided by experts in pediatric MRI (i.e., radiologists, MRI technologists, child-life specialists), children and parents with previous MRI experience, and children and parents naïve to MRI. Both child and parent forms of the MRI-SEC were subsequently investigated for internal reliability, test-retest reliability, convergent validity, and divergent validity among a community sample of children and parents naïve to MRI.

The second manuscript (Chapter 3) describes a randomized-controlled trial (RCT) that examined the modifiability of MRI self-efficacy and parent confidence in their child's ability to complete MRI, as measured by the MRI-SEC, among a community sample of children and parents with no prior MRI experience. A preparation intervention targeting MRI self-efficacy through all four pathways of self-efficacy enhancement was developed for this study. An attention control group was used as a comparison group. It was hypothesized children in the preparation condition would report higher MRI self-efficacy and lower fear toward MRI, as compared to children in the attention control condition. It was further hypothesized that MRI self-efficacy would mediate the effect that preparation had on anticipated fear toward MRI. Similarly, it was expected that parents of children in the preparation condition would report higher confidence in their child's ability to complete MRI and lower self- and child-worry toward MRI, as compared to parents of children in the attention control condition. Lastly, it was expected that parent confidence in their child's ability to complete MRI would mediate the effect of preparation on self- and child-worry toward MRI.

The third manuscript (Chapter 4) demonstrates an empirical study in which MRI self-efficacy and parent confidence in their child's ability to complete MRI were investigated as predictors of child procedural anxiety, cooperation, scan outcomes (i.e., image quality), and the need for general anesthesia among school-aged children scheduled for clinical MRI at a tertiary care hospital. This study employed observational measures of child procedural stress and cooperation. It was hypothesized that children who reported higher MRI self-efficacy would be less anxious and more cooperative during the procedure and obtain clearer images. It was also hypothesized that children who completed MRI with general anesthesia would report lower MRI self-efficacy than children who completed their scan without general anesthesia. Likewise, it was expected that children whose parents reported higher confidence in their ability to complete MRI would be less anxious and more cooperative during the procedure, obtain clearer images, and be more likely to complete the procedure without general anesthesia.

Following the presentation of each manuscript, a discussion of the overall results is provided (Chapter 5), including theoretical and clinical implications, strengths and limitations, and future research directions derived from this dissertation.

CHAPTER 2. THE MRI SELF-EFFICACY SCALE FOR CHILDREN: DEVELOPMENT AND PRELIMINARY PSYCHOMETRICS

The manuscript prepared for this study is presented below. Melissa Howlett, under the supervision of Dr. Jill Chorney, was responsible for developing the research questions and hypotheses, planning the methodology and analytic approach, and obtaining ethical approval. Melissa consulted with her dissertation committee (Dr. Christine Chambers, Dr. Sherry Stewart, and Dr. Rudolf Uher) during the development phase, and their feedback was incorporated into the conceptualization and design of the study. Melissa developed the study protocol and completed data collection, with the help of undergraduate volunteers whom Melissa oversaw. She was responsible for preparing the dataset for analysis, conducting the analyses, and writing the current manuscript. The manuscript was reviewed by the co-author, Dr. Chorney, and her feedback was incorporated prior to submission. The manuscript was submitted to the *Journal of Pediatric Psychology* and underwent peer-review. Melissa led the response to reviewers through two rounds of revisions. The manuscript was accepted for publication on May 15, 2020. See Appendix A for copyright permission from the publisher (Oxford University Press).

The full reference is as follows:

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Abstract

Objective: Magnetic resonance imaging (MRI) is a common procedure that can be distressing for children. Although not yet studied in the context of pediatric medical procedures, self-efficacy may be a good predictor of procedural stress and a clinically feasible target for behavioral intervention. The objectives of this study were to develop the MRI Self-Efficacy Scale for Children (MRI-SEC) and assess its preliminary psychometric properties. **Method:** Development of the MRI-SEC was informed by literature searches and feedback from healthcare providers. Twenty child-parent dyads naïve to MRI and 10 child-parent dyads with MRI experience completed the MRI-SEC to assess the comprehensibility and ease of use, and to inform item and scale refinement. The final version includes four practice items and 12 items directly assessing MRI self-efficacy. To evaluate its psychometric properties, 127 children (ages 6 to 12) and parents naïve to MRI completed the MRI-SEC, and a series of measures to assess construct validity. To evaluate test-retest reliability, twenty-seven children completed the MRI-SEC a second time. **Results:** The MRI-SEC demonstrated acceptable internal consistency, test-retest reliability, and convergent validity. **Conclusion:** Development of the MRI-SEC provides an opportunity to better understand the role of self-efficacy as a predictor of procedural stress and cooperation with MRI, informing reliable prediction of children who may benefit from additional support for MRI and the development of tailored behavioral interventions.

Keywords: self-efficacy, pediatric MRI, procedural stress, measure development, psychometrics

Introduction

Magnetic resonance imaging (MRI) is a commonly used diagnostic imaging procedure, as it offers excellent image quality and resolution without exposure to ionizing radiation found in other imaging procedures (Rosenberg et al., 1997). The requirements necessary to obtain good quality images can be distressing and/or difficult for children, as they must remain still for the duration of the scan (i.e., up to one hour), while enduring loud noises, and lying in a narrow, enclosed space (Westra et al., 2011). Although the procedure itself is painless, there is the possibility of a venipuncture for the administration of contrast, which can create additional distress and fear (Marshall et al., 1995; Tyc et al., 1995).

Given the unique sensory experience and demands of MRI, some children require general anesthesia in order to obtain good quality images, thereby increasing the medical risk (Cravero et al., 2009; Malviya et al., 2000), hospital resources (Carter et al., 2010), and wait times associated with the procedure. It is estimated that approximately 25% of school-age children require general anesthesia for MRI and recent data suggests that this estimate is growing as advancements in MRI technology have become more sensitive to movement (Uffman et al., 2017).

There is currently no evidence-based or standardized protocol in place to facilitate decision-making around the use of general anesthesia for MRI and predictors of distress and compliance toward MRI are not well understood. Currently, decisions are based on professional judgment (e.g., referring physician, MRI technologist), largely informed by non-modifiable factors (e.g., age, developmental disorder, previous medical experiences). To date, only one study has explored predictors of MRI compliance among school-aged children, concluding that parent-report of child compliance with previous medical procedures, attention (i.e., ability to maintain attention on a task for a sustained period of time), and adaptability (i.e., ability to cope with novel situations) were shown to be the strongest predictors of compliance with the MRI procedure (Cahoon & Davison, 2014). However, these findings have not been implemented into clinical practice when screening the need for general anesthesia. Noteworthy, neither age nor the presence of a developmental delay were predictive of compliance (Cahoon & Davison, 2014), despite reliance on such factors in current decisions. Evidently there is a research-to-practice gap around screening the need for general anesthesia for MRI and there are risks in making incorrect predictions. In some cases, children may be scheduled to receive general anesthesia and not need it, meaning the child is subjected to unjustified risk and unnecessary hospital resources and costs are accrued. On the other hand, if a child is scheduled for MRI without general anesthesia and is unsuccessful, they must return on another day when general anesthesia is available. This situation results in undue stress on the child, the potential for a negative medical experience, and system inefficiencies.

Investigation of predictors of distress and compliance in the context of MRI is warranted, in an effort to inform accurate screening and decision-making around general anesthesia and to understand how to best support children during the procedure. With the aim of reducing the need for general anesthesia, research should focus on potential predictors that are modifiable and thus can be targeted with intervention. There is a large body of research demonstrating that many children as young as 4-years-old can complete MRI successfully with the addition of preparation (e.g., mock-MRI exposure, practice of the skills required, procedural and sensory information about the procedure, play therapy;

Barnea-Goraly et al., 2014; Bharti, Malhi, & Khandelwal, 2016; Carter et al., 2010; Hallowell et al., 2008; Munn & Jordan, 2013; Nordahl et al., 2008; Rothman et al., 2016; Rosenberg et al., 1997). A better understanding of modifiable predictors in this setting could contribute immensely to accurate screening and assist in hospital planning around clinical MRI. For example, such predictors could inform if an awake MRI will be achievable, if preparation may be helpful, what exactly must be targeted through preparation, or if the child will require general anesthesia.

Self-efficacy, defined as judgements of one's own capability to perform the actions required to attain a desired outcome in a specific situation (Bandura, 1977), may be a promising modifiable predictor of child distress and compliance with MRI. Although not yet studied in pediatric medical procedures, research in other contexts (e.g., adherence, academic performance) suggest that self-efficacy can inform affective responses, the use of coping behaviours, cooperation, and persistence through challenging tasks (Bandura, 1997; Barlow et al., 2001). These characteristics suggest that self-efficacy is a reliable predictor of behaviour. Further, self-efficacy is considered a modifiable construct that can be influenced through four main pathways: mastery experiences, vicarious exposure through peer modelling, verbal persuasion, and interpretation of physiological states (Bandura, 1997). Given the overlap between the pathways to self-efficacy and the components of many preparation programs, it is plausible that self-efficacy could be targeted directly through intervention.

Taken together, the predictive capability and modifiable nature of self-efficacy suggests that it may be an informative factor in pediatric MRI. To date, there is no validated measure of self-efficacy for children undergoing MRI. Given the context-specific nature of self-efficacy (Bandura, 1977; 1986; Hofstetter et al., 1990), a measure specific to MRI is warranted. Thus, the objective of this study is to develop, refine, and test the psychometric properties of the MRI Self-Efficacy Scale for Children.

Objective 1: Development of the MRI Self-Efficacy Scale for Children

For the purpose of this research, ‘MRI self-efficacy’ is defined as children’s perceived ability to manage the salient aspects of MRI and carry out the skills necessary for successful scan completion. Development of the MRI Self-Efficacy Scale for Children (MRI-SEC) was informed through relevant literature searches and feedback from healthcare providers and MRI staff (i.e., Child Life Specialists, Radiologists, MRI Technologists). One pre-existing measure to assess MRI self-efficacy among adult populations was retrieved (Powell et al., 2015). This measure was not at an age-appropriate level for children and not fully applicable to pediatric MRI, warranting a novel measure specific to pediatric MRI.

The initial version of the MRI-SEC included 18 items. Given that self-efficacy is context-specific, it was necessary that children have information on the sensory and procedural steps involved in having an MRI scan in order to report their self-efficacy. Thus, the MRI-SEC includes a step-by-step depiction of the procedure using both words and pictures to facilitate understanding. Children are asked how confident they are in their ability to complete each of 14 steps in the MRI procedure (e.g., *“how confident are you that you can lie completely still, like a statue, in the tunnel?”*). Simple, child-friendly language was used throughout (e.g., picture test, tunnel, donut-like hole). Healthcare providers with expertise in MRI were involved in all stages of development, through review of the MRI-SEC. Through discussion, healthcare providers provided feedback regarding the items and language used in the measure to ensure it accurately matched the MRI procedure and language used in the environment. A parent version of the MRI-SEC was also developed, with the purpose of assessing parents' confidence in their child's ability to complete MRI (e.g., *"how confident are you that your child can lie still in the scanner, while it is making loud noises?"*).

The MRI-SEC begins with four practice questions unrelated to MRI (e.g., *"how confident are you that you can pick up a pencil?"*) to ensure that children understand the word 'confident' and can use the response scale. A 4-point response scale (i.e., not confident at all, a little confident, quite confident, very confident) was chosen based on previous literature demonstrating valid use of this type of scale with children (Szeszak et al., 2016); however, numerical rating scales (NRS) are typically recommended for use in self-efficacy scales (Bandura, 2006). Given that there is no gold standard or formal guidelines regarding the most valid response scale to use with children (Cremeens et al., 2006), both the 4-point Likert scale and an NRS were included in the initial version of the MRI-SEC to assess which would work better with children in this specific context.

Objective 2: Refinement of the MRI-SEC

Pilot testing was conducted to assess the content and face validity of the MRI-SEC, and to further refine items, the rating scale, and administration instructions. This objective was met through review and completion of the measure by children, parents, and healthcare providers with expertise in MRI. Data collection was completed in two iterative cycles, with modifications made to the MRI-SEC based on feedback gathered in each cycle. Ethics approval for this study was obtained through the Research Ethics Board in a tertiary care pediatric health centre.

Method

Participants

Participants included children between the ages of 6 and 12, and one parent. Twenty children without prior MRI experience and 10 children who completed an awake MRI scan within the past year participated, over the course of two data collection cycles. Participant demographic characteristics are displayed in Table 2.1. Families were excluded if they were not fluent in English and if the child did not possess cognitive and language skills developed to a 6-year-old level.

Procedure

Children and parents were informed of the study through online platforms, word of mouth, and recruitment postings in community locations. Parent consent and authorization, child assent, and participation were completed during a short visit to a research lab in a health centre. Parents completed the study measures independently, while children completed their measures one-on-one with a research assistant (RA). Healthcare providers (2 child-life specialists, 4 MRI technologists, 1 radiologist) reviewed the MRI-SEC following each set of modifications and provided feedback through discussion with the primary author (MH).

Measures

Demographic Information. Parents reported on child's age and sex, and any neurodevelopmental and/or mental health diagnoses.

MRI Self-Efficacy. See Objective 1 for a detailed description of the MRI-SEC.

Parent and Child Feedback on the MRI-SEC. Following completion of the MRI-SEC, children and parents provided feedback on their experience, within two areas:

comprehensibility (e.g., children's understanding of the language used in the MRI-SEC in order to provide valid responses) and ease of use (e.g., how easy and straightforward the MRI-SEC was to navigate and complete, acceptability of the length). Children completed two items, assessing ease of use: 1) *Was completing that book ... easy, a little bit hard, or hard*, and 2) *Was completing that book … lots of fun, a little bit of fun, or no fun at all.* Parents completed one item assessing comprehensibility (*Are there any questions that you think your child had difficulty understanding? [yes, no]*) and one item assessing ease of use (*How would you describe the length? NRS: 0 = too short, 5 = just right, 10 = too long*). The first 10 participants completed both a 4-point Likert scale and NRS for the practice items on the MRI-SEC and were asked to provide feedback on their preferred scale. To assess face validity, participants with previous MRI experience were asked open ended questions assessing how well the MRI-SEC matched their own MRI experience and whether there was anything missing from the MRI-SEC that was salient to their own experience having an MRI scan.

Researcher Feedback on the MRI-SEC. To further assess comprehensibility of the MRI-SEC, the RA noted items in which the child required clarification (i.e., item needed to be reworded) or repetition (i.e., item repeated word for word). Ease of use was assessed by noting if children required redirection during completion and duration of time required for completion.

Data Analysis and Refinement Procedure

Comprehensibility, ease of use, and face validity were examined using frequencies and descriptive statistics. Item refinement and determination of response scale was informed through frequencies. Items that required clarification and/or repetition or were reported as difficult, by over half of the sample, were rewritten or discarded. Of note, data provided by children and parents with prior MRI experience were analyzed separately to those of the MRI naïve participants and used only to provide a measure of face validity.

Results

Details of child, parent, and RA feedback for each cycle is outlined in the supplemental materials. Given healthcare provider involvement in the initial development of the MRI-SEC, feedback at the refinement stage largely involved minor wording modifications to simplify the language and reduce wordiness of items. As such, specific feedback from healthcare providers is not included in the supplemental materials. A condensed summary, combining feedback from all participants in both cycles is provided below.

Comprehensibility and Ease of Use

Most children reported the MRI-SEC to be 'easy' (40%, n = 8) or 'a little bit hard' (50%, n = 10), while two children (10%) indicated that it was 'hard'. Most children also reported the MRI-SEC to be 'lots of fun' (60%, n = 12) or a 'little bit of fun' (30%, n = 6), with only 10% (n = 2) reporting 'no fun at all'. The majority of parents (85%, n = 17) reported no concerns about their child's understanding of the instructions or items. The MRI-SEC took on average 10 minutes for children to complete (range: 8 to 15 minutes). The length was reported as acceptable by most parents (85%, n = 17). Two children required redirection, due to chattiness, as opposed to inattention or boredom.

Face Validity

All children and parents (100%, n = 10) with previous MRI experience reported that the MRI-SEC matched their own MRI experience, noting that there was nothing missing from the scale that should be added. Healthcare providers reported that the MRI-SEC included all necessary information to adequately assess MRI self-efficacy.

Item Refinement

Three items required clarification by half of the children (n = 5) who participated in cycle one. On the basis of these results and accompanying notes (see Supplemental Materials), one of the practice items was modified and two items were removed prior to cycle two. No items were modified or removed following feedback gathered in cycle two.

Response Scale Refinement

Although 70% (n = 7) of children and 50% (n = 5) of parents indicated preference for the NRS, RA feedback indicated that the NRS required more explanation and practice than the 4-point Likert scale, and children were hesitant to provide responses at the extreme ends. Based on RA feedback the Likert scale was chosen as the response scale.

Instructions Refinement

Twenty percent (n = 4) of children had initial difficulty understanding concepts of confidence and time. Thus, detailed "Instructions for Administration" were formally added, outlining three main points: 1) teaching and ensuring the child understands the word 'confident' and how to use the response scale (i.e., use teaching script, do not move past practice items until understanding of response scale is achieved), 2) ensuring the child's response is valid and discussing a child's response with them if it appears invalid (i.e., if the child says "I can't do that", but responds "very confident", then discuss incongruence prior to moving on), and 3) providing meaningful examples when necessary (e.g., “1 hour is as long as a movie”).

The Final Version of the MRI-SEC

The final version of the MRI-SEC includes formal instructions for administration, four practice items and 12 items assessing MRI self-efficacy. Each of the 12 items describe the steps involved in the MRI procedure and assess self-efficacy using the 4-point Likert-type scale at each step. A total MRI self-efficacy score is calculated by summing responses to the 12 items (scale = 1 to 4), resulting in a possible range of 12 to 48. One overall MRI self-efficacy score was deemed to be most useful in a clinical setting as compared to multiple subscale scores, as it allows for efficient scoring and interpretation. The child and parent versions of the MRI-SEC can be viewed in Appendices B and C, respectively.

Objective 3: Psychometric Evaluation of the MRI-SEC

Objective 3 was to examine the internal consistency, test-retest reliability, and convergent and divergent validity of the MRI-SEC. It was expected that self-efficacy would be related to response to previous medical procedures, claustrophobia (Munn et al., 2015), anticipated MRI distress, fear of the unknown, medical fears, anxiety sensitivity, and various dimensions of temperament (Cahoon & Davison, 2014; Simonds & Rothbart, 2004). Concordance between child-and parent-report on the MRI-SEC was also assessed. Based on previous research assessing concordance between parent and child reports in health-related domains (i.e., pain, quality of life), poor to moderate concordance was expected between child-reported MRI self-efficacy and parent-reported confidence in their child’s abilities to complete MRI (Chambers et al., 1998; Davis et al., 2007; Eiser & Morse, 2001; Upton et al., 2008).

Method

Participants

Participants included 127 children between the ages of 6 and 12, with no prior experience with MRI, and one accompanying parent. Participant demographic characteristics are displayed in Table 2.1. The inclusion and exclusion criteria were the same as those in Objective 2. This study was part a larger research program assessing MRI self-efficacy in the context of MRI. Fifty-five participants included in the current sample were derived from a related randomized-controlled trial (RCT) assessing the modifiability of MRI self-efficacy, as the procedure in the two studies was the same. Those included in the current sample were in the control group of the RCT. An independent samples *t*-test revealed no difference in MRI-SEC scores between participants who participated in the original pilot study and those who participated in the RCT for both parent (t (122) = -1.27, p = .205) and child report (t(125) = 1.51, p = .134). The sample size was informed by recommendations that a minimum of 10 participants for each scale item is reasonable for a pilot study in which the purpose is preliminary scale development and estimations of reliability and validity (Boateng et al., 2018).

Procedure

The psychometric evaluation followed the same procedure as outlined in Objective 2. To assess test-retest reliability, a randomly selected subsample of 27 participants completed the MRI-SEC for a second time, approximately two-weeks after their initial completion.

Measures

The measures outlined in Objective 2 were included, in addition to those described below.

Medical History and Response to Previous Procedures. Parents completed seven items assessing their child's medical history and typical response to various medical procedures (e.g., routine visits to the doctor, painful and non-painful medical procedures, needles) using a numerical rating scale (0 = responds extremely poorly, 10 = responds extremely well). Parents also indicated whether their child had a history of claustrophobia (yes/no). Children completed three items, assessing their fear toward doctor visits, needles, and having to go to the hospital, using a 3-point Likert scale (not scared at all, a little bit scared, very scared).

Anticipated MRI Distress. Children completed three items assessing how scared they would feel if they had to have an MRI scan (not scared at all, a little bit scared, very scared) and how much fun they thought they would have during an MRI scan (no fun at all, a little bit of fun, lots of fun). Child distress toward MRI was also measured using the Children's Fear Scale (CFS; McMurtry et al., 2011), which consists of five sex-neutral faces ranging from a face showing no fear (neutral) to a face showing extreme fear. Children were asked to indicate which face depicts how scared they would feel if they had to have an MRI scan. The CFS has demonstrated good validity and reliability among children ages 5- to 10-years old, undergoing venipuncture (McMurtry et al., 2011). Parents completed four-items assessing their perception of their child's distress toward MRI, how they thought their child would respond to the procedure, and their own anticipated distress, using a 10-point numerical rating scale. Parents also indicated whether they thought their child would require general anesthesia if they had to have an MRI scan.

Child Fears. The Fear Survey Schedule for Children-Revised-Short Form (FSS-R-SF; Muris et al., 2014) is a 25-item questionnaire assessing fears and fearfulness in children. Children indicate their level of fear to various stimuli and situations using a 3-point scale (none, some, a lot). Two of the five subscales were used in the current study to assess convergent validity: Fear of the Unknown (e.g., thunderstorms, small closed places, $\alpha = 0.66$) and medical fears (e.g., having to go to the hospital, getting very sick, $\alpha = 0.68$). The fear of animals' subscale ($\alpha = 0.69$) was also included, as a measure of divergent validity. Each subscale was composed of five items. The FSS-R-SF has demonstrated good internal consistency when used with clinical and non-clinical samples of children (ages 4 to 17), and convergent validity with measures of child anxiety (Muris et al., 2014). Internal consistencies in the current study are noted above in parentheses for each subscale.

Anxiety Sensitivity. Children completed the Childhood Anxiety Sensitivity Index (CASI; Silverman et al., 1991), which assesses the extent to which children believe the experience of anxiety will result in negative consequences. The CASI contains 18-items, rated on a 3-point scale (none, some, a lot), in which higher scores reflect higher anxiety sensitivity. The CASI has shown good internal consistency ($\alpha = 0.87$) and test-retest reliability ($r = .76$) for clinical and non-clinical samples of children (ages 7 to 16), and appropriate convergent validity with measures of fear and anxiety (Silverman et al., 1991; Silverman et al., 2003). Support for a four-factor model of the CASI has been demonstrated (Silverman et al., 2003) revealing the following subscales: Disease Concerns ($\alpha = 0.71$; 8 items), Unsteady Concerns ($\alpha = 0.66$; 4 items), Mental Incapacitation Concerns ($\alpha = 0.53$; 3 items), and Social Concerns ($\alpha = 0.33$; 3 items).

Internal consistency in the current study was acceptable for the total score ($\alpha = 0.81$) and the Disease Concerns subscale, while lower for the remaining subscales that were each composed of few items.

Child Temperament. The Temperament in Middle Childhood Questionnaire (TMCQ; Simonds & Rothbart, 2004) is a parent-report measure of child temperament; validated for parents of children ages 7 to 11 years. Seven of the 17 subscales deemed to be the most relevant to MRI self-efficacy, cooperation, and distress were included in this study: Activity Level (i.e., level of gross motor activity; $\alpha = 0.93$; 9 items), Discomfort (i.e., negative affect related to sensory stimulation; $\alpha = 0.76$; 10 items), Fear (i.e., negative affect related to anticipated pain, distress, and/or threatening situations; $\alpha = 0.82$; 9 items), Falling Reactivity and Soothability (i.e., rate of recovery from peak distress or excitement; $\alpha = 0.80$; 8 items), Attention Focusing (i.e., the tendency to maintain attention during tasks; $\alpha = 0.91$; 7 items), Activation Control (i.e., capacity to perform an action when there is a strong tendency to avoid it; $\alpha = 0.79$; 15 items), and Inhibitory Control (i.e., capacity to suppress responses under instruction or novel, uncertain situations; $\alpha = 0.70$; 8 items). The subscales included have shown appropriate convergent validity with measures of reward and punishment sensitivity subscales (Nystrom & Bengtsson, 2017), and displayed acceptable-to-excellent internal consistency in the current study, as displayed above.

Data Analysis

Internal consistency was assessed using Cronbach's α-coefficients. Test-retest reliability was calculated using Pearson's correlation coefficients for the overall scale score and Kendall's tau correlation coefficients for the individual item scores. Inter-item and adjusted item-total correlations were assessed using Kendall's tau correlation coefficients. Convergent and divergent validity were assessed using Pearson's correlation coefficients, *t*-tests, and ANOVA. Interpretation of validity coefficients was based on guidelines from Drummond and colleagues (2016), in which a correlation greater than .50 was considered very high, .40 to .49 considered high, .21 to .40 considered moderate, but acceptable, and a correlation less than .2 considered low and unacceptable (Swank & Mullen, 2017). Descriptive statistics and group comparisons using *t*-tests were completed to characterize the sample and compare MRI-SEC scores between children predicted to require versus not require general anesthesia for MRI. Pearson correlation coefficient and intraclass correlation were conducted to explore agreement between child- and parent-report on the MRI-SEC, with < 0.40 representing poor to fair agreement, 0.41-0.60 representing moderate agreement, 0.61-0.80 representing good agreement, and 0.81-1.00 representing excellent agreement (Bartko, 1966; Varni & Burwinkle, 2006).

Results

Descriptive statistics for each of the 12 items and the total score are listed in Table 2.2 for both child and parent report.

Internal Consistency

Excellent internal consistency was achieved for both child-report (α = .91) and parent-report (α = .93) on the MRI-SEC.

Test-Retest Reliability

The Pearson's correlation coefficients for the total score and Kendall's tau correlations for each of the items are presented in Table 2.2, for child and parent-report. Both child (r = .82) and parent (r = .90) forms of the MRI-SEC demonstrated test-retest reliability above the acceptable range (i.e., greater than .70; Litwin, 1995).

Inter-Item and Adjusted Item-Total Correlations

Inter-item correlations for all items and adjusted item-total correlations are displayed in Table 2.3. Inter-item correlations were high between most items. Consistent trends were observed across child and parent-report. Specifically, item one (e.g., hospital gown) displayed the lowest inter-item correlations and the lowest adjusted correlation with the total score. As expected, items concerning related topics displayed higher correlations (i.e., staying still for specific amounts of time, various types of coils). All items displayed adequate adjusted item-total correlations to rationalize inclusion in the scale (i.e., greater than .30; Boateng et al., 2018).

