

Social Learning Pathways in the Intergenerational Transmission of Risk for Chronic Pain
and Functional Impairment from Parents to Offspring

By

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CHAPTER I

INTRODUCTION

Chronic pain tends to run in families. A recent systematic review and meta-analysis identified increased pain complaints, greater internalizing and externalizing symptoms, and poorer social competence in offspring of parents with chronic pain (Higgins et al., 2015). In clinical populations of children with chronic pain, parental chronic pain characteristics (e.g., current pain severity, number of pain sites for which parents sought treatment) corresponded with greater pain severity and functional impairment in their children (Kashikar-Zuck et al., 2008; Schanberg et al., 2001; Schanberg, Keefe, Lefebvre, Kredich, & Gil, 1998). Additionally, having a parent with chronic pain may confer greater risk for persistence of chronic pain from childhood into young adulthood (Aasland, Flato, & Vandvik, 1997; Sherman, Bruehl, Smith, & Walker, 2013).

The relation between parental chronic pain and children's pain is complex and best understood within a biopsychosocial framework (Gatchel, Peng, Peters, Fuchs, & Turk, 2007). The intergenerational transmission of risk for chronic pain could be explained by multiple pathways including genetics, early neurobiological changes, pain-specific social learning, general parenting and health behaviors, and shared environmental stress (Stone & Wilson, 2016). These factors likely contribute to children's individual vulnerabilities (e.g., pain threat appraisal, catastrophizing, pain coping self-efficacy) that increase or decrease risk for chronic pain in children of parents with chronic pain. The ultimate goal of elucidating mechanisms for the transmission of risk for chronic pain from parents to offspring is to develop preventive interventions for at-risk youth and family based interventions for pediatric patients whose parents have chronic pain.

Although multiple factors likely influence the intergenerational transmission of risk for pain and related functional impairment, the present study focuses on pain-specific social learning. Social learning theory (SLT), originally proposed by Bandura (1977), suggests that individuals can learn behaviors through observational learning of behavior modeled by others and operant reinforcement of their own behaviors. In the pediatric pain literature, these two social learning processes typically have been examined independently from each other. For example, experimental laboratory studies of observational learning have manipulated parental modeling of pain behaviors (Boerner, Chambers, McGrath, LoLordo, & Uher, 2017; Chambers, Craig, & Bennett, 2002) and studies of operant reinforcement have manipulated parental responses to children's pain (Walker et al., 2006). Additionally, many studies do not evaluate either parent modeling or reinforcement of their children's pain behavior but rather infer social learning based on the concordance between familial histories of chronic pain and children's pain experiences (Lynch, Kashikar-Zuck, Goldschneider, & Jones, 2006; Osborne, Hatcher, & Richtsmeier, 1989; Schanberg et al., 2001).

Social Learning in Pediatric Functional Abdominal Pain

The present study focuses on social learning pathways in the intergenerational risk for heightened pain severity and functional impairment in adolescents with functional abdominal pain (FAP). In this study, FAP refers to recurrent abdominal pain lasting at least two months in the absence of medical findings suggesting the presence of organic disease (e.g., Crohn's disease). A significant subset of these patients meets Rome III criteria for a pain-related functional gastrointestinal disorder, including irritable bowel syndrome (IBS) and functional dyspepsia (Baber, Anderson, Puzanovova, & Walker, 2008). Adolescents were the target population of the present study because the prevalence of chronic pain tends to increase as children transition into adolescence (King et al., 2011). For pediatric patients with functional abdominal pain (FAP), parental chronic pain may be associated with long-term risk for

increased pain severity and functional disability, particularly if both parents have chronic pain (Sherman et al., 2013).

In the literature on the intergenerational transmission of risk for pain-related gastrointestinal symptoms (Levy, Whitehead, Von Korff, & Feld, 2000), social learning is suggested to play a significant role in children's gastrointestinal symptoms based on two findings from Levy's (2001; 2004) studies of children of mothers with IBS. First, a twin study found that having a parent with IBS was a stronger predictor of IBS than having a dizygotic (DZ) twin with IBS even though siblings and parents share roughly the same amount of genetic material (Levy et al., 2001). The authors inferred that parental behaviors may account for equal or greater variance than genetic heritability in the development of IBS symptoms. Second, Levy et al. (2004) examined both observational learning and parental reinforcement in children of mothers with and without IBS. The authors inferred observational learning based on the finding that children of mothers with IBS, compared to children of mothers without IBS, were more likely to experience more frequent abdominal pain, school absences, and physician visits. Parental reinforcement was supported by an association between higher levels of parental solicitousness and increased severity of children's abdominal pain. Although these studies provide some evidence for the role of social learning in the relation between parent and child pain-related gastrointestinal symptoms, they were conducted in non-clinical samples of children and did not directly measure parental pain behaviors. Indeed, to date no empirical studies of youth with clinically significant chronic pain have examined whether parents with chronic pain, compared to parents without chronic pain, are more likely to both model pain behaviors for their children and reinforce their children's pain behaviors.

The Role of Cognitive Processes in Social Learning Theory

Studies evaluating SLT in pediatric chronic pain are further limited in that they ignore one of the key components of Bandura's theory — cognitive processes. Indeed, a key factor

that differentiates SLT from earlier Skinnerian behavioral models of learning is the inclusion of cognition as a mediating process in learning. Instead of focusing solely on learning through the observation of a stimulus and response, SLT proposes two cognitive components necessary for observational learning to occur: (1) attention to the modeled behavior and (2) cognitive encoding of the modeled behavior (Bandura, 1977). These cognitive processes allow individuals to retain and reproduce learned behaviors. With regard to reinforcement, SLT proposes that individuals are most likely to learn from reinforcement when they are consciously aware of what behaviors lead to the desired outcome. Although individuals can learn from reinforcement that occurs outside of their awareness, those who are aware of the potential benefits or consequences of a behavior may learn desired behaviors faster and more strongly.

Thus, the present study incorporated two novel elements to the evaluation of social learning in pediatric chronic pain: (1) adolescents' awareness of parent behaviors, and (2) adolescents' encoding of learned pain behaviors into cognitive appraisals of pain threat. Aim 1 focused on parental modeling of pain behaviors—specifically whether adolescents observe parent pain behaviors and the extent to which these observations correspond with adolescents' own pain severity and functional impairment. Aim 2 focused on parental reinforcement of adolescents' pain behaviors by examining parents' self-reported responses to adolescent pain as well as adolescents' reports of parents' responses to their pain. Finally, Aim 3 tested a comprehensive model of social learning pathways by incorporating not only parental modeling of pain behavior and reinforcement of their adolescents' pain behavior but also adolescents' cognitive appraisals of pain threat as potential mechanisms in the relation between parental chronic pain and adolescents' pain severity and functional impairment.

Aim 1: Parental Modeling of Pain Behaviors

Social learning theory (Bandura, 1977) would predict that adolescents can learn pain-related cognitions and behaviors by observing their parents' pain behaviors. These

observations, in turn, may lead adolescents to adopt similar behaviors that facilitate or inhibit maintenance of their own chronic pain. For example, by observing a parent with chronic pain consistently avoid daily activities, adolescents may learn that activity avoidance is an appropriate way to manage their own chronic pain.

Modeling of pain behavior by parents with chronic pain has typically been inferred based on the concordance of pain reports between parents and children (Higgins et al., 2015) or on the association between parental chronic pain and increased school absences and health care visits in their children (Levy et al., 2004). However, the extent to which parents with chronic pain model observable pain behaviors is unknown as children's observation of their parents' pain behavior has not been directly assessed. If parental modeling of pain behavior is the mechanism for the association between chronic pain in parents and their children, one would expect that the relation between parental pain behavior and children's pain severity and functional impairment would be stronger than the relation between parental chronic pain status (present vs absent, as reported by the parent) and children's pain severity and functional impairment. Thus, the first hypothesis proposed here is that the frequency of parent pain behavior compared to the simple presence of a positive parental chronic pain status, would exhibit a stronger association with adolescents' pain severity and functional impairment (Hypothesis 1a).

Even though parents with chronic pain may exhibit pain behavior, the social modeling hypothesis holds that parental pain behavior will only influence adolescents' pain behavior if adolescents actually observe their parents' pain behavior. The ideal approach to testing this hypothesis would be to observe the pain behavior of parents and their children in a naturalistic setting. However, observational measures require a high level of resources and are difficult to incorporate into large clinical research studies. Assessing adolescents' observations of parental pain behavior with questionnaire measures may be the closest proxy for recording observable parental pain behavior in a natural setting. We propose that adolescents' reported observations

of parental pain behavior will more closely reflect potential parental modeling than parents' self-reported pain behavior because adolescents' reports reflect their observation and encoding of parent behavior. Thus, this study evaluated whether adolescents' reported observations of parental pain behavior, compared to parents' self-reported pain behavior, exhibited stronger relations to adolescents' pain severity and functional impairment (Hypothesis 1b). We hypothesized that adolescents who reported observing a greater frequency of parent pain behaviors would report higher levels of pain severity and functional impairment. As an exploratory hypothesis, we also evaluated whether a high frequency of adolescent observations of parent pain behaviors were more strongly associated with adolescent daily pain severity and functional impairment when parents also self-reported a high frequency of pain behaviors.

Aim 2: Parental Reinforcement of Children's Pain Behaviors

Children also may learn pain-related behaviors when parents reinforce children's enactment of these behaviors by providing attention or other responses valued by the child. Fordyce's theory of behavioral methods for treating chronic pain and illness (Main, Keefe, Jensen, Vlaeyen, & Vowles, 2014) provides a theoretical framework to guide the investigation of reinforcement of pain behaviors. Fordyce's behavioral interventions for adults with chronic pain, pioneered in the 1970's, focused on reducing attention and secondary rewards obtained in response to pain complaints and disability. By reducing these potential reinforcers of pain behavior, patients would learn to adopt behaviors that would be more effective for the achievement of long-term goals and would improve overall functioning.