Validity

Convergent Validity. Bivariate correlations are listed in Table 2.4. The association between MRI self-efficacy and claustrophobia was not assessed, as claustrophobia was only endorsed by two participants.

Child Report. Child-reported MRI self-efficacy was very highly negatively correlated with child-reported anticipated MRI distress, as measured by the Children's Fear Scale. MRI self-efficacy was moderately positively correlated with how fun children expected MRI scan to be and moderately negatively correlated with child-reported fear toward routine doctor visits, fear of the unknown, and medically related fears. Fear of needles and hospital visits, and anxiety sensitivity (total score and all four subscales) demonstrated low and unacceptable correlations with MRI self-efficacy. Moderate positive correlations were observed between child-reported MRI self-efficacy and parent-report of their child's typical response to non-painful procedures (e.g., x-ray). For parent-report of child temperament, child-reported MRI self-efficacy was moderately negatively correlated with discomfort. Child-reported MRI self-efficacy was moderately negatively correlated with parent-reported child worry toward MRI and expected response to MRI.

Parent Report. Parent-reported confidence in their child's ability to complete MRI was very highly positively correlated with parent-report of anticipated child response to MRI, and highly negatively correlated with parent-report of anticipated child worry toward MRI and parent worry of their child's ability to complete MRI. Parent-report on the MRI-SEC was moderately positively correlated with parent-report of child's typical response to non-painful and painful procedures, needles, and routine visits to the doctor. With the exception of activity levels, all aspects of temperament assessed were moderately correlated with parent-report on the MRI-SEC. Specifically, moderate negative correlations were observed for Discomfort and Fear, and moderate positive correlations were observed for Falling, Reactivity, and Soothability, Attention Focusing, Activation Control, and Inhibitory Control. Lastly, a moderate negative correlation was observed between parent-report on the MRI-SEC and child-reported medical fears. Low and unacceptable correlations were observed with child-reported measures assessing anxiety sensitivity (total score and all four subscales), procedural fear toward doctor visits, needles, and hospital visits, as well as anticipated fear toward MRI and how fun children expected MRI to be.

Divergent Validity. Unexpectedly, moderate negative correlations were observed between child-reported fear of animals and both child- and parent-report on the MRI-SEC.

Preliminary Predictive Validity. Scores on the MRI-SEC were significantly lower among the group in which parents indicated that their child would require general anesthesia for MRI (n = 31), as compared to those who indicated that their child would not require general anesthesia (n = 93) for both child, $t(122) = 2.30$, p = .02, 95% CI: [0.527, 7.02], M = 30.2, SD = 8.20 vs. M = 34.0, SD = 7.81, and parent-report, $t(122)$ = 9.06, p = < .001, 95% CI: [8.54, 12.3], M = 23.5, SD = 5.38 vs. M = 34.4, SD = 5.95.

Mean comparisons also demonstrated differences in MRI-SEC scores based on child-report of how scared they would feel if they had to have an MRI scan. There was a significant difference between child-reported MRI-SEC scores, $F(2, 124) = 26.9$, $p <$ .001, with post-hoc Bonferroni tests demonstrating significant difference ($p < .001$) between each of the three groups; not scared at all (n = 23, M = 40.1, SD = 7.55), a little bit scared (n = 69, M = 33.2, SD = 6.41), and very scared (n = 35, M = 26.7, SD = 7.50). A significant difference was also found for parent-reported MRI-SEC scores, F (2, 121) = 3.89, p = .02, with post-hoc Bonferroni tests demonstrating a significant difference between children who reported ‘not scared at all’ (M = 33.2, SD = 7.43) and those who reported ‘very scared’ (M = 28.9, SD = 7.90), p = .02, but not children who reported ‘a little bit scared’ (M = 31.5, SD = 5.88).

Child-Parent Agreement

Child and parent-report on the MRI-SEC demonstrated a small correlation (r = .21, p = .018) with one another. Further investigation of concordance between child and parent-report on the MRI-SEC revealed poor to fair agreement, with an intraclass correlation coefficient (ICC) of .35.

Discussion

The purpose of this study was to develop and refine a measure to assess self-efficacy among children undergoing MRI and evaluate its preliminary psychometric properties. Content and face validity of the items were established through pilot testing, informed by children and parents with MRI experience, those naïve to MRI, and healthcare providers with expertise in pediatric MRI. Larger-scale testing demonstrated overall acceptable psychometric properties, including internal consistency, test-retest reliability, and convergent validity.

For the most part, correlations between scores on the MRI-SEC and variables assessed for convergent validity were as expected. For children, anticipated fear toward MRI showed the strongest correlation with MRI self-efficacy, while child-reported fear of needles and having to go to the hospital, global anxiety sensitivity, and the subscales of anxiety sensitivity were unexpectedly not associated with MRI self-efficacy. The fact that needles are often associated with pain and visits to the hospital were often reported to be for painful injuries and/or illness, may explain the lack of correlation between MRI self-efficacy, as they may have tapped into different areas. Similarly, anxiety sensitivity may have been too general of a construct to assess in conjunction with MRI self-efficacy, given the context-specific nature of MRI self-efficacy and format of items on the MRI-SEC (e.g., children's ability to complete specific tasks associated with MRI). Anxiety sensitivity may be more likely to be associated to actual compliance and/or distress toward MRI, rather than MRI self-efficacy itself.

Moderate to high correlations were observed between parent-report on the MRI-SEC and predictors of MRI compliance identified in previous research (Cahoon & Davison, 2014), such as parent-report of child compliance with previous medical procedures, attention, and dimensions of temperament conceptually similar to adaptability (e.g., Falling, Reactivity, and Soothability, Activation Control, Inhibitory Control), thus supporting convergent validity. Parent-reported self and child anticipated distress and fear toward MRI presented with the strongest correlation with parent scores on the MRI-SEC; however, child-reported anticipated fear was not associated with parent-report on the MRI-SEC. This is noteworthy, as current decisions around general anesthesia rely heavily on parent predictions; however, these results suggest that parental predictions may not be entirely congruent with how children feel about MRI. Similarly, many child-reported variables were not associated with parent-report on the MRI-SEC (e.g., fear toward doctor visits/hospital visits/needles, anticipated fear toward MRI, how fun they expected MRI to be).

Poor concordance between child and parent report on the MRI-SEC was observed, with parents demonstrating a lower total score. Given that the child-report version of the MRI-SEC assesses children's own perceived self-efficacy, while the parent-report version assesses parents' own perceived confidence in their child's ability to complete MRI, perfect agreement was not expected; however, the overall concordance observed was quite low. Previous research suggests that discordance between parents and children is often observed due to the use of different reasoning processes and justification of responses (Davis et al., 2007). Of note, in the current study, children had no prior MRI experience or knowledge until it was introduced during participation. As such, children and parents may have made use of different reasons and examples to inform their responses, as they did not have direct experience to draw upon. For example, children's own anxiety and fear toward MRI may have impacted their responses, whereas parents may have been influenced by their own anxiety, experiences, and knowledge around

MRI. Further, it is well established that non-observable factors (e.g., emotional or social functioning) often display lower agreement among children and parents as compared to observable factors (Eiser & Morse, 2001). Self-efficacy is inherently a non-observable and personal construct, informed by the child's own experiences and emotional reaction to the specific situation. Further, children and parents did not have the opportunity to discuss the procedure and the child's feelings toward potentially having an MRI scan. It is possible that higher concordance would be observed in a situation in which the child requires a clinical MRI scan and children and parents are able to discuss the procedure in advance. Nonetheless, the discrepancy observed between child- and parent-report on the MRI-SEC is clinically relevant. At the present time, parents are more likely to be involved in decision-making around the delivery of MRI and the necessity of general anesthesia. The discordance observed in the current study suggests that consulting only parents may lead to decisions incongruent with children's own perceived self-efficacy toward MRI. Given the novelty of this research, it is difficult to conclude which informant is most accurate and/or informative in terms of predicting MRI compliance and distress, but the current results suggest that both informants should at the least be assessed. Further research is warranted to inform specific clinical implications and implementation, such as which informant decision-makers should focus on when planning the delivery of clinical MRI.

To assess divergent validity, it was expected that fear of animals would not be associated with MRI self-efficacy; however, moderate correlations between scores on the MRI-SEC and fear of animals were observed for both child and parent report. It is possible that there was a flaw in the variable chosen to assess divergent validity, as fear of animals may have tapped into general anxiety and fears, which may have also had an influence on MRI self-efficacy.

Clinical Applications

There is a large literature base demonstrating the effects of preparation for MRI, in improving compliance, reducing distress, and even reducing rates of general anesthesia use (Barnea-Goraly et al., 2014; Bharti et al., 2016; Carter et al., 2010; Hallowell et al., 2008; Munn & Jordan, 2013; Nordahl et al., 2008; Rothman et al., 2016; Rosenberg et al., 1997). However, the implementation and use of preparation techniques is time and resource demanding, and therefore not routinely available in many health centres. A measure of MRI self-efficacy could help to screen and identify children who could benefit from preparation (e.g., MRI readiness assessment) and assess the effects of preparation before the day of MRI (post-preparation assessment), in order to ensure the child's needs are met and an overall positive MRI experience.

Preparation programs can be developed to target self-efficacy through each of four identified pathways that influence self-efficacy (Bandura, 1997). For example, programs could include components such as exposure and practice to target mastery experiences (e.g., exposure to the scanner, sounds, practice lying still in a small space, mock-MRI), successful modelling by peers to target vicarious exposure (e.g., video of another child successfully completing MRI and discussing their experience), praise and reinforcement by parents and staff during exposure practice to target verbal persuasion, and teaching of coping techniques (e.g. deep breathing, mental imagery) to target physiological states. With further research, the MRI-SEC could also be useful in suggesting which preparation techniques are required for a given child, at the item-level.

For example, perhaps a child responds favorably to items on the MRI-SEC that assess staying still and lying in the tunnel, but they are particularly worried about the noise. In that case, preparation could involve primarily providing exposure to the MRI sounds and putting supports in place to minimize the sound during the MRI scan itself (e.g., music, watching a movie).

Clinical application of the MRI-SEC will depend on existing methods of MRI readiness assessment and delivery of preparation interventions at individual healthcare centres. Ideally the MRI-SEC would be administered to children at the time in which a discussion regarding the need for general anesthesia occurs. While further research is needed to determine the best method of delivery, it is possible that the MRI-SEC could be completed at home by children, with the support of their parent depending on their age, thus providing results to necessary healthcare providers with ample time to plan for delivery of a preparation intervention.

Limitations & Future Research

This research should be interpreted in light of limitations. The participant group was fairly homogenous (e.g., predominantly Caucasian and mothers), thus future research and validation of the MRI-SEC is required to ensure generalizability to families with demographics not represented in the study's sample. Children in the study did not have to have an MRI scan, and therefore most questions were hypothetical. It is possible that children may have responded differently to items on the MRI-SEC and those pertaining to MRI distress if they actually had to have an MRI scan. Additionally, the internal reliability of the subscales from the Fear Survey Schedule for Children and the Childhood Anxiety Sensitivity Index were lower than the widely accepted value of .70, which may impact the validity of the results using those subscales.

Although assessing the true predictive validity of the MRI-SEC in a clinical MRI setting was not possible in the current study, the MRI-SEC did demonstrate the ability to differentiate between children whose parents predicted they would require general anesthesia for MRI and those whose parents predicted that an awake scan would be possible. Additionally, child and parent MRI-SEC scores successfully differentiated between children who reported higher and lower fear toward MRI. Future research assessing the use of the MRI-SEC with children who are scheduled to undergo a clinical MRI scan is warranted, thus allowing for investigation of MRI self-efficacy as a predictor of compliance with the procedure and distress toward the procedure. Such research should also assess the predictive capability of each item included in the MRI-SEC, thus determining whether a condensed version of the measure is possible in order to ensure efficiency in a busy clinical setting.

Future research is needed to assess the clinical effectiveness and utility of the MRI-SEC in a pediatric MRI setting. Such research should further investigate the concordance between child and parent-report, with efforts focused on determining which informant is most accurate in predicting compliance and distress. The sensitivity and specificity of the MRI-SEC should also be assessed, particularly in determining a cut-off score to inform the likelihood of a successful awake scan versus the necessity of general anesthesia or additional support before and/or during the procedure. Lastly, self-efficacy theory (Bandura, 1986) suggests that MRI self-efficacy should be modifiable and applicable to clinical intervention. Future research should assess the modifiability of MRI self-efficacy through a targeted preparation program, and the sensitivity to change of the

MRI-SEC.

Conclusions

Modifiable and accurate predictors of procedural stress and compliance are needed to inform how to best support children through stressful and/or painful medical procedures. The MRI-SEC was developed as a tool to assess MRI self-efficacy among children and to assess parent confidence in their child's ability to complete MRI. The findings of this study demonstrate adequate preliminary psychometric properties, suggesting that the MRI-SEC is worthy of further psychometric testing, particularly in terms of predictive validity in a clinical setting. Testing of self-efficacy in the context of medical procedures may inform development of screening tools to facilitate predictions around child distress and compliance, in order to better understand how to best support children through stressful procedures, on an individualized basis.

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Tables

Table 2.1.

Descriptive statistics of participant characteristics.

Variable	Objective 2: MRI Naïve *n* = 20	Objective 2: MRI Experienced *n* = 10	Objective 3: Psychometric Evaluation *n* = 127
	M(SD) or Frequency(n)	*M(SD) or Frequency(n)*	*M(SD) or Frequency(n)*
Age (years)	8.00 (1.84)	9.00 (1.33)	8.54 (1.88)
Sex			
Female	50.0% (10)	70.0% (7)	44.1% (56)
Male	50.0% (10)	30.0% (3)	55.9% (71)
Child Race			
White	70.0% (14)	90.0% (9)	89.0% (113)
Other	30.0% (6)	10.0% (1)	11.0% (14)
Parent Race			
White	100.0% (20)	90.0% (9)	91.3% (116)
Other	0.0% (0)	10.0% (1)	8.7% (11)
Parent Relation			
Mother	90.0% (18)	90.0% (9)	87.4% (111)
Father	10.0% (2)	10.0% (1)	11.0% (14)
Other	0.0% (0)	0.0% (0)	1.6% (2)
Neurodevelopmental or Mental Health Diagnosis			
ADHD	5.0% (1)	0.0% (0)	6.5% (8)*
ASD	0.0% (0)	0.0% (0)	0.8% (1)*
Anxiety	15.0% (3)	10.0% (1)	5.7% (7)*
Cerebral Palsy	0.0% (0)	10.0% (1)	0.0% (0)
Claustrophobia	0.0% (0)	10.0% (1)	1.61% (2)*

Notes. M = mean, *SD* = standard deviation, *n* = sample size. "Other" for race includes participants who self-identified as Aboriginal, Arab/West Asian, South Asian, and Biracial. ADHD = Attention Deficit Hyperactivity Disorder. ASD = Autism Spectrum Disorder. *indicates *n* = 124.

Table 2.2.

Descriptive statistics and test-retest coefficients for the individual items and total score of the MRI-SEC for child- and parent-report.

	Child-report (*n* = 127)				Parent-report (*n* = 124)			
Item	*M*(*SD*)	Skewness	Kurtosis	Test-retest*	*M*(*SD*)	Skewness	Kurtosis	Test-retest*
1. Wear a hospital gown	3.56(0.80)	-1.83	2.50	.24	3.79(0.50)	-2.38	4.93	.41
2. Lie on the bed	3.46(0.90)	-1.51	1.11	.56	3.54(0.72)	-1.37	0.88	.54
3. Lie on the bed, while moving into scanner	3.06(0.99)	-0.65	-0.76	.57	2.98(0.87)	-0.41	-0.66	.65
4. Stay still inside scanner for 5 minutes	2.91(0.99)	-0.35	-1.08	.62	2.78(0.94)	-0.38	-0.71	.69
5. Stay still inside scanner for 15 minutes	2.27(1.05)	0.28	-1.12	.53	2.27(0.94)	0.26	-0.80	.51
6. Stay still inside scanner for 30 minutes	1.87(0.99)	0.81	-0.54	.62	1.71(0.84)	1.01	0.26	.43
7. Stay still inside scanner for 1 hour	1.54(0.92)	1.63	1.50	.52	1.35(0.63)	2.22	6.04	-.01
8. Stay still for 1 hour, with breaks	3.10(0.97)	-0.74	-0.54	.48	2.58(0.85)	-0.05	-0.58	.52
9. Stay still inside scanner, with coil helmet	2.86(0.98)	-0.43	-0.84	.33	2.41(0.87)	0.01	-0.65	.80
10. Stay still inside scanner, with stomach coil	2.84(0.98)	-0.40	-0.94	.56	2.85(0.87)	-0.31	-0.62	.66
11. Stay still inside scanner, coil over a limb	2.88(0.98)	-0.38	-0.95	.46	2.97(0.86)	-0.41	-0.56	.67
12. Stay still inside scanner, with loud noises	2.61(1.06)	-0.10	-1.22	.43	2.48(1.01)	0.04	-1.07	.50
TOTAL SCORE	32.9(8.24)	-0.18	-0.27	.82	31.7(7.49)	-0.15	-0.62	.90

Notes. M = mean, *SD* = standard deviation. Possible range = 1 to 4 for individual items, 12 to 48 for total score. Test-retest is represented by Kendall's Tau for individual items and Pearson's correlation coefficient for total score. * indicates *n* = 27.

Table 2.3.

Inter-item and adjusted item-total correlations for child- and parent-report.

Item	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Hospital gown	-	.43	.19	.16	.13	.09	.06	.07	.19	.09	.15	.18	**.31**
2. Lie on bed	.39	-	.53	.40	.32	.28	.22	.31	.35	.36	.39	.39	**.52**
3. Moving into hole	.32	.41	-	.66	.60	.53	.43	.60	.58	.59	.61	.58	**.81**
4. Stay still for 5 minutes	.18	.40	.30	-	.77	.60	.45	.56	.58	.56	.57	.58	**.82**
5. Stay still for 15 minutes	.16	.36	.34	.69	-	.72	.60	.61	.56	.50	.49	.56	**.81**
6. Stay still for 30 minutes	.20	.29	.40	.56	.71	-	.69	.58	.44	.39	.37	.46	**.68**
7. Stay still for 1 hour	.26	.27	.31	.54	.59	.71	-	.50	.35	.30	.27	.36	**.55**
8. Stay still for 1 hour with breaks	.25	.27	.33	.37	.33	.43	.38	-	.50	.50	.55	.57	**.74**
9. Head coil	.32	.41	.40	.39	.36	.32	.32	.38	-	.69	.60	.56	**.75**
10. Stomach coil	.36	.46	.41	.45	.39	.36	.36	.39	.56	-	.82	.61	**.77**
11. Extremity coil	.36	.41	.41	.37	.37	.39	.32	.38	.61	.61	-	.68	**.77**
12. Loud noises	.26	.34	.37	.47	.49	.41	.37	.35	.57	.40	.46	-	**.77**
13. Total Score	**.43**	**.59**	**.58**	**.70**	**.72**	**.70**	**.60**	**.57**	**.68**	**.70**	**.70**	**.67**	-

Notes. Child-report displayed in non-shaded half. Parent-report displayed in shaded half. Inter-item correlations are represented by Kendall's tau correlation coefficients. Bolded values represent adjusted item-total correlations.

Table 2.4.

Correlation coefficients between MRI self-efficacy and other child- and parent-reported constructs to assess convergent validity of the MRI-SEC.

Variable	Child Report (*n* = 127)	Parent Report (*n* = 124)
Child-reported Fears		
Fear of the Unknown	-.36*	-.12
Medical Fears	-.30*	-.25*
Child-reported Anxiety Sensitivity (Total)	-.10	-.06
Disease Concerns	-.11	-.04
Unsteady Concerns	-.02	-.04
Mental Incapacitation Concerns	-.02	-.09
Social Concerns	-.01	-.03
Response to Past Procedures (Parent-report)		
Needles	.08	.26*
Non-painful Procedures	.33*	.39*
Painful procedures	-.02	.41**
Routine Doctor Visits	.12	.35*
Child-reported Procedural Fear		
Routine Doctor Visits	.22*	.09
Needles	.01	-.05
Hospital Visits	.14	.03
Temperament (Parent-report)		
Activity Level	-.07	-.12
Discomfort	-.27*	-.35*
Fear	-.07	-.31*
Falling, Reactivity, & Soothability	.17	.30*
Attention Focusing	.13	.30*
Activation Control	.11	.26*
Inhibitory Control	.07	.38*
Anticipated MRI Distress		
Child-Report		
Children's Fear Scale	-.55***	-.18
Anticipated Fun	.36*	.11
Parent-Report		
Child Worry	-.23*	-.43**
Child Response	.26*	.70***
Parent Worry	-.09	-.40*

Notes. * indicates moderate, but acceptable correlation; ** indicates high correlation; *** indicates very high correlation.

Supplemental Materials

Table 1. Outline of child, parent, and RA feedback regarding the comprehensibility, ease of use, and response scale for Cycle 1 of pilot testing, and detailed modifications and justifications made based on the feedback provided.

	Child Feedback	**Parent Feedback**	**RA Feedback**	**Modification/Justification**
Comprehensibility Definition: Children's understanding of the language used in the MRI-SEC.	N/A	**Are there any items that your child had difficulty understanding?* 90% (n = 9) of parents reported no concerns about their child's understanding of any items. 10% (n = 1) of parents indicated that their child had difficulty understanding the word 'confident' initially.	**Note items that required clarification and/or repetition.* One child reported difficulty understanding the word 'confident'. However, they were able to understand once further explained and after completing the practice items. Two items required clarification by 5 children. Item 1: How confident are you that you can lie completely still in the tunnel if the bed moved into the tunnel 'head-first'? Item 2: How confident are you that you can lie completely still in the tunnel if the bed moved into the tunnel 'feet-first'? Three children required clarification on items that involved the concept of time (i.e., how confident are you that you can lie completely still in the tunnel for 1) 5 minutes,	**Items that required clarification and/or repetition or were reported to be difficult by over half of the sample, were rewritten or discarded.* **Item Refinement:** Two items were removed. Basis for removal of the 2 items was to improve children's understanding and ensure congruence with the clinical experience (i.e., children do not have a choice of whether they go into the scanner head- or feet-first). Many children did not realize MRI could be completed feet-first and many indicated less confidence completing the scan head-first once learning it could be completed feet-first. As such, it was determined that these items were not clinically useful and may increase stress and/or reduce self-efficacy. The items involving the concept of time were not modified, as fewer than half of the sample had difficulty.

	Child Feedback	Parent Feedback	RA Feedback	Modification/Justification
			2) 15 minutes, 3) 30 minutes, 4) 1 hour). One practice item asked children how confident they are that they can pick up a feather, to which 3 children responded that they are not allowed to touch feathers.	One practice item modified from feather to pencil, as ‘feather’ caused confusion for many children who indicated they are not allowed to pick up feathers. **Instructions:** RA was instructed to use meaningful examples of time, if necessary (e.g., 1 hour is as long as a movie).
Ease of Use How easy the MRI-SEC was to navigate and complete, length of completion.	**Was completing that book: easy, a little bit hard, or hard?* ‘Easy’ (*n* = 3) ‘A little bit hard’ (*n* = 6) ‘Hard’ (*n* = 1) Younger children (6 to 7 years old) reported more difficulty than older children. Qualitatively, children reported that it was somewhat challenging to learn something new and predict how they would feel in the situation, since they have never seen an MRI in person (*n* = 6).	**How would you describe the length of the MRI-SEC?* 70% (*n* = 7) of parents reported that the length was ‘just right’. 30% (*n* = 3) of parents reported that the length was ‘too long’.	**Note if child required redirection back to the MRI-SEC during completion and at what item.* Two children required redirection during completion, due to chattiness rather than difficulty paying attention or boredom. No child appeared to lose interest to the point where completion was difficult to achieve. **Note completion time.* Average: 10 minutes Range: 8 to 15 minutes	No modifications were made to the MRI-SEC on the basis of feedback regarding the length, time of completion, or ease of completion.

	Child Feedback	Parent Feedback	RA Feedback	Modification/Justification
	**Was completing that book: lots of fun, a little bit of fun, or no fun at all?* 'Lots of fun' (*n* = 7) 'A little bit of fun' (*n* = 3) 'No fun at all' (*n* = 0)			
Response Scale **was a 4-point Likert scale or 10-point numerical rating scale (NRS) preferable to participants?*	70% (*n* = 7) of children reported preference for the NRS, indicating that it was "more fun", they could "work on math", and they liked making a circle on the line.	50% (*n* = 5) of parents indicated preference for the NRS for their child. One parent reported that their child responded quicker when using the NRS, but that the Likert scale provided a more valid response.	In comparing child responses on the Likert scale and the NRS for the items that used both scales, responses were generally consistent between the two (e.g., for items in which a child circled 8, 9, or 10 on the NRS, they also indicated "very confident" on the Likert scale). Responses were consistent between scales for 9/10 children for items 1 and 2, 8/10 children for item 3, and 4/10 children for item 4. In cases of inconsistency, the child's response on the Likert scale was most representative of the child's verbal description of how they felt. Children appeared to get in the habit of thinking out loud and stating which of the four scale options they felt reflected how they would feel (i.e., not at all, a little, quite, or very confident), thus suggesting that they	Based on RA feedback, clinical utility, and the literature revealing children's difficulty expressing themselves using quantitative terms (Creemans et al., 2006; von Baeyer, 2006), it was decided that the 4-point Likert scale would be chosen as the primary response scale.

	Child Feedback	Parent Feedback	RA Feedback	Modification/Justification
			understood the scale and provided valid responses. The NRS required more time to explain and practice and children were hesitant to provide responses at the extreme ends.	

Notes. *n* = 10. Questions/prompts to gather feedback within each area is italicized and in lighter font.

Table 2. Outline of child, parent, and RA feedback regarding the comprehensibility, ease of use, and response scale for Cycle 2 of pilot testing, and detailed modifications and justifications made based on the feedback provided.

	Child Feedback	**Parent Feedback**	**RA Feedback**	**Decision/Modification**
Comprehensibility Definition: Children's understanding of the language used in the MRI-SEC.	N/A	**Are there any items that your child had difficulty understanding?* 80% (*n* = 8) of parents reported no concerns about their child's understanding of any items. 20% (*n* = 2) of parents indicated that it 'may have' been challenging for their child to understand, with one parent more specifically expressing that their child had difficulty understanding some concepts of the procedure, but seemed to grasp the questions being asked.	**Note items that required clarification and/or repetition.* Two children required clarification of the word 'confident'; however, understanding was achieved through clarification and completion of the practice items. One child required clarification of the items involving time. Three additional items required clarification by one child each. One child, who recently turned six-years-old was reported to have difficulty understanding many aspects of the MRI-SEC and required significant clarification and rewording of items and the scale.	**Items that required clarification and/or repetition or were reported to be difficulty by over half of the sample, were rewritten or discarded.* Based on child, parent, and RA feedback, no modifications were made to the individual items; however, detailed "Instructions for Administration" were formally added. These instructions highlighted three main points: 1) teaching and ensuring the child understands the concept of "confidence" and how to use the response scale (i.e., go through the full teaching script and do not move past the practice items until the child understands the response scale), 2) ensuring the child's response is valid and discussing a child's response with them if it appears invalid (i.e., if the child says "I can't do that", but responds with "very confident", then a discussion should occur to ensure the child's response is valid prior to moving on to the next item), and 3) providing meaningful examples when necessary (e.g., 1 hour is as long as a movie).

	Child Feedback	Parent Feedback	RA Feedback	Decision/Modification
Ease of Use Definition: How easy the MRI-SEC was to navigate and complete, length of completion.	**Was completing that book: easy, a little bit hard, or hard?* ‘Easy’ (n = 5) ‘A little bit hard’ (n = 4) ‘Hard’ (n = 1) Children reported that difficulty ratings were based on the fact that they had never heard of MRI before (n = 2) and it was sometimes challenging to predict how they would feel in the future (n = 3). **Was completing that book: lots of fun, a little bit of fun, or no fun at all?* ‘Lots of fun’ (n = 5) ‘A little bit of fun’ (n = 3) ‘No fun at all’ (n = 2)	**How would you describe the length of the MRI-SEC?* All parents (n = 10) reported that the length was ‘just right’.	**Note if child required redirection back to the MRI-SEC during completion and at what item.* Similar to cycle one, children were engaged during completion of the scale and no loss of interest was observed. Redirection back to the scale was not required for any child. **Note completion time.* Average: 10 minutes Range: 9 to 15 minutes	No modifications were made to the scale on the basis of feedback regarding the length, time of completion, or ease of completion.

Notes. n = 10. Questions/prompts to gather feedback within each area is italicized and in lighter font.

CHAPTER 3. CAN CHILDREN'S SELF-EFFICACY TOWARD MRI BE MODIFIED THROUGH A TARGETED PREPARATION PROGRAM? A RANDOMIZED CONTROLLED TRIAL

The manuscript prepared for this experimental study is presented below. Melissa Howlett, under the supervision of Dr. Jill Chorney, was responsible for developing the research questions and hypotheses, planning the methodology and analytic approach, and obtaining ethical approval. Melissa consulted with her dissertation committee (Dr. Christine Chambers, Dr. Sherry Stewart, and Dr. Rudolf Uher) during the development phase, and their feedback was incorporated into the conceptualization and design of the study. Melissa developed the study protocol and contributed substantially to data collection, while overseeing undergraduate volunteers who also helped during the data collection process. Melissa was responsible for preparing the dataset for analysis, conducting the analyses, and writing the current manuscript. The manuscript was reviewed by Dr. Chorney and Melissa's dissertation committee members, and feedback was incorporated accordingly. Melissa also applied for and was successful in obtaining a Project Funding Grant through the Anesthesia Research Fund within the Department of Anesthesia, Pain Management, and Perioperative Medicine, at Dalhousie University, to support this research. The authors (Howlett, M., & Chorney, J) plan to submit the manuscript for peer-review and publication at a later date.

Abstract

Objective: Procedural distress is common among children. Preparation has been shown to decrease procedural distress and improve cooperation during procedures; however, the mechanism by which preparation functions is less understood. Using magnetic resonance imaging (MRI) as a model procedure, the objectives of this study were to assess the modifiability of self-efficacy through the use of preparation and to assess self-efficacy as a mediator of the effect of preparation on procedural distress. The modifiability of parent-reported confidence in their child's ability to complete MRI was also explored. **Method:** Children (n = 104), aged 6 to 12 years, with no prior MRI experience participated together with their parents. Children were randomly assigned to an MRI preparation condition or an attention control condition. Children in each group were compared on measures of MRI self-efficacy and anticipated fear toward MRI, while parents in each group were compared on measures of confidence in their child's ability to complete MRI, anticipated child worry and response toward MRI, and anticipated parent worry. Mediation analyses assessed self-efficacy as a mediator of the effect of preparation on anticipated fear toward MRI. **Results:** Children in the preparation condition reported higher MRI self-efficacy and lower anticipated fear, as compared to children in the control condition following intervention. An increase in MRI self-efficacy through preparation was shown to mediate the reduction in anticipated fear. Group differences were not observed for parent measures, with the exception of anticipated child response toward MRI. **Conclusion:** Children's perceived self-efficacy holds promise as a modifiable predictor of procedural distress. Better understanding of self-efficacy in the context of pediatric medical procedures can guide the development of targeted preparation programs and screening of procedural distress, thus informing treatment planning and ensuring positive medical experiences for children.

Keywords: self-efficacy, pediatric MRI, preparation, procedural distress, RCT

Introduction

Procedural distress is common among children and has been shown to interfere with cooperation and response during medical procedures (Racine et al., 2015; Taddio et al., 2012). Although many predictors of procedural distress have been identified, most are non-modifiable (e.g., age, temperament, response to previous medical procedures) and therefore do not inform how to best assess and manage procedural distress. Research suggests that preparation (e.g., information provision, teaching and practicing the components and skills associated with the procedure) can reduce procedural distress and improve cooperation (Blount et al., 2003), but the mechanism by which preparation operates has not been examined, thus limiting theoretical advancements.

While not yet studied in the context of pediatric medical procedures, self-efficacy (i.e., judgments of one's capability to perform actions required to attain a desired outcome; Bandura, 1977) may be informative in better understanding how preparation works and predicting child distress toward medical procedures. Research in other contexts (e.g., adherence, academic performance) suggests that self-efficacy can inform an individual's affective response in a particular situation, the use of coping behaviours, cooperation, and persistence through challenging tasks, thus making it a reliable predictor of behaviour (Bandura, 1997; Barlow et al., 2001). Self-efficacy theory posits that self-efficacy is a modifiable construct that can be influenced through four main pathways: mastery experiences, vicarious exposure through peer modelling, verbal persuasion, and interpretation of physiological states (Bandura, 1997). Given the overlap between the pathways to self-efficacy and the components of many preparation programs, it is plausible that self-efficacy may be a mechanism by which preparation decreases procedural distress and improves cooperation and procedural outcomes.

Magnetic resonance imaging (MRI) is a good model for the initial investigation of self-efficacy in the context of medical procedures. MRI is a commonly used diagnostic imaging procedure that is painless, but often distressing for children (Westra et al., 2011). Some children are unable to cope with the demands (e.g., remaining still, long duration, loud noises, enclosed narrow space) and consequently require general anesthesia in order to complete the procedure, increasing the risks, costs, and wait times (Carter et al., 2010; Rosenberg et al., 1997; Vanderby, et al., 2020). Approximately 50% of 6-year-olds, more than 30% of 7 and 8-year-olds, and 10% of 9 to 12-year-olds require general anesthesia to complete MRI (Rosenberg et al., 1997), and recent data suggest that the need for anesthesia is increasing as advancements in MRI technology are becoming more sensitive to movement (Uffman et al., 2017). Predictors of child distress and compliance toward MRI are not well understood and often the decision for general anesthesia is based on professional judgment, informed by non-modifiable factors (e.g., age, developmental disorder, response to previous medical procedures), resulting in the potential for inaccurate predictions which carry real risks (e.g., unjustified exposure to general anesthesia, unnecessary use of hospital resources, undue stress on child, system inefficiencies). Noteworthy, neither age nor developmental level have not been shown to be predictive of compliance with MRI (Cahoon & Davison, 2014).

Although the use of general anesthesia for MRI continues to be high, research suggests the addition of preparation (e.g., mock-MRI, play therapy) and/or support during the procedure (e.g., breaks, audio-visual systems) can improve cooperation with MRI, leading to enhanced scan success and reduced anxiety and fear toward the procedure

(Cahoon & Davison, 2014; Carter et al., 2010; Rosenberg et al., 1997; Slifer et al., 1994). Despite such findings, implementation of preparation programs in clinical settings is limited. Given the modifiable nature of self-efficacy (Bandura, 1997), it may be a useful indicator of children who are likely to benefit from preparation (pre-preparation assessment) and/or additional support during the procedure, as well as identify those who have successfully benefited from preparation (post-preparation assessment), increasing the likelihood for success completing MRI without general anesthesia and facilitating accurate predictions. Preliminary investigation among adult populations has demonstrated that targeting self-efficacy through intervention leads to improved behavioural and emotional scan outcomes (Powell et al., 2015).

Objectives & Hypotheses

The primary objective of this study was to assess the modifiability of self-efficacy in the context of pediatric MRI, through experimental manipulation comparing a targeted preparation program for MRI to an attention control. MRI self-efficacy was measured using the MRI Self-Efficacy Scale for Children (Howlett & Chorney, 2020). It was hypothesized that children in the preparation condition would report higher self-efficacy than children in the control condition, and that parents of children in the preparation condition would report higher confidence in their child's ability to complete MRI, as compared to parents of children in the control condition.

The secondary objective was to investigate the influence of preparation for MRI on anticipated fear and distress toward MRI and the mediating effect of MRI self-efficacy. Based on research with adult populations, it was expected that children in the preparation condition would report less fear toward MRI, as compared to children in the control condition, and that MRI self-efficacy would be a mediator of that association (Powell et al., 2015). Similarly, it was hypothesized that parents of children in the preparation condition would report their child to have less distress and a better response toward MRI, as compared to parents of children in the control condition, and that parent-reported confidence in their child's ability to complete MRI would mediate that association.

Method

Design

This study was a randomized, single blind, parallel group trial, stratified by age. The trial was not registered, as the purpose was not to test the efficacy or effectiveness of an intervention, rather it was to assess self-efficacy as a specific mechanism of change in a simulated environment. The study was approved by a research ethics board at a tertiary care health centre and written informed consent and assent was obtained from all participants.

Participants

Participants in this study included 104 children between the ages of 6 and 12, with no prior experience with MRI, and one accompanying parent. Recruitment was stratified by age to ensure a representative sample, with 52 child-parent dyads in each of two age groups (younger age group: 6 to 8 years old, older age group: 9 to 12 years old). Participant demographic characteristics are displayed in Table 3.1. Exclusion criteria included families who were not fluent in English, if the child did not possess cognitive and language skills developed to a 6-year-old level, and if the child had prior experience with MRI.

Procedure

Children and parents were informed of the study through online platforms, word of mouth, and recruitment postings in community locations. The purpose of the study was advertised as investigating how children feel when learning and trying new activities, rather than the topic of MRI specifically. This mild deception was used to ensure participants were blinded to their randomized condition and to minimize the possibility of participants researching and learning about MRI prior to participation. Parent consent and authorization, child assent, and participation were completed during a visit to a research lab in a healthcare centre. Following parent consent, authorization, and child assent, parents completed a demographic questionnaire and participants were randomized into one of the two conditions. Following completion of either the preparation intervention or control intervention, children and parents completed post-intervention measures, assessing MRI self-efficacy and anticipated MRI distress. Parents completed the study measures independently, while children completed their measures one-on-one with a research assistant. Debriefing was provided following completion of the study procedure for each parent-child dyad.

Randomization was generated by an individual outside of the study, using permuted blocks stratified by age (6 to 8 years, 9 to 12 years). Block size (either 4 or 6) was determined using a computer-generated list of random numbers. Within blocks group allocation (preparation condition or control condition) was determined randomly, also through a computer-generated list of random numbers. Sequentially numbered, opaque, sealed envelopes were used to conceal the randomized allocation sequence (Doig & Simpson, 2005). The Consolidated Standards of Reporting Trials (CONSORT) reporting checklist is displayed in Figure 3.1.

Preparation Condition

Children in the preparation condition watched a video and practiced the skills associated with having an MRI scan. The video provided procedural information, including a tour of a diagnostic imaging area and MRI suite and a description of the procedure in the order of events children are asked to do when arriving at the hospital for an MRI scan (i.e., beginning with registration and ending with successful scan completion). The video also described the sensory experience of MRI, such as what children can expect to see, hear, and feel during the procedure. The video was retrieved from YouTube and developed by Beaumont Children's Hospital (Beaumont Health, 2016). In addition to information provision, each individual pathway of self-efficacy enhancement was targeted by components in the preparation intervention, through hands-on practice and teaching, as outlined in Figure 3.2. Parents were present and actively involved during completion of the preparation intervention, as they were instructed to provide praise and encouragement to their child throughout the practice.

Attention Control Condition

Children in the attention control condition watched a video describing healthy dental hygiene. The video was time-matched to that of the preparation condition. Children also completed hands-on practice of the dental hygiene skills introduced in the video (i.e., brushing, flossing) on a model tooth set for approximately the same amount of time as children in the preparation condition spent in active practice. The video was retrieved from YouTube and presented by Colgate (Colgate-Palmolive Company, 2009). The purpose of the attention control intervention was to control for time spent in the lab environment, time spent with a research assistant, and time spent learning about a procedure/skill.

Measures

Demographic Information

Parents reported on their child's age and sex, any neurodevelopmental and/or mental health diagnoses, and the presence of claustrophobia. Parents also reported on their child's medical history, in order to determine level of experience in a medical context and experience with various procedures, such as nonpainful diagnostic imaging procedures similar to MRI.

Primary Outcome Measure

MRI Self-Efficacy. The MRI Self-efficacy Scale for Children (MRI-SEC; Howlett & Chorney, 2020), is a 12-item questionnaire aimed at assessing children's self-efficacy toward MRI, among school-aged children. The MRI-SEC includes a step-by-step depiction of the MRI procedure using both words and pictures to facilitate understanding. Children are asked how confident they are in their ability to complete each of 12 steps involved in the MRI procedure (e.g., *"how confident are you that you can lie completely still, like a statue, in the tunnel?"*). Responses are provided using a 4-point Likert scale (e.g., not confident at all, a little confident, quite confident, very confident). The MRI-SEC begins with four practice questions unrelated to MRI (e.g., *"how confident are you that you can pick up a pencil?"*) to ensure children understand the word 'confident' and can demonstrate appropriate use of the response scale. Simple, child-friendly language is used throughout (e.g., picture test, tunnel, donut-like hole), matching the language used in the video shown as part of the preparation intervention. An overall MRI self-efficacy score is calculated by summing responses for all 12 items, resulting in a possible range of 12 to 48, with higher values indicating higher MRI self-efficacy. Excellent internal consistency was observed in the current study ($\alpha = 0.932$).

A parent version of the MRI-SEC was completed by parents, with the purpose of assessing parent confidence in their child's ability to complete MRI (e.g., *"how confident are you that your child can lie still in the scanner, while it is making loud noises?"*). The parent version includes the same number of items and follows the same format and scoring as the child version. Excellent internal consistency was also observed for the parent version ($\alpha = 0.934$).

Secondary Outcome Measures

Anticipated Fear and Distress Toward MRI. Child fear toward MRI was measured using the Children's Fear Scale (CFS; McMurtry et al., 2011), which consists of five sex-neutral faces ranging from a face showing no fear (neutral) to a face showing extreme fear. Children were asked to indicate which face depicts how scared they would feel if they had to have an MRI scan. Potential scores range from 0 to 4, with higher values indicating higher fear. The CFS has demonstrated good validity and reliability among children ages 5- to 10-years old, undergoing venipuncture (McMurtry et al., 2011).

Parents completed three, author-made items, assessing their perception of their child's worry toward MRI, how they thought their child would respond to the procedure, and their own anticipated worry if their child had to have an MRI scan, using a 10-point numerical rating scale (1 'not worried at all' or 'respond very well' to 10 'extremely worried' or 'respond very poorly'). Parents also indicated whether they thought their child would require general anesthesia if they had to have an MRI scan.

Other Post-Intervention Measures

Manipulation Check. Children in the preparation condition completed four items assessing how well they identified with the child in the video shown in the preparation condition (e.g., *How easy is it to picture yourself doing what the child in the video was doing?*). Responses were provided using a 10-point numerical rating scale (1 'not easy at all' to 10 'very easy'). Research suggests that peer modelling is most successful when the peer is matched with the child on as many components as possible (e.g., age, sex, race); however, exact guidelines are vague. The purpose of these items was to inform the success of peer modelling.

Cooperation with Preparation Intervention. For participants in the MRI preparation group, the research assistant completed six items assessing engagement and cooperation with each of six individual steps during the preparation intervention (e.g., explaining the practice to the child, getting the child to stay in the tunnel). Responses were provided using a 5-point Likert scale (1 'very easy' to 5 'very difficult'). The research assistant also provided a rating of the child's effort during completion of the preparation intervention. Ratings were completed using a 10-point numerical rating scale (1 'poor effort', 10 'high effort').

Sample Size Calculation & Data Analysis

Sample Size Calculation

To date, self-efficacy in the context of pediatric medical procedures has not been investigated. Much of the previous research assessing preparation for MRI has focused on reduction in the use of general anesthesia for MRI, compliance with the MRI procedure, or scan success, which are not directly applicable to the primary outcome of the current study (i.e., self-efficacy). As such, the effect-size estimate used for power calculations were based on research conducted with an adult population, in which the influence of preparation on MRI-related self-efficacy has been assessed, demonstrating a large effect size (*d = 0.81;* Powell et al., 2015). A power analysis (conducted using G*Power) for an independent samples *t*-test with 90% power and alpha set at 0.05, revealed that a total sample size of 68 (34 per group) would be needed to detect a large effect (*d* = 0.81) between groups. This number was considered an underestimate given the comparison of adult to child population and a larger sample size was deemed necessary in order to stratify groups by age; therefore, the target sample size was set at 100 parent-child dyads.

Preliminary and Descriptive Analyses

All variables were examined for approximation to a normal distribution (e.g., skewness and kurtosis statistic greater than |1|). With the exception of the items included in the manipulation check and cooperation with the preparation intervention, all variables met the assumption of normality. Independent samples *t*-tests and chi-square analyses were conducted to compare groups on demographic characteristics (e.g., age, sex, previous medical experience). Differences between groups were not expected given stratification and randomization procedures. Data related to the manipulation check and cooperation with the preparation intervention were examined using descriptive analyses. Means and standard deviations are reported for variables in which normal distribution was met, whereas medians and ranges are reported for those in which the assumption of normality was violated. Concordance between child- and parent-report on the MRI-SEC was also explored, using the Pearson correlation coefficient and the intraclass correlation (ICC; absolute agreement, two-way random effects model). An ICC < 0.40 represented poor to fair agreement, 0.41-0.60 represented moderate agreement, 0.61-0.80 represented good agreement, and 0.81-1.00 represented excellent agreement (Bartko, 1966; Varni & Burwinkle, 2006).

Primary Objective

T-tests were conducted to examine differences between groups on the primary outcome variable for both children (MRI self-efficacy, MRI-SEC child report) and parents (confidence in their child's ability to complete MRI, MRI-SEC parent report).

Secondary Objective

T-tests were conducted to examine differences between groups on the secondary outcome variable for children (anticipated child-reported fear toward MRI, on the Children's Fear Scale) and parents (parent-reported anticipated worry, child fear and response toward MRI, on the NRS). Mediation analyses using a non-parametric bootstrap resampling technique (Hayes, 2013) to determine the indirect effect was used to assess MRI self-efficacy as a mediator of the effect of preparation for MRI on anticipated fear toward MRI. An indirect effect was considered to signify significant mediation when zero did not fall within the 95% bias corrected and accelerated confidence intervals (Preacher & Hayes, 2004). The effect size of the indirect effect was calculated using kappa-squared (κ^2) and interpreted based on guidelines provided by Preacher and Kelley, 2011 (small effect = 0.01, medium effect = 0.09, large effect = 0.25).

Results

Preliminary and Descriptive Analyses

Data was collected between August 2018 and February 2019. Of the 165 families who expressed interest in participating, 18 did not meet inclusion criteria (e.g., previous experience with MRI, outside of age range), five did not attend on the day of scheduled participation, and 38 did not respond to inquiries to schedule a date for participation. Of the remaining 104 families, 52 were randomly assigned to the preparation group and 52 were randomly assigned to the control group (Figure 3.1). Missing data was detected for medical history information completed by parents (n = 3), parent-report of the MRI-SEC and anticipated fear and response toward MRI (n = 4), and child report of the MRI-SEC and anticipated fear and distress toward MRI (n = 1). Listwise deletion was conducted in all analyses to account for missing data.

Children in the intervention and control groups were similar with respect to age and their demographic characteristics (Table 3.1), indicating that successful stratification and randomization procedures were achieved, and the sample was equally distributed across age groups. Descriptive statistics and correlations for the primary and secondary objective variables are displayed in Table 3.2.

Manipulation Check

The median rating indicating how much the child in the video reminded participants of themselves was 4.00 (*range:* 1 to 10), with a total of 14 out of 51 children rating 7 or higher on the numerical rating scale. Twenty-eight children indicated that it was easy (i.e., rated 7 or higher) to picture themselves doing what the child in the video was doing (e.g., having an MRI scan; *Med* = 7.00, *range:* 1 to 10). Further, 43 children reported that seeing the child in the video helped to teach them about what an MRI picture test is (*Med* = 10.0, *range:* 1 to 10) and 33 indicated that seeing the child in the video helped them feel like they could have an MRI picture test (*Med* = 8.00, *range:* 1 to 10).

Cooperation with the Preparation Intervention

Reports from the research assistant indicated that explaining the preparation intervention to children was easy or very easy for 94.2% (*n* = 49) of children (percentage includes rating of easy and very easy combined) and getting the child to lay properly in the practice tunnel was easy or very easy for 86.5% (*n* = 45) of children. The research assistant also indicated that 82.7% (*n* = 43) of children stayed in the tunnel during the practice with no difficulty, and 90.4% (*n* = 47) had no difficulty staying still during the initial practice and when the MRI sounds were introduced. Lastly, 86.5% (*n* = 45) of children were reported to remain still for the full five-minute practice with little difficulty. Child effort during completion of the preparation intervention was rated high (e.g., 7 or above on a numerical rating scale) for 46 participants (*Med* = 10.0, *range:* 1 to 10). The practice session in the preparation intervention was considered a success for 92.3% of participants (*n* = 48), while 7.7% (*n* = 4) were unable to complete the practice. Reasons for unsuccessful completion were excessive movement (*n* = 2) and fear of going into the tunnel (*n* = 2). Intention to treat was employed and all participants were included in the analyses regardless of whether they successfully completed the intervention, with the exception of one child-parent dyad who did not complete the post-intervention measures and thus the primary outcome variable was missing (i.e., MRI-SEC).

Child and Parent Concordance on the MRI-SEC

Child and parent-report on the MRI-SEC demonstrated a small correlation with one another in both the preparation condition ($r = .19$, $p = .184$) and the control condition ($r = .19$, $p = .192$). An ICC of .300 was observed for the preparation condition and an ICC of .314 was observed for the control condition, indicating poor to fair agreement for both conditions (Bartko, 1966; Varni & Burwinkle, 2006).

Primary Objective (Group Comparisons)

Group comparisons indicated a significant difference in MRI self-efficacy between children in the preparation condition ($M = 37.9$, $SD = 7.42$, $n = 51$) and children in the control condition ($M = 30.9$, $SD = 9.67$, $n = 52$), $t\,(101) = 4.07$, $p < .0001$, 95% CI [3.55, 10.3], Hedge's $g = 0.80$), indicating that children in the preparation condition reported higher self-efficacy toward MRI than children in the control condition following the intervention. Based on the examined effect size, it is suggested that the difference between groups represents a large effect (Figure 3.3).

A significant group difference was not observed for parent confidence in their child's ability to complete MRI, between parents of children in the preparation condition ($M = 34.8$, $SD = 7.79$, $n = 50$) and parents of children in the control condition ($M = 32.5$, $SD = 7.92$, $n = 50$), $t\,(98) = 1.46$, $p = .148$, 95% CI [-0.83, 5.43], Hedge's $g = 0.29$).

Secondary Objective (Mediation Analyses)

Child Report

Group comparisons indicated a significant difference in child-reported anticipated fear toward MRI between those in the preparation condition ($M = 1.27$, $SD = 1.38$, $n = 51$) and children in the control condition ($M = 1.94$, $SD = 1.36$, $n = 52$), $t\,(101) = -2.56$, $p = .01$, 95% CI [-1.19, -0.15], Hedge's $g = 0.50$), indicating that children in the preparation condition reported lower anticipated fear toward MRI than children in the control condition.

Mediation analyses indicated that MRI self-efficacy was a significant mediator of the association between group allocation (preparation condition or control condition) and anticipated fear toward MRI (Figure 3.4). Group allocation was a significant predictor of MRI self-efficacy and MRI self-efficacy was a significant predictor of anticipated fear toward MRI. Group allocation was a significant predictor of anticipated fear toward MRI ('total effect'), however, this association was no longer significant when MRI self-efficacy was included in the model ('direct effect'; i.e., the association between group allocation and anticipated fear toward MRI operated through MRI self-efficacy). These results indicate that preparation for MRI reduces anticipated fear toward MRI, through an increase in MRI self-efficacy. Bootstrap analyses with 5000 samples revealed a significant indirect effect for group allocation on anticipated fear toward MRI, through MRI self-efficacy, $b = 0.60$, $SE = 0.17$, 95% BCa CI [0.31, 0.97]), with $\kappa^2 = 0.23$ indicating a large effect.

Parent Report

Group comparisons did not reveal significant differences in parent-report of how worried they thought their child would be if they had to have an MRI scan (t (98) = -1.41, p = .16, 95% CI [-2.02, 0.34]) nor parent-report of how worried they themselves would feel if their child had to have an MRI scan (t (98) = -1.28, p = .20, 95% CI [-1.99, 0.43]). However, a significant difference in how parents expected their child to respond to MRI was detected between those in the preparation condition (M = 2.76, SD = 1.67, n = 50) and children in the control condition (M = 3.84, SD = 2.31, n = 50), t (98) = -2.68, p =

.009, 95% CI [-1.88, -0.28], Hedge's $g = 0.53$), indicating that parents of children in the preparation condition expected their child to respond more positively to MRI than parents of children in the control condition. Chi-square tests indicated no association between group allocation and parent predictions of whether their child would require general anesthesia if they had to have an MRI scan ($\chi^2 = 0.51$, $p = 0.48$). A total of 23 parents (21.7%) reported that their child would require general anesthesia for MRI ($n = 10$ in the preparation condition (19.2%); $n = 13$ in the control condition (25.0%)). Due to the lack of group differences for parent-report on the MRI-SEC, mediation analyses were not completed for parent-reported data.