In the pediatric literature, behavioral interventions similar to those developed by Fordyce have focused on reducing parental attention toward children's pain behaviors in order to reduce children's pain and functional impairment (Levy et al., 2010; Palermo, 2012). Heightened parental attention toward children's pain has been associated with greater symptom severity and functional impairment (Claar, Simons, & Logan, 2008; Walker et al., 2006). Parental

responses that are solicitous or protective (e.g., giving their child special treats or gifts, letting their child stay home from school) have been identified as pain promoting responses (Van Slyke & Walker, 2006; Walker & Zeman, 1992), whereas parental responses that distract or redirect children's attention have been associated with a reduction in children's pain complaints (Walker et al., 2006). Much of the research on parental responses to children's pain, however, has used cross-sectional designs or has been conducted in experimental pain settings. Thus, the extent to which parental responses to children's pain prospectively predict increased or decreased pain and functional impairment in children with FAP is unclear. In this study, we examined the predictive relation of parents' baseline self-reported protective and solicitous responses to adolescents' subsequent reports of pain severity and functional impairment over a one-week online pain diary. We hypothesized that children of parents who reported more frequent protective and solicitous responses would report greater pain severity and functional impairment during the one-week online pain diary period (Hypothesis 2a).

Studies of reinforcement of pain behavior in clinical populations of children with chronic pain have almost exclusively utilized parent self-report measures (Chow, Otis, & Simons, 2016; Claar, Guite, Kaczynski, & Logan, 2010; Van Slyke & Walker, 2006) that do not assess children's awareness of parental attention to their pain behaviors. Bandura's SLT proposed that individuals learn more from reinforcers when they are aware of what behaviors receive the desired outcome (Bandura, 1977). Therefore, adolescents' observations of parents' solicitous and protective responses to their pain, as opposed to parental self-reports of their responses, may exhibit a stronger relation to adolescents' pain behavior because adolescents' observations would reflect their awareness that pain behaviors receive desired attention from parents. Thus, we hypothesized that adolescent observations of parental protective and solicitous responses, compared to parents' self-reported protective and solicitous responses, would exhibit a stronger relation to adolescents' daily pain severity and daily functional impairment (Hypothesis 2b). As an exploratory hypothesis, we evaluated whether a high frequency of adolescent observations

of parent protective and solicitous responses were more strongly associated with adolescent daily pain severity and functional impairment when parents also self-reported a high frequency of protective and solicitous responses to adolescent pain.

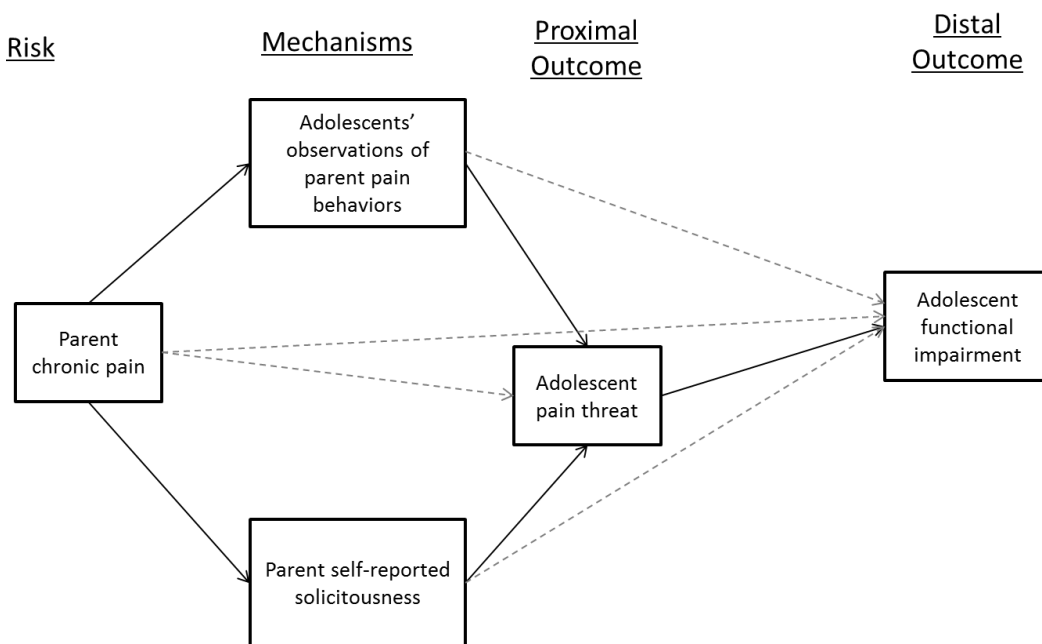
Several studies have examined the extent to which solicitous parental responses to children's pain are associated with greater pain severity and disability in children with chronic pain (Claar et al., 2008; Sieberg, Williams, & Simons, 2011; Van Der Veek et al., 2012; Vowles, Cohen, McCracken, & Eccleston, 2010), but few have evaluated how parents' own characteristics (e.g., pain symptoms) may inform their responses to children's pain (Langer, Romano, Levy, Walker, & Whitehead, 2009; Langer et al., 2007; Wilson & Fales, 2015). Based on these studies, there is some evidence to suggest parents with greater somatic complaints tend to engage in more solicitous and protective responses to children's pain. However, these studies were conducted in non-clinical samples of children with relatively low levels of pain. Thus, our study aimed to evaluate the extent to which parents own chronic pain status was associated with variability in parental responses to children's pain in a clinical sample of adolescents with FAP. We hypothesized that parents with chronic pain, compared to those without chronic pain, would engage in more protective and solicitous responses to their children's pain (Hypothesis 2c). Parents with chronic pain may be more likely to engage in protective and solicitous responses to their children's pain because of their own tendency to view pain as a threat that demands attention.

Aim 3: Testing Social Learning Pathways for the Intergenerational Transmission of Pain and Functional Impairment

The final aim of our study was to test a conceptual model of the social learning pathways (i.e., parental modeling and reinforcement) that account for the relation between parental chronic pain status and adolescents' average daily pain severity and average daily functional impairment during the course of a one-week online pain diary (Figure 1). Specifically, the model

hypothesized that parents' chronic pain status would influence adolescents' pain severity and pain-related functional impairment through parental modeling of pain behavior and parental reinforcement of adolescents' pain behaviors. The risk factor in this model, parental chronic pain, was operationalized as the presence versus absence of clinically significant chronic pain reported by the parent for the past three months or longer. Multiple models were tested with different informants (parent versus adolescent) for the social learning mechanisms (parental modeling and reinforcement) to determine the best fit.

Figure 1. Hypothesized model for social learning mechanisms accounting for the relation between parent and child pain and functional impairment



Note. Solid black lines represent pathways hypothesized as statistically significant. Dotted grey lines represent pathways included in hypothesized model, but not as part of primary hypotheses. The same model was hypothesized substituting adolescent pain severity for adolescent functional impairment as the distal outcome.

The model included both distal and proximal outcomes. Distal outcomes referred to adolescents' average daily pain severity and pain interference over a 7-day pain diary following their baseline evaluation for FAP. Adolescents' pain threat appraisals were added as a proximal

outcome between baseline parental behaviors and adolescents' subsequent pain severity and pain-related impairment. The inclusion of adolescents' pain threat appraisals as a proximal outcome is novel as it represents cognition—an intermediate step in adolescents' social learning that is consistent with Bandura's SLT but has not previously been included in research in this area. Similarly, parents' cognitions about their own pain originate as internal experiences before they are manifest in pain behaviors (e.g., facial expression, vocalizations, body language) that children can observe and learn (Craig, 2009). When children learn, they encode observed behaviors into cognitive representations and appraisals which then influence the expression of their learned behaviors (Bandura, 1977). Thus, we hypothesized that parental modeling and reinforcement of adolescents' pain behaviors would impact adolescents' pain severity and functional impairment over the 7-day diary period indirectly through adolescents' pain threat appraisals. Specifically, adolescents observing frequent negative pain behaviors (e.g., grimacing, avoiding activities) modeled by their parents would learn to appraise pain as threatening which would subsequently influence adolescents themselves to report more severe daily pain and pain-related impairment. Similarly, adolescents receiving frequent reinforcement for pain behaviors may appraise pain as more threatening due to increased attention to negative aspects of their pain experience. The processes by which parental chronic pain influences parental modeling of pain behavior and reinforcement of adolescents' pain behaviors occurs throughout development and thus, cross-sectional measures of these processes likely reflect dynamic interactions that have occurred over a timeframe of years.

CHAPTER II

METHOD

Participants

Participants comprised pediatric patients between 11 and 17 years of age and a caregiver presenting to the pediatric gastroenterology clinic at Monroe Carell Jr. Children's Hospital at Vanderbilt for their initial evaluation for abdominal pain. Inclusion criteria for pediatric patients included: (1) recurrent abdominal pain for at least the past two months, (2) can read and write in English at sixth grade level, and (3) easy access to a computer for completion of diary. Exclusion criteria for pediatric patients included: (1) presence of chronic disease (e.g., inflammatory bowel disease, diabetes) and (2) hospitalization within the month prior to study enrollment.

We enrolled 160 dyads who met eligibility requirements for participation in the study. If either the parent or child did not complete the baseline survey the dyad was excluded from analyses ($n = 3$). In addition, based on an examination of medical records from the clinic evaluation, two dyads were excluded because the adolescent was diagnosed with inflammatory bowel disease and one dyad was excluded after enrollment due to developmental delay. Thus, the final sample comprised 154 dyads (adolescent age: $M = 14.14$, $SD = 1.87$; adolescent sex: 66.9% female; 90.9% mothers).

Procedures

A member of our research staff approached patients and parents who agreed to hear more about our study in the clinic. Informed consent was obtained from parents and informed assent was obtained from adolescents. Both adolescents and their parents completed a baseline survey during their clinic visit on REDCap, a secure online survey site (Harris et al., 2009). Adolescents were informed that they were going to be asked questions about pain,

mood, sleep, and activities. Research staff did not provide any additional rationale for asking about parent pain beyond the instructions included with the measures. Adolescents and parents completed their surveys independently and neither was allowed to see the others' answers. Following the initial clinic visit, adolescents completed a seven day online daily diary which assessed pain and functional impairment during each day.

Baseline Measures

Parent pain behaviors. Parent pain behaviors were assessed with the PROMIS Pain Behavior – Short Form (PPB; parent self-report) and the Parent Pain Behavior-Proxy (PPB-Proxy; adolescent proxy-report) (Assessment Center, 2014; Stone & Walker, 2017). These measures each comprised 7 items which captured observable pain behaviors over the past 7 days (e.g., “moved extremely slowly”; see Appendix 1 for measure). Both measures contain the same items. However, the PPB utilized the stem, “When I was in pain, I...,” while the PPB-Proxy utilized the stems, “When my mother was in pain, she...” and “When my father was in pain, he...” Response options ranged from (1) “Had No Pain” to (6) “Always.” Items were scored by computing a total raw score ranging from 7 to 42. Separate totals were computed for the parent self-report and proxy reports of mothers’ and fathers’ pain behavior. For data analyses, we used either the mother or father report depending on which parent participated in the study so that adolescents and parents reported on the same individual. In a preliminary measure validation study utilizing a portion of the present sample, the PPB-Proxy exhibited good internal consistency, moderate agreement with the PPB, and adequate convergent and discriminant validity (Stone & Walker, 2017). Alpha reliabilities in the current study for the PPB and PPB-Proxy were .93 and .95, respectively.