Discussion

This study sought to assess the modifiability of self-efficacy, in an effort to identify and establish a modifiable predictor of child distress and cooperation in the context of pediatric medical procedures. As hypothesized, children in the preparation condition reported higher MRI self-efficacy as compared to children in the control condition. Also, consistent with *a priori* hypotheses, children in the preparation condition reported less fear toward MRI than children in the control condition, and this effect was mediated by MRI self-efficacy. In contrast to child findings, parent-reported confidence in their child's ability to complete MRI, anticipated child worry and their own worry toward MRI did not differ between groups. Parents of children in the preparation condition did report expectations that their child would have a more positive response to MRI, as compared to parents of children in the control condition.

The Effect of Preparation on Child MRI Self-Efficacy

The preparation intervention developed for this study was guided by self-efficacy theory in that it targeted all four pathways to self-efficacy (Bandura, 1997) in an effort to directly enhance MRI self-efficacy among children. While the manipulation of self-efficacy has yet to be assessed in the context of pediatric medical procedures, the modifiability of self-efficacy has been established in other literature areas (e.g., health-related behaviour change, adherence for chronic illness; Ashford et al., 2010; Bandura, 2004; Barlow & Barefoot, 1996; Barlow et al., 1999; Dutton et al., 2009; Dishman et al., 2004; Ott et al., 2000; Tuuri et al., 2009). As such, results of this study are consistent with previous research and extend the theoretical implications of targeting self-efficacy to a novel literature area. In line with previous research, preparation also demonstrated a positive impact on child distress toward MRI (Rothman et al., 2016; Train et al., 2006; Viggiano et al., 2015), which was largely mediated by an increase in self-efficacy. Together these findings suggest that self-efficacy would make a useful and informative target for preparation interventions, thus guiding the development of novel interventions with direct clinical implications. A notable element of self-efficacy is that it is a measurable construct. Building interventions with a specific, measurable target in mind provides opportunity for assessment that can directly inform clinical decisions. For example, the assessment of child self-efficacy may inform if a child will require preparation (i.e., pre-preparation assessment) and furthermore if preparation was successful (i.e., post-preparation assessment). This information could guide treatment planning around the level of support a child might require during a procedure, including whether general anesthesia is needed.

The Effect of Preparation on Parent-reported Outcomes

Parents were present and actively involved in the preparation intervention (i.e., instructed to provide praise and encouragement); therefore, it was expected that parents of children in the preparation condition would report higher confidence in their child's ability to complete MRI, particularly following successful completion of the practice components included in the preparation condition. However, contrary to predictions, preparation did not have a significant effect on parent confidence in their child's ability to complete MRI, nor their predictions of their own or their child's worry toward MRI. Previous research suggests mixed results in whether preparation interventions for children also function to alleviate parent anxiety in the context of child medical procedures (e.g., MRI, surgery). While some research demonstrates a positive influence on parent anxiety (Elkins, 1983; Rothman et al., 2016; Yun et al., 2015; Zuwala & Barber, 2001), others report no significant decrease in parent anxiety (Tyc et al., 1997; Walker et al., 2019). The latter is consistent with results of the current study.

There are a number of speculative factors that may have influenced parent perception of their child's ability to complete MRI, including their knowledge and understanding of the procedural and sensory components involved in MRI, their own experiences and anxiety toward MRI, and their buy in and engagement with the preparation intervention. For example, if parents perceive the procedure to be really challenging, then they may report lower confidence in their child's ability, despite watching their child complete the preparation intervention successfully. Similarly, if a parent has had a negative experience with MRI or feels particularly anxious toward the procedure themselves, these feelings may inadvertently influence how well they expect their child to do during the procedure, as well as their child's level of anxiety. Lastly, it is possible that some parents did not believe the play tunnel was truly representative of the

MRI experience, and thus expect their child to have increased difficulty in the actual MRI, despite successful participation in the preparation intervention. Noteworthy, delivery of preparation did improve parent's rating of how they expected their child to respond to MRI, but this did not translate to parent's perception of enhanced skills and/or ability to complete the procedure.

Consistent with previous research in various health-related domains, poor concordance was observed between child- and parent-report on the MRI-SEC (Chambers et al., 1998; Riley, 2004; Upton et al., 2008). Perfect concordance was not expected, as the child and parent versions of the MRI-SEC likely tap into two distinct constructs (i.e., children's own perceived self-efficacy vs. parents' own perceived confidence in their child's ability to complete MRI). Of note, children and parents did not have the opportunity to discuss how the child felt about having an MRI scan prior to completing their individuals forms of the MRI-SEC. It is possible that if parents and children had an opportunity to discuss the child's feelings around MRI, parents would have had a more informed understanding of how their child felt toward the procedure and their perception may have changed, resulting in reports more congruent with their child. Nonetheless, poor concordance, in addition to the lack of effect of preparation on parent-reported outcomes, carry noteworthy implications from a clinical standpoint. Parents are often the primary individual involved in conversations with healthcare providers around the delivery of MRI and the necessity of general anesthesia. The results of this study suggest that parents and children are not in agreement with the child's ability to complete MRI, even after successful completion of preparation for MRI. As such, it is possible that failing to consider the child's perspective may lead to decisions incongruent with the child's own perceived self-efficacy toward MRI. Given that MRI self-efficacy has yet to be assessed in a clinical setting, it is not possible to discern which informant is most accurate in terms of predicting the child's actual ability to complete MRI; however, consistent with pleas from other researchers (Bevans et al., 2010; Ravens-Sieberer et al., 2006; Upton et al., 2008; Varni et al., 2007), parent-report should not be an automatic replacement of child-report solely on the basis of poor concordance.

Limitations & Future Directions

The findings of this study must be considered in light of limitations. First, children in this study were not exposed to the clinical MRI environment, as they were not required to have an MRI scan clinically or as part of the study. Thus, participants reported on their MRI self-efficacy and anticipated fear toward MRI hypothetically ("if you had to have an MRI scan tomorrow"), limiting generalizability of the findings. It is possible that the absence of requiring an MRI scan could have influenced both child and parent responses on the study measures, as well as their level of engagement with the preparation intervention. Nonetheless, given that this was the first study to use preparation to directly target self-efficacy in the context of a medical procedure, the lab-based environment provided the opportunity for a robust and controlled examination of the experimental manipulation of MRI self-efficacy. Further, child engagement and effort during the preparation intervention was rated to be high, thus indicating that despite the hypothetical nature of the study, children were still highly engaged.

A second limitation is that the MRI-SEC is a newly developed measure. While the current study assessed the modifiability of MRI self-efficacy using the MRI-SEC, the application and validity of the MRI-SEC in a clinical MRI setting has yet to be fully established. With these limitations in mind, it is imperative that future research assess the validity and utility of the MRI-SEC in a clinical context, with children who are scheduled to undergo a clinical MRI scan. The reality of actually having to have an MRI scan may impact both the emotional (e.g., anxiety, fear) and behavioural (e.g., cooperation) responses observed during the study procedure. Future research should also focus on assessing the sensitivity and specificity of the MRI-SEC and accuracy of the construct as a predictor of procedural distress and compliance. Specifically, determining a cut-off score would inform the likelihood of a successful awake scan or the necessity for additional support before and/or during the procedure to facilitate a successful awake scan, thus solidifying the clinical utility of assessing self-efficacy in this context.

A strength of this study was including both child and parent measures, thus gathering both perspectives. Further investigation of the concordance between child- and parent-report on the MRI-SEC is warranted, particularly in a clinical setting. Efforts should focus on determining which informant is most accurate in predicting procedural distress and compliance. Lastly, the preparation intervention in the current study consisted of many components, targeting each of the four individual pathways to self-efficacy enhancement. In an effort to inform the development of feasible and accessible interventions, future research should assess the relative effect of targeting each individual pathway of self-efficacy. Such research could inform whether all components are necessary or if a shortened intervention could be as successful toward increasing self-efficacy and thus decreasing procedural distress and improving procedural outcomes.

Conclusions

Children often exhibit stress and fear around medical procedures (Racine et al., 2015; Taddio et al., 2012). Identifying and understanding the mechanisms involved in reducing procedural distress, and thus improving cooperation and medical experiences for children is imperative in advancing research in this area of literature and informing the development of novel and feasible clinical interventions. The current study demonstrates initial evidence that child perceived self-efficacy can be modified through preparation and that an increase in self-efficacy largely accounts for a reduction of fear, in the context of pediatric MRI. This finding may provide knowledge crucial to guiding the screening and decision-making process around whether a child requires general anesthesia for MRI and informing the identification of children considered ideal candidates for preparation in an effort to reduce the rates of general anesthesia for pediatric MRI.

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Figures

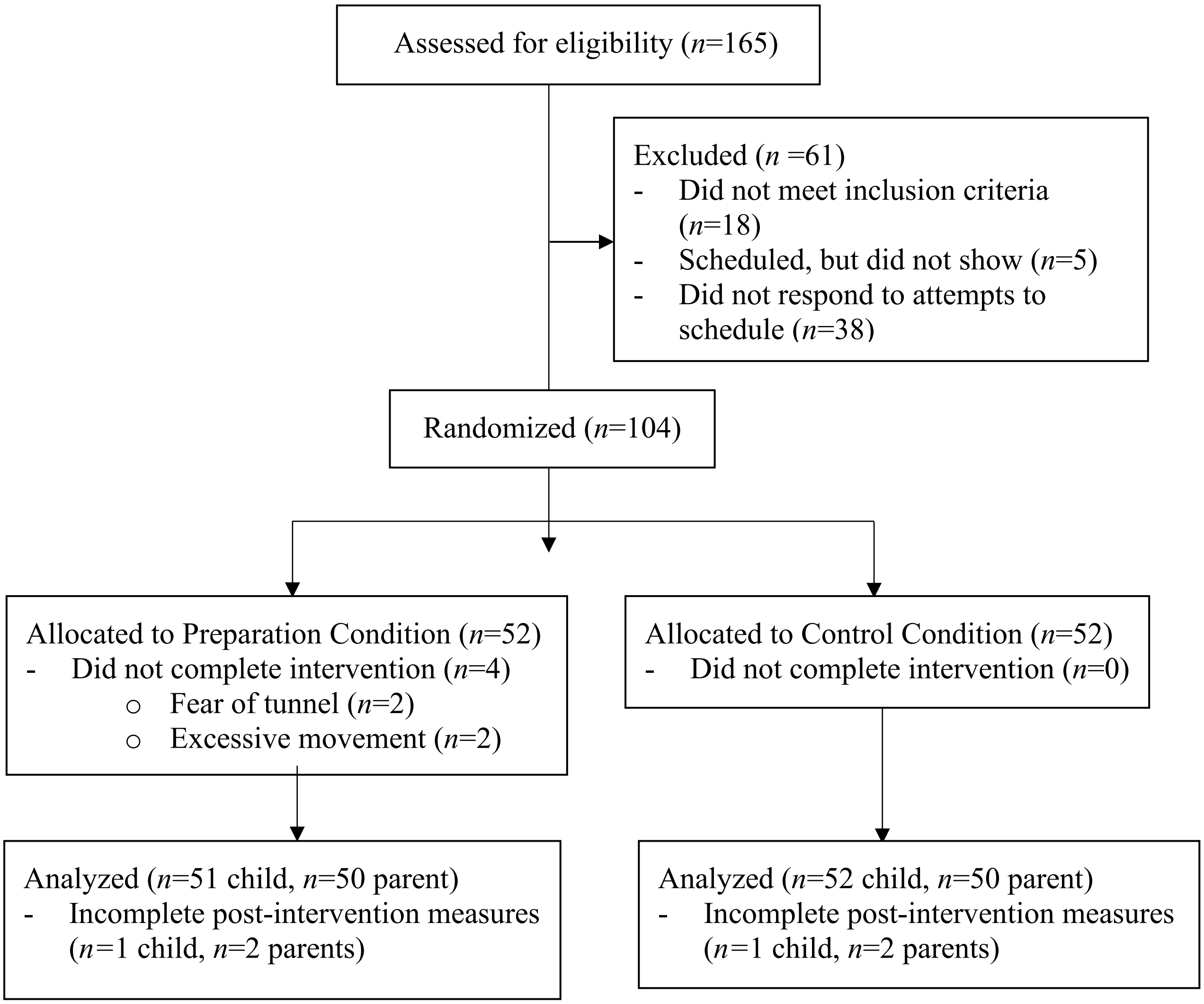

Figure 3.1. CONSORT diagram of participant flow.

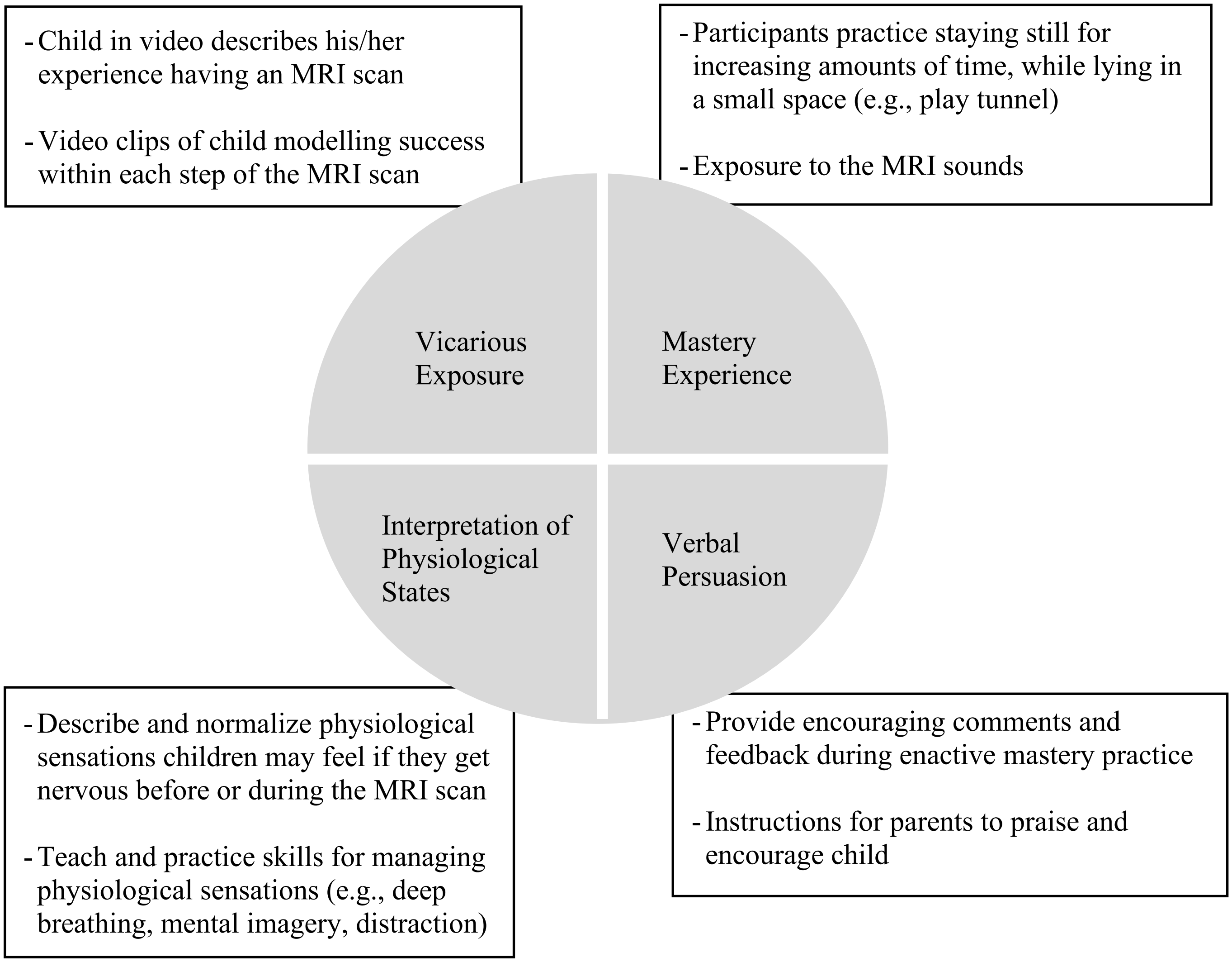

Figure 3.2. Breakdown of the MRI preparation intervention, targeting all four pathways of self-efficacy.

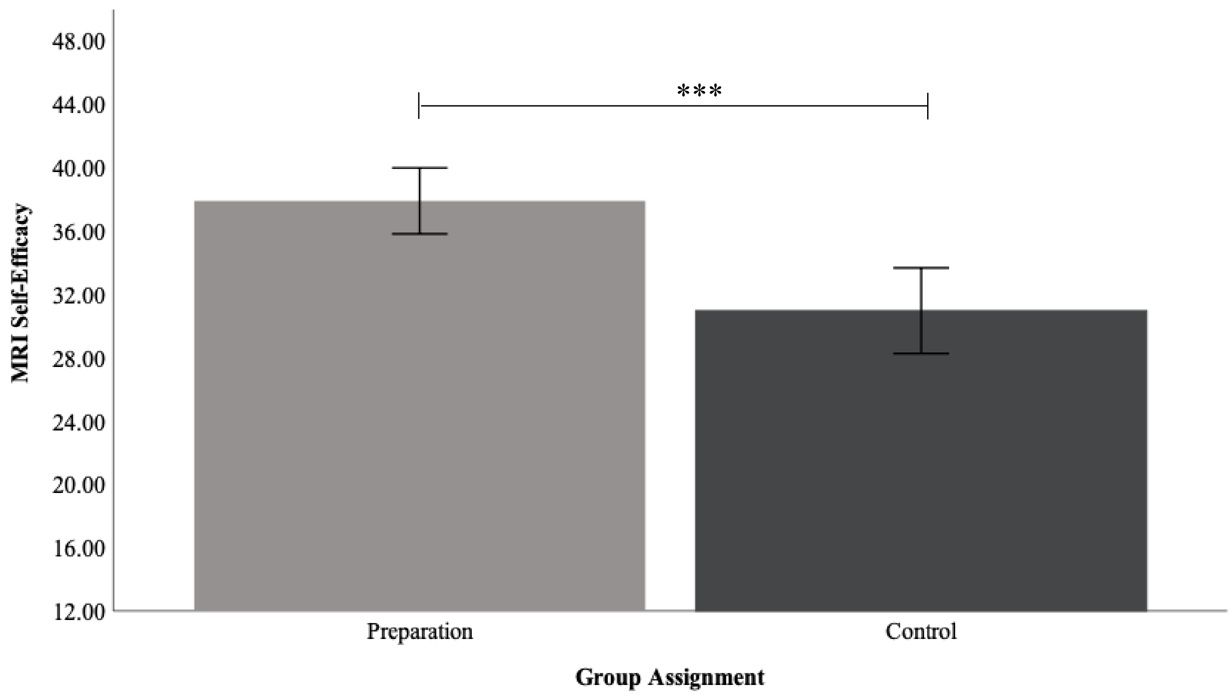

Figure 3.3. Mean MRI Self-Efficacy for children in the preparation and control conditions. Scores of MRI Self-Efficacy can range from 12 to 48. Error bars represent the 95% confidence interval. **p* < .0001.

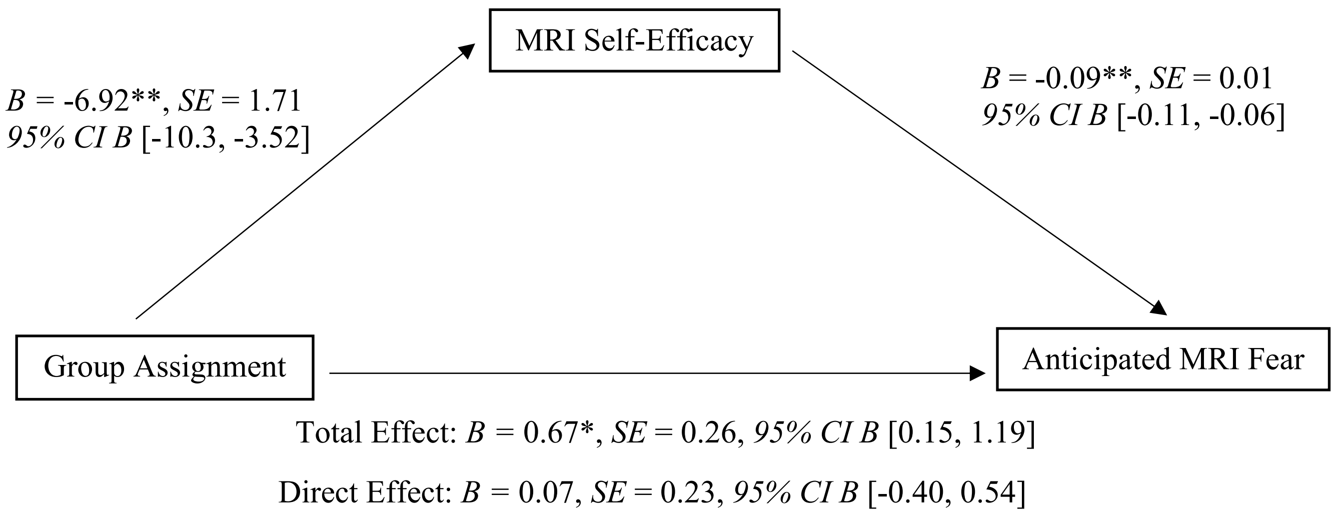

Figure 3.4. The mediating effect of MRI Self-Efficacy on the effect of group assignment on child's anticipated fear of MRI. *B* = unstandardized coefficient, *SE* = standard error of unstandardized coefficients, *95% CI B* = 95% confidence interval of the unstandardized coefficients. For Group Assignment: Preparation condition was coded as 1 and control condition was coded as 0. * denotes $p < .01$; ** denotes $p < .0001$.

Tables

Table 3.1

Descriptive statistics of participant characteristics.

	Preparation Condition	Control Condition	*p*
Child's Age, *M* (SD)	8.60 (1.94)	8.58 (1.91)	.96
Child's Sex (% female)	46.2	34.6	.32
Parent Participant (% mothers)	86.5	86.5	.99
Diagnosed Neurodevelopmental Disorder (ADHD, ASD; % yes)	15.7	8.0	.53
Diagnosed Anxiety Disorder (% yes)	5.9	2.0	.62
Previous Experience with Non-Painful Procedures (x-ray, CT scan; % yes)	56.9	64.0	.54
Previous Hospitalization (% yes)	35.3	40.0	.68
Claustrophobia (% yes)	0	0	--

Notes. All statistical comparisons on demographic characteristics were nonsignificant. *M* = mean, *SD* = standard deviation. ADHD = Attention Deficit Hyperactivity Disorder. ASD = Autism Spectrum Disorder.

Table 3.2

Correlations, means, and standard deviations for MRI self-efficacy and anticipated distress toward MRI variables.

Variable	Preparation Condition (n=50)						Control Condition (n=50)					
	2.	3.	4.	5.	6.	*M* (*SD*)	2.	3.	4.	5.	6.	*M* (*SD*)
1. MRI-SEC (child-report)	.19	-.45**	-.32*	-.04	-.16	38.1 (7.33)	.19	-.60**	-.23	-.16	-.08	31.3 (9.48)
2. MRI-SEC (parent-report)	-	-.25	-.53**	-.62**	-.66**	34.8 (7.79)	-	-.22	-.41**	-.50**	-.67**	32.5 (7.97)
3. Anticipated distress (child-report)	-	-	.35*	.20	.18	1.22 (1.23)	-	-	.23	.33*	.25	1.90 (1.36)
4. Anticipated child worry (parent-report)	-	-	-	.56**	.52**	4.76 (3.30)	-	-	-	.47**	.49**	5.64 (2.53)
5. Anticipated parent worry (parent-report)	-	-	-	-	.47**	3.94 (3.05)	-	-	-	-	.40**	4.72 (3.05)
6. Anticipated response (parent-report)	-	-	-	-	-	2.76 (1.67)	-	-	-	-	-	3.84 (2.31)

Note: M = mean, *SD* = standard deviation. MRI-SEC can range from 12 to 48. Anticipated distress (child-report) was measured with the Children's Fear Scale and can range from 0 to 4. Parent-report of child anticipated worry and response to MRI was measured with 10-point numerical rating scales, with higher scores indicating higher worry and less positive response. * $p < .05$, ** $p < .01$.

CHAPTER 4. SELF-EFFICACY AS A PREDICTOR OF PROCEDURAL ANXIETY, COOPERATION, AND SCAN OUTCOMES IN PEDIATRIC MAGNETIC RESONANCE IMAGING

The manuscript prepared for this empirical study is presented below. Melissa Howlett, under the supervision of Dr. Jill Chorney, was responsible for developing the research questions and hypotheses, planning the methodology and analytic approach, and obtaining ethical approval. Melissa consulted with her dissertation committee (Dr. Christine Chambers, Dr. Sherry Stewart, and Dr. Rudolf Uher) during the development and planning phase, and their feedback was incorporated into the conceptualization and design of the study. Melissa developed the study protocol and contributed substantially to data collection, while overseeing staff who helped during the data collection process. Melissa was responsible for preparing the dataset for analysis, conducting the analyses, and writing the current manuscript. The manuscript was reviewed by Dr. Chorney and Melissa's dissertation committee members, and feedback was incorporated accordingly. Melissa also applied for and was successful in obtaining a Project Funding Grant through the Anesthesia Research Fund within the Department of Anesthesia, Pain Management, and Perioperative Medicine, at Dalhousie University, to support this research. The authors (Howlett, M., & Chorney, J.) plan to submit the manuscript for peer-review and publication at a later date.

Abstract

Objective: Procedural anxiety and fear is common among children. Many previously identified predictors of procedural stress and cooperation are non-modifiable and therefore do not inform what should be the target of effects to reduce procedural stress and increase cooperation. Self-efficacy may be a measurable and modifiable predictor in the context of pediatric medical procedures. Using magnetic resonance imaging (MRI) as a model procedure, the objectives of this study were to assess child-reported MRI self-efficacy and parent-reported confidence in their child's ability to complete MRI as predictors of observed child procedural anxiety and cooperation during MRI, MRI scan outcomes, and the need for general anesthesia. **Method:** Children, aged 6 to 12 years, scheduled for MRI with (n = 30) and without (n = 109) general anesthesia participated on the day of their clinical MRI scan with one accompanying parent. Prior to the MRI scan, children reported on their MRI self-efficacy and anticipatory anxiety, while parents reported on their confidence in their child's ability to complete MRI, their child's anticipatory anxiety, and their own state anxiety. Procedural anxiety, cooperation, and scan outcomes were coded during the MRI scan by a research assistant and MRI technologist. Child- and parent-report on the MRI-SEC were each assessed as independent predictors. **Results:** Child MRI self-efficacy predicted observed procedural anxiety and cooperation, and the need for general anesthesia, while parent confidence in their child's ability to complete MRI predicted image quality and the need for general anesthesia. These results were present when controlling for various covariates depending on the outcome (e.g., child-reported anticipatory anxiety, parent-report of child anticipatory anxiety, age, sex). **Conclusion:** Children's perceived self-efficacy and parent confidence in their child's abilities are unique predictors in the context of pediatric MRI. Self-efficacy is a modifiable predictor, amenable to clinical intervention, and thus may play a role in decision-making around the need for general anesthesia for MRI, as well as efforts to reduce general anesthesia for MRI.

Keywords: self-efficacy, pediatric MRI, procedural anxiety, cooperation, screening

Introduction

Medical procedures are often distressing for children. Fear and stress can have an impact on cooperation during the procedure and even lead to an increase in fear and stress toward future medical encounters (Racine et al., 2015; Taddio et al., 2012). Many predictors of procedural stress have been identified and studied, including dimensions of child temperament, child psychopathology, parent anxiety, previous medical experience, and responses to previous medical procedures, age and developmental level (Racine et al., 2015). While these factors can provide information around a child's risk for procedural distress, they are largely non-modifiable, and thus do not inform how to best manage procedural distress to ensure a positive medical experience for children.

Self-efficacy (i.e., judgments of one's capability to perform actions required to attain a desired outcome; Bandura, 1977), may be an important factor in better understanding and predicting procedural distress and cooperation. Although not yet studied in pediatric medical procedures, research in other areas (e.g., health-related behaviour change, adherence to medical treatment for chronic illness, academic and social self-efficacy) suggests that self-efficacy can inform affective responses, initiation of coping behaviours, cooperation, and persistence through challenging tasks, thus making it a reliable predictor of behaviour (Bandura, 1986; Barlow et al., 2001; Maibach & Murphy, 1995). Further, self-efficacy theory suggests that self-efficacy is a modifiable construct and thus amenable to clinical intervention (Bandura, 1997; Gattuso et al., 1992).

Magnetic resonance imaging (MRI) is a good model for the initial investigation of self-efficacy in the area of pediatric medical procedures. MRI is a commonly used diagnostic imaging procedure that is generally painless; however, the requirements necessary to obtain good quality images (e.g., remaining still for up to an hour, loud noises, narrow enclosed space) are distressing and can be challenging for many children (Westra et al., 2011). Indeed, 20-30% of children and families report significant distress in response to MRI (Tyc et al., 1995; Westra et al., 2011). Some children are unable to cope with the sensory experience and demands of MRI and consequently require general anesthesia in order to obtain quality images, thus increasing the risks, costs, and wait times associated with the procedure (Carter et al., 2010; Rosenberg et al., 1997; Vanderby et al., 2010). It is estimated that approximately 50% of 6-year-olds, more than 30% of 7- and 8-year-olds, and 10% of 9- to 12-year-olds require general anesthesia to complete MRI (Rosenberg et al., 1997). More recent data suggests that the need for anesthesia is increasing as advancements in MRI technology are becoming more sensitive to movement (Uffman et al., 2017).

Currently, there is no standardized method of assessing and predicting child distress and compliance toward MRI, and predictors in this setting are not well understood. To date, only one study has explored predictors of MRI compliance among school-aged children, demonstrating support for parent-report of child compliance with previous medical procedures, attention, and adaptability (i.e., ability to cope with novel situations) (Cahoon & Davison, 2014). These findings have not been implemented into clinical practice and decisions around general anesthesia are often based on professional judgment (e.g., referring physician, MRI technologist), largely informed by non-modifiable factors (e.g., age, developmental disorder). The potential for inaccurate predictions is high and carries real risks. In some cases, children may be scheduled to receive general anesthesia and not need it, meaning the child is subjected to unjustified risk and necessary hospital resources and costs are accrued. On the other hand, some children are scheduled for MRI without general anesthesia and are unsuccessful. In these cases, children must return on another day when general anesthesia is available, resulting in undue stress on the child, a potentially avoidable negative medical experience, extra costs, and system inefficiencies.

There is a clear need for the investigation of potential predictors of distress and cooperation during MRI, to inform screening for the need for general anesthesia. Identification of predictors that are modifiable would provide valuable information expanding on the utility of current factors of procedural distress. Specifically, a modifiable predictor would provide a target for intervention, and a construct that could be measured to assess whether intervention was successful in decreasing procedural distress, thus guiding accurate and informed decision-making around the delivery of procedures. In the context of pediatric MRI, the identification of such predictors could provide assistance and guidance in screening whether a child will be able to comply with the MRI procedure, whether preparation or support during the procedure may be beneficial (pre-preparation assessment), if preparation was successful (post-preparation assessment), or if general anesthesia is required. Given that self-efficacy is theoretically a strong predictor of behaviour, measurable among children, and amenable to clinical intervention, it may be an informative construct in the context pediatric MRI.

Objectives & Hypotheses

The first objective of this study was to determine whether child-reported MRI self-efficacy and parent-reported confidence in their child's ability to complete MRI could predict child procedural anxiety and cooperation during MRI and procedural outcomes (e.g., image quality). It was hypothesized that children who reported higher MRI self-efficacy before their MRI scan, would be less anxious and more cooperative during the procedure, and would have clearer images obtained. It was also hypothesized that children whose parents reported higher confidence in their child's ability to complete MRI would be less anxious and more cooperative during the procedure, and obtain clearer images.

The second objective of this study was to assess child-reported MRI self-efficacy and parent-reported confidence in their child's ability to complete MRI as predictors of the need for general anesthesia. It was hypothesized that children scheduled for MRI with general anesthesia would report lower MRI self-efficacy as compared to children who were scheduled for MRI without general anesthesia. Similarly, it was hypothesized that parents of children who were scheduled for general anesthesia would report lower confidence in their child's ability to complete MRI, as compared to parents of children who were scheduled for MRI without general anesthesia.

Method

Participants

Participants in this study included 109 children ages 6 to 12 scheduled for a clinical MRI scan without general anesthesia and 30 children scheduled for a clinical MRI scan with general anesthesia, and one accompanying parent. Participant demographic characteristics are displayed in Table 4.1. Exclusion criteria included families who were not fluent in English and children who did not possess cognitive and language skills developed to a 6-year-old level. Children undergoing Magnetic

Resonance Enterography (MRE) were also excluded, as such scans require extra clinical procedures (e.g., drinking up to 1.5 liters of a solution consisting of 2% Sorbitol, active 10 to 15 second breath holds during the scan, placement of a band over the abdomen to recognize breathing) and therefore do not follow the standard procedure outlined in the questionnaire used to assess the primary independent variable (MRI self-efficacy).

Procedure

Parent authorization, consent, and child assent were obtained on the day of the child's scheduled MRI scan, upon arrival to the Diagnostic Imaging department and MRI waiting area. Following consent, children completed measures assessing MRI self-efficacy and anticipatory anxiety, and parents completed measures assessing demographic information, confidence in their child's ability to complete MRI, MRI-related worry, and state anxiety. Parents completed their measures independently, while children completed their measures one-on-one with a research assistant (RA).

MRI Without General Anesthesia

For children scheduled for MRI without general anesthesia, an RA unobtrusively observed the full duration of the child's MRI scan through a one-way mirror. The RA observed and coded child procedural anxiety and cooperation upon entry to the MRI suite and initiation of the scan. Throughout the scan the RA observed and documented child cooperation and scan characteristics. The MRI technologist working with the child reported on child cooperation throughout the duration of the scan, image quality, and success of the scan. All children watched a movie during their MRI scan and were offered to have their parent accompanying them in the MRI suite during their scan, as part of standard care.

MRI with General Anesthesia

Participation followed the same procedure for children scheduled for MRI with general anesthesia up to and through the induction of anesthesia. The RA coded anxiety and cooperation upon entry into the MRI suite and during the induction of anesthesia phase only.

Measures

Demographic Information

Parents reported on child age and sex, any neurodevelopmental and/or mental health diagnoses, and the presence of claustrophobia. Parents also reported on their child's past MRI experiences, such as previous scans, if applicable, and whether they were completed with or without general anesthesia.

MRI Self-Efficacy

The MRI Self-efficacy Scale for Children (MRI-SEC; Howlett & Chorney, 2020), is a 12-item questionnaire assessing children's self-efficacy toward MRI among school-aged children. The MRI-SEC includes a step-by-step depiction of the MRI procedure using both words and pictures to facilitate understanding. Children are asked how confident they are in their ability to complete each of 12 steps included in the MRI procedure (e.g., *"how confident are you that you can lie completely still, like a statue, in the tunnel?"*). Responses are provided using a 4-point Likert scale (e.g., not confident at all, a little confident, quite confident, very confident). The MRI-SEC begins with four practice questions unrelated to MRI (e.g., *"how confident are you that you can pick up a pencil?"*) to ensure that children understand the word 'confident' and can use the response scale. Simple, child-friendly language is used throughout (e.g., picture test, tunnel, donut-like hole). An overall MRI self-efficacy score is calculated by summing responses for all 12 items, resulting in a possible range of 12 to 48, with higher values indicating higher MRI self-efficacy. Excellent internal consistency was observed in the current study ($\alpha = 0.924$).

A parent version of the MRI-SEC was completed by parents, with the purpose of assessing parent confidence in their child's ability to complete MRI (e.g., *"how confident are you that your child can lie still in the scanner, while it is making loud noises?"*). The parent version follows the same format and scoring as the child version. Excellent internal consistency was also observed for the parent version ($\alpha = 0.953$).

Anticipatory Anxiety

Child anticipatory anxiety was measured using the Child Anxiety Meter (CAM-S; Ersig et al., 2013). The CAM-S is a brief, one-item measure of state anxiety, in which children are shown an image of a thermometer. Children were asked to point to the spot on the thermometer that showed how much worry they were feeling in that moment ("right now"). The CAM-S is a validated measure of child anxiety and has been assessed for use with children ages 4 to 10 undergoing intravenous insertion (Ersig et al., 2013). The CAM-S has demonstrated convergent validity with observational measures of child distress, parent ratings of child anxiety and distress, and typical levels of distress toward medical procedures, clinical appointments, and intravenous insertion (Ersig et al., 2013).

Parents completed one item capturing their perception of how worried they thought their child felt about their MRI scan (1 = not at all, 10 = extremely). Parent state anxiety was measured using the State-Trait Anxiety Inventory – State subscale (STAI-S; Speilberger, 1983). The STAI is a self-report measure of anxiety that includes two forms of 20-likert type items scored on a 4-point scale. One form measures trait (general) anxiety and the other measures state (current) anxiety. For the purpose of this study, parents completed the state form only, to assess state anxiety before their child's MRI scan. Total scores range from 20 to 80, with higher scores reflecting higher levels of state anxiety.

Procedural Anxiety

Child anxiety was measured using the modified-Yale Preoperative Anxiety Scale (mYPAS; Kain et al., 1997), completed by an RA. The mYPAS is an observational measure of child anxiety, designed to assess anxiety during four stages of the preoperative experience, including holding (waiting room), separation (walking into the operating room), induction 1 (entrance to the operating room), and induction 2 (introduction of the anesthesia mask). For the purpose of this study, the four stages were modified for the MRI experience, and thus included, holding (waiting room), separation (walking from waiting area to the MRI suite), procedure 1 (entering the MRI suite up to laying on the bed, introduction of coils), procedure 2 (bed moving into the tunnel to the point of the scan beginning). The mYPAS is comprised of five categories: Activity, Vocalizations, Emotional Expressivity, State of Arousal, and Use of Parent. Children are assigned a score between 0 and 4 or 0 and 5, depending on the category, that are determined by specific scoring criteria. Total scores for each stage of the MRI experience range from 23 to 100, with scores greater than 30 indicating anxiety. For the present study, the 'Procedure 1' stage was used as a measure of procedural anxiety. A secondary rater was present to code a random 20% of the data (n = 27). Intraclass correlations ranged from .993 to .996 for each stage, indicating excellent agreement between raters (p

< .0001).

Cooperation

Child cooperation was measured using the Induction Compliance Checklist (Kain, et al., 1998), completed by an RA. The Induction Compliance Checklist is a behaviour checklist that contains 10 behaviours (e.g., verbal refusal, requires physical restraint) that are dichotomously scored as present or absent. The Induction Compliance Checklist is typically used to assess compliance during induction to anesthesia and was therefore modified by the authors to be applicable to the MRI setting. Coding began when children entered the MRI suite, up until the bed was moved into the tunnel and the scan began. The number of behaviours coded as 'present' are summed to provide a score between 0 and 10. A secondary rater was present to code a random 20% of the data ($n = 27$). An intraclass correlation of .988 was achieved, indicating excellent agreement between raters ($p < .0001$).

The MRI technologist working with each child also reported on child cooperation throughout the duration of the scan. MRI technologists were asked to provide a rating of cooperation based on a 5-point Likert scale (very easy, easy, neither easy or difficult, difficult, very difficult) for eight individual steps of the MRI procedure (e.g., getting child to enter the MRI suite, getting child to lay on the MRI bed, getting the child to stay still in the middle of the scan).

Scan Characteristics, Image Quality, and Scan Success

The RA observing the child's scan recorded scan characteristics (e.g., scan location, length of scan, direction entering the scanner), whether a venipuncture was required for contrast administration, and success of the scan, including failure due to uncooperativeness, distress, or movement. Diagnostic imaging technologists were asked to rate image quality using a 3-point scale (good and viable images, somewhat degraded by movement, but viable, or degraded by movement and not viable). They were also asked to indicate whether the scan was a success (i.e., the child did not have to return for a second scan). Following completion of the MRI scan, parents indicated how well the scan went in comparison to their expectation using a numerical rating scale (1 = much worse than expected, 5 = just as expected, 10 = much better than expected).

Sample Size Calculation and Statistical Analyses

Sample Size Calculation

Objective 1. An a priori power analysis (conducted using G*Power) for multiple linear regression with three predictors (e.g., main predictor = self-efficacy, potential covariates = age, previous MRI experience), power level of .90, and alpha set at .05, revealed that 75 participants would be needed to detect a medium effect ($f^2 = 0.15$). The effect size f^2 was determined based on correlations observed in previous literature between the predictor variables and distress during MRI ($r = .20$) as the outcome variable (Tyc et al., 1995). Given that MRI self-efficacy has not yet been assessed in pediatric populations, the broader self-efficacy literature was used and demonstrated correlations of .25 to .30 between self-efficacy and functional outcomes (Barlow et al., 2001). To ensure statistical power for the multiple analyses required given the number of outcome variables, the target sample size was determined to be 100 parent-child dyads.

Objective 2. A second power analysis was conducted for a *t*-test with two independent, unequal groups (group 1 = general anesthesia, group 2 = awake scan). A medium to large effect was expected between the two groups on the outcome of MRI self-efficacy, given that decisions around general anesthesia are presumably based on predictions of children's ability to complete MRI successfully while awake. The power analysis with a power level of .90 and alpha set at .05 revealed that if there are 100 participants in the awake group, then 28 participants would be needed in the anesthesia group to detect a medium to large effect size (d = 0.70).

Preliminary and Descriptive Analyses

Statistical analyses were performed using SPSS 25.0 (IBM Corp, 2017). Data were screened for missing data and approximation to a normal distribution (e.g., skewness and kurtosis great than |1|). The MRI-SEC was missing for one child participant in the general anesthesia group due to time constraints. Listwise deletion was employed for subsequent analyses. All variables met the assumption of normality with the exception of the total scores for the mYPAS and the Induction Compliance Checklist, and the MRI technologist ratings of cooperation. Demographic and scan characteristics were examined using descriptive statistics. Means and standard deviations are reported for continuous variables and categorical variables were summarized using frequencies and percentages. Independent samples t-tests, chi-square tests, and Fisher's exact tests were conducted to compare the two participant groups (e.g., scheduled for a scan without general anesthesia scan or a scan with general anesthesia) on demographic and scan characteristics.

Concordance between child- and parent-report on the MRI-SEC was also explored, using the Pearson correlation coefficient and the intraclass correlation (ICC; absolute agreement, two-way random effects model). An ICC < 0.40 represented poor to fair agreement, 0.41-0.60 represented moderate agreement, 0.61-0.80 represented good agreement, and 0.81-1.00 represented excellent agreement (Bartko, 1966; Varni & Burwinkle, 2006).

Objectives 1 and 2

The mYPAS, Induction Compliance Checklist, and MRI technologist ratings of cooperation demonstrated a strong positive skew. To facilitate interpretation, these variables were classified into dichotomous variables. The mYPAS was dichotomized into ‘low’ and ‘high’ anxiety groups, based on the cut-off score of 30. The Induction Compliance Checklist was dichotomized into ‘perfect’ cooperation (total score = 0; no behaviours coded as present) and ‘moderate to poor’ cooperation (total score ≥ 1; at least one behaviour coded as present; *Median* = 1, range: 1 to 7). Ratings of cooperation provided by the MRI technologists were dichotomized into ‘perfect cooperation’ (all items rated ‘easy’ or ‘very easy’) and ‘moderate to poor cooperation’ (one or more items rated ‘neither easy or difficult’, ‘difficult’, or ‘very difficult’). Image quality and need for general anesthesia were both naturally dichotomized into ‘perfect images’ versus ‘degraded images’, and ‘scan with general anesthesia’ versus ‘scan without general anesthesia’, respectfully. Independent samples *t*-tests were conducted to examine differences between groups for the two primary predictors (child- and parent-report on the MRI-SEC).

Logistic regression analyses were performed to assess MRI self-efficacy (child-report on the MRI-SEC) and parent confidence in their child’s ability to complete MRI (parent-report on the MRI-SEC) as predictors of child procedural anxiety (mYPAS), cooperation (Induction Compliance Checklist and MRI technologist ratings), image quality (MRI technologist report), and the need for general anesthesia. MRI-SEC scores were standardized for both children and parents, in order to facilitate interpretation of the odds ratios (e.g., one-unit change refers to one standard deviation rather than one point on the MRI-SEC scale). Given that the investigation of self-efficacy in this context is novel to the literature, child and parent-report on the MRI-SEC were analyzed in separate regression models to establish individual contributions and to limit the potential effect of multicollinearity. The statistical assumptions for logistic regression were inspected. Potential covariates (e.g., child age, child sex, diagnosis of a developmental delay, parental presence, previous MRI experience, child self-reported anticipatory worry, parent rating of child anticipatory worry, parent state anxiety prior to the child's MRI) were assessed for each outcome individually, using chi-square tests and *t*-tests as appropriate. Significant covariates were included in subsequent analyses and entered in the first step, followed by one of the two primary predictors in the second step. Multicollinearity was assessed through examination of correlations between the primary predictor variables and identified covariates, in addition to inspection of the variance inflation factor. Given multiple analyses, family-wise error was controlled by adjusting the *p*-value using the Bonferroni correction for children and parent analyses individually. As such, a *p*-value of < 0.01 was considered to be statistically significant, in addition to examination of the 95% confidence intervals of the odds ratio.

Post-hoc power analyses were conducted (using G*Power) and are presented for each logistic regression model, as the analysis plan was modified from that used for the original sample size calculation. The post-hoc power analysis was conducted using the odds ratio detected for the primary predictor variable (i.e., child- and parent-report on the MRI-SEC) in each model, the calculated probability of the outcome variable when the primary predictor is set to its mean (i.e., Pr(Y=1 | X=1) H_0), and the squared multiple correlation coefficient (R^2) between the main predictor variable and all covariates, thus accounting for the power to detect a main effect of the primary predictor variable in the final step of the overall model. Power less than .80 was considered inadequate, while power greater than .80 was considered acceptable (Onwuegbuzie & Leech, 2004).

Results

Preliminary and Descriptive Analyses

Data were collected between November 2018 and September 2019. A total of 258 families were approached for interest in participation. Eighteen families did not meet the inclusion criteria (e.g., fluency in English, cognitive and language skills at a 6-year-old level), 37 families were not interested in participating, and 64 families expressed interest, but for various reasons participation did not occur (e.g., scan cancelled, scan started early, family showed up late limiting time to complete measures before the scan). Demographic characteristics are presented in Table 4.1 for children scheduled for MRI without general anesthesia and those scheduled for MRI with general anesthesia. Significant group differences were identified for age ($t(137) = 2.69$, $p = .008$, 95% CI [0.277, 1.813], Hedge's $g = 0.55$), diagnosis of a neurodevelopmental disorder ($\chi^2 = 6.50$, $p = .011$), and previous MRI experience ($\chi^2 = 7.54$, $p = .006$) between children scheduled for MRI without general anesthesia and children scheduled for MRI with general anesthesia. Specifically, children scheduled for MRI with general anesthesia were younger in age, more likely to have a diagnosis of a neurodevelopmental disorder, and more likely to have prior MRI experience. Of the 20 children scheduled for general anesthesia who had prior MRI experience, 13 children had received general anesthesia for all previous MRI scans and seven had received general anesthesia for 'some' previous scans. MRI scan characteristics are presented in Table 4.2. There were no significant group differences identified based on scan characteristics.

Of the 109 children scheduled for MRI without general anesthesia, 101 successfully completed the scan, while eight children were scheduled to return on another date with the addition of general anesthesia. Of the eight 'failed scans', two children were unable to begin the scan due to fear and anxiety upon entry to the MRI suite, four children were unable to hold still for the duration of the scan and thus the scan was cancelled due to movement interference, one child became anxious during the scan and was unable to complete the scan, and one child was unable to cope with the contrast administration due to needle phobia and thus the scan could not be fully completed.

Most children (89%, n = 96) who completed an awake scan had a parent present during their MRI scan. Seven parents (6.4%) indicated that their child's MRI scan went worse than they expected (rating below 5), 31 parents (28.4%) reported that the scan went as expected (rating of 5), and 71 parents (65.1%) stated that the scan went better than expected, with 58 of those parents providing a rating of 8 or above (10 = much better than expected). Of the 101 children who successfully completed an awake MRI scan, good and viable images were obtained for 75 children, while images were somewhat degraded, but viable for 26 children. Six children whose images were deemed 'good and viable' required one image sequence to be retaken due to movement, while 19 children whose images were deemed 'somewhat degraded, but viable' required between one and four sequences to be retaken.

As displayed in Table 4.3, significant mean differences were observed in children's MRI self-efficacy for all five outcomes, including procedural anxiety ($t(107) = -4.78$, 95% CI [-9.74, -4.03], Hedge's $g = 0.91$), cooperation assessed by the Induction Compliance Checklist ($t(107) = -4.91$, 95% CI [-10.1, -4.30], Hedge's $g = 0.99$), cooperation assessed through MRI technologist ratings ($t(107) = -3.14$, 95% CI [-7.75, -1.75], Hedge's $g = 0.61$), image quality ($t(107) = 2.79$, 95% CI [1.31, 7.69], Hedge's $g = 0.57$), and scan delivery ($t(136) = -6.95$, 95% CI [-13.6. -7.59], Hedge's $g = 1.33$).

Significant mean differences were also observed in parent confidence in their child's ability to complete MRI for procedural anxiety ($t(107) = -2.77$, 95% CI [-6.27, -1.03], Hedge's $g = 0.53$), cooperation assessed by the Induction Compliance Checklist ($t(107) = -3.28$, 95% CI [-7.03, -1.73], Hedge's $g = 0.67$), cooperation assessed through MRI technologist ratings ($t(107) = -4.70$, 95% CI [-7.22, -2.18], Hedge's $g = 0.72$), image quality ($t(107) = 3.72$, 95% CI [2.34, 7.64], Hedge's $g = 0.77$), and scan delivery ($t(137) = -9.93$, 95% CI [-15.8, -10.5], Hedge's $g = 1.89$).

Descriptive statistics and correlation coefficients between the primary predictor variables and variables assessed as potential covariates are displayed in Table 4.4. Several of the variables demonstrated moderate correlations, but no intercorrelations were strong enough to invalidate subsequent regression models due to multicollinearity.

Child and parent-report on the MRI-SEC demonstrated a large correlation with one another for participants who were scheduled for an awake MRI scan ($r = .60$, $p < .001$) and a moderate correlation for participants scheduled for MRI with general anesthesia ($r = .35$, $p = .060$). An ICC of .730 was observed for those scheduled for an awake MRI scan, indicating good agreement, and an ICC of .494 was observed for those scheduled for an MRI scan with general anesthesia, indicating fair to moderate agreement

(Bartko, 1966; Varni & Burwinkle, 2006).

Objective 1:

Procedural Anxiety (mYPAS)

Investigation of between group differences revealed child self-reported anticipatory anxiety ($t(107) = -4.49$, $p < .0001$, 95% CI [-2.63, -1.02])) and parent-report of child anticipatory anxiety ($t(107) = -3.33$, $p < .001$, 95% CI [-2.78, -0.71]) as significant covariates. MRI self-efficacy accounted for significant variance above and beyond child anticipatory anxiety, demonstrating a significant negative main effect in which lower self-efficacy was predictive of higher procedural anxiety (Table 4.5). The overall model accounted for 31.4% of variance and classification was good, with 76.1% of cases being correctly classified into the high or low anxiety groups. Post-hoc power analyses revealed 71% power (inadequate) to detect an effect of the primary predictor.

A significant main effect of parent-reported child anticipatory anxiety was detected; however, parent confidence in their child's ability to complete MRI did not account for significant variance in child procedural anxiety (Table 4.5). While parent confidence did not reach significance, a trend in the expected direction was observed. Post-hoc power analyses revealed 37% power (inadequate) to detect an effect of the primary predictor.

Cooperation (Induction Compliance Checklist)

Investigation of between group differences revealed child age ($t(107) = 2.55$, $p = .01$, 95% CI [0.21, 1.68]), child self-reported anticipatory anxiety ($t(107) = -5.80$, $p < .0001$, 95% CI [-3.08, -1.51]), and parent-reported child anticipatory anxiety ($t(107) = -2.98$, $p = .004$, 95% CI [-2.69, -0.54]) as significant covariates. Adding child-reported

MRI self-efficacy to the model accounted for significant variance above and beyond child anticipatory anxiety and child age, thus demonstrating a main effect, in which higher self-efficacy was predictive of perfect cooperation (Table 4.6). The overall model accounted for 44.7% of variance and classification was good, with 78% of cases being correctly classified into the 'perfect' or 'moderate to poor cooperation' groups. Post-hoc power analyses revealed 81% power (acceptable) to detect an effect of the primary predictor.

While parent-reported predictors as a set significantly predicted child cooperation, neither the covariates (age, parent-report of child anticipatory anxiety) nor the primary predictor (parent confidence in their child's ability to complete MRI) demonstrated significant main effects (Table 4.6). While parent confidence did not reach significance as predictor, a trend in the expected direction was observed. Post-hoc power analyses revealed 66% power (inadequate) to detect an effect of the primary predictor.