Parental responses to adolescents’ pain. Parent-report and adolescent proxy-report short-form versions of the Adult Responses to Children’s Symptoms (ARCS-SF-A) assessed parental solicitous and protective responses to children’s pain. The ARCS-SF-A contains 10

items from the Solicitousness, Protect, and Distract subscales determined to be well suited for parents of adolescents based on a developmental analysis of the factor structure of the ARCS (Noel et al., 2015). The ARCS-SF-A contains all three items from the Solicitousness subscale (“Do your child’s chores or pick up your child’s things instead of making him/her do it,” “Bring your child special treats or little gifts,” and “Give your child special privileges”) and all three items from the Distract subscale (“Talk to your child about something else to take your child’s mind off of it,” “Encourage your child to do something he or she enjoys,” and “Try to involve your child in some activity”). The Protect subscale contains 4 items selected based on high factor loadings and conceptual coherence (see Appendix 2 for measure). The parent report version of the measure utilizes the stem, “When your child has a stomachache or abdominal pain, how often do you...” The adolescent report version utilizes the stem, “When you have a stomachache or abdominal pain, how often do your parents...” Item responses range from (0) “Never” to (4) “Always,” and responses to items for each subscale are summed to yield a total score. Alpha reliabilities for the Solicitous and Protect subscales were 0.61 and 0.72, respectively, which are similar to alpha reliabilities reported previously in parents of adolescents with chronic pain (Noel et al., 2015). For the adolescent-proxy report ARCS-SF-A, alpha reliabilities for the Solicitous and Protect subscales were 0.66 and 0.73, respectively.

Parental chronic pain. The Persistent Pain Questionnaire (PPQ) assessed parental chronic pain (Bruehl & Chung, 2006; Bruehl, France, France, Harju, & al'Absi, 2005; Sherman et al., 2013; Stone & Walker, 2017). The primary participating parent identified locations of current chronic pain based on eight standard body locations described by the International Association for the Study of Pain (Merskey & Bogduk, 1994): head, neck, shoulder/arm/hand, chest, abdomen, pelvic area, upper or lower back, and legs/feet. For each site, parents were asked if they had experienced chronic pain daily or almost daily for the past 3 months. If they responded positively to this question, they were asked to rate their current pain severity on a

scale of 0-100. Parents were considered to have current chronic pain at a body location if they rated the pain at that site at greater than or equal to 30.

Adolescent pain threat appraisal. The Pain Beliefs Questionnaire-Short Form (PBQ-SF) assessed adolescents' pain threat appraisals (Stone, Walker, Laird, Shirkey, & Smith, 2016). The PBQ-SF is an 18-item questionnaire that includes a six-item Pain Threat scale. Pediatric patients rated how true each item seemed to them regarding their stomach aches on a 0 ("not at all true") to 4 ("very true") scale. The Pain Threat scale measures the extent to which patients view their pain as a serious threat to their wellbeing. Items from the scale are summed to yield a total score with higher scores indicating stronger beliefs that pain represents a significant threat. Alpha reliability in the current study for the Pain Threat scale was 0.78.

Adolescent pain frequency. The Abdominal Pain Index (API) is a patient self-report measure of abdominal pain duration, frequency, and intensity over the past two weeks (Laird, Sherman, Smith, & Walker, 2015). For the purposes of the present study, the question regarding abdominal pain frequency ("In the past two weeks, how often have you had abdominal pain?") was utilized as a control variable in analyses related to parental responses to children's pain.

Adolescent Daily Diary Measures

An online, secure, seven-day diary assessed children's daily pain and functional impairment following their initial clinic visit.

Average daily pain severity. Each day, adolescents reported on their pain severity using an 11-point numerical rating scale (0 = no pain and 10 = worst pain). Higher scores indicate greater pain severity. Daily diary pain ratings were averaged across the seven days to yield a pain severity mean score.

Average daily functional impairment. Items from the Child Activity Limitations Interview (CALI) were administered daily during the diary period to assess adolescent's

functional impairment due to pain (Palermo, Lewandowski, Long, & Burant, 2008; Palermo, Witherspoon, Valenzuela, & Drotar, 2004). The CALI was administered to pediatric patients during the initial clinic visit by a trained research assistant. Based on this interview, eight activities identified by the patient as most difficult were selected for the patient's daily diary. Patients then provided daily difficulty ratings for each activity on a 5-point scale ranging from 0 (no difficulty) to 4 (extremely difficult). Daily difficulty ratings were averaged across the seven days to yield a functional limitation mean score. Other studies have administered the CALI in a daily diary format with adolescents with chronic pain (Law, Beals-Erickson, Noel, Claar, & Palermo, 2015; Palermo, Wilson, Peters, Lewandowski, & Somhegyi, 2009).

CHAPTER III

RESULTS

Demographics

Descriptive, correlation, and regression analyses were conducted with IBM SPSS Statistics for Windows, Version 24.0 (IBM Corp, 2016). The sample comprised 154 dyads (see Table 1 for demographic characteristics). Adolescents on average were approximately 14-years-old and predominately female. The majority of parents were mothers and reported at least one chronic pain site (76.6%, $n = 118$; see Table 2 for parent pain characteristics). On average, parents reported 2.44 chronic pain locations ($SD = 2.15$).

Table 1. Participant demographic characteristics

Demographic Characteristic	FAP ($n = 152$)
Age, $M \pm SD$	14.14 ± 1.87
Sex, n (%)	
Female	103 (66.9)
Race, n (%)	
Caucasian	128 (83.1)
African-American	13 (8.4)
Other	13 (8.4)
Participating parent, n (%)	
Mother	140 (90.9)
Father	11 (7.1)
Grandmother	3 (1.9)
Parent highest level of education, n (%)	
High school or less	34 (22.1)
Vocational school/some college	55 (35.7)
Four-year college	47 (30.5)

Graduate/professional school	18 (11.7)
Parent marital status, <i>n</i> (%)	
Married or partnered	105 (68.2)
Separated or divorced	30 (19.5)
Single	19 (12.3)

Table 2. Parent pain characteristics

Parent Pain Characteristics	<i>n</i> = 154
Parent reported at least one chronic pain location, <i>n</i> (%)	118 (76.6)
Number of parent chronic pain locations, <i>M</i> ± <i>SD</i>	2.44 ± 2.15
Parent chronic pain locations, <i>n</i> (%)	
Head	77 (50.0)
Upper or lower back	73 (47.4)
Leg, foot, knees, or ankles	51 (33.1)
Shoulder, arm, or hand	46 (29.9)
Abdomen	45 (29.2)
Neck	44 (28.6)
Pelvis	22 (14.3)
Chest	18 (11.7)
Highest pain intensity reported at any one pain location (0-100), <i>M</i> ± <i>SD</i>	58.68 ± 32.48

Aim 1: Parental Modeling of Pain Behaviors

Hypothesis 1a. We hypothesized that the frequency of parental self-reported baseline pain behavior, compared to the simple presence versus absence of parental chronic pain, would exhibit a stronger relation to adolescents' subsequent pain severity and functional impairment averaged over a 7-day pain diary. Table 3 presents zero-correlations examining the associations between parent self-reported pain behaviors, parental chronic pain status, and adolescents' average daily pain severity, daily functional impairment, age, and sex. Parental self-reported baseline pain behavior significantly correlated with adolescents' subsequent average daily pain severity, but not with their average daily functional impairment. Parental

chronic pain status (present versus absent) did not significantly correlate with adolescents' average daily pain severity or functional impairment.

Table 3. Zero order Pearson r correlations between parent self-reported pain behaviors and prospective measures of adolescent pain severity and functional impairment

Variable	1	2	3	4	5	6
1 Parent self-report pain behaviors	--					
2 Parental chronic pain (presence/absence)	.57**	--				
3 Adolescent daily pain severity	.27**	.13	--			
4 Adolescent daily functional impairment	.16	.09	.64**	--		
5 Adolescent age	.004	-.12	.21**	.25**	--	
6 Adolescent sex	-.15	-.003	-.25**	-.24**	-.18*	--

Note. ** p < .01; * p < .05

Multiple regression analyses further examined whether the frequency of parents' self-reported baseline pain behavior contributed significantly to adolescents' subsequent average daily pain severity and functional impairment beyond the simple presence versus absence of parental chronic pain. Controlling for adolescent age, sex, and parental chronic pain status, parents' self-reported baseline pain behavior, reported at the clinic visit, was significantly associated with adolescents' subsequent average daily pain severity, but not with their average daily functional impairment, over the daily diary period (Table 4).

Table 4. Multiple regression analyses examining the relation of parents' self-reported pain behaviors to adolescent daily pain severity, and functional impairment controlling for parental chronic pain status, adolescent age, and sex

Variable	Adolescent daily pain severity			Adolescent daily functional impairment		
	β	p	ΔR^2	β	p	ΔR^2
Step 1: Control variables			.11*			.11*
Adolescent age	.19	.02		.22	.01	
Adolescent sex	-.21	.01		-.20	.02	
Parental chronic pain status	.15	.06		.11	.17	
Step 2			.04*			.01
Parent self-reported pain behavior	.23	.02		.10	.31	

Note. * p for $\Delta R^2 < .05$

Hypothesis 1b. Steiger's Z-test for dependent correlations (1980) examined whether adolescents' reported baseline observations of parental pain behavior, as compared to parents' self-reported baseline pain behavior, was more strongly related to adolescent's subsequent daily average pain severity and functional impairment. Steiger's Z-test analyses were conducted with an online program developed by Lee and Preacher (2013). Figures 2 and 3 present the correlations between adolescents' observations of parent pain behavior, parent self-reported pain behavior, adolescent daily pain severity, and adolescent daily functional impairment utilized for Steiger's Z-test.