Cooperation (MRI Technologist Rating)

Investigation of between group differences revealed child age ($t(107) = -4.15$, $p < .0001$, 95% CI [-2.09, -0.74]), child sex ($\chi^2 = 17.6$, $p < .0001$), and diagnosis of a neurodevelopmental disorder ($\chi^2 = 12.0$, $p = .001$) as significant covariates. Review of a contingency table including the frequency of each cell when all predictors and the outcome were included, indicated that more than 20% of the cells had fewer than 5 cases; therefore, diagnosis of a neurodevelopmental disorder was not included as a covariate in the logistic regression models. As displayed in Table 4.7, while the predictors as sets significantly predicted cooperation and main effects of child age and sex were identified, neither child MRI self-efficacy nor parent confidence in their child's ability to complete MRI demonstrated significant main effects. Trends in the expected direction were observed for both primary predictors. Post-hoc power analyses revealed 14% and 17% power (inadequate) to detect an effect of the primary predictor for children and parents, respectively.

Image Quality

For the investigation of image quality, the 'degraded images' group was composed of the 26 children who were deemed to have 'degraded, but viable images', the six participants who did not successfully complete the scan, and the two participants who did not begin the scan, as there was not enough individuals to include a third group composing of children who did not successfully complete the scan. Investigation of between group differences revealed child age ($t(107) = 4.39$, $p < .0001$, 95% CI [0.86, 2.28]) and child sex ($\chi^2 = 6.48$, $p = .01$) as significant covariates. While child-reported predictors as a set significantly predicted image quality, only child age demonstrated a significant main effect (Table 4.8), while trends were observed in the expected direction for child self-efficacy. Post-hoc power analyses revealed 20% power (inadequate) to detect an effect of the primary predictor.

For parents, adding report of confidence in their child's ability to complete MRI to the model accounted for significant variance above and beyond child age and sex, demonstrating a main effect, in which higher confidence was predictive of clearer images (Table 4.8). The overall model accounted for 31.6% of variance and classification was good, with 73.4% of cases being correctly classified into the 'perfect' or 'degraded' images group. Post-hoc power analyses revealed 37% power (inadequate) to detect an effect of the primary predictor.

Objective 2

For the purpose of these analyses, the eight participants who were unsuccessful in completing an awake MRI scan were added to the general anesthesia group. The original groups were pre-determined based on clinical judgement during scheduling of the MRI. Based on the scan outcome these eight participants were determined to belong better in the general anesthesia group than the awake group, as they were required to return for a second MRI with the addition of general anesthesia.

Investigation of between group differences revealed child self-reported anticipatory anxiety ($t(1137) =-3.26$, $p = .002$, 95% CI [-2.88, -0.68]), parent-report of child anticipatory anxiety ($t(137) = -2.17$, $p = .032$, 95% CI [-2.22, -0.10]), child age ($t(137) = 3.88$, $p < .0001$, 95% CI [0.66, 2.05]), and diagnosis of a neurodevelopmental disorder ($\chi^2 = 12.6$, $p < .0001$) as significant covariates. As displayed in Table 4.9, MRI self-efficacy accounted for significant variance above and beyond child age, diagnosis of a neurodevelopmental diagnosis, and child-reported anticipatory anxiety. As such a significant negative main effect of self-efficacy was identified, in that as child-report MRI self-efficacy decreased, the odds of requiring general anesthesia for MRI increased. The overall model accounted for 46% of the variance and classification was good, with 82.6% of cases being correctly classified as requiring general anesthesia or not. Post-hoc power analyses revealed 59% power (inadequate) to detect an effect.

Parent confidence in their child's ability to complete MRI also accounted for significant variance above and beyond child age, diagnosis of a neurodevelopmental diagnosis, and parent-report of child anticipatory anxiety. A significant negative main effect of parent confidence in their child's ability was identified, in that as parent confidence in their child's ability to complete MRI decreased, the odds of children requiring general anesthesia for MRI increased (Table 4.9). The overall model accounted for 62% of the variance in the need for general anesthesia and classification was good, with 85.6% of cases being correctly classified as requiring general anesthesia or not. Post-hoc power analyses revealed 98% power (acceptable) to detect an effect.

Discussion

The purpose of this study was to assess child-reported MRI self-efficacy and parent-reported confidence in their child's ability to complete MRI as predictors of children's emotional (procedural anxiety at the initiation of the scan) and behavioural (cooperation at the initiation of the scan and during the scan) response to MRI, scan outcomes (image quality), and the need for general anesthesia. Univariate analyses revealed that both child self-efficacy and parent confidence in their child's ability to complete MRI differed between groups for each outcome variable. Specifically, higher self-efficacy and higher parent confidence was reported for children who were observed to have less anxiety at the beginning of the scan, observed to be more cooperative at the beginning and throughout the duration of the scan, obtained higher quality images, and completed MRI without general anesthesia. Investigation of predictors while controlling for covariates revealed that child MRI self-efficacy was a significant predictor of observed procedural anxiety and cooperation at the initiation of the scan, and the need for general anesthesia, while parent confidence was a significant predictor of image quality and the need for general anesthesia.

Procedural Anxiety, Cooperation, and Image Quality

Child MRI self-efficacy was a significant predictor of observed procedural anxiety and cooperation at the beginning of the scan, above and beyond child-reported anticipatory anxiety, which is a well-documented predictor of procedural distress in the context of many medical procedures (Claar et al., 2002; Racine et al., 2015; Thung et al., 2017). These results suggest that the MRI-SEC could be useful in screening children prior to MRI to identify children who may experience greater emotional and behavioural difficulties at the beginning of the procedure. This information could guide planning around the need for preparation and/or support on the day of the child's MRI scan. A growing body of literature demonstrates that higher child anxiety during painful procedures can negatively impact pain memories and attitudes toward future procedures, such that children in a higher state of anxiety exhibit more negative memories of the event and more negative attitudes toward future procedures (Claar et al., 2002; Cohen et al., 2001; Noel et al., 2010; Noel et al., 2012). MRI is not a 'painful' procedure per se; however, a higher state of distress may contribute negatively to memories of the event and impact distress and response toward future medical events. These findings validate the importance of assessing child self-efficacy prior to MRI in an effort to ensure a positive medical experience for children.

Differences were observed between the predictive capability of child self-efficacy and parent confidence in their child's ability to complete MRI. While child self-efficacy was predictive of procedural stress and cooperation at the beginning of the scan (Induction Compliance Checklist), statistical significance was not reached for cooperation during the procedure (i.e., MRI technologist ratings of cooperation) and image quality, although trends were observed in the expected direction. On the other hand, parent confidence in their child's ability to complete MRI was a significant predictor of image quality, while trends in the expected direction were observed for procedural anxiety and cooperation. The contrast between child and parent findings is notable and suggests that child self-efficacy is most influential over children's emotional and behavioural reaction at the beginning of the scan, whereas parent confidence is most important in predicting the objective outcomes of the procedure (i.e., image quality). These findings suggest that the MRI-SEC may be tapping into different areas for children and parents. For example, consistent with previous research, children and parents may use different reasoning processes and justification of their responses (Davis et al., 2007). While speculative, it is possible that child ratings on the MRI-SEC are informed more so by their emotional reaction to the demands of MRI as described by the items, while parents are particularly focused on their prediction of their child's specific capabilities (i.e., ability to stay still) that would inform direct objective outcomes of the scan. Children and parents may draw on different experiences to inform their responses, resulting in differences in the predictive capability of the two distinct variables. Additionally, it is important to note that the child and parent versions of the MRI-SEC likely tap into two distinct constructs. Specifically, the child version assesses children's own perceived self-efficacy, whereas the parent version assesses parents' own perceived confidence in their child's ability to complete MRI.

From a clinical perspective, both children's emotional and behavioural initial reaction to MRI, and the objective outcomes, such as image quality, are important. For example, predictions of image quality can inform whether scheduling a longer scan time may be required to ensure good quality images. Consistent with previous literature (Bevans et al., 2010; Ravens-Sieberer et al., 2006; Upton et al., 2008; Varni et al., 2007), these results suggest that both child self-efficacy and parent-reported confidence may provide unique, but complementary perspectives in predicting important and informative outcomes in the context of pediatric MRI. Thus, findings from the current study provide evidence that both child and parent perspectives offer valuable information and should be considered in planning delivery of MRI for children.

Scan Delivery (Awake versus General Anesthesia)

Both child self-efficacy and parent confidence were significant predictors of children who required general anesthesia and those who did not. Of note, 30 of the 38 children in the general anesthesia group were scheduled for general anesthesia prior to enrolment in the study. Standard practice suggests that parents were likely involved in that decision, which likely contributes to the large observed effect.

Consistent with the factors staff currently report using to make decisions around general anesthesia (Cahoon & Davison, 2014), there were significant group differences for age, diagnosis of a neurodevelopmental disorder, and previous experience with MRI. The fact that child self-efficacy and parent confidence in their child predicted the need for general anesthesia above-and-beyond these factors, speaks to the potential of MRI-SEC as a screener for the need for general anesthesia, and thus the value of self-efficacy as a construct in this setting. The factors informing current decisions are not consistent with the literature assessing predictors in the context of pediatric (Cahoon & Davison, 2014), allowing for the potential for incorrect decisions. The findings of the current study suggest that child self-efficacy and parent confidence in their child's abilities, as measured by the MRI-SEC, could be useful as a screener to guide accurate decisions around the need for general anesthesia for MRI. The MRI-SEC could also function to identify children who may benefit from preparation and/or support, in an effort to reduce the need for general anesthesia.

Although both child- and parent-report on the MRI-SEC were shown to be significant predictors of the need for general anesthesia, concordance between child and parent report on the MRI-SEC for those scheduled for general anesthesia revealed only fair to moderate agreement. This finding is clinically relevant and merits attention, as parents are often involved in decisions around general anesthesia. Of note, 68% of parents whose children completed MRI without general anesthesia, were surprised with how well their child did during the awake scan. Together, these results suggest that children and parents may not be on the same page and decisions concerning MRI delivery when the decision is general anesthesia. It is possible that parents in the general anesthesia group may not have discussed the specifics of the MRI procedure with their child beforehand, since the child was going to receive anesthesia. Further research is needed to inform whether any children pre-scheduled for general anesthesia could have completed MRI without general anesthesia, and whether child MRI self-efficacy is predictive of that outcome.

Limitations and Future Directions

There are a number of limitations in this study that must be considered. Most children who were scheduled for an awake MRI scan, actually did fairly well in completing the scan successfully. This resulted in a restricted distribution of some outcome variables, thus limiting the ability to complete planned analyses (i.e., multiple linear regression). As such, outcome variables were dichotomized, leading to a reduction of power and restricting the ability to detect some effects. As displayed for each outcome variable, statistical power to detect an effect was quite low for many outcome variables. For this reason, it is possible that there are some effects that have been missed. Future research with a larger sample size is required to further inform the predictive capability of child self-efficacy and parent confidence in their child's abilities. Participant selection may represent a limitation as well. Approximately 14% of families approached declined participation. It could be the case that families in which the child and/or parent(s) were highly anxious or concerned about the MRI scan itself, may have been less inclined to participate, resulting in a skewed and non-representative sample. Future investigations should seek to achieve a larger and representative sample in an effort to obtain a higher power level to detect effects.

Group allocation into the general anesthesia or awake groups was pre-determined based on clinical judgement and completed prior to enrolment in the study (i.e., when scheduling the MRI scan). The eight children who were unable to complete an awake MRI scan were added to the general anesthesia group for analyses involving the general anesthesia group; however, it is unknown whether any of the 30 children scheduled for MRI with general anesthesia could have completed an awake MRI scan, if given the opportunity to try. In order to fully assess the predictive capability of the MRI-SEC in predicting the need for general anesthesia, future research should provide all children with the opportunity to attempt an awake scan following completion of the MRI-SEC. Such research should also focus on determining cut-off scores for the MRI-SEC to inform whether a child may benefit from preparation, if preparation was successful, if additional support may be required during the procedure to facilitate an awake scan, or if general anesthesia is required. Investigation and determination of cut-off scores would solidify the clinical utility and guide implementation of the MRI-SEC in clinical settings.

A final limitation of this study is the potential for observer bias, as the RA who completed the MRI-SEC with the child before their MRI scan also completed the observational measures assessing procedural anxiety (mYPAS) and cooperation (Induction Compliance Checklist). However, excellent agreement was observed between the first and second raters for a random subset of participants, and the second rater was blind to the child's responses on the MRI-SEC.

Conclusion

Child-reported MRI self-efficacy and parent-reported confidence in their child's ability to complete MRI, as measured by the MRI-SEC, demonstrated potential as predictors in the context of pediatric MRI. Specifically, child MRI self-efficacy was found to be a significant predictor of procedural anxiety and cooperation at the beginning of the scan, and the need for general anesthesia, while parent confidence in their child's ability to complete MRI was found to be a significant predictor of image quality and the need for general anesthesia. Assessing MRI self-efficacy can inform decision-making around general anesthesia for MRI, as well as planning for an awake scan (e.g., if preparation or support may be helpful). The results of this study provide evidence that assessing perceived self-efficacy prior to medical procedures can provide critical information around how the child is feeling about the procedure and the level of support they may require to ensure a positive medical experience.

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Tables

Table 4.1.

Descriptive Statistics of Participant Characteristics.

	Non-GA MRI Scan (n = 109)	MRI Scan with GA (n = 30)	p
Child's Age, M (SD)	9.6 (1.9)	8.53 (1.9)	.008*
Child's Sex			
% (n) female	50.5 (55)	36.7 (11)	.18
% (n) male	49.5 (54)	63.3 (19)	
Parent Participant			
% (n) mothers	77.1 (84)	76.7 (23)	.99
% (n) fathers	19.3 (21)	20.0 (20)	
% (n) other	3.7 (4)	3.3 (1)	
Child Ethnicity			
% (n) Caucasian	87.2 (95)	86.7 (26)	.28
% (n) Other	12.8 (14)	13.3 (4)	
Parent Ethnicity			
% (n) Caucasian	89.0 (97)	90.0 (27)	.30
% (n) Other	11.0 (12)	10.0 (3)	
Diagnosed Neurodevelopmental Disorder (ADHD, ASD; %, n yes)	13.8 (15)	33.3 (10)	.01*
Diagnosed Anxiety Disorder (%, n yes)	6.4 (7)	13.3 (4)	.20
Previous MRI Experience (%, n yes)	38.5 (42)	66.7 (20)	.006*
Claustrophobia (%, n yes)	4.6 (5)	3.3 (1)	.81

Notes. GA = general anesthesia, M = mean, SD = standard deviation. ADHD = Attention Deficit Hyperactivity Disorder. ASD = Autism Spectrum Disorder. "Other" includes participants who self-identified as Aboriginal, Black, Arab/West Asian, and Chinese. * denotes significant difference between groups ($p < .01$).

Table 4.2

Descriptive Statistics of MRI Scan Characteristics.

	Non-GA MRI Scan (n = 109)	MRI Scan with GA (n = 30)	p
Scan Location			.72
% (n) Head/Neck/Spine	67.9 (74)	73.3 (22)	
% (n) Spine/Torso/Chest/Pelvis	14.7 (18)	16.7 (5)	
% (n) Lower Extremity	16.5 (18)	6.7 (2)	
% (n) Upper Extremity	4.6 (5)	3.3 (1)	
Scan Direction			
% (n) Head-first	74.5 (81)	83.3 (25)	
% (n) Feet-first	25.7 (28)	16.7 (5)	.30
Scan Length, M (SD) (minutes)	48.2 (17.9)	--	--
Contrast Administration Required			
% (n) Yes	26.6 (29)	36.7 (11)	.34

Notes. GA = general anesthesia, M = mean, SD = standard deviation, p = p-value. 'Scan Length' consisted of 107 participants, as two scans did not begin.

Table 4.3.

Mean Total Scores on the MRI-SEC for Children and Parents Across Each Outcome Variable.

Outcome Variable	MRI-SEC (Child) *M(SD)*	*p*	MRI-SEC (Parent) *M(SD)*	*p*
Procedural Anxiety				
Low (*n* = 69)	39.4 (6.9)	< .0001	39.3 (6.5)	.007
High (*n* = 40)	32.5 (8.6)		35.7 (6.9)	
Cooperation (Induction Compliance Checklist)				
Perfect (*n* = 73)	39.2 (7.1)	< .0001	39.4 (6.7)	.001
Moderate to Poor (*n* = 36)	32.0 (7.5)		35.0 (6.3)	
Cooperation (MRI Technologist Rating)				
Perfect (*n* = 66)	38.9 (7.5)	.002	39.8 (6.1)	<.0001
Moderate to Poor (*n* = 43)	34.2 (8.1)		35.1 (7.0)	
Image Quality				
Perfect (*n* = 75)	38.4 (7.6)	.006	39.5 (6.2)	<.0001
Degraded (*n* = 34)	33.9 (8.3)		34.5 (7.1)	
Scan Delivery				
Non-GA (*n* = 101)	37.8 (7.5)	< .0001	38.5 (6.6)	<.0001
GA (*n* = 37 for children *n* = 38 for parents)	27.2 (9.1)		25.3 (7.9)	

Notes. M = mean, *SD* = standard deviation, GA = general anesthesia, *p* = p-value. Differences between groups were assessed using *t*-tests. The first four outcomes include only children scheduled for a non-GA scan.

Table 4.4.

Correlations, Means, and Standard Deviations for Predictor Variables and Variables Assessed as Covariates.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	*M* (*SD*)
1. MRI-SEC (child-report)	-	.35	.11	.13	-.10	-.15	-.37	-.30	-.22	27.1 (9.31)
2. MRI-SEC (parent-report)	.60**	-	.12	-.12	-.17	-.07	-.47*	-.24	-.26	23.7 (7.35)
3. Child Age	.18	.19	-	.15	.40	.12	.26	.22	.31	8.53 (1.94)
4. Child Sex	.15	.22	.25*	-	-	-	.25	.62**	.00	-
5. Diagnosis of NDD	-.13	-.21	.01	-	-	-	.01	.05	.31	-
6. Previous MRI Experience	.18	.41**	.03	-	-	-	-.01	.02	-.04	-
7. Child Anticipatory Anxiety (child-report)	-.38**	-.24	-.04	-.08	.23	-.15	-	.61**	-.03	4.86 (3.35)
8. Child Anticipatory Anxiety (parent-report)	-.25*	-.25*	-.14	-.08	.02	-.04	.42**	-	.02	5.80 (3.07)
9. Parent State Anxiety	-.19	-.26*	-.29*	-.26*	.09	.02	.20	0.33*	-	37.0 (9.30)
M (SD)	36.8 (8.0)	37.9 (6.9)	9.6 (1.9)	-	-	-	3.3 (2.2)	4.7 (2.8)	34.0 (11.2)	-

Notes. Non-GA participants (n = 109) displayed in non-shaded half. GA (n = 30) participants displayed in shaded half. M = mean, SD = standard deviation, NDD = neurodevelopmental disorder. * $p < .01$, ** $p < .001$. Pearson correlations were conducted for continuous variables. Point-biserial correlations were conducted between continuous and binary variables. Child sex (female = 1, male = 0), Diagnosis of NDD (No = 0, Yes = 1), Previous MRI Experience (No = 0, Yes = 1).

Table 4.5.

Logistic Regression Analysis Predicting Procedural Anxiety (mYPAS) from Child MRI Self-Efficacy and Parent Confidence in their Child's Ability to Complete MRI.

	B(SE)	*p*	Odds Ratio (95% CI)	
Children				
Model 1				
Anticipatory Anxiety	0.41(0.11)**	<.0001	1.50 (1.22, 1.85)	Model χ^2 = 17.7** Model R^2 = .205
Model 2				
Anticipatory anxiety	0.32(0.11)*	.004	1.37 (1.10, 1.71)	Block χ^2 = 10.7** Model χ^2 = 28.4** Model R^2 = .314
Self-efficacy	-0.78(0.25)*	.002	0.46 (0.28, 0.75)	
Parents				
Model 1				
Parent-report Child Anticipatory Anxiety	0.24(0.08)*	.002	1.28 (1.09, 1.49)	Model χ^2 = 10.5* Model R^2 = .125
Model 2				
Parent-report Child Anticipatory Anxiety	0.22(0.08)*	.007	1.24 (1.06, 1.46)	Block χ^2 = 4.46 Model χ^2 = 14.9* Model R^2 = .175
Parent-report MRI-SEC	-0.46(0.22)	.038	0.63 (0.41, 0.98)	

Notes. Low Anxiety: n = 69, High Anxiety: n = 40. Target group (coded 1) = High Anxiety, Low Anxiety coded 0. '*p*' = *p*-value. '95% CI' = 95% confidence interval of the odds ratio. * $p < .01$, ** $p < .0001$. R^2 = Nagelkerke R^2. Hosmer-Lemeshow goodness-of-fit test $p > .05$ in each model.

Table 4.6.

*Logistic Regression Analysis Predicting Cooperation (*Induction Compliance Checklist*) from Child MRI Self-Efficacy and Parent Confidence in their Child's Ability to Complete MRI.*

	B(SE)	*p*	Odds Ratio (95% CI)	
Children				
Model 1				
Child Age	0.36(0.14)*	.007	1.45 (1.11, 1.89)	Model χ^2 = 34.9** Model R^2 = .381
Anticipatory Anxiety	-0.58(0.13)**	<.0001	0.56 (0.44, 0.72)	
Model 2				
Child Age	0.33(0.15)	.022	1.39 (1.05, 1.85)	Block χ^2 = 7.32* Model χ^2 = 42.2** Model R^2 = .447
Anticipatory anxiety	-0.50(0.13)**	<.0001	0.61 (0.47, 0.78)	
Self-efficacy	0.72(0.28)*	.009	2.06 (1.20, 3.53)	
Parents				
Model 1				
Child Age	0.25(0.12)	.031	1.29 (1.02, 1.62)	Model χ^2 = 13.3* Model R^2 = .160
Parent-report Child Anticipatory Anxiety	-0.21(0.08)	.010	0.81 (0.69, 0.95)	
Model 2				
Child Age	0.22(0.12)	.072	1.24 (0.98, 1.56)	Block χ^2 = 5.54 Model χ^2 = 18.8** Model R^2 = .221
Parent-report Child Anticipatory Anxiety	-0.18(0.09)	.032	0.83 (0.71, 0.99)	
Parent-report MRI-SEC	0.53(0.23)	.022	1.70 (1.08, 2.69)	

Notes. Perfect Cooperation: *n* = 73, Moderate to Poor Cooperation: *n* = 36. Target group (coded 1) = Perfect Cooperation, Moderate to Poor Cooperation coded 0. '*p*' = *p*-value. '95% CI' = 95% confidence interval of the odds ratio. * $p < .01$, ** $p < .0001$. R^2 = Nagelkerke R^2. Hosmer-Lemeshow goodness-of-fit test $p > .05$ in each model.

Table 4.7.

Logistic Regression Analysis Predicting Cooperation (technologist rating) from Child MRI Self-Efficacy and Parent Confidence in their Child's Ability to Complete MRI.

	B(SE)	*p*	Odds Ratio (95% CI)	
Children				
Model 1				
Child Age	0.39(0.13)*	.002	1.48 (1.15, 1.91)	Model χ^2 = 28.5** Model R^2 = .312
Child Sex	1.59(0.46)*	.001	4.89 (1.99, 12.0)	
Model 2				
Child Age	0.37(0.13)*	.004	1.41 (1.09, 1.82)	Block χ^2 = 4.57 Model χ^2 = 33.1** Model R^2 = .354
Child Sex	1.56(0.47)*	.001	4.77 (1.89, 12.0)	
Self-Efficacy	0.49(0.23)	.036	1.63 (1.03, 2.58)	
Parents				
Model 1				
Child Age	0.39(0.13)*	.002	1.48 (1.15, 1.91)	Model χ^2 = 28.5** Model R^2 = .312
Child Sex	1.59(0.49)*	.001	4.89 (1.99, 12.0)	
Model 2				
Child Age	0.36(0.13)*	.005	1.43 (1.11, 1.85)	Block χ^2 = 6.48 Model χ^2 = 35.0** Model R^2 = .372
Child Sex	1.48(0.48)*	.002	4.39 (1.72, 11.2)	
Parent-report MRI-SEC	0.60(0.24)	.014	1.82 (1.13, 2.93)	

Notes. Perfect Cooperation: n = 66, Moderate to Poor Cooperation: n = 43. Target group (coded 1) = Perfect Cooperation, Moderate to Poor Cooperation coded 0. Female coded 1, Male coded 0. '*p*' = *p*-value. '95% CI' = 95% confidence interval of the odds ratio. * $p < .01$, ** $p < .0001$. R^2 = Nagelkerke R^2. Hosmer-Lemeshow goodness-of-fit test $p >$ .05 in each model.

Table 4.8.

Logistic Regression Analysis Predicting Image Quality from Child MRI Self-Efficacy and Parent Confidence in their Child's Ability to Complete MRI.

	B(SE)	*p*	Odds Ratio (95% CI)	
Children				
Model 1				
Child Age	0.45(0.13)*	.001	1.57 (1.22, 2.03)	Model χ^2 =20.1**
Child Sex	0.81(0.47)	.082	2.25 (0.90, 5.62)	Model R^2 = .237
Model 2				
Child Age	0.41(0.13)*	.002	1.51 (1.17, 1.96)	Block χ^2 = 3.38
Child Sex	0.75(0.48)	.118	2.11 (0.83, 5.40)	Model χ^2 = 23.5**
Self-efficacy	0.42(0.23)	.069	1.52 (0.97, 2.39)	Model R^2 = .273
Parents				
Model 1				
Child Age	0.45(0.13)*	.001	1.57 (1.22, 2.03)	Model χ^2 = 20.1**
Child Sex	0.81(0.47)	.082	2.25 (0.90, 5.62)	Model R^2 = .237
Model 2				
Child Age	0.42(0.13)*	.001	1.53 (1.18, 1.98)	Block χ^2 = 7.61*
Child Sex	0.65(0.49)	.187	1.91 (0.73, 5.02)	Model χ^2 = 27.7**
Parent-report MRI-SEC	0.66(0.25)*	.008	1.93 (1.18, 3.13)	Model R^2 = .316

Notes. Perfect Images: *n* = 75, Degraded Images: *n* = 34. Target group (coded 1) = Perfect Images, Degraded Images coded 0. Female coded 1, Male coded 0. '*p*' = *p*-value; '95% CI' = 95% confidence interval of the odds ratio. * $p < .01$, ** $p < .0001$. R^2 = Nagelkerke R^2. Hosmer-Lemeshow goodness-of-fit test $p > .05$ in each model.

Table 4.9.

Logistic Regression Analysis Predicting the Need for General Anesthesia from Child MRI Self-Efficacy and Parent Confidence in their Child's Ability to Complete MRI.

	B(SE)	*p*	Odds Ratio (95% CI)	
Children (GA Scans: n = 37, Non-GA Scans: n = 101)				
Model 1				
Child Age	-0.49(0.13)**	<.0001	0.61 (0.47, 0.79)	
Diagnosed NDD	1.75(0.56)*	.002	5.74 (1.93, 17.0)	Model χ^2 =36.8** Model R^2 = .341
Anticipatory Anxiety	0.25(0.08)*	.003	1.28 (1.09, 1.51)	
Model 2				
Child Age	-0.40(0.14)*	.003	0.67 (0.51, 0.87)	
Diagnosed NDD	1.50(0.61)	.013	4.50 (1.37, 14.8)	Block χ^2 =15.8** Model χ^2 =52.6** Model R^2 = .461
Anticipatory Anxiety	0.13(0.10)	.192	1.14 (0.94, 1.37)	
Self-efficacy	-1.01(0.28)**	<.0001	0.36 (0.21, 0.62)	
Parents (GA Scans: n = 38, Non-GA Scans: n = 101)				
Model 1				
Child Age	-0.47(0.12)**	<.0001	0.63 (0.49, 0.80)	
Diagnosed NDD	1.96(0.53)**	<.0001	7.12 (2.50, 20.3)	Model χ^2 =32.3** Model R^2 = .301
Parent-report Child Anticipatory Anxiety	0.13(0.08)	.099	1.14 (0.98, 1.33)	
Model 2				
Child Age	-0.42(0.15)*	.005	0.66 (0.49, 0.88)	
Diagnosed NDD	1.50(0.68)	.027	4.79 (1.19, 16.9)	Block χ^2 =45.5** Model χ^2 =77.8** Model R^2 = .621
Parent-report Child Anticipatory Anxiety	0.05(0.10)	.617	1.05 (0.86, 1.29)	
Parent-report MRI-SEC	-1.99(0.40)**	<.0001	0.14 (0.06, 0.30)	

Notes. 'GA' = general anesthesia, NDD = neurodevelopmental disorder. Target group (coded 1) = GA, Non-GA coded 0. Diagnosis of an NDD coded 1. *'p'* = *p*-value. '95% CI' = 95% confidence interval of the odds ratio. * $p < .01$, ** $p < .0001$. R^2 = Nagelkerke R^2. Hosmer-Lemeshow goodness-of-fit test $p > .05$ in each model.

CHAPTER 5. DISCUSSION

The overarching goal of this dissertation was to assess self-efficacy as a measurable and modifiable predictor of procedural distress and outcomes in the context of pediatric medical procedures. This goal was addressed through the completion of three individual research studies, using pediatric MRI as a model procedure that is often distressing for children. First, a measure of MRI self-efficacy was developed, and the preliminary psychometric properties were established among a community sample. Next, the modifiability of MRI self-efficacy was examined experimentally, among a community sample. Lastly, the predictive capability of MRI self-efficacy toward procedural anxiety, cooperation, scan outcomes, and the need for general anesthesia was assessed among a sample of children undergoing a clinical MRI scan. The following sections provide a summary of the main findings of each study and integrate the findings of each study together and within existing literature. Next a discussion of the theoretical and clinical implications is provided, followed by the strengths and limitations of this dissertation and areas for future research.

Summary and Integration of Key Findings

Summary of Study 1

Study 1 (Chapter 2) outlined the development of a novel measure, titled the MRI Self-Efficacy Scale for Children (MRI-SEC), to assess children's self-efficacy toward MRI. A parent version of the MRI-SEC was also developed to allow for the assessment of parent confidence in their child's ability to complete MRI. Development of the MRI-SEC followed an iterative approach, guided by best practice guidelines to measure development (Boateng et al., 2018; Holmbeck & Devine, 2009). Item refinement, content validity, and face validity were established through pilot testing with community children and parents with and without prior MRI experience, as well as feedback from healthcare providers with expertise in pediatric MRI. Following development of the MRI-SEC, the preliminary psychometric properties were investigated, utilizing a community sample of children and parents with no prior MRI experience. The MRI-SEC demonstrated excellent internal consistency and test-retest reliability over a period of two weeks. Good convergent validity was also observed (i.e., MRI self-efficacy was associated with constructs hypothesized to be related) for both children and parents. Preliminary predictive validity was also established, as both child- and parent-report on the MRI-SEC differentiated between children based on their self-reported fear if they had to have an MRI scan (i.e., not scared at all, a little bit scared, very scared), and parent predictions of whether their child would require general anesthesia for MRI. The MRI-SEC was used as the primary measure in assessing the modifiability and predictive capability of children's MRI self-efficacy and parent's confidence in their child's ability to complete MRI in the subsequent two studies.

Summary of Study 2

Study two (Chapter 3) was an RCT that examined the modifiability of MRI self-efficacy when targeted with a preparation intervention, among a community sample of children and parents with no prior MRI experience. MRI self-efficacy was also assessed as the mechanism by which preparation functions to decrease children's anticipated distress toward MRI. The modifiability of parent confidence in their child's ability to complete MRI was also examined, in addition to the impact of preparation on parent ratings of child worry, self-worry, and anticipated child response to MRI. Results showed that children in the preparation condition reported higher MRI self-efficacy and lower anticipated fear toward MRI, as compared to children in the control condition, following the intervention. As hypothesized, MRI self-efficacy significantly mediated the impact of preparation on fear toward MRI. There were no group differences for parent confidence in their child's ability to complete MRI, nor parent ratings of anticipated child worry or self-worry if their child were to have an MRI scan. However, parents of children in the preparation condition did report expectations that their child would have a more positive response toward MRI than parents of children in the control condition, after completing the preparation intervention. These results illustrated important differences in the impact of preparation on child and parent outcomes. Ultimately the findings of this study provided evidence for the modifiability of MRI self-efficacy among children, as well as preliminary evidence for self-efficacy as a predictor of anticipated MRI distress and as the mechanism by which preparation functions.

Summary of Study 3

Study 1 and 2 were both completed with children and parents from the community, whom did not require an MRI scan. To truly assess the role of self-efficacy in the context of MRI it was imperative that research was applied to a clinical sample. As such, Study 3 (Chapter 4) investigated MRI self-efficacy as a predictor of children's emotional, behavioural, and scan outcomes, and the need for general anesthesia. The results indicated that MRI self-efficacy was a significant predictor of procedural anxiety and cooperation at the beginning of the scan, and the need for general anesthesia. MRI self-efficacy was not shown to be a significant predictor of cooperation during the scan and image quality, although trends in the expected direction were observed. Parent confidence in their child's ability to complete MRI was found to be a significant predictor of image quality and the need for general anesthesia. Significant findings of parental confidence for child procedural anxiety and cooperation were not observed, although trends were observed in the expected direction. Similar to Study 2, the results of this study revealed important differences between child- and parent-report on the MRI-SEC and the different perspectives both respondents have to offer. Most importantly, the results of this study demonstrated preliminary evidence for the predictive capability of MRI self-efficacy in the context of clinical pediatric MRI.

Integration of Findings with Existing Research

The Assessment of Self-Efficacy with Children

The ultimate goal of this research was to examine self-efficacy in the context of pediatric medical procedures, making contributions to both theoretical and clinical advancements in this established area of literature. In order to do so, a novel measure of self-efficacy was required, given the situation-specific nature of self-efficacy. Study 1 demonstrated evidence that self-efficacy can be assessed among children in the context of MRI. Studies 2 and 3 provided further evidence that children can reliably and validly report on their self-efficacy toward a specific procedure.

There are many cognitive skills and demands required for children to provide reliable and valid self-report ratings (Jaaniste et al., 2016). Reporting on self-efficacy requires children to think about and apply their mental state, skills, and behaviour to a hypothetical and/or future situation. In order for children to do this, certain cognitive skills are required, such as theory of mind, the ability to generate secondary representations and anticipate future needs, metacognition, and self-awareness and evaluation (Jaaniste et al., 2016). School-age children, ages 6 to 12, were chosen as the target sample for this research, as previous research and theoretical frameworks indicate that many of the required skills are largely developed to some extent by the age of six years (Arbuckle & Abetz-Webb, 2013; Borgers et al., 2000; Inhelder & Piaget, 2013; Jaaniste et al., 2016). Over the course of the three studies included in this dissertation, a total of 345 children completed the MRI-SEC. While children at the younger boundary of the age-range were more likely to require support of the RA, all children were able to complete the measure. Also, of note, there were no significant differences between younger and older age groups (i.e., ages 6 to 8 compared to ages 9 to 12) in terms of MRI self-efficacy scores. This provides evidence of good variability across ages and suggests that older children are not reporting higher self-efficacy due to more developed reporting capacities. Consistent with previous research on the topic of self-efficacy with children (Barlow et al., 2001; Pajares, 2005), the studies included in this dissertation provide evidence that children as young as six years can report on their perceived self-efficacy in this setting.

The Enhancement of Self-Efficacy

Once a measure of MRI self-efficacy was developed, the next steps were to assess whether MRI self-efficacy was truly modifiable as suggested by self-efficacy theory (Bandura, 1982; Bandura, 1997) and supported by previous research in other areas (Ashford et al., 2010; Bandura, 2004; Barlow & Barefoot, 1996; Barlow et al., 1999; Dutton et al., 2009; Dishman et al., 2004; Tomlinson et al., 2017; Tuuri et al., 2009; Williams & French, 2011). As outlined in Chapter 3, a preparation intervention was developed specifically to assess the modifiability of self-efficacy and whether self-efficacy functioned as a mechanism of change for the beneficial effects of preparation on procedural distress. The preparation intervention included evidence-based components of preparation (e.g., information provision, exposure and mastery, modelling, teaching coping skills; Blount et al., 2003; Blount et al., 2006; Blount et al., 2008; Cohen, 2008; Cohen & MacLaren, 2007; Cohen et al., 2017; Dalley & McMurtry, 2016; Jaaniste et al., 2007; Tak & van Bon, 2006; Wright et al., 2007), with specific components that targeted each of the four pathways to self-efficacy enhancement (Bandura, 1997). Previous research in a variety of domains has illustrated that self-efficacy is a facilitator of health-related behaviour change, and the modifiability of self-efficacy has been demonstrated in a number of areas (e.g., adherence to treatment and management of chronic illness, promoting physical activity, changing addiction behaviours, increasing knowledge of healthy nutrition practices) among adults and children. Thus the findings of the current study are consistent with previous research indicating that self-efficacy is amenable to clinical intervention and can be enhanced when targeted through intervention (Ashford et al., 2010; Dutton et al., 2009; Dishman et al., 2004; Williams & French, 2011; Barlow & Barefoot, 1996; Barlow et al., 1999; Hyde et al., 2008; Tuuri et al., 2009; Tomlinson et al., 2017). Also consistent with previous research (Barlow et al., 1999; Dishman et al., 2004; Ott et al., 2000; Williams & French, 2011), the findings of Study 2 illustrated that enhancement in self-efficacy fully accounted for improved outcomes (i.e., reduction in children's anticipated fear toward MRI). The modifiability of self-efficacy and evidence of self-efficacy as mediator of the benefits of preparation are also consistent with preliminary research in the area of adult MRI. Powell and colleagues (2015) recently demonstrated that self-efficacy mediated the influence of preparation on scan behaviour among a sample of adults. Thus, the results of the current dissertation extend well-established knowledge that self-efficacy is a modifiable construct, to a novel area and population (i.e., pediatric MRI).

Self-Efficacy as a Predictor of Procedural Distress and Outcomes

Self-efficacy theory and supporting literature suggests that self-efficacy is a valid predictor of behaviour in specific situations (Bandura, 1986; Dunbar-Jacob & Mortimer-Stephens, 2001; Guttuso et al., 1992; Maibach & Murphy, 1995). The clinical significance of MRI self-efficacy lies in its ability to predict children's emotional and behavioural reactions to MRI and procedural outcomes. Prediction of outcomes in MRI is particularly important as there is a decision point regarding the delivery of the procedure (i.e., awake scan or general anesthesia), and current decisions are not guided by standardized or evidence-informed methods. As such, the predictive capability of MRI self-efficacy toward the need for general anesthesia for MRI was also important to assess. Current predictors of children's distress toward MRI, compliance during the procedure, and the need for general anesthesia are not well understood and have been understudied. One study to date has identified compliance with previous medical procedures, attention, adaptability, and parent prediction of how well their child would do, as significant predictors of compliance (Cahoon & Davison, 2014). The sample used in the study by Cahoon and Davison (2014) was composed entirely of children referred for mock-MRI training prior to their MRI scan, and thus did not include children who were referred for general anesthesia or those referred for an awake scan without preparation. To the author's knowledge, no research to date has examined predictors of children's distress toward MRI, cooperation during the procedure, procedural outcomes, and the need for general anesthesia among a representative sample of children undergoing MRI without preparation. While an exhaustive list of potential predictors was not examined in the current dissertation, the finding that self-efficacy is a significant predictor of procedural anxiety, cooperation, and the need for general anesthesia, provides a starting point.

The predictive capability of age and developmental level in the context of pediatric MRI has been controversial in the literature. Such factors are commonly reported as key criteria considered when making decisions on whether a child will be scheduled for MRI with or without general anesthesia. Interestingly, in Cahoon and Davison's (2014) study, age and developmental level were not predictive of scan compliance. Further, research assessing interventions aimed at reducing the need for general anesthesia illustrate that many children as young as four years old can complete MRI successfully without general anesthesia (Barnea-Goraly et al., 2014; Bharti, Malhi, & Khandelwal, 2016; Carter et al., 2010; Hallowell et al., 2015; Munn & Jordan, 2013; Nordahl et al., 2008; Rothman et al., 2016; Rosenberg et al., 1997). In Study 3, age and a diagnosis of a neurodevelopmental disorder differed significantly between the group of children scheduled for general anesthesia and those scheduled for an awake scan, reflecting the use of such factors during scheduling. That said, MRI self-efficacy was a significant predictor of the need for general anesthesia above and beyond age and a diagnosis of a neurodevelopmental disorder. Further, across all three studies, MRI self-efficacy did not differ based on child age (i.e., ages 6-8 compared to ages 9-12). The findings from this dissertation in conjunction with previous literature (Cahoon & Davison, 2014) provide evidence against the use of age and developmental level as automatic criteria in determining the need for general anesthesia. This is also consistent with the broader procedural literature in which the evidence for age and developmental level as predictors of distress has been largely inconclusive (Racine et al., 2015).

As outlined in Chapter 4 (Study 3), child MRI self-efficacy was a significant predictor of child procedural anxiety and cooperation, above and beyond anticipatory anxiety, which is a well-documented predictor of child procedural distress (Claar et al., 2002; Racine et al., 2015; Thung et al., 2017). Further, as discussed, it was also a significant predictor above and beyond age and a diagnosis of a neurodevelopmental disorder for the need for general anesthesia. These results demonstrate preliminary evidence for incremental validity of the MRI-SEC, such that self-efficacy, as measured by the MRI-SEC demonstrated predictive ability above and beyond factors used in current decisions around general anesthesia for MRI.

The Role of Parent Confidence in their Child's Abilities

As noted throughout the previous chapters of this dissertation, important differences were observed between child and parent respondents. First, concordance between child- and parent-report on the MRI-SEC was varied across studies and samples. Low parent-child concordance on measures is common among previous research, particularly in the area of health (Bevans et al., 2010; Chambers et al., 1998; Davis et al., 2007; Eiser & Morse, 2001; Upton et al., 2008). In the case of the current research, perfect concordance was not expected, as child and parent versions of the MRI-SEC were technically measuring two different perspectives and constructs. With that said, poor parent-child concordance on the MRI-SEC is clinically relevant, as parents are most likely to be involved in decision-making around the delivery of MRI.

As discussed in Chapter 2, there are a number of reasons to explain poor concordance, including the use of different reasoning processes and justification of responses between respondents (Davis et al., 2007). The variability in concordance observed across samples is consistent with this explanation. For Studies 1 and 2 (ICC = .300 to .350 depending on the sample; poor to fair agreement), MRI was new to all children and likely some parents. For this reason, children and parents did not have direct experience with MRI to draw upon. Further, they did not have an opportunity to discuss how the child felt about MRI prior to completing the MRI-SEC, thus their judgements were generated independently. Interestingly, child-parent concordance was higher among the samples in Study 3. An ICC of .730 (good agreement) was observed for children who were scheduled for MRI without general anesthesia and an ICC of .494 (moderate agreement) was observed for those who were scheduled for MRI with general anesthesia. The higher concordance among the clinical sample may be explained by the fact that some children in that sample had prior experience with MRI with which both children and parents could draw from to inform their responses. Additionally, for children who completed MRI without general anesthesia, it is possible that some children and parents discussed the procedure together beforehand in preparation, resulting in parents having a more informed understanding of how their child felt about the procedure. On the other hand, parents of children scheduled for general anesthesia may have been less likely to discuss the procedure in detail with their child, given the delivery modality. While these explanations are purely speculative, the variability in concordance is important for considerations in future research and informative clinically.

In line with varied parent-child concordance on the MRI-SEC, each study revealed important differences in the results between children and parents. In Study 1, many of the child-reported variables assessed for convergent validity were not associated with parent-report on the MRI-SEC, including child-reported anticipated fear toward MRI. This once again raises concern about only involving parents in the conversations and decisions around general anesthesia for MRI. In Study 2, the preparation intervention did not seem to change parent-report on the MRI-SEC, nor parent-report of self and child worry toward MRI, whereas the benefits of preparation were clear for child-reported measures (i.e., MRI self-efficacy, anticipated fear toward MRI). Lastly, Study 3 identified that child self-efficacy and parent confidence in their child's ability to complete MRI were each independently stronger predictors of different procedural outcomes. Specifically, child self-efficacy was predictive of procedural anxiety and cooperation at the beginning of the scan, whereas parent-report on the MRI-SEC was predictive of image quality. Taken together, these findings are in line with previous research indicating that children and parents can provide different, but equally valuable, perspectives (Riley, 2004; Upton et al., 2008). Given the differences observed, it is particularly important that in the context of MRI both child and parent perspectives are in the very least included. This is imperative in future research and clinical decisions. Consulting only parents may lead to decisions inconsistent with children's own perceived self-efficacy toward MRI.

Overall Summary

In summary, the findings of this dissertation demonstrate the application of child perceived self-efficacy and parent confidence in their child's ability to complete MRI to a medical procedure that is often stressful for children. Specifically, MRI self-efficacy was measurable among school-aged children, modifiable and amenable to intervention, and a predictor in the context of pediatric MRI. These findings carry many theoretical implications and clinical applications that are discussed in detail in the following sections.

Theoretical Implications

Many factors have been shown to demonstrate substantial impact on procedural distress among children. While significant progress in the development of empirically supported interventions to minimize procedural distress has been made, the theoretical bases of the development, maintenance, and management of procedural distress is lacking. The current dissertation addressed this gap in the literature by using self-efficacy theory as a guiding framework, with the goal of informing theoretical advancements in the pediatric procedural literature.

Self-Efficacy Theory

The current dissertation was based on the framework of Bandura's theory of self-efficacy (Bandura, 1986), which posits that self-efficacy is predictive of behaviour in specific situations. When children do not believe they have the capability to perform the skills required in a particular situation, distress and avoidant behaviours are observed (Page & Blanchette, 2009). This chain of events mirrors what is often observed among children in response to medical procedures (i.e., procedural distress and non-compliant behaviours in an effort to avoid the situation). The findings of Study 3 establish that examining self-efficacy toward a particular medical procedure is of value, and perhaps necessary, to understand how children feel about an upcoming procedure. This is an important contribution to the literature, as much of the previous research on the topic of procedural distress has not been grounded in a particular model or theory.

Self-efficacy theory also asserts that self-efficacy can be enhanced through four main pathways: mastery experiences, peer modelling, social persuasion, and re-interpretation of physiological symptoms. The findings of Study 2 provide evidence for the assertion that self-efficacy is modifiable and may be a pathway by which preparation exerts effects. This finding is an important contribution to the literature, demonstrating the application of self-efficacy theory to a novel area and advancing understanding of how to best assess and manage procedural distress. Many of the effective components of intervention for procedural distress overlap directly with the pathways for enhancing self-efficacy (e.g., mastery experiences, behavioural rehearsal, exposures, modelling, relaxation) (Bandura, 1977; Blount et al., 2003; Blount et al., 2006; Cohen, 2008; Cohen et al., 2017; Dalley & McMurtry, 2016; Jaaniste et al., 2007; Tak & van Bon, 2006; Wright et al., 2007). Thus, applying self-efficacy theory to intervention development provides a guiding framework, informing the inclusion of information provision, modelling and coping skills, and the underlying mechanisms of such programs. Results from the current dissertation provided evidence of this overlap and evidence that intervention guided by the tenants of self-efficacy theory can lead to improved outcomes in the context of pediatric medical procedures.

Given the nature of self-efficacy, the MRI-SEC included some components that are unique to many measures, but important in the context of measure development when assessing self-efficacy. Specifically, self-efficacy theory indicates that in order to report on self-efficacy, individuals must understand what is being asked of them in the specific context being studied (Bandura, 2006). MRI is a novel situation for many children; therefore, it was necessary to introduce and describe the procedure to children in order for them to accurately report on their perceived efficacy. Pictures were included to facilitate understanding and to minimize the abstract reasoning required to fully understand the procedure. Future measures of self-efficacy in the context of pediatric medical procedures should adopt these components to ensure children fully understand the abilities required, and thus toward what exactly they are reporting self-efficacy.

Knowledge of Predictors of Procedural Distress

This dissertation contributes to the broader literature on the topic of procedural distress by introducing a novel predictor of procedural distress that is directly amenable to clinical intervention. To the author's knowledge, this dissertation represents the first research to explicitly examine self-efficacy in the context of pediatric medical procedures. It is well established that contributions to procedural distress are multifactorial (Racine et al., 2015; Blount et al., 2000), and this dissertation provides support for self-efficacy as another child-specific factor that contributes to procedural distress. Many predictors of procedural distress identified in previous research, such as past experience and compliance with medical procedures, psychopathology, dimensions of child temperament, and parent anxiety and expectations, differ from self-efficacy in that they do not directly inform a specific target for intervention (Blount et al., 2000; Racine et al., 2015). While such predictors are useful in identifying children at higher risk for procedural distress and therefore informing whether preparation and/or support may be helpful, they are not informative in terms of assessing whether the intervention was successful. In the context of pediatric MRI, post-preparation assessment is important to determine whether the child is ready for the procedure following preparation and thus, if they will be able to complete the procedure without general anesthesia. As displayed in the findings of the current dissertation, self-efficacy can build upon previously identified predictors of procedural distress, as it is measurable, modifiable, and predictive of procedural distress and specific procedural outcomes. Additional research is required to better understand the association between previously studied predictors and self-efficacy. For example, perhaps previous negative medical experiences are a precursor of lower self-efficacy toward future medical procedures. In that case, knowledge of such experiences could play a role in identifying children who may have lower self-efficacy to begin with and thus may benefit most from intervention. Following intervention, the assessment of self-efficacy could indicate whether the intervention was successful or whether additional supports are necessary to facilitate a positive medical experience.

Knowledge of Intervention for Procedural Distress

This dissertation also contributes to the broader literature on the topic of intervention for procedural distress, as self-efficacy is amenable to clinical intervention. Research in the area of preparation has demonstrated that information provision alone is not sufficient in reducing procedural distress among children (Kain & Caldwell-Andrews, 2005; Wright et al., 2007). While information provision may minimize unknowns about the procedure, children must also believe they have the ability to do what is being asked of them (Bandura, 1997; Muris, 2001; Shunk & Meece, 2006) in order for successful performance to ensue. The findings of the current dissertation provide a construct that can be measured among children to assess beliefs in their ability to complete the skills required for a particular procedure. The construct of self-efficacy can then be targeted through intervention, with specific techniques shown to enhance self-efficacy, as discussed above. While information provision is an important component to preparation, it is also imperative that mastery experiences are achieved and coping skills are taught, in order to enhance a child's belief that they have the capabilities required. Comfort in such knowledge will minimize distress and improve cooperation. The findings of the current dissertation provide evidence for the value of targeting self-efficacy through preparation and contribute to the literature by offering a more cohesive model of preparation for procedural distress.

Clinical Implications

The findings of this dissertation as a whole provide many direct clinical implications. First, from an assessment perspective, the MRI-SEC provides a measure of child self-efficacy for MRI that can be used to inform the level of support a child may need for the procedure. For example, the MRI-SEC could be used to screen and identify children who may benefit from preparation (i.e., MRI readiness assessment) and assess the success of preparation before the day of MRI (i.e., post-preparation assessment). Previous literature clearly demonstrates the benefits of preparation for MRI, specifically toward reducing rates of general anesthesia use (Barnea-Goraly et al., 2014; Bharti et al., 2016; Carter et al., 2010; Hallowell et al., 2015; Munn & Jordan, 2013; Nordahl et al., 2008; Rothman et al., 2016; Rosenberg et al., 1997); however, implementation of preparation into clinical settings is lacking. Routine delivery of preparation is not often available in all healthcare centres, as it can be costly in terms of personnel, hospital resources, and time (Brewer et al., 2006). Assessing for self-efficacy may help streamline identification of those who may be at risk for procedural distress (i.e., lower self-efficacy) and those who will benefit from preparation and/or additional support during the procedure. Assessing self-efficacy after the delivery of preparation and before the day of a child's MRI scan would provide time to guide and inform accurate decisions around whether additional intervention could be helpful in facilitating an awake scan or if general anesthesia is required, to ensure a positive medical experience for the child and family.

Findings from Study 3 provide evidence for child self-efficacy as a predictor of the need for general anesthesia, suggesting that self-efficacy as measured by the MRI-SEC can be useful clinically in guiding decisions around general anesthesia. Clinical implementation and application of the MRI-SEC will depend on existing resources in individual healthcare centres. Ideally the measure could be completed online at home, with the support of a parent, in order to reduce barriers to implementation requiring hospital resources. This would allow for ample time to develop an appropriate treatment plan, such as facilitating preparation, planning for general anesthesia, or providing support during the procedure. Aside from use as a clinical predictor, there may be benefits of having children complete the MRI-SEC with parent support, as a form of information provision. This would allow children and parents to learn more about the procedure and reduce associated unknowns. Further research is needed to determine the best method of administration of the MRI-SEC (e.g., online, combined with online preparation); however, the findings of the current dissertation support the utility of self-efficacy, as measured by the MRI-SEC, for use in clinical pediatric MRI settings. Future research is also needed to determine exact cut-off scores for the MRI-SEC to indicate when general anesthesia is indicated.