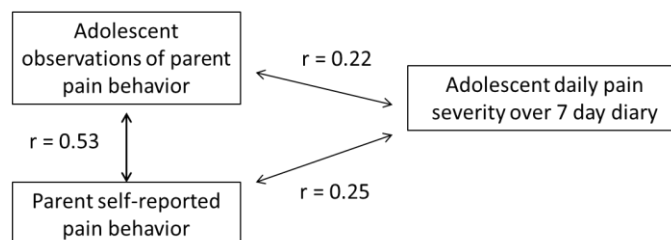


Figure 2. Pearson r correlations between adolescent s' baseline observations of parent pain behavior, parents' baseline self-reported pain behavior, and adolescents' subsequent average daily pain severity over the 7-day diary.

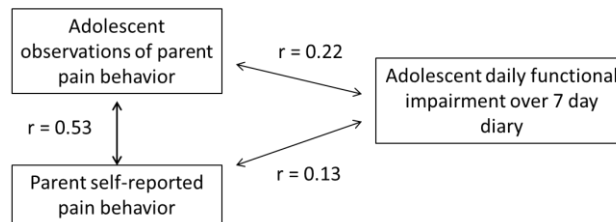


Figure 3. Pearson r correlations between adolescent s' baseline observations of parent pain behavior, parents' self-reported baseline pain behavior, and adolescents' subsequent average daily functional impairment over the 7-day diary.

Results from Steiger's Z-test for dependent correlations failed to support hypothesis 1b: adolescent observations of parent pain behavior, compared to parent self-reported pain behavior, were not more strongly related to adolescent daily pain severity (z-score = -0.39, $p = 0.67$) and functional impairment (z-score = 1.10, $p = 0.27$). Adolescent observations of parent pain behavior were moderately correlated with parent self-reported pain behaviors ($r = 0.53$) and both exhibited modest correlations with adolescents' subsequent average daily pain severity and functional impairment reported over the 7-day diary period.

Additional exploratory analyses examined whether there was an additive effect between adolescent observations of parent pain behavior and parent self-reported pain behavior in predicting subsequent adolescent average daily pain severity and impairment. We hypothesized that adolescents who reported observing a high frequency of parent pain behavior and had a parent who similarly self-reported a high frequency of pain behavior would report the highest levels of pain and functional impairment over the 7-day diary period. These analyses utilized a multiple regression approach to test moderation where Step 1 included main effects (adolescent observations of parent pain behavior, parent self-reported pain behavior) and Step 2 included the interaction (adolescent observations of parent pain behavior X parent self-

reported pain behavior). Adolescent observations of parent pain behavior and parent self-reported pain behavior were mean centered prior to completing these moderation analyses. Table 5 presents the results of these analyses.

For adolescent pain severity, the interaction between parent self-reported pain behavior and adolescent observations of parent pain behavior was not a significant predictor of subsequent adolescent average daily pain severity and impairment. The main effect for parent self-reported pain behavior approached significance ($p = 0.06$), although the main effect for adolescent observations of parent pain behavior was non-significant. Thus, parent self-reported pain behavior at the time of the adolescent's clinic visit, subsequently predicted higher levels of adolescent pain severity during the 7-day diary. A high level of agreement between parent self-report and adolescent observations of parent pain behaviors did not emerge as a significant predictor of adolescent pain severity.

For adolescent functional impairment, results indicated no evidence for an interaction between adolescent observations of parent pain behavior and parent self-reported pain behavior. A significant main effect was observed for adolescent observations of parent pain behavior, but not parent self-reported pain behavior. Thus, adolescents who, at the time of their clinic visit, reported observing more frequent parent pain behavior, subsequently reported higher levels of daily functional impairment during the 7-day diary. A high level of agreement between parent self-report and adolescent observations of parent pain behaviors did not emerge as a significant predictor of adolescent functional impairment.

In sum, adolescents' observations of parent pain behavior and parent self-reported pain behavior, exhibited similar correlations with adolescents' subsequent average daily pain severity and functional impairment over the 7-day diary period. Results from exploratory analyses did not support an additive relation between adolescent observations of parent pain behavior and parent self-reported pain behavior.

Table 5. Adolescent and parent report of parent pain behaviors as predictors of adolescent daily pain severity and adolescent daily pain interference over a seven-day diary period

Variable	Adolescent Daily Pain Severity				Adolescent Daily Pain Interference			
	<i>b</i>	SE <i>b</i>	β	<i>p</i>	<i>b</i>	SE <i>b</i>	β	<i>p</i>
	Model 1:							
Ado. age	0.17	0.08	0.17	0.04	0.09	0.04	0.20	0.02
Ado. sex	-0.58	0.33	-0.14	0.08	-0.38	0.16	-0.20	0.02
Ado. report PPB	0.03	0.02	0.12	0.20	0.02	0.01	0.20	0.04
Parent self-report PPB	0.04	0.02	0.17	0.06	0.01	0.01	0.00	0.99
Model 2:								
Adolescent x parent report PPB	0.01	0.01	0.02	0.84	0.01	0.01	0.03	0.77

Note. Ado. = adolescent, PPB = parent pain behavior

Aim 2: Parental Reinforcement of Children’s Pain Behaviors

Hypothesis 2a. We hypothesized that more frequent baseline parent self-reported protective and solicitous responses to children’s pain would predict subsequent greater pain and functional impairment over the online diary period. Separate hierarchical linear regression models were conducted with each type of parental response (protective, solicitous) to children’s pain entered as the independent variable and subsequent adolescent average daily pain severity and impairment over the seven-day diary period as dependent variables. Adolescent age, sex, and baseline abdominal pain frequency were entered in step one to control for demographic factors known to affect adolescents’ pain outcomes and parental responses to children’s pain. Parents’ self-reported responses to children’s pain were entered in step two.

Regression analyses for parent self-reported protectiveness and solicitousness are presented in Tables 6 and 7.

Table 6. Parent self-reported protective responses to adolescent pain predict adolescents' pain severity and functional impairment over a 7-day diary period

Variable	Adolescent Daily Pain Severity				Adolescent Daily Pain Interference			
	β	p	R ²	ΔR^2	β	p	R ²	ΔR^2
	Step 1: Control variables			.23	.23*			.35
Adolescent age	.11	.15			.11	.14		
Adolescent sex	-.10	.19			-.08	.28		
Adolescent baseline pain frequency	.40	<.001			.53	<.001		
Step 2			.27	.04*			.39	.04*
Parent self-reported protectiveness	.20	.01			.19	.01		

Note. * ΔR^2 significant at $p < .05$ level.

Table 7. Parent self-reported solicitous responses to adolescent pain predict adolescents' pain severity and functional impairment over a 7-day diary period

Variable	Adolescent Daily Pain Severity				Adolescent Daily Pain Interference			
	β	p	R ²	ΔR^2	β	p	R ²	ΔR^2
	Step 1: Control variables			.23	.23*			.35
Adolescent age	.11	.15			.11	.14		
Adolescent sex	-.10	.19			-.08	.28		
Adolescent baseline pain frequency	.40	<.001			.53	<.001		

Step 2			.27	.04*		.38	.03*
Parent self-reported solicitousness	.20	.01			.17	.02	

Note. * ΔR^2 significant at $p < .05$ level.

Results of these analyses indicated that both more frequent protective and more frequent solicitous responses reported by parents at the clinic baseline predicted subsequent adolescent reports of greater average daily pain severity and functional impairment over the seven-day diary period.

Hypothesis 2b. Steiger’s Z-test for dependent correlations tested whether adolescents’ baseline observations of parental protective and solicitous responses to adolescent pain, compared to parents’ baseline self-reported protective and solicitous responses, exhibited a stronger relation to adolescents’ daily pain severity and daily functional impairment over the 7-day diary period. Figures 4 and 5 present the correlations between adolescents’ baseline observations of parent solicitous responses to adolescent pain, parent self-reported baseline solicitous responses, adolescent average daily pain severity, and adolescent average daily functional impairment utilized for Steiger’s Z-test.

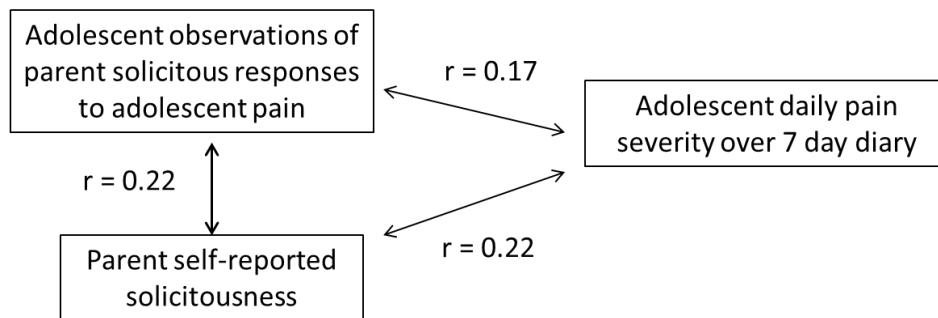


Figure 4. Pearson r correlations between baseline adolescent observations of parent solicitous responses to adolescent pain, parent self-reported solicitousness, and adolescent daily pain severity over the 7-day diary.

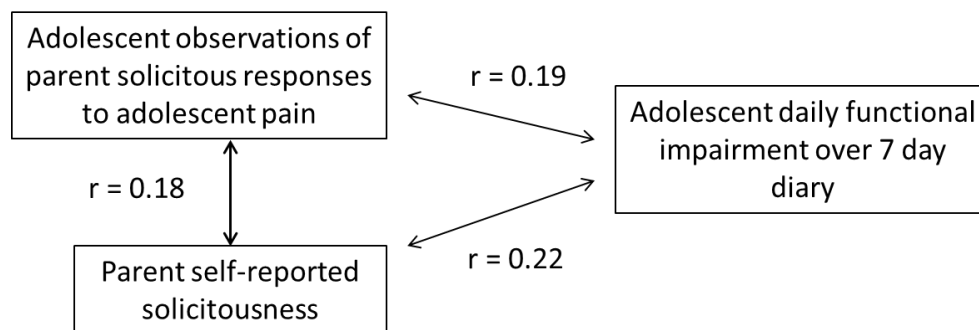


Figure 5. Pearson r correlations between baseline adolescent observations of parent solicitous responses to adolescent pain, parent self-reported solicitousness, and adolescent daily functional impairment over the 7-day diary.

Results from Steiger's Z-test for dependent correlations indicated no differences between adolescent observations of parental solicitous responses to adolescent pain and parent self-reported solicitous responses in the strength of their relation to adolescent daily pain severity (z-score = -0.48, $p = 0.63$) and to adolescent daily functional impairment (z-score = -0.30, $p = 0.76$). Adolescent observations of parent solicitous responses exhibited a small to medium correlation with parent self-reported solicitous responses ($r = 0.22$) and both exhibited modest correlations with adolescents' daily pain severity and functional impairment reported over the 7-day diary period.

Figures 6 and 7 present the correlations between adolescents' baseline observations of parent protective responses to adolescent pain, parent self-reported baseline protective responses, adolescent average daily pain severity, and adolescent average daily functional impairment utilized for Steiger's Z-test. Results from Steiger's Z-test for dependent correlations indicated no differences between adolescent observations of parental protective responses to adolescent pain and parent self-reported protective responses in the strength of their relation to adolescent daily pain severity (z-score = -0.30, $p = 0.76$) and adolescent daily functional impairment (z-score = 0.95, $p = 0.34$). Adolescent observations of parent protective responses exhibited a medium correlation with parent self-reported protective responses ($r = 0.35$) and

both exhibited modest correlations with adolescents' daily pain severity and functional impairment reported over the 7-day diary period.

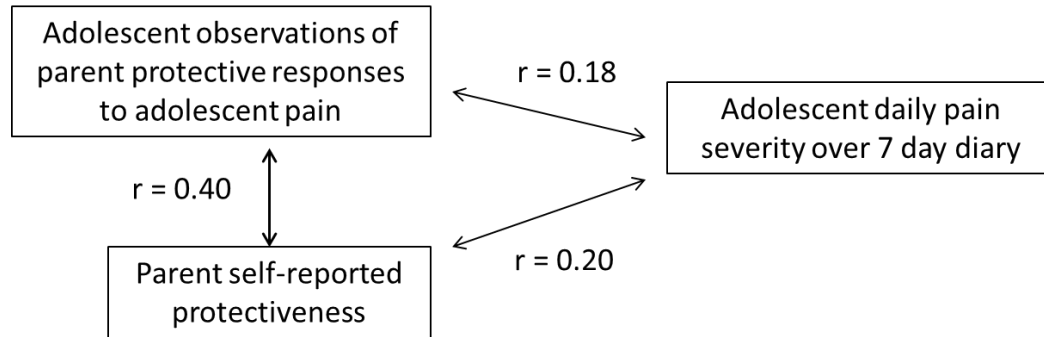


Figure 6. Pearson r correlations between baseline adolescent observations of parent protective responses to adolescent pain, parent self-reported solicitousness, and adolescent daily pain severity over the 7-day diary.

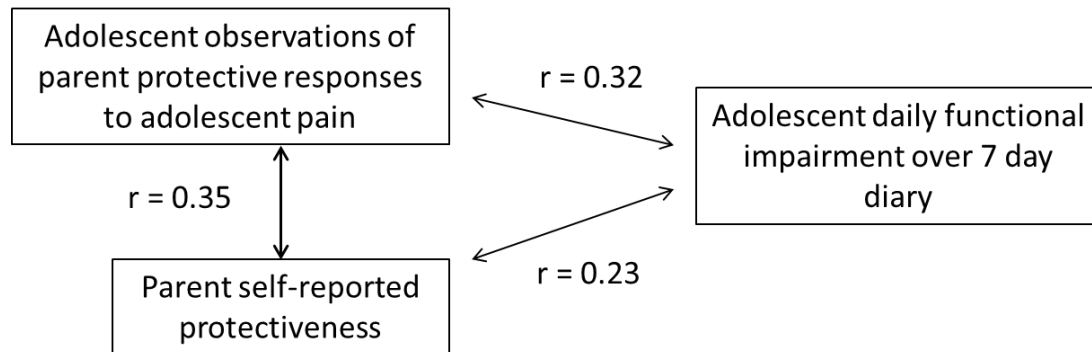


Figure 7. Pearson r correlations between baseline adolescent observations of parent protective responses to adolescent pain, parent self-reported solicitousness, and adolescent daily functional impairment over the 7-day diary.

Additional exploratory analyses evaluated whether a high baseline frequency of adolescent observations of parent protective and solicitous responses were more strongly associated with adolescent daily pain severity and functional impairment in the week following the baseline clinic evaluation when parents also self-reported a high baseline frequency of protective and solicitous responses to adolescent pain. These analyses utilized a multiple

regression approach to test interaction effects. Regression analyses included age, gender, and abdominal pain frequency as covariates, adolescent report, parent self-report in Model 1, and entered the adolescent X parent report interaction in Model 2. Continuous predictors were mean centered prior to conducting analyses. Separate analyses were conducted for parent solicitous responses and parent protective responses. Tables 8 and 9 present the results from these analyses.

For adolescents' average daily pain severity over the 7-day diary period, results indicated a significant interaction between adolescents' baseline observations of parents' solicitous responses and parents' baseline self-reported solicitousness. Specifically, adolescents reported more severe pain over the 7-day diary period when both the adolescent observed and the parent self-reported more frequent solicitous responses to adolescent pain at the time of the baseline clinic visit (Figure 8). Simple slopes analyses indicated a statistically significant slope for adolescents' baseline observations of parent solicitousness predicting adolescents' subsequent daily pain severity at 1 SD above the mean of parent self-reported solicitousness ($b = 0.50$, 95% CI: 0.18-0.83; $t[139] = 3.05$, $p = 0.002$), but not at 1 SD below the mean. Thus, when adolescents observed and parents self-reported high levels of solicitous responding to adolescents' pain at their initial clinic visit, adolescents reported more severe daily pain over the subsequent 7 days. With regard to protectiveness, the interaction between adolescent observations of parent protectiveness and parent self-reported protectiveness did not predict adolescent daily pain severity.

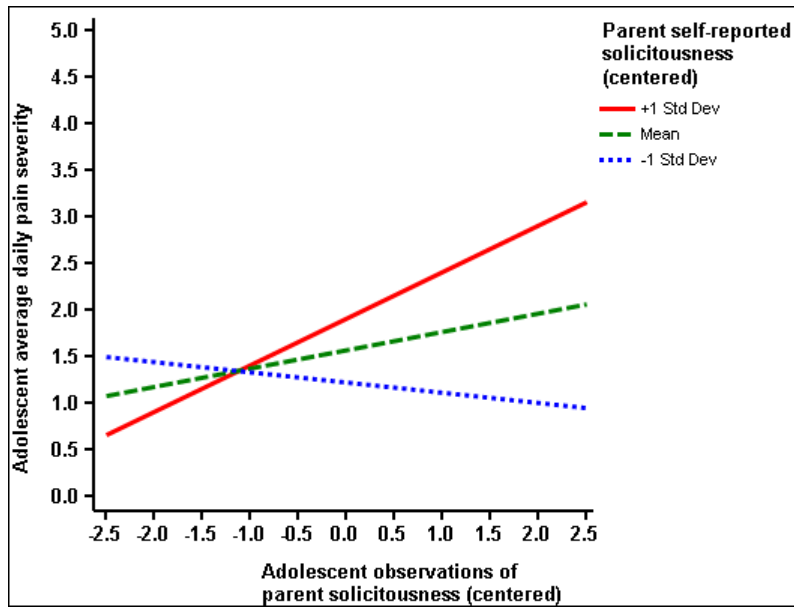


Figure 8. Adolescent and parent report of parent solicitous responses to adolescent pain as predictors of adolescent daily pain severity

For adolescent daily functional impairment, results indicated no significant interactions between adolescents’ baseline observations of parent responses to their pain and parents’ baseline self-reported responses to their pain. There was a significant main effect for parent baseline self-report solicitous responses to adolescent pain on adolescent daily functional impairment and the main effect for adolescent observations of parent solicitousness approached significance when both were entered into the same regression model. Regarding protectiveness, when both adolescents’ baseline observations of parent protectiveness and parents’ baseline self-reported protectiveness were included in the same regression model, only the main effect for adolescent observations of parent protectiveness on adolescent daily functional impairment was significant.

Table 8. Adolescent and parent report of parent solicitous responses to adolescent pain as predictors of adolescent daily pain severity and adolescent daily pain interference over a 7-day diary period

Variable	Adolescent Daily Pain				Adolescent Daily Pain			
	Severity				Interference			
	<i>b</i>	SE <i>b</i>	β	<i>p</i>	<i>b</i>	SE <i>b</i>	β	<i>p</i>
Model 1:								
Ado. age	0.08	0.08	0.08	0.28	0.06	0.03	0.12	0.09
Ado. sex	-0.16	0.31	-0.04	0.61	-0.08	0.14	-0.04	0.59
Ado. pain frequency	0.58	0.10	0.46	0.00	0.34	0.04	0.57	0.00
Ado. report sol.	0.22	0.15	0.11	0.14	0.12	0.07	0.12	0.08
Parent self-report sol.	0.41	0.18	0.17	0.03	0.20	0.08	0.17	0.02
Model 2:								
Adolescent x parent report solicitousness	0.38	0.18	0.16	0.03	-0.10	0.09	-0.08	0.27

Note. Ado. = adolescent; sol. = solicitousness responses to adolescent pain

Table 9. Adolescent and parent report of parent protective responses to adolescent pain as predictors of adolescent daily pain severity and adolescent daily pain interference over a seven-day diary period

Variable	Adolescent Daily Pain Severity				Adolescent Daily Pain Interference			
	<i>b</i>	SE <i>b</i>	β	<i>p</i>	<i>b</i>	SE <i>b</i>	β	<i>p</i>
	Model 1:							
Ado. age	0.06	0.08	0.06	0.42	0.04	0.03	0.08	0.23
Ado. sex	-0.28	0.30	-0.07	0.35	-0.16	0.13	-0.08	0.22
Ado. pain frequency	0.55	0.10	0.44	0.00	0.33	0.04	0.55	0.00
Ado. report protect	0.19	0.16	0.09	0.23	0.20	0.07	0.22	0.00
Parent self-report protect	0.33	0.19	0.14	0.08	0.13	0.08	0.11	0.11
Model 2:								
Adolescent x parent report protectiveness	0.11	0.18	0.05	0.53	0.05	0.08	0.04	0.56

Note. Ado. = adolescent; protect = parent protective responses to adolescent pain

Hypothesis 2c. We hypothesized that parents with chronic pain compared to parents without chronic pain would be more likely to engage in solicitous or protective responses to children’s pain. Controlling for pain frequency reported by adolescents at the clinic visit, adolescent sex, and adolescent age, results from ANCOVA analyses indicated that parents with chronic pain, compared to parents without chronic pain, were significantly more likely to report engaging in solicitous responses to adolescents’ pain [$F(1, 148) = 4.89, p = .03$], but not protective responses to adolescents’ pain [$F(1, 149) = 0.72, p = 0.40$]. In contrast, adolescents of parents with chronic pain did not themselves report observing more parent solicitous or protectiveness compared to adolescents of parents without chronic pain.