In addition to the utility of the MRI-SEC as a screener for the need for preparation and/or support during MRI, the theoretical application of self-efficacy to preparation as displayed in Study 2 provides important clinical implications. The preparation intervention developed for Study 2 targeted all four pathways to self-efficacy enhancement (Bandura, 1997). Key components included exposure and practice to target mastery experience (i.e., exposure to a small “tunnel-like” space, sounds, practice lying still), vicarious exposure via peer modelling (i.e., video describing the MRI procedure, clips of a school-age girl completing the procedure successfully and describing her experience), praise and reinforcement by parents and the RA during practice, and teaching of coping strategies (e.g., deep breathing, mental imagery). These components can be implemented into future preparation programs to directly target self-efficacy. The MRI-SEC was developed in a way to guide children through each step involved in having an MRI scan. Given this format, it is possible that with further research the MRI-SEC could be useful in suggesting which preparation strategies are suggested for a given child, when there is not enough time to complete a full program. For example, if a child is particularly worried about staying still for long durations, preparation could focus on practice staying still, while also ensuring supports are put in place to help the child stay still during the procedure (e.g., frequent breaks, distraction with a movie).

Strengths and Limitations

While the strengths and limitations of each individual study have been presented in the corresponding manuscripts included in Chapters 2, 3, and 4, the full dissertation has a number of broader strengths and limitations.

Participant Samples

A strength of this dissertation was the use of multiple samples, including both community samples of children and parents naïve to MRI, and samples of children scheduled for clinical MRI. Two fairly large samples of children with no prior MRI experience were utilized during the initial validation phase of the MRI-SEC and to assess the modifiability of MRI self-efficacy, using the MRI-SEC. Research has shown that previous experience can influence a person's self-efficacy toward that specific situation (Piira et al., 2002); thus, it was important to assess MRI self-efficacy among children who had no prior experience in the domain. Supplementing Studies 1 and 2 with a clinical sample in Study 3 to truly assess the role of self-efficacy in a clinical context was also a strength. Without assessing self-efficacy among a clinical sample, it would have been difficult to draw firm conclusions around the importance of self-efficacy in the context of pediatric MRI.

Also tied to the multiple samples used in this dissertation are a number of limitations. For example, in Study 3, children were pre-scheduled for a scan with or without general anesthesia before enrolment in the study. This limited the ability to assess whether children who were scheduled for general anesthesia could have completed the scan without general anesthesia. Additionally, the samples in Studies 1 and 2 were not required to have an MRI scan. There are limits to how children respond to hypothetical situations (Bandura, 2006) and it is possible children and parents would have responded differently if they had to face the reality of having an MRI scan. Nonetheless, the findings of the current dissertation provide preliminary evidence for the role of self-efficacy in the context of pediatric MRI. As a starting point, these findings will allow for future research to more directly assess additional research questions to inform the application and implementation of the MRI-SEC and self-efficacy in this context.

Also, it is important to note that the samples of children and parents across all three studies were fairly homogenous, limiting the generalizability of the findings to the broader general population. Participants primarily identified as Caucasian, participating parents were often mothers, and samples included a large number of families in which parents reported having a university level education and high annual household income. Replication with more diverse and representative samples will be important in future research, in order to examine the influences of such factors.

Research Design

A strength of Study 1 was that the development and investigation of the preliminary psychometrics adhered to guidelines for best practice in measure development and validation (Boateng et al., 2018; Holmbeck & Devine, 2009). It was also developed and validated with a community sample prior to applying it to a clinical sample, which is consistent with other measure development studies. Another strength of this dissertation as a whole was the involvement of the MRI department and staff. Their expertise was influential in all stages of this research and guided decisions to ensure the research was important and useful to stakeholders. This collaboration will facilitate implementation of the research findings into clinical practice.

A third strength in the area of research design was the robust design of Study 2 and the development of the preparation intervention. Previous research demonstrates that some pathways to self-efficacy enhancement are more influential than others (Bandura, 1982; Bandura, 1997; Muretta, 2005; Ott et al., 2000; Wise & Trunnell, 2001). Specifically, performance accomplishments informing mastery experience is the most influential in enhancing self-efficacy, because it provides the most authentic evidence that once can succeed (Page & Blanchette, 2009). Thus, it was important that the opportunity for mastery experience was included in the preparation intervention. Further, it was important the intervention developed was easily accessible without the use of expensive equipment that is not readily available in many health centres (i.e., mock-MRI scanner). These components can inform the development and clinical implementation of more easily accessible interventions for MRI.

A limitation of this research across studies was the potential for bias during data collection of both self-report and observational measures. Some of the potential limitations of using self-report measures include the risk of response bias, the need for participants to have the ability to look into the future and predict their abilities and needs, and the reliance on participants to answer honestly (Chan, 2009). It is important to note that children completed their self-report measures one-on-one with an RA, and therefore there was the potential for social desirability bias, which may have influenced children's responses. A strength of Study 3 was the inclusion of validated observational measures of procedural anxiety and cooperation, including both RA and MRI technologist perspectives. As such, there was a potential for observer bias, given that the RA who completed the MRI-SEC with the child also completed the observational measures; however, this was complemented with excellent inter-rater reliability scores from an unbiased second rater for a subset of participants.

Inclusion of Multiple Informants

Developing both child and parent versions of the MRI-SEC and including both child and parent report in each study was a strength of this dissertation. The inclusion of both informants provided very important results demonstrating differences between each informant. This illustrated that while children and parent perspectives may differ, they can both offer important perspectives. It is important that children’s perspectives are considered in decisions that involve their healthcare (Bevans et al., 2010; Ravens-Sieberer et al., 2006; Upton et al., 2008; Varni et al., 2007). A limitation of this dissertation was the fact that relative comparisons between child and parent reports were not possible due to limits in power and sample size, as well as design limitations. For example, given that parents were likely involved in decisions around general anesthesia in Study 3, directly comparing the predictive capability of child- and parent-report on the MRI-SEC would have resulted in skewed results as the outcome of scan delivery would have inherently favored parent-report as a predictor. Future research is needed to truly assess the predictive capability of both child and parent perspectives and to compare the accuracy and importance of each informant in predicting procedural distress and outcomes.

Directions for Future Research

Future research could expand on the findings of this dissertation in a number of ways. First, in an effort to fully assess the predictive capability of the MRI-SEC in informing scan delivery, future research should provide all children with the opportunity to attempt an awake scan following completion of the MRI-SEC. This research should also focus on examining the sensitivity and specificity of the MRI-SEC to determine cut-off scores associated with identifying whether a child will benefit from preparation, whether preparation is considered successful and a successful awake scan is probable, or whether general anesthesia is required. Investigation and determination of cut-off scores would solidify the clinical utility and provide meaningful insight to guide implementation of the MRI-SEC in clinical settings. Additionally, Study 3 did not account for some previously identified factors of procedural distress (e.g., temperament, previous response to medical procedures). Future research must investigate the role that such factors have on self-efficacy and examine whether self-efficacy is a predictor above-and-beyond such factors.

As discussed, the preparation intervention developed for Study 2 targeted each of the four individual pathways to self-efficacy enhancement. Previous research has provided consistent evidence in the varying influence that each pathway exerts in other areas of research (e.g., health-related behaviour change; Bandura, 1997; Muretta, 2005; Ott et al., 2000). Future research should assess the individual contribution of each of the four pathways in the context of pediatric MRI, and pediatric medical procedures in general. Such research could inform the development of feasible and accessible interventions, by determining whether all components are necessary or if a shortened intervention could be as successful in increasing self-efficacy and thus decreasing procedural distress and leading to improved procedural outcomes.

Additionally, while Study 2 demonstrated the benefits of preparation on both self-efficacy enhancement and reducing anticipated fear toward MRI, these effects were not assessed among a clinical sample. As such, future research is warranted to replicate the results of Study 2, with a clinical sample, in order to truly examine the effect of preparation on perceived self-efficacy and the mediating influence of self-efficacy on procedural outcomes (e.g., procedural distress, cooperation, image quality, need for general anesthesia). Such research would provide further information around the clinical utility of the MRI-SEC and self-efficacy in the context of pediatric MRI.

It can be argued that the MRI-SEC provides some level of information provision, given that it describes each step in the procedure with visual cues, thus reducing the unknowns for children. While previous research demonstrates that information provision alone is not sufficient (Kain & Caldwell-Andrews, 2005; Wright et al., 2007), future research should assess whether completion of the MRI-SEC prior to MRI has any impact on procedural distress and outcomes.

Future research is also warranted to assess the relation between child self-efficacy and parent factors. The impact of parent behaviour and the reciprocal nature that parent factors have on child procedural distress has been established in the literature (Page & Blanchette, 2009; Racine et al., 2015) and may have important implications for a child's development and presentation of perceived self-efficacy when facing a stressful medical procedure. Previous research demonstrates the impacts that parent behaviour during procedures can have on procedural distress (Chorney et al., 2009; Cline et al., 2006; Manimala et al., 2000; McMurtry et al., 2010). Future research should investigate the impact that parent behaviours (e.g., reassurance) might have on child self-efficacy before and during procedures. Notably, the four pathways to self-efficacy enhancement can also function to reduce self-efficacy. Specifically, it is possible that non-supportive parent behaviour during procedures can provide an unhelpful form of verbal persuasion that undermines self-efficacy, thus leading to a decrease in self-efficacy. It is important to identify ways that this may happen during procedures. It is also possible that low parental confidence in their child's ability to complete MRI may undermine child MRI self-efficacy through parent behaviours. As such, the association between child and parent report on the MRI-SEC and potential transmission must be examined in future research.

Lastly, the current dissertation applied self-efficacy theory in one specific stressful medical procedure (i.e., pediatric MRI). Investigation of self-efficacy in the context of other pediatric medical procedures is needed to replicate and extend these findings. MRI is a unique procedure in that it requires a number of specific skills and abilities from children (e.g., staying still, enduring loud noise) and it is a relatively painless procedure. Future research is needed to extend the present findings to other medical procedures. Such research will increase the scope and contribution of these research findings scientifically and clinically.

Conclusion

In conclusion, this dissertation sought to identify and examine a measurable and modifiable predictor of procedural distress, using pediatric MRI as a model procedure. The first study involved development and preliminary validation of a measure to assess child MRI self-efficacy, as well as parent confidence in their child's ability to complete MRI. Next, in the second study, the modifiability of MRI self-efficacy was assessed experimentally, in which MRI self-efficacy was deemed to be modifiable through targeted preparation, and it was identified as the mechanism by which preparation functioned to reduce anticipated fear toward MRI. Finally, MRI self-efficacy was assessed among children undergoing a clinical MRI scan. MRI self-efficacy was found to be a significant predictor of procedural anxiety, cooperation, and the need for general anesthesia, while parent confidence in their child's ability to complete MRI was found to be a significant predictor of image quality and the need for general anesthesia. Taken together, the findings of this dissertation provide evidence that self-efficacy can be measured among school-aged children and that it is a modifiable predictor in the context of pediatric MRI. These findings provide a number of theoretical and clinical implications that directly inform how to best support children through stressful medical procedures.

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APPENDIX A. COPYRIGHT PERMISSIONS

Re: Permission to include published paper in dissertation - Journal of Pediatric Psychology (DOI: jsaa045) ~1871725

jnls.author.support@oup.com <jnls.author.support@oup.com> Wed, Jun 10, 2020 at 12:42 PM
Reply-To: jnls.author.support@oup.com
To: Melissa.Howlett@dal.ca

This will be fine - please ensure that the original publication location (Journal and Doi) of the paper are cited in the thesis.

Many thanks,

Calum Novak-Mitchell

---------- Original message ----------
From: Melissa.Howlett@Dal.Ca
Date: Monday, 8 June 2020, 18:49
To: jnls.author.support@oup.com
Subject: Permission to include published paper in dissertation - Journal of Pediatric Psychology (DOI: jsaa045)

Hello,

I recently had a manuscript accepted to the Journal of Pediatric Psychology (DOI: jsaa045), titled The MRI Self-Efficacy Scale for Children: Development and preliminary psychometrics. I'm seeking permission to include this manuscript as a chapter in my thesis. Because it is currently in press, I was not able to figure out how to request copyright permission online.

I am preparing my Clinical Psychology PhD thesis for submission to the Faculty of Graduate Studies at Dalhousie University, Halifax, Nova Scotia, Canada. I am seeking your permission to include a manuscript version of the following paper as a chapter in the thesis:

Howlett, M. & Chorney, J. (in press). The MRI Self-Efficacy Scale for Children: Development and preliminary psychometrics.

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Sincerely,

Melissa Howlett

APPENDIX B. THE MRI SELF-EFFICACY SCALE FOR CHILDREN (CHILD-REPORT)

The MRI Self-Efficacy Scale for Children (Child-Report)

INSTRUCTIONS FOR ADMINISTATION

- Read all items verbatim to the child.

- Spend time on practice sheet to ensure child understands the term "confident" and that they understand how to use the response scale prior to moving forward to the MRI-related items. If the child's responses seem inconsistent or do not make sense *(e.g., very confident they can pick up a car)*, then explain how to use the scale and reiterate what confidence means.
    - **Do not move past practice questions until you are sure the child understands the word confident and how to use the rating scale.**

- Ensure the child knows there are no right or wrong answers.

- For items 6 to 8 use examples to demonstrate time (e.g., 30 minutes = episode of TV show) **only** if necessary *(e.g., if the child seems to have difficulty understanding how long a certain time frame is)*.

- Provide clarification of items when necessary to ensure the child's response is valid
    - If you feel the child does not understand an item, then clarify, prior to moving on to the next item.
    - If the child's response appears to be inconsistent with what child says *(e.g., child says "I can't do that", but he/she responds with "very confident")* then discuss with the child until their response appears to be valid.

Practice Questions:

Do you know what the word **confident** means?

____

The word "confident" means how sure you are that you can do something. So, if you are really sure that you can do something, then you would feel confident and if you know you cannot do something then you would not feel confident. Sometimes you might not be sure if you can or cannot do something and then you might feel quite confident or a little confident. For example, you might be confident that you can run faster than a snail, a little confident that you can run faster than a dog, but not confident that you can run faster than a tiger.
The questions below will ask how **confident** you are that you can pick up certain items.

For each question below, put an X on the line beside the choice that best describes how confident you are. There is no right or wrong answer.

1. How confident are you that you can pick up a pencil?

____ Not confident at all
____ A little confident
____ Quite confident
____ Very confident

2. How confident are you that you can pick up a big watermelon?

____ Not confident at all
____ A little confident
____ Quite confident
____ Very confident

3. How confident are you that you can pick up a box of books?

____ Not confident at all
____ A little confident
____ Quite confident
____ Very confident

4. How confident are you that you can pick up a car?

____ Not confident at all
____ A little confident
____ Quite confident
____ Very confident

<u>MRI Self-Efficacy Scale for Children</u>

This book will give you information about a picture test called MRI. We want to learn how confident you are that you can do different parts of the picture test. MRI stands for Magnetic Resonance Imaging. An MRI picture test is used when doctors need to see detailed pictures of inside a person's body.

As you read and learn about MRI picture tests below, there will be questions asking how confident you are that you can do the job being described. For each question, put an X beside the choice that best describes **how confident you are**.

Remember to answer the questions honestly! There are no right or wrong answers.

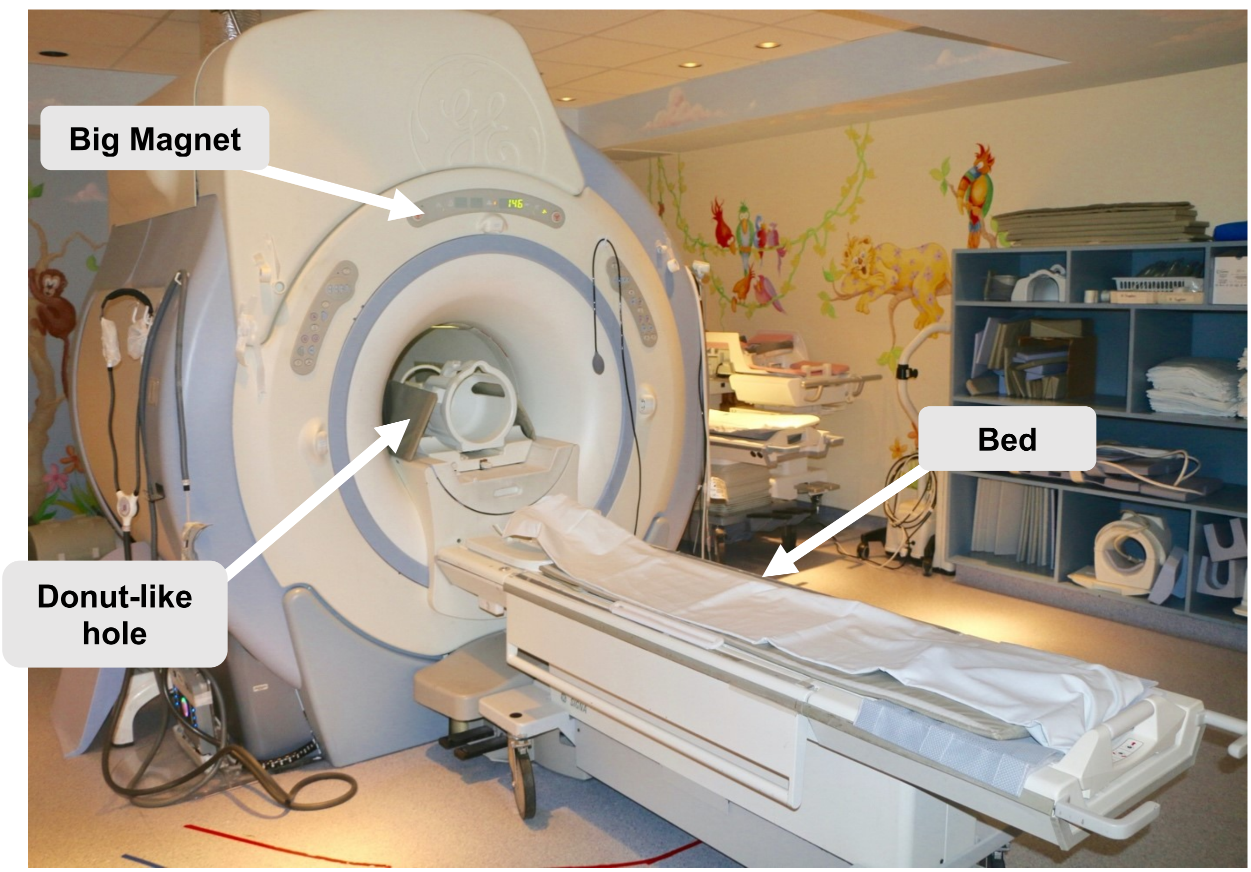
What is an MRI Picture Test?

The doctor needs to take pictures of the inside of your body, so you need to have an MRI picture test.

This is what the MRI machine looks like. It is pretty big, because it needs to be big enough to take pictures of a person's whole body! It has a hole in the middle, like a donut.

The outside of the donut-like hole is a big, round magnet. This part helps the doctor take pictures of the inside of a person's body.

To have an MRI picture test, you have to lie down on the bed that sticks out of the donut-like hole.



What will I be asked to do when I have an MRI picture test?

The first step in having an MRI picture test is to change into a hospital gown. Because of the big magnet, there can be no metal near the machine. The nurse or doctor will ask you to take off any metal that you are wearing, like a watch or earrings, and change into a hospital gown.

A hospital gown looks like this:

1. **How confident are you that you can wear a hospital gown?**
   ____ Not confident at all
   ____ A little confident
   ____ Quite confident
   ____ Very confident

To have an MRI picture test, you have to lie down on the bed that sticks out of the donut-like hole. The bed is the only part of the machine that will touch you. You will be given a blanket, so you are comfortable.

This is how you lie down on the bed:

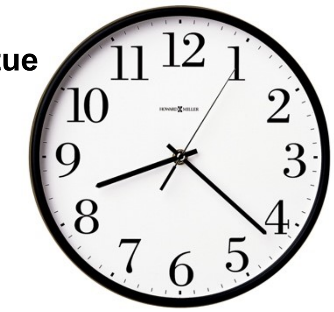
2. **How confident are you that you can lie on the bed?**
   ____ Not confident at all
   ____ A little confident
   ____ Quite confident
   ____ Very confident

Once you are lying down and ready, the bed will slowly move into the donut-like hole, like this:

Being inside the MRI machine is like lying inside a tunnel, similar to a tunnel that you might see at a playground. This is what it looks like from inside the tunnel.

3. **How confident are you that you can lie on the bed while it is being moved into the donut-like hole?**
   _____ Not confident at all
   _____ A little confident
   _____ Quite confident
   _____ Very confident

It is important that you **stay really still like a statue** inside the tunnel, so your pictures are clear for the doctor.



4. **How confident are you that you can stay still like a statue inside the tunnel for <u>5 minutes</u>?**
    ____ Not confident at all
    ____ A little confident
    ____ Quite confident
    ____ Very confident

5. **How confident are you that you can stay still like a statue inside the tunnel for <u>15 minutes</u>?**
    ____ Not confident at all
    ____ A little confident
    ____ Quite confident
    ____ Very confident

6. **How confident are you that you can stay still like a statue inside the tunnel for <u>30 minutes</u>?**
    ____ Not confident at all
    ____ A little confident
    ____ Quite confident
    ____ Very confident

7. **How confident are you that you can stay still like a statue inside the tunnel for <u>1 hour</u>?**
    ____ Not confident at all
    ____ A little confident
    ____ Quite confident
    ____ Very confident

8. **How confident are you that you can stay still like a statue inside the tunnel for <u>1 hour, if you are allowed to take breaks to wiggle around?</u>**
    ____ Not confident at all
    ____ A little confident
    ____ Quite confident
    ____ Very confident

Sometimes special equipment called “coils” are used, so the pictures look better. There are different kinds, depending on what part of the body needs to be seen in the picture. The coils go over or around that part of the body. The coils do not hurt, and you do not feel them

<u>Head coil:</u> A special helmet that helps make pictures of the brain look better. It will not move or touch you.

9. **How confident are you that you can stay still like a statue in the tunnel, if the coil helmet was over your head?**
   _____ Not confident at all
   _____ A little confident
   _____ Quite confident
   _____ Very confident

<u>Stomach coil</u>:

10. **How confident are you that you can stay still like a statue in the tunnel if the stomach coil was over your stomach area?**
   _____ Not confident at all
   _____ A little confident
   _____ Quite confident
   _____ Very confident

Leg coil ***Foot coil*** ***Arm coil***

11. How confident are you that you can stay still like a statue in the tunnel if the leg, foot, or arm coil was over one of your limbs?

____ Not confident at all
____ A little confident
____ Quite confident
____ Very confident

Once you are comfortable inside the tunnel, the person doing the picture test will leave the room and turn on the MRI machine. It will start taking pictures of your body. When the machine is taking pictures, it makes really loud noises. There are a lot of different noises. Some children say the noises sound like a hammer, chirping, or loud knocking. The doctor will give you ***headphones*** to wear so the noise is not too loud for your ears.

12. How confident are you that you can stay still like a statue in the tunnel, while the machine is making loud noises?

____ Not confident at all
____ A little confident
____ Quite confident
____ Very confident

APPENDIX C. THE MRI SELF-EFFICACY SCALE FOR CHILDREN

(PARENT-REPORT)

The MRI Self-Efficacy Scale for Children (Parent-Report)

This book provides information about a diagnostic procedure called Magnetic Resonance Imaging (MRI). An MRI is a common procedure used in hospitals when doctors need to see structures and/or organs inside the body. The questions in this book will ask you how confident you are that your child can complete various aspects of the MRI procedure. For each question below, put an X beside the choice that best describes **your confidence** in your child's ability to carry out that task.

What is an MRI Scan?

Below is a picture of an MRI scanner. There is a large magnet around the outside of the scanner that is used to take pictures of the inside of a person's body. To have an MRI scan, your child will lie on the table sticking out of the hole in the middle of the scanner. The table will be moved into the hole until the body part being investigated is inside the scanner. The table is the only part of the MRI scanner that will touch your child.

Because of the large magnet, there can be no metal near the MRI scanner, so the nurse or MRI technician will ask your child to remove any metal they are wearing (e.g., jewelry, glasses) and change into a hospital gown.

1. **How confident are you that your child can wear a hospital gown for an MRI scan?**
   ____ Not confident at all
   ____ A little confident
   ____ Quite confident
   ____ Very confident

2. **How confident are you that your child can lie down on the table?**
   _____ Not confident at all
   _____ A little confident
   _____ Quite confident
   _____ Very confident

3. **How confident are you that your child can lie down on the table while it is being moved into the hole?**
   _____ Not confident at all
   _____ A little confident
   _____ Quite confident
   _____ Very confident

Some children say that the space inside the MRI scanner can feel small, like lying in a tunnel. Below is a picture of what it looks like from inside the MRI scanner.

Children must remain very still for the duration of the scan. Any movement will lead to unclear images, which may result in your child having to return for a second MRI scan in order to obtain clear, useable images.

4. **How confident are you that your child can lie still inside the scanner for 5 minutes?**
   ____ Not confident at all
   ____ A little confident
   ____ Quite confident
   ____ Very confident

5. **How confident are you that your child can lie still inside the scanner for <u>15 minutes?</u>**
   ____ Not confident at all
   ____ A little confident
   ____ Quite confident
   ____ Very confident

6. **How confident are you that your child can lie still inside the scanner for <u>30 minutes?</u>**
   ____ Not confident at all
   ____ A little confident
   ____ Quite confident
   ____ Very confident

7. **How confident are you that your child can lie still inside the scanner for <u>1 hour?</u>**
   ____ Not confident at all
   ____ A little confident
   ____ Quite confident
   ____ Very confident

8. **How confident are you that your child can lie still inside the scanner for <u>1 hour if he/she is allowed to take breaks?</u>**
   ____ Not confident at all
   ____ A little confident
   ____ Quite confident
   ____ Very confident

Sometimes special equipment called a “coil” is required during an MRI scan, in order to improve the quality and clarity of the images being taken. There are different kinds of coils depending on the body part being scanned. The coil goes over or around the body part being scanned. The coils do not hurt, and your child will not feel them. Below are examples of coils in place for an MRI scan of the head, abdomen, leg, and arm.

9. **How confident are you that your child can lie still in the scanner with the head coil around his/her head?**
   _____ Not confident at all
   _____ A little confident
   _____ Quite confident
   _____ Very confident

10. **How confident are you that your child can lie still in the scanner if the stomach coil was over his/her abdominal area?**
   _____ Not confident at all
   _____ A little confident
   _____ Quite confident
   _____ Very confident

11. **How confident are you that your child can lie completely still in the scanner if a coil was around one of his/her limbs?**
   _____ Not confident at all
   _____ A little confident
   _____ Quite confident
   _____ Very confident

The MRI machine makes very loud noises throughout the duration of the scan. Some children say the noises sound like a jack hammer, chirping, and loud knocking. Your child will wear headphones during the MRI scan to protect his/her ears.

12. **How confident are you that your child can lie still in the scanner, while it is making loud noises?**
    ____ Not confident at all
    ____ A little confident
    ____ Quite confident
    ____ Very confident