Aim 3: Testing Social Learning Pathways for the Intergenerational Transmission of Pain Severity and Pain-Related Functional Impairment

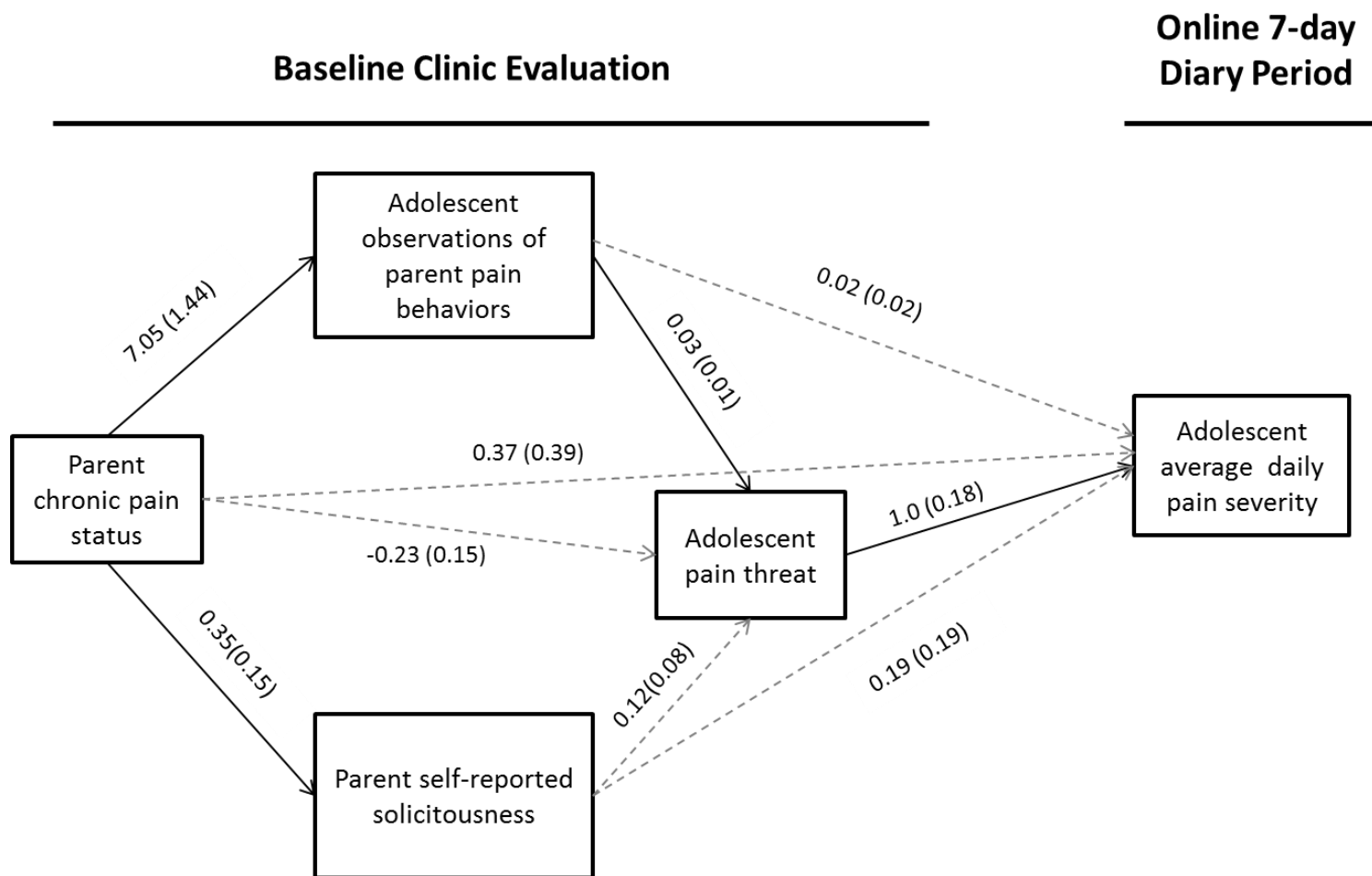
Path analyses were conducted with MPlus7 (2015) to examine multiple mediation pathways accounting for the relation between parental chronic pain status reported at the baseline clinic visit and adolescents' daily pain and functional impairment over a subsequent 7-day diary period. These analyses utilized a bootstrap estimation approach with 5000 samples. Two different models were tested to examine path effects for two primary outcomes: (1) pain severity averaged over the 7-day diary period and (2) functional impairment averaged over the 7-day diary period. Adolescent's pain threat appraisal was the proximal outcome in both models. Adolescent's observations of parent pain behaviors and parents' self-reported solicitous responses to adolescents' pain were entered as the mediators. Parent solicitousness was chosen to represent parent responses in the final model because it exhibited the strongest relation to parental chronic pain, i.e., stronger than parent protectiveness.

Figure 9 presents the statistical model for adolescents' average daily pain severity and Figure 10 presents the statistical model for adolescents' average daily functional impairment. In both models, positive parental chronic pain status was significantly associated with more frequent adolescent reported baseline observations of parental pain behaviors ($b = 7.05$, $SE = 1.44$, $p < .001$) and with more frequent parent reported baseline solicitous responses to adolescents' pain ($b = 0.35$, $SE = 0.15$, $p = 0.02$). More frequent adolescent baseline observations of parental pain behaviors, in turn, were significantly associated with more severe adolescent baseline pain threat appraisals ($b = 0.03$, $SE = 0.01$, $p < .01$). More severe adolescent baseline pain threat appraisals significantly predicted adolescents' average daily pain severity over the 7 day diary period ($b = 1.0$, $SE = 0.18$, $p < .001$). The indirect pathway from parental chronic pain status through adolescents' observations of parent pain behaviors and adolescent pain threat appraisal was significant for both adolescent average daily pain

severity ($b = 0.18$, $SE = 0.08$, 95% CI: 0.04, 0.31, $p = 0.03$) and adolescent average daily functional impairment ($b = 0.08$, $SE = 0.04$, 95% CI: 0.02, 0.15, $p = 0.03$). The indirect pathway through parental solicitousness did not reach significance for either adolescent pain severity or adolescent functional impairment. Overall model fit indices indicated a good fit for both models (pain severity: RMSEA = 0.00, 90% CI for RMSEA = 0.01, 0.15, $\chi^2 = 0.13$, $p = 0.72$, CFI = 1.00; functional impairment: RMSEA = 0.00, 90% CI for RMSEA = 0.01, 0.15, $\chi^2 = 0.10$, $p = 0.76$, CFI = 1.00).

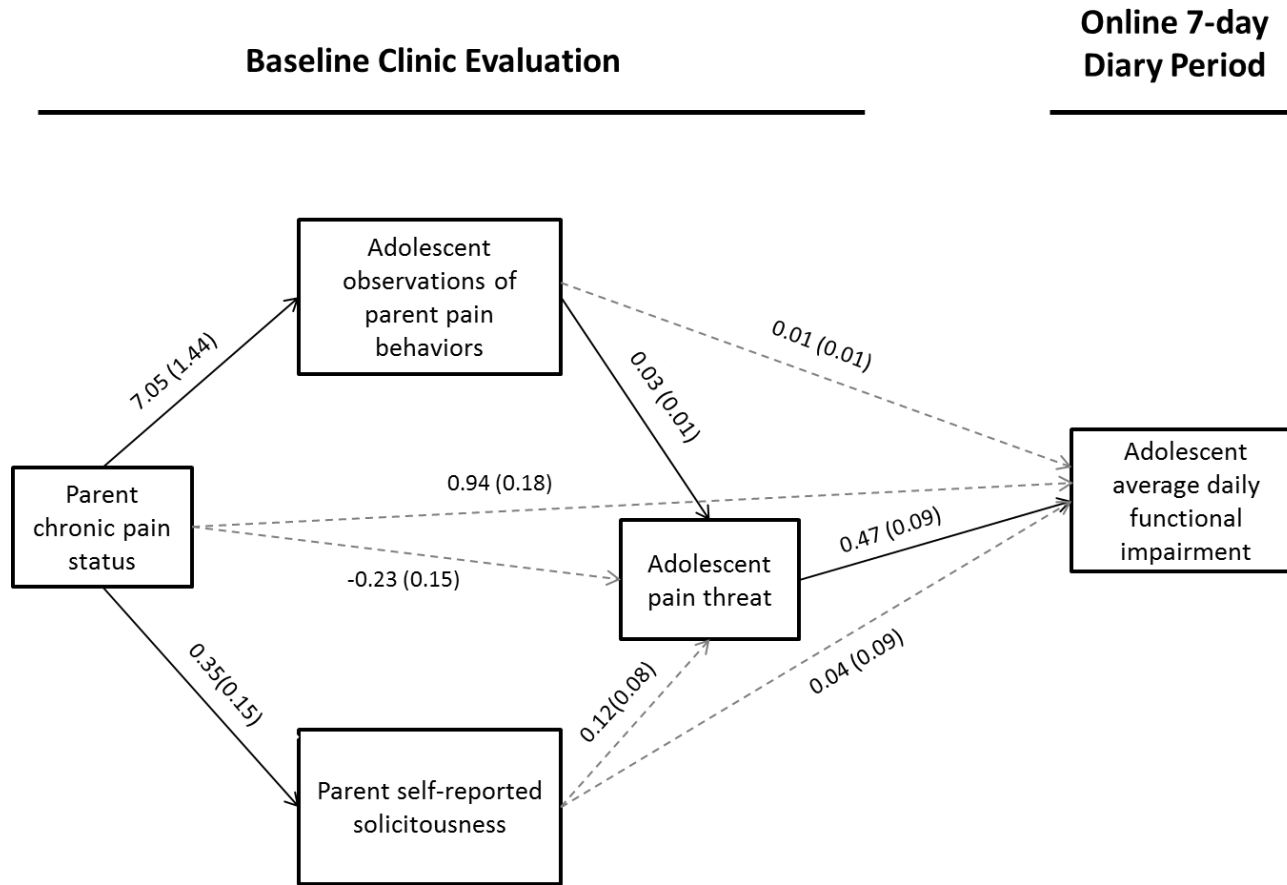
In exploratory analyses, parents' self-reported pain behavior was substituted into the models in place of adolescents' reported observation of parent pain behavior. The same pattern of results was found for parents' self-reported pain behaviors, that is, the indirect pathway from parental chronic pain status through adolescents' observations of parent pain behaviors and adolescent pain threat appraisal was significant for both adolescent pain severity ($b = 0.27$, $SE = 0.12$, 95% CI: 0.07, 0.46, $p = 0.02$) and adolescent functional impairment ($b = 0.13$, $SE = 0.06$, 95% CI: 0.04, 0.22, $p = 0.02$). The indirect pathway through parental solicitousness remained non-significant for both outcomes. However, the overall model fit indices were inconsistent for parents' self-reported pain behaviors (pain severity: RMSEA = 0.14, 90% CI for RMSEA = 0.01, 0.29, $\chi^2 = 3.95$, $p = 0.05$, CFI = 0.97; functional impairment: RMSEA = 0.14, 90% CI for RMSEA = 0.05, 0.29, $\chi^2 = 3.95$, $p = 0.05$, CFI = 0.97).

Figure 9. Path analysis testing social learning theory mechanisms for the relation between parental chronic pain status and adolescent daily pain severity



Note. Each path labeled with coefficient estimate (standard error). Black solid lines indicate significant direct paths ($p < .05$). Grey dotted lines indicate non-significant paths ($p > .05$). Error variances are as follows: $e_{\text{painbeh}} = 68.04 (6.01)$, $e_{\text{solicit}} = 0.62 (0.06)$, $e_{\text{painthreat}} = 0.69 (0.07)$, $e_{\text{painseverity}} = 2.82(0.31)$.

Figure 10. Path analysis testing social learning theory mechanisms for the relation between parental chronic pain status and adolescent daily functional impairment



Note. Each path labeled with coefficient estimate (standard error). Black solid lines indicate significant direct paths ($p < .05$). Grey dotted lines indicate non-significant paths ($p > .05$). Error variances are as follows: $e_{\text{painbeh}} = 68.04 (6.01)$, $e_{\text{solicit}} = 0.62 (0.06)$, $e_{\text{painthreat}} = 0.69 (0.07)$, $e_{\text{impairment}} = 0.58(0.06)$

CHAPTER IV

DISCUSSION

This study of adolescent patients with functional abdominal pain, for the first time, evaluated adolescents' observations of parental pain behavior and parental reinforcement as prospective predictors of daily pain severity and daily functional impairment over a 7-day online pain diary. The findings make three important contributions to our understanding of social learning in pediatric chronic pain. First, assuming parental modeling of pain behavior based on the presence of parental chronic pain misses important information regarding specific pain behaviors parents display that adolescents can observe and learn. Second, parents' pain behavior and reinforcement of adolescents' pain at baseline prospectively predicted adolescents' subsequent average daily pain severity and average daily functional impairment over a 7-day online pain diary. Third, the present study incorporated adolescents' cognitive appraisal of pain threat as a proximal outcome in social learning pathways, addressing an important aspect of Bandura's social learning theory that is often overlooked in pediatric pain research.

Parental Modeling of Pain Behavior

The first aim of our study was to examine the effects of parental modeling of pain behaviors reported during adolescents' initial clinic visit on adolescents' daily pain severity and daily functional impairment over a subsequent 7-day online diary period. This study expanded upon prior literature by assessing not only parental chronic pain status but also the frequency of parent pain behavior based on both parent self-report and adolescents' proxy-report of their

observations of parent pain behavior. Parent self-reported pain behaviors, above and beyond whether or not the parent had chronic pain, significantly predicted adolescents' daily pain severity, but not adolescent daily functional impairment, over the following week.

To our knowledge, this study is the first to assess both parental self-reported pain behaviors and adolescent's observations of parent pain behaviors. Adolescents' observations of parent pain behavior and parent self-reported pain behavior, exhibited similar correlations with adolescents' subsequent average daily pain severity and functional impairment over the 7-day diary period. However, adolescents who reported a high frequency of parent pain behaviors did not experience greater subsequent average daily pain severity and functional impairment when parents also self-reported a high frequency of pain behaviors. Although parent self-reported and adolescent observations of parent pain behaviors exhibit a moderate degree of agreement (Stone & Walker, 2017), these two informants may capture different perspectives and associate with different adolescent pain outcomes. For example, adolescent observations of parent pain behavior may more closely reflect observational learning and in turn, exhibit a stronger relation to functional impairment than to pain severity. Indeed, functional impairment, in contrast to pain severity, has been conceptualized as a learned behavior in response to pain (Asmundson, Noel, Petter, & Parkerson, 2012). Researchers have contended that psychosocial interventions for pediatric chronic pain lead to reductions in functional impairment before or in the absence of changes in pain severity (Lynch-Jordan et al., 2014). On the other hand, it is plausible that parents' self-reported pain behaviors reflect parents' internal appraisals of their own pain severity and the correspondence between parents' self-reported pain behavior and adolescent pain severity reflects genetic mechanisms.

Parent Reinforcement of Adolescent Pain

The second aim of our study examined whether parent self-reported and adolescent observations of parent solicitous and protective responses to adolescent pain during the initial

clinic visit predicted adolescent's daily pain severity and daily functional impairment over the subsequent 7-day online diary period. As hypothesized, adolescents whose parents self-reported more frequent solicitous and protective responses at the clinic visit experienced greater daily pain severity and functional impairment over the diary period. This is consistent with previous studies conducted in pediatric FAP samples and pediatric non-abdominal chronic pain samples which have found a positive association between parental protective and solicitous responses to adolescent pain and adolescent pain severity and functional impairment (Claar et al., 2008; Guite, McCue, Sherker, Sherry, & Rose, 2011; Van Slyke & Walker, 2006).

This study furthered the literature on parent protective and solicitous responses to adolescents' pain by assessing adolescent observations of these parental responses. Consistent with our exploratory hypothesis, adolescents reported more severe pain over the 7-day diary period when both the adolescent observed and the parent self-reported more frequent solicitous responses to adolescent pain during the clinic visit. For parental solicitous responses, adolescents' awareness of these parental responses strengthened the relation between parental solicitousness and adolescent pain severity, but this same effect was not found for adolescent functional impairment.

A different pattern emerged for parental protective responses to adolescent pain. Adolescent observation of parent protectiveness predicted adolescent functional impairment above and beyond parent self-reported protectiveness. Neither parent self-reported nor adolescent observations of parent protectiveness significantly predicted adolescent pain severity. It is plausible that adolescents who self-report greater functional impairment in response to pain (e.g., staying home from school or social activities) would be more likely to endorse that parents engage in protective responses based on their own beliefs. Observational studies are needed to determine the extent to which adolescents' observations of parent protectiveness truly reflect parent behaviors versus adolescents' own beliefs.

Parental solicitousness and parental protectiveness likely serve different functions. Parental protectiveness fits well within the fear-avoidance model of pain (Asmundson et al., 2012). According to this model, parents who perceive pain as a significant threat to their child engage in behaviors to protect their child from potential harm. Indeed, prior research has shown that parental protective responses to adolescents' pain are related to parents' own fear-avoidance beliefs (Wilson, Lewandowski, & Palermo, 2011). On the other hand, parental solicitousness could be interpreted either within the traditional operant reinforcement framework or conceptualized as a means by which parents try to build relational closeness with their child. In the literature on spousal responses to pain, solicitousness has been conceptualized in terms of the interpersonal process model of intimacy (Cano & Williams, 2010) where spousal attempts to give special attention to their significant others' pain function as a means of expressing empathy and building intimacy. As adolescence marks a transition towards greater child autonomy, decreased parent-child closeness, and increases in parent-child conflict (Steinberg & Morris, 2001), parents may engage in behaviors to try to maintain closeness with their child, particularly when they perceive their child is in pain.

Parents with chronic pain were more likely to report solicitous responses, but not protective responses, to their children's pain. The finding that parents with chronic pain were more likely to report solicitous responses is similar to the finding by Wilson and Fales (2015) that parents with chronic pain, compared to a healthy parent control group, engaged in more attentive responses to their children's pain. However, our finding differs in that the present study examined solicitousness and protectiveness as two separate constructs, while the Wilson and Fales study utilized the original ARCS protect subscale which included items assessing both protectiveness and solicitousness. Alternatively, Langer and colleagues (2007) found that parents with IBS were not more likely to engage in protective responses to children's pain; similar to the Wilson and Fales study, Langer and colleagues utilized the original ARCS protect scale. Thus, the literature on whether parents with chronic pain engage in more solicitous or

protective responses to children's pain has been mixed. Theoretically, parents with chronic pain may engage in more solicitous responses to adolescents' pain either due to parents' beliefs that pain represents a significant threat that necessitates special attention or due to parents' empathy towards adolescents' pain that prompts a bid for closeness. If parents with chronic pain were more likely to report solicitous responses due to beliefs that pain is a threat that demands attention, one would expect parents with chronic pain to also engage in more protective responses. Thus, it may be more plausible that parents with chronic pain, due to their own experiences with pain, experience a high level of empathy for adolescents' pain and engage in solicitous responses in order to build relational closeness. However, the motivations and goals driving parental responses to adolescents' pain have not been studied and these conclusions must be interpreted with caution.

Testing Social Learning Pathways in the Intergenerational Transmission of Risk for Pain and Functional Impairment

Parental modeling of pain behaviors, compared to parental reinforcement of adolescents' pain behaviors, appears to exhibit a stronger relation to adolescents' pain severity and impairment in the context of parental chronic pain. Although parents with chronic pain were more likely to report solicitous responses to adolescents' pain, parental solicitousness did not significantly relate to adolescents' pain threat appraisals, pain severity, or functional impairment in the test of the SLT model that included parent modeling of pain behaviors. Although parent protective and solicitous responses to children's pain have consistently been associated with increased pain and functional impairment in the literature (Chow et al., 2016; Claar et al., 2008; Connelly, Bromberg, Anthony, Gil, & Schanberg, 2016; Guite et al., 2011; Sieberg et al., 2011; Vowles et al., 2010; Welkom, Hwang, & Guite, 2013), the influence of parental responses on adolescents' pain may be a mechanism driving increased pain and functional impairment in adolescents independent from the relation between parent and child chronic pain. This is

consistent with Levy and colleagues (2004) which found that the impact of parental IBS and the impact of parental solicitousness on children's gastrointestinal symptoms were distinct. The present study extends these findings by examining the differential impact of these two pathways in a clinical sample of youth with FAP, specifically measuring parent pain behaviors in addition to chronic pain status, and incorporating the role of adolescents' cognitive appraisals.

The test of our SLT model suggests that adolescents' interpretations and appraisals of pain may account in part for the relation between parental modeling of pain behavior and adolescents' own pain behavior. Both adolescents' observations of parent pain behavior and parents' self-reported pain behavior exhibited significant relations with adolescents' pain severity and functional impairment through adolescents' pain threat appraisals. The incorporation of adolescents' pain appraisals into the evaluation of observational learning of parent pain behavior is novel. The incorporation of appraisal is supported by Bandura's SLT (1977) and social learning models of fear acquisition (Olsson & Phelps, 2007). Utilizing this framework, a parent's behavior (e.g., activity avoidance) in response to an event (e.g., parent experience of pain) may serve as an unconditioned stimulus that elicits a similar conditioned response (e.g., activity avoidance) in the child when paired with a similar event (e.g., child experience of pain). These external cues and behaviors exhibited by the parent are meant to alert the receiver, in this case, the child, about potential danger. Thus, the child's encoding and attribution of the parent's pain behavior to mean that pain is threatening ultimately motivates the child to respond similarly to a potentially painful situation.

Prior pediatric pain research has inferred observational learning of pain behavior based on the high rate of chronic pain within families or clustering of health care seeking behaviors for pain within families (Kashikar-Zuck et al., 2008; Levy et al., 2004; Schanberg et al., 2001; van Tilburg et al., 2015) without specifically addressing children's attention toward and encoding of specific pain behaviors. The present study advanced the literature in that it incorporated children's encoding of parents' modeled behaviors by assessing their observations of parent

pain behaviors and their appraisal of pain threat. The indirect pathway between parent pain behavior and adolescents' daily pain severity and daily functional impairment through adolescent pain threat appraisal remained significant regardless of whether parent pain behavior was reported by adolescent or parent self-report.

Strengths and Limitations

The present study had a number of strengths including the clinical sample of youth with FAP, measurement of both parent self-reported pain behaviors and adolescent proxy-report of parental pain behaviors, use of daily diaries to measure adolescent outcomes, and utilizing a theoretical framework to guide the formulation of the tested model. The social learning pathways tested in this model were theoretically driven and mapped onto the proposed integrative conceptual model for the transmission of risk for chronic pain from parents to offspring (Stone & Wilson, 2016). Indeed, the present model tested parental chronic pain as a major risk factor operating through two plausible social learning mechanisms (parental modeling and parental reinforcement) which may contribute to children's vulnerabilities (e.g., pain threat appraisals) to influence children's outcomes (pain severity and disability).

However, it is important to note a few limitations regarding the interpretability and generalization of the present findings. A high proportion of parents in the present study (76.6%) reported chronic pain within the past three months which could have limited variability within the tested model. Parents in the study were predominantly mothers and thus effects may be specific to maternal chronic pain. The present study focused on social learning mechanisms as possible explanations for the relation between parent and child pain, but this relationship is likely a complex representation of biopsychosocial factors. Genetic factors could account for up to 50% of the variance in chronic pain and may contribute to both the affective and sensory experience of pain (Diatchenko, Fillingim, Smith, & Maixner, 2013). Additionally, aside from adolescent pain severity and functional impairment assessed with a daily diary, the majority of

the measures collected in this study were collected at the same time point. Thus, temporal effects cannot be determined from the present study. However, observational learning of pain behaviors likely emerges throughout development and the present study represents a snapshot of processes that have been in effect for years prior to adolescents' development of chronic pain. It is also possible that adolescents' chronic pain behaviors affect parents' pain behaviors, but this has not been studied.

Implications and Future Directions

Social learning theory has guided the development of interventions which target parents of children with FAP and have resulted in modest reductions in parent-reported solicitousness and children's pain (Levy et al., 2010). These cognitive-behavioral interventions include modules focused both on parental modeling and parental solicitousness (Levy et al., 2010; Palermo et al., 2009). However, these interventions have exclusively measured parental reinforcement as a treatment mechanism without measuring parental modeling of pain behavior. Given that parental modeling and parental solicitousness may have differential impact on children's symptoms (Levy et al., 2004), measuring both will be essential for determining the efficacy of interventions on social learning mechanisms. In clinical populations of children with chronic pain where a significant proportion of parents have chronic pain, greater emphasis on parental modeling of pain behaviors may yield greater reductions in children's symptoms.

To further test the proposed model, that adolescents' pain appraisals mediate the relation between parental pain behaviors and adolescents' pain and functional impairment, both intervention studies and longitudinal, translational studies are needed to determine the timing of effects. Intervention studies targeted at reducing adolescent pain threat appraisals could measure whether reductions in adolescent pain threat decouples the relation between parental pain behaviors and adolescent pain and functional impairment. Longitudinal studies are needed both to determine temporal effects and to test dyadic interactions between parent and child pain

and pain behaviors. For example, advanced statistical techniques such as actor-partner interdependence models (APIM; Cook & Kenny, 2005) could examine the differential effects of adolescent pain behavior and parent pain behavior at time 1 on adolescent pain behavior and parent pain behavior at time 2. Using the APIM framework, one can separate out the *actor* effects, or the impact of adolescent pain behavior at time 1 on their own pain behavior at time 2, from *partner* effects, or the impact of adolescent pain behavior at time 1 on parent pain behavior at time 2. These types of sequential, bidirectional analyses will be essential for furthering the field's understanding of the timing of social learning mechanisms.

A number of cognitive behavioral therapy trials for pediatric chronic pain have resulted in moderate reductions in adolescent pain and functional impairment (Fisher et al., 2014). However, the effects of these interventions rarely continue to show improvement at follow-up intervals between three and twelve months post-intervention (Eccleston et al., 2014). Children who achieve improvements in pain and functional impairment through individual psychotherapy who have parents with chronic pain who continue to model frequent maladaptive pain behaviors may have more difficulty responding to treatment and maintaining treatment gains. One could hypothesize that this could be due to continued modeling and signaling from parents that pain represents a significant threat which demands attention in the face of opposite messages conveyed by psychotherapeutic interventions for chronic pain. In treatment studies of youth psychopathology, higher levels of maternal depressive symptoms have been associated with poorer response to cognitive behavioral therapy in their children (Southam-Gerow, Kendall, & Weersing, 2001); similarly, it is plausible that parental chronic pain could impact the extent to which their children respond to interventions. Future research incorporating more active parental intervention focused on parents' own pain beliefs and behaviors in addition to how parents communicate about pain to their children could test these hypotheses.

The ultimate goal of examining mechanisms of the transmission of risk for pain and functional impairment from parents with chronic pain to their children is to develop novel targets

for intervention and prevention efforts. The present study focused on a clinical sample of youth with chronic pain for whom these intergenerational mechanisms may have played a role in both the development of their pain and in the risk for chronic pain maintenance. However, similar mechanisms may also be present in children of parents with chronic pain who have yet to develop chronic pain or pain-related functional impairment. Research extending the present study to at-risk youth of parents with chronic pain could yield targets for preventive interventions. Additionally, understanding individual differences in children of parents with chronic pain who observe frequent parental pain behaviors, but do not develop pediatric chronic pain or functional impairment, could further identify targets for prevention and intervention efforts. Identifying and studying mechanisms of increased risk for pain and functional impairment in children of parents with chronic pain ultimately could lead to interventions which could lead to decreased health costs and improved functioning and quality of life in families with chronic pain. Based on the present study, parental modeling of pain behaviors represents a potentially promising target for family based interventions to prevent or ameliorate pediatric chronic pain.

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APPENDIX 1

Parent Pain Behavior-Proxy

Please respond to each item by circling one option per row.

In the past 7 days, did your mother/father have pain? Yes No*

In the past 7 days...

When my mother/father was in pain she/he became irritable	Never (2)	Rarely (3)	Sometimes (4)	Often (5)	Always (6)
When my mother/father was in pain she/he grimaced	Never (2)	Rarely (3)	Sometimes (4)	Often (5)	Always (6)
When my mother/father was in pain she/he moved extremely slowly	Never (2)	Rarely (3)	Sometimes (4)	Often (5)	Always (6)
When my mother/father was in pain she/he moved stiffly	Never (2)	Rarely (3)	Sometimes (4)	Often (5)	Always (6)
When my mother/father was in pain she/he called out for someone to help her/him	Never (2)	Rarely (3)	Sometimes (4)	Often (5)	Always (6)
When my mother/father was in pain she/he isolated herself/himself from others	Never (2)	Rarely (3)	Sometimes (4)	Often (5)	Always (6)
When my mother/father was in pain she/he thrashed (tossed and turned**)	Never (2)	Rarely (3)	Sometimes (4)	Often (5)	Always (6)

Notes. *If child selects no, discontinue measure. “Had no Pain” equals 1 point for each item so the child is then assigned a score of 7 for the measure sum score.

** “Tossed and turned” did not appear in the original administered measure, but has been added as an alternative definition based on participant feedback.

Reference: Stone, A.L. & Walker, L.S. (2017). Adolescents' observations of parent pain behaviors: Preliminary measure validation and test of social learning theory in pediatric chronic pain. *Journal of Pediatric Psychology*, 42(1), 65-74. doi: 10.1093/jpepsy/jsw038

APPENDIX 2

**ADULT RESPONSES TO CHILDREN'S SYMPTOMS (ARCS) – Adolescent Short-Form
Adolescent Report on Parent**

What happens when you are sick?

The next questions are about what your mother does when you have a stomachache. For each question, choose one of the answers:

- | | |
|-----------------|--|
| Never | means that she never does this. |
| Once in a while | means that she only does this once in a while. |
| Sometimes | means that she does this some of the time. |
| Often | means that she usually does this. |
| Always | means that she always does this. |

When you have stomachaches, how often does your parent . . .

	<u>Never</u>	<u>Once in a while</u>	<u>Some- times</u>	<u>Often</u>	<u>Always</u>
1. Do your chores or pick up your things instead of making you do it?	0	1	2	3	4
2. Talk to you about something else to take your mind off it?	0	1	2	3	4
3. Bring you special treats or little gifts?	0	1	2	3	4
4. Let you stay home from school?	0	1	2	3	4
5. Encourage you to do something you enjoy (like watch TV or play a game)?	0	1	2	3	4
6. Give you special privileges?	0	1	2	3	4
7. Stay home from work or come home early (or stay home instead of going out or running errands)?	0	1	2	3	4
8. Tell others in the family not to bother you or to be especially nice to you?	0	1	2	3	4
9. Let you sleep later than usual in the morning?	0	1	2	3	4
10. Try to involve you in some activity?	0	1	2	3	